Ostracoda from Subsurface Sediments of Karimata Strait as Indicator of Environmental Changes

Ostracoda dari Sedimen Bawah Permukaan Selat Karimata sebagai Indikator Perubahan Lingkungan

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ABSTRACT: Karimata Strait is a part of Sunda Shelf connected South China Sea with Malacca Strait, Indian Ocean and Java Sea. This shelf was a large Sunda Land that has been detected by many evidences as records of various paleo-environments. The purpose of this study is to recognize the characteristic community of ostracoda related to the environmental history of this shelf. Three selected cores sediments represented east (A), middle (B) and west (C) parts of Karimata Strait were used for Ostracoda based on standard method on micropaleontology. Additional method was applied of SEM-EDX analysis to abnormal specimens. The result shows that there are 43 species of ostracoda belonging to 34 genera identified in the study area. The highest number of ostracoda is found in Core B, in the middle part of the strait, and the lowest value belongs to the Core A that close to the land of Kalimantan. Several genera of Ostracoda were documented in all cores: *Actinocythereis, Cytherella, Cytherelloidea, Keijia, Keijella, Hemicytheridea, Hemikrithe, Neocytheretta, Neomonoceratina, Loxoconcha, Pistocythereis, Stigmatocythere* and *Xestoleberis.* Vertically, ostracoda are mostly found in the upper part of the cores and decrease or disappear in the lower part of Cores A and C where dominated by black organic materials. It may relate to a wide swampy area before the last sea level rise as part of the history of the SundaShelf about 15,000 years ago. Some major elements (C, CaO, Al_2O_3, FeO, SiO_2, MgOdan SO_3) covered or filled abnormal specimens that can provide additional information about environmental changes in the study area, such as Carbon may relate to charcoal from land of Kalimatan and Sumatera

Keywords: Ostracoda, subsurface sediment, EDX, environmental changes, Karimata Strait

ABSTRAK : *Selat Karimata merupakan bagian dari Paparan Sunda menghubungkan Laut China Selatan dengan Selat Malaka, Samudera Hindia, dan Laut Jawa. Paparan ini merupakan sebuah Dataran Sunda yang luas yang terdeteksi dari bukti-bukti sebagai rekaman berbagai lingkungan purba.Tujuan dari studi ini adalah untuk mengetahui karakteristik komunitas ostracoda berkaitan dengan sejarah lingkungan paparan ini. Terpilih tiga sedimen pemercontoh inti mewakili bagian timur (A), tengah (B) dan barat (C) Selat Karimata digunakan untuk studi Ostracoda berdasarkan metoda standar pada mikropaleontologi. Metoda tambahan adalah aplikasi SEM-EDX terhadap spesimen abnormal. Hasil menunjukkan bahwa di daerah penelitian teridentifikasi 43 spesies ostracoda termasuk dalam 34 genera. Jumlah ostracoda tertinggi ditemukan di Core B dari bagian tengah selat dan terendah di Core A yang berdekatan dengan daratan Kalimantan. Beberapa genera ostracoda ditemukan di semua sampel: Actinocythereis, Cytherella, Cytherelloidea, Keijia, Keijella, Hemicytheridea, Hemikrithe, Neocytheretta, Neomonoceratina, Loxoconcha, Pistocythereis, Stigmatocythere dan Xestoleberis. Secara vertikal, ostracoda umumnya ditemukan di bagian atas dari core dan menurun atau menghilang di bagian bawah Core A dan C yang di dominasi oleh material organik berwarna hitam. Hal ini kemungkinan berkaitan dengan daerah rawa yang luas dan sebelum muka laut naik terakhir pada sejarah Paparan Sunda sekitar 15.000 tahun yang lalu. Beberapa zat kimia (C, CaO,* Al_2O_3*, FeO,* SiO_2*, MgO dan* SO_3*) menutupi atau mengisi spesimen abnormal dapat memberi informasi tambahan tentang perubahan lingkungan di daerah penelitian, seperti karbon mungkin berkaitan dengan arang dari daratan Kalimantan dan Sumatera.*

Kata kunci: *Ostracoda, sedimen bawah dasar laut, EDX, perubahan lingkungan, Selat Karimata*

INTRODUCTION

Ostracoda is a meiobenthic Crustacean that have been used as indicator of (paleo) environmental changes in the world. Soter et al., (2001) used ostracoda and foraminifera for reconstructing environmental changes in Halike (Greece) which disappeared due to earthquake in 373BC. Then, Yasuhara and Yamazaki (2005) found the decreasing of ostracode assemblage up to 90% in Osaka Bay in between 1910-1920 to 1960-1970. This change was related to increasing of industrial activities rapidly in that area. In Indonesia, ostracoda from subsurface marine sediment were also studied by Dewi (1997) and Fauzielly et al (2013) from off Bawean Island and the Jakarta Bay, respectively. Their results stated that the variation of ostracode assemblage and certain species of ostracodacan be used as markers of environmental changes in these areas. Based on these good results, the similar study will be applied to another area of Indonesia, such as Karimata Strait. The purpose of the present study isto describe the vertical distribution of ostracoda from Karimata Strait related to environmental changes.

This Strait of Karimata is located in the southern part of South China Sea between Kalimantan and Sumatera as part of the Sunda Shelf. The exposure of the SundaShelf, particularly in the southern of South China Sea, was showed by increasing terrigenous input to the basin when sea level was -120 m lower at the last glacial maximum (Schonfeld and Kudrass, 1993 in Steinke et al, 2003). According to Steinke et al (2005), based on sedimentological and geochemical variability during 20,000 years ago, there were five stages of depositional changes detected in the northern part of Sunda shelf: a) stage 1 (ca20-16.5 ka) when sea-level lowstand, b) stage 2 (16.5-14.5ka), it was characterized by decreasing clay and terrigenous organic materials and trapped in surrounding the river mouths c) stage 3 (14-8.5 ka) when an abrupt change in sedimentation and flooding and d) stage 4 (8.5 – 6 ka) as the final change of coastline and stage 5 (8.5 to 0 ka) the establishmentof almost modern sedimentary conditions

Ostracoda from surface sediment of Karimata Strait has been studied by Mostafawi (1992), therefore another aim of this study is to complete this previous study on ostracoda from surface sediments between Kalimantan and Sumatera.

METHODS

This study used three selected short core sediment samples that were collected by R/V Geomarin 1 in between 1994 and 2004. They were collected during marine geological and geophysical surveys of Marine Geological Institute. The sample locations were represented eastern (A), middle (B) and western parts (C) of the study area (Figure 1): A (01^{o}24' 59" 109^{o}49' 54"; water depth 12 m;132 cm length of sediment); B (01^{o}25' 00" 105^{o} 14' 59"; 27 m water depth, 82cm) and

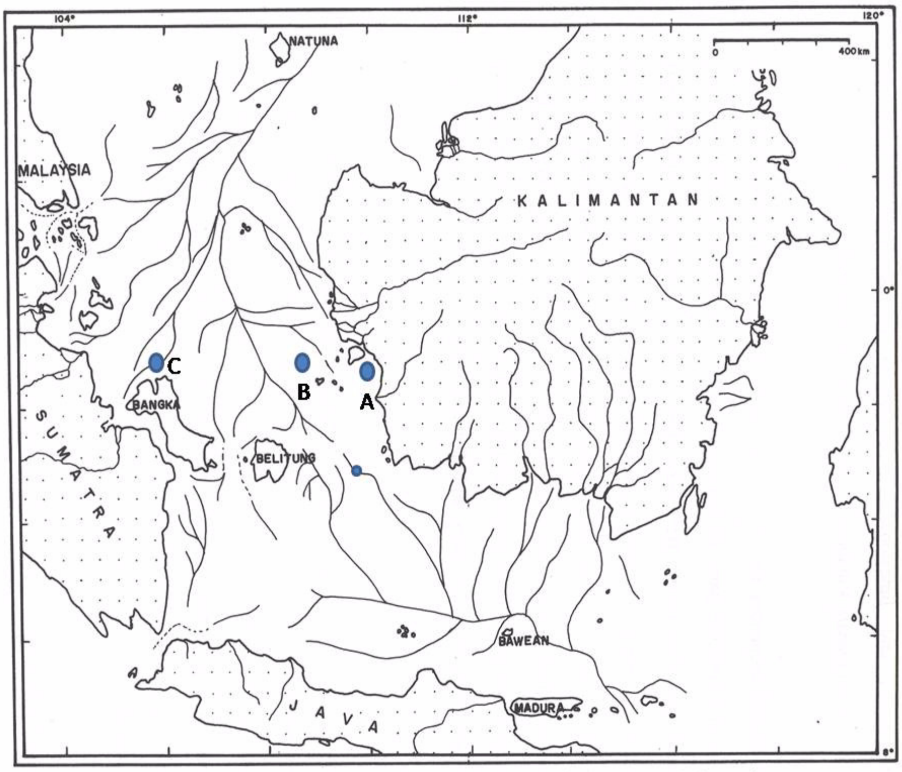

Figure 1 Location of three core samples and system of drowned Sunda River interpreted by Kuenen (1950 in Dewi, 1997))

C (01^o 29' 12" 104^o 45' 02"; water depth 11 m; 112cm length).

In the laboratory, half part of three core sediment samples were then sliced at 10 cm depth interval and divided into two parts for grain size and micro faunal analyses (ostracoda and foraminifera). A total of 35 subsamples were subjected to grain size analysis using standardized procedures of Folk (1980). The sand fraction was sieved and the mud fraction was analyzed using the pipette method. The 35 micro faunal subsamples were washed through a 63-?m sieve then dried in an oven. The ostracode analysis started by picking, identification and counting of specimens under a binocular microscope. Identification based on previous works such of Whatley and Zhao (1987 and 1988), Zhao and Wang (1988); Mostafawi (1992), Yassini and Jones (1994) and Dewi (1997). Microfaunal data processing used software package PAST (**PA**leontological **ST**atistics; Hammer et al., (2001) to recognize community structure of ostracoda such as species richness (S), Shannon index (H), Dominance (D), and Evenness (E) and cluster analysis. Selected ostracod specimens were documented by using *NIST Element* that connected with a camera. About 1-5 mg black sediment sample from Core C at 70 cm below sea floor was prepared for ^{14}C dating analyses at the Australian National University, Australia.

Furthermore, five abnormal specimens of micro fauna were selected to be analyzed by using EDX (*Scanning Electron Microscope-Energy Dispersive X-ray spectroscopy*) in Quaternary Laboratory, Center of Geological Survey to recognize their chemical compositions.

RESULT

In the study area of Karimata Strait, it can be identified 43 species of ostracoda belonging to 34 genera. Their distribution and abundance are grouped at generic level as seen at Table 1. The highest number of ostracoda is found in Core B, in the middle part of the strait, and the lowest value belongs to the Core A that close to the land of Kalimantan. There are several genera of ostracoda that distribute in all sample studied: *Actinocythereis, Cytherella, Cytherelloidea, Keijia, Keijella, Hemicytheridea, Hemikrithe, Neocytheretta, Neomonoceratina, Loxoconcha, Pistocythereis, Stigmatocythere*and*Xestoleberis.* Several genera of ostracoda were documented by using Scanning electron Microscope (SEM) that appears in Plate 1, especially number 2 and might be a new species of *Paijenborchella* that was not found in previous study of Mostafawi.

Vertically, the distribution of ostracoda has similarity among the three sites that mostly occurs in upper part of the cores between 0 and 70 cm below seafloor. The distribution of ostracoda from this core is tabulated in Tables1, 2, and 3.

Core A was collected in the offshore area of Kalimantan and divided into 14 subsamples from 0 cm to 130 cm down core. There are six teen genera of ostracoda identified with the number of specimen between 1 and 51. The maximum number is found at interval 20-22 cm continuous to interval 30-32 cm below seafloor. Generally, ostracodais only found abundantly from 0 to 30 cm and it tends to decrease or disappear from 40 cm to 130 cm below seafloor. Typical ostracod species from this core are: *Hemicytherideareticulata, Actinocythereisscutigera, Loxoconcha*sp.*, Neocytherettavandijki, Neomonoceratinabataviana*, and *Stigmatocythererugosa.* The first species is found abundantly at interval 20-22 cm below seafloor. Based on microscopic description of sedimentary particles, the subsamples from 60 cm to 100 cm are mostly composed of blackish particles and white chalky materials, whereas at intervals 110 to the bottom part (130 cm) are characterized by quartz sands and few organic materials (Figure 2). Sediment types of this core mostly composed of silt and some parts are silty sand.

Core B was collected in the middle part of the study area and divided into nine sediment subsamples from 0 to 80 cm below seafloor. It was identified 29 genera of ostracoda and they are found at all subsamples throughout the core (Table 2). Their occurrences differ to ostracoda from Core A that occurs only in the upper part of the core. Total number of specimen is mostly more than 150 specimens. The very dominant species is *Phlyctenophoraorientalis* that can reach 69 specimens at interval 30-32 cm below seafloor. *Pistocythereiscribriformis, Neomonoceratinabataviana*, and *Actinocythereisscutigera* are also found slightly abundant throughout the core studied. Several ostracod species are found very rare (one specimen) to rare (less than 5 specimens) such as *Alataconchapterogona, Stigmatocythererugosa, Bairdopillata*sp.*,* and *Tanellagracilis.* The sediment particles composed of organic materials of foraminifera, ostracoda, mollusks, rubble corals, and other components (Figure 3). Sediment types of this core are all samples composed of silty sand from top part down to the bottom part.

Core C was sampled in the western part of Karimata Strait that is close to northern part of Bangka Island. From 13 subsamples of this core, it has been identified 32 genera of ostracoda (Table 3). They are mostly distributed in two groups: at intervals 0-20 cm and 40-60 cm below seafloor. In between this intervals, at interval 30-32 cm, ostracoda is found very rarely (*Parakrithe* and *Stigmatocythere)* among black organic particles (Figure 4). The subsamples below 60 cm down

Table 1. Ostracoda distribution from Core A

No	Ostracoda	Depth of subsamples below seafloor (cm)													
	Core A	0-2	10-12	20-22	30-32	40-42	50-52	60-62	70-72	80-82	90-92	100-102	110-112	120-122	130-132
1	*Actinocythereis*	2	3	3	6						1				
2	*Atjehella*	1			2										
3	*Cornucoquimba*			1	1										
4	*Cushmanidae*			1											
5	*Cytherella*	4		2			1								
6	*Cytherelloidea*			1	2										
7	*Eucytherura*			1	1										
8	*Hemicytheridea*	1	10	22	4										
9	*Keijella*	1													
10	*Keijia*	1													
11	*Loxoconcha*	5	4	6	3										1
12	*Neocytheretta*	1	1	7	2										
13	*Neomonoceratina*	2	1	1	5										
14	*Pistocythereis*				2	1	1								
15	*Stigmatocythere*	3	2	5	3										
16	*Xestoleberis*			1											

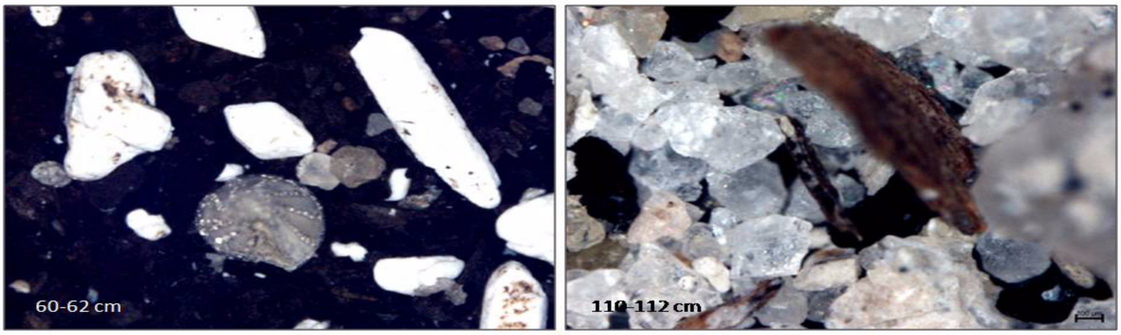

Figure 2 Sedimentary particles from Core A at certain intervals: 60-62 cm (left) and 110-112 cm (right) below seafloor

core, the ostracoda tends to decrease gradually and it disappears at 70 cm below seafloor. At the first interval in upper part of the core, ostracoda composes of 29 genera of ostracoda dominated by *Cytherelloidea, Foveloleberis* and *Neomonoceratina*. The second interval is characterized by *Cytherelloidea, Foveoleberis, Keijella, Keijia, Neocytheretta, Neomonoceratina*, and *Semicytherura.* In general, ostracoda from this core C is slightly similar with Core A that ostracoda decreases or disappear started certain at intervals. The differentiation is that the low occurrences of ostracoda are found twice at this core. Sediment types of this core are various and composed of muddy silt, silty sand, sandy silt, and silt

The calculation of diversity index (H'), evenness (E') and dominance (D) shows that samples with few specimens could not be calculated as seen at Table 2. The values of H' are varies between 0.69 and 3.04, the value H' < 1 or low diversity is only found in Core B at interval 30-32 cm below seafloor. Diversity indices provide important information about rarity and commonness of species in a community. Most subsamples lie in stable environments by indicating values of H' between one and three.

The evenness values identify the individual equivalent among species in one community. In the study area, the values of E are between 0.51 and 1. The group of 0.4 < e < 0.6 or medium scale is only found at three subsamples that indicate there is a certain dominant species in a particular sample: Core A (20 cm below seafloor) is dominated by *Hemicytheridea reticulate* and Core B (at intervals 30 and 70 cm) are dominated by *Phlyctenophorazealandica.* Most subsamples have values E more than 0.6 or high evenness that indicate every species/genus occur almost at the same number or equal. The dominance index in

Table 2 Ostracoda distribution from Core B

No	Ostracoda	Depth of subsamples below seafloor (cm)								
	Core B	0-2	10-12	20-22	30-32	40-42	50-52	60-62	70-72	80-82
1	*Actinocythereis*	4	16	17	10	17	11	10	27	8
2	*Alatoconcha*		1							
3	*Alocopocythere*	4								
4	*Argilloecia*	13	8	27	9	32	11	22	5	8
5	*Atjehella*	3	2	16	5	4	13	16	8	9
6	*Bairdia*		1		1					
7	*Cornucoquimba*	6	14	4	2	10	4	5	1	8
8	*Cushmanidea*	2	7	1	12	11	16	12	11	8
9	*Cytherella*		3	6	10	2	9	9	5	2
10	*Cytherelloidea*	1	6	7	5	8	6	9	7	5
11	*Cytheropteron*	2	4	13		7	3		3	7
12	*Foveoleberis*	6	10	11	11	10	8	11	13	22
13	*Hemicytheridea*	5	3	2	2	6	2	10	8	7
14	*Hemikrithe*	3	4	1	1	8	12	4	16	4
15	*Keijella*	3	2	6	2		2	5	1	3
16	*Keijia*	8	12	16	2	9	4	12	1	16
17	*Loxoconcha*	2	1	11	2	1	1	2		6
18	*Macrocypris*	4	12	15	15	9	17	11	8	10
19	*Neocytheretta*	7	2	10	12	4	10		4	2
20	*Neomonoceratina*	12	11	12	12	11	21	18	13	7
21	*Parakrithe*	2		1				2		
22	*Phlyctecyhere*		1		1	2	1			2
23	*Phlyctenophora*	46	41	51	69	38	28	48	65	23
24	*Pistocythereis*	17	8	18	25	20	20	16	17	8
25	*Pontocypris*		2	1	1					2
26	*Semicytherura*	2		1	1	1	1			1
27	*Spinoceratina*	2						3		
28	*Stigmatocythere*						1			
29	*Tanella*									2
30	*Xestoleberis*	19	11	53	4	10	8	5	3	11

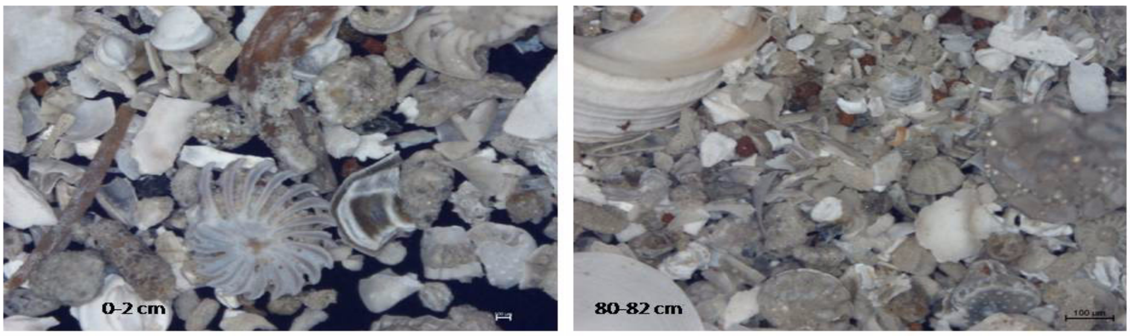

Figure 3. Sedimentary particles from Core B represented at certain intervals: 0-2 cm (left) and 80-82 cm (right) below seafloor

all subsamples is less than 0.5. It means that there is no dominant species found in the study area or in another word the study area is not categorized as stress environments

Based on[14]Carbon dating analysis, it is resulted the age of the selected sample is 15.050±60 BP. The result of SEM-EDX analysis on 5 selected specimens shows that there are seven major elements C, CaO, Al_2O_3, FeO, SiO_2, MgO and SO_3 covered or filled the specimens. The amount of every element is various as follows as seen in Table 4. Carbon (C), Al_2O_3 and Silicon dioxide (SiO_2) are found in all analyzed specimens in more than 40%, 1-2% and 2-20%, respectively. Other elements of CaO, FeO, MgO and SO_3 53 are covered in certain specimens.

Table 3 Ostracoda distribution from Core C

No	Ostracoda	Depth of subsamples below seafloor (cm)											
	Core C	0-2	10-12	20-22	30-32	40-42	50-52	60-62	70-72	80-82	90-92	100-102	110-112
1	*Actinocythereis*	1	7	3		1	2	12	1		1	1	5
2	*Alocopocythere*	13	14					1					6
3	*Atjehella*	5	5	7		2	6	5					
4	*Bairdia*							2					
5	*Baltraella*			1			1	3					
6	*Copytus*			2									
7	*Cornucoquimba*		4	8		3	2	11					
8	*Cushmanidea*	5	4	2		6		8					
9	*Cytherella*	1	3	12		3		6					
10	*Cytherelloidea*	13	19	28		12	8	16					1
11	*Cytheropteron*	7	9	10			1	5					
12	*Foveoleberis*	17	28	20		13	15	11	1				1
13	*Hemicytheridea*						1					1	
14	*Hemikrithe*	1	5	5			3	5					
15	*Keijella*	5	6	5		6	3	13					
16	*Keijia*	4	6	14		1	5	17					
17	*Loxoconcha*			1									
19	*Macrocypris*	1	2	1		4	4	8					
20	*Neocytheretta*	5	14	11		13	12	21					
22	*Neomonoceratina*	10	3	23		10	20	23					1
24	*Pajienborchella*	2	2	2				5					
25	*Parakrithe*	2	5	9	1	2	2	6					
26	*Phlyctenophora*	6	4	10		6	1	7					1
27	*Pistocythereis*	9	17	16		6	5	9					
28	*Pontocypris*					1							
29	*Psammocythere*	2		2				4					
30	*Semicytherura*	2	5	4			2	16					
31	*Stigmatocythere*		3	8	1	1	2	7			1		
32	*Tanella*	2	7	2		1	3	7					
33	*Xestoleberis*	2	2	1			1	1					2

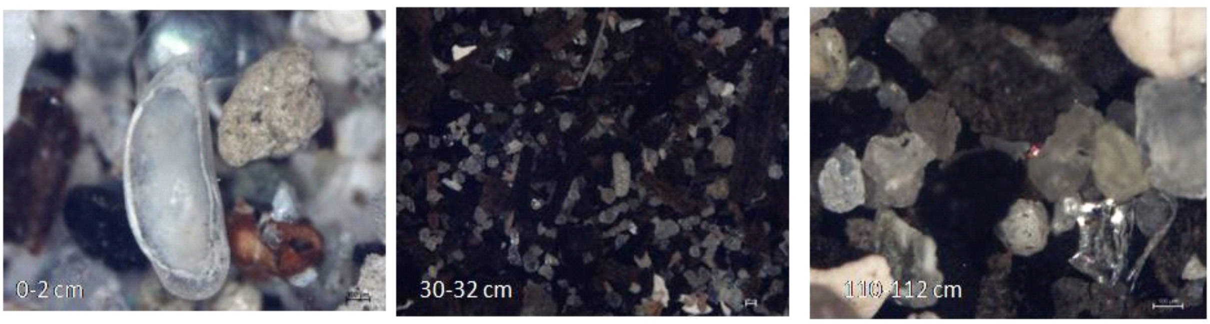

Figure 4. Sedimentary particles from Core C represented at certain intervals: 0-2 cm (left), 30-32 cm (middle) and 110-112 cm (right) below seafloor

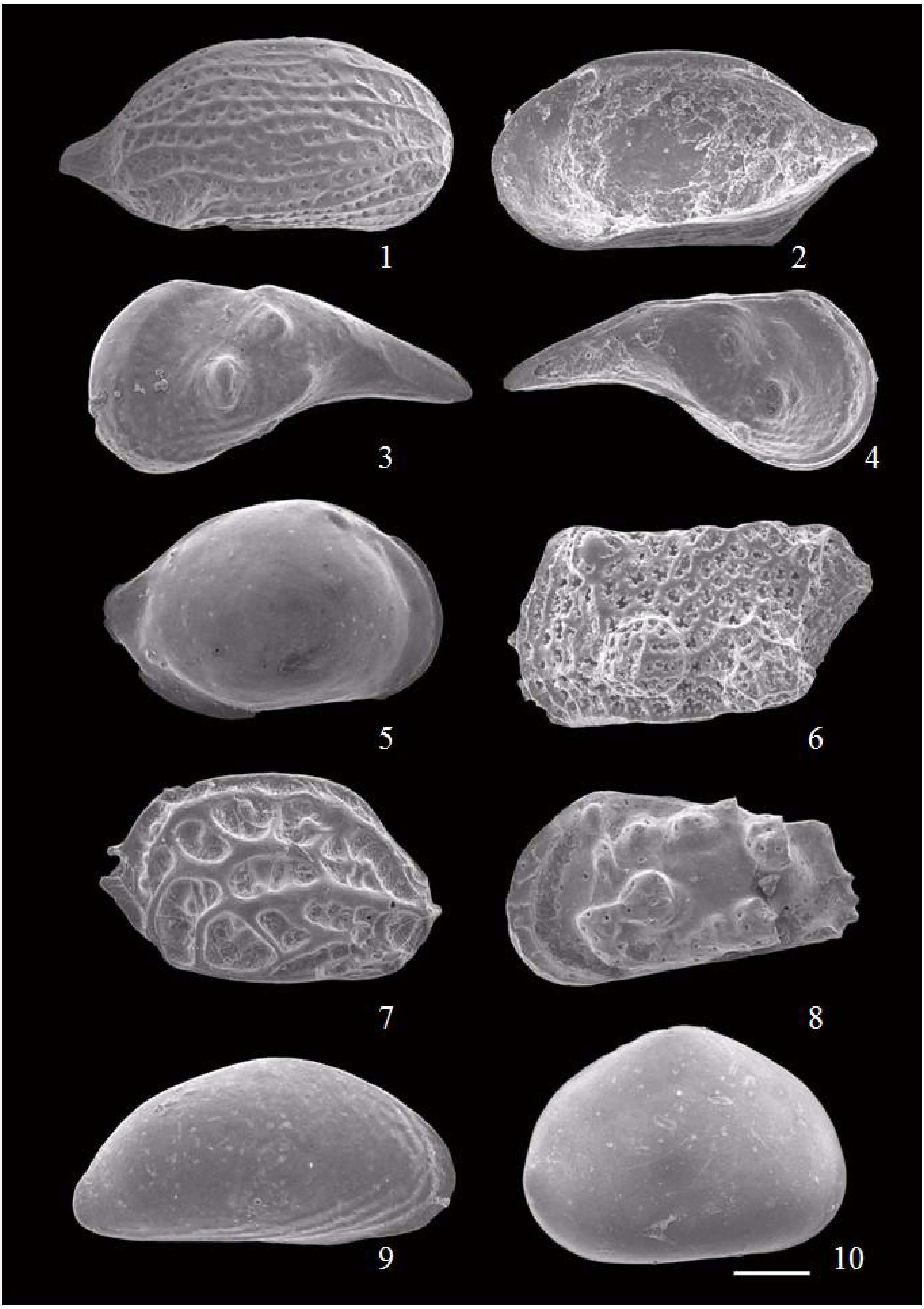

Plate 1. Selected ostracoda represented the study area of Karimata Strait
1 and 2 *Semicytherura* (external and internal views); 3 and 4. *Paijenborchella (*external and internal views); 5. *Phlyctocythere;* 6. *Eucytherur*a; 7. *Mutilus*; 8. *Cornucoquimba;* 9. *Cushmanidea*; 10. *Xestoleberis*.

Table 4 Community structures of ostracoda from three cores of the study area

Core	Community structures	Water depth (cm) below seafloor													
		0 cm	10 cm	20 cm	30 cm	40 cm	50 cm	60 cm	70 cm	80 cm	90 cm	100 cm	110 cm	120 cm	130 cm
A	Taxa (genus)	10	6	12	11	1	2	0	0	0	1	0	0	0	1
	Individuals (specimens)	21	21	51	31	1	2	0	0	0	1	0	0	0	1
	Shannon ('H)	2.11	1.46	1.87	2.26	-	-	-	-	-	-	-	-	-	-
	Evenness (J)	0.82	0.72	0.54	0.87	-	-	-	-	-	-	-	-	-	-
	Dominance (D)	0.14	0.3	0.24	0.12	-	-	-	-	-	-	-	-	-	-
B	Taxa (genus)	22	23	25	2	18	21	26	1	0					
	Individuals (specimens)	143	182	300	214	220	209	228	217	181					
	Shannon ('H)	2.82	2.73	2.65	2.45	2.71	2.81	2.68	2.44	2.92					
	Evenness (J)	0.73	0.64	0.64	0.51	0.72	0.72	0.77	0.57	0.77					
	Dominance (D)	0.07	0.09	0.09	0.14	0.09	0.07	0.09	0.13	0.07					
C	Taxa (genus)	23	24	23	21	23	19	20	24	2	-	2	2	7	
	Individuals (specimens)	143	182	214	220	209	228	217	181	2	-	2	2	17	
	Shannon ('H)	2.82	2.73	2.45	2.71	2.81	2.68	2.44	2.92	-	-	-	-	-	
	Evenness (J)	0.73	0.64	0.51	0.72	0.72	0.77	0.57	0.77	-	-	-	-	-	
	Dominance (D)	0.07	0.09	0.14	0.09	0.07	0.09	0.13	0.07	-	-	-	-	-	

Table 4 Chemical component detected from ostracod shells

Chemical component on microfaunal shells							
Specimens	C	CaO	Al_2O3	FeO	SiO_2	MgO	SO_3
A	52.64	36.59	3.95		8.62		
B	45.11	19.43	11.76	1.85	19.14	2.71	
C	40.14	16.25	7.86	7.87	19.93	7.98	
D	41.34	48.35	2.46		7.85		
E	52.15		1.38	15.68	2.21		28.58

DISCUSSIONS

The present study of ostracoda from subsurface sediments of Karimata Strait provides an indication of environmental change. It seems based on various data on number of taxa, diversity index, dominance, evennessand the certain species of ostracoda (Figure 6). All species/genus of ostracoda from the study area are commonly found in the shallow marine environments in many parts of the Sunda Shelf, such as Malacca Strait (Whatley and Zhao, 1988 and 1989) and Java Sea (Dewi, 1997). The occurrence of *Alataconchapterogona* in Core B rarely indicates current activity that displaced this specimen from its original habitat of South China Sea. The low number of taxa occurs in the eastern and western parts of the study area, particularly the lowest parts of Cores A and C compared to Core B. The decreasing number of ostracoda at certain intervals may be related to paleo-environmental changes. Core A is located close to West Kalimantan as high energy environment and it was located in a wide swampy area and fluvial lowland before the last sea level rise. It is indicating by the abundance of organic black materials in the bottom parts of the two cores. The black materials is not found in the Core B due to this core is located in the middle parts far away from land of Kalimantan and Sumatera. Furthermore, this core is shorter (80 cm length) than previous cores (more than 100 cm) and did not reach the black material. But the short core is not the good reason, because at interval 30 cm in Core C, it has already found the low diversity of ostracoda in black sediment. This core differs from Core A by occurring two groups of ostracoda that abundant and diverse at interval 0-20 cm and 40-60 cm. A layer between these intervals (30 cm below seafloor), the ostracoda is found rarely and it may indicate something environmental changes happened at that time (15,050 years ago), such as flooding detected by high occurrence of terrigenous materials. The flooding in the paleo-Sunda Shelf was described in detail by Hannebuth et al (2000). It was also detecting by sedimentation rates in this area of Core C (close to Bangka Island) is higher than Core A in the west of

Kalimantan (Dewi et al., 2012). Steinke et al (2003) also stated that most of the terrigenous material was probably trapped near the coastline as seen in the rivers in the north of Sunda Shelf. Furthermore, Sahiamurthy and Voris (2006) also identified the exposed Sunda Land that was dominated by lowland rainforest and mangroves during the LGM based on Digital Elevation Model (DEM). Therefore, the Cores A and C might be previously located in the swampy area or close to the river mouth when sea level was lower than today.

Another result of this study is an evenness index that there are two species dominated at certain layers with values of $0.4 < e < 0.6$: *Hemicytheridea reticulata* in Core A (20 cm below seafloor) and *Phlyctenophora zealandica* d Core B (at intervals 30 and 70 cm). It differs with the value of the Dominance index (D) that there is no dominant species found in the sample studied. It should be paid attention deeply on the data and the finding of no dominant species found in the study area. If there is a dominant species there will be less diversity or low number for other species. At these three intervals, the other species of ostracoda are still found commonly and there is no very dominant species. Therefore, the ostracoda from the upper parts of core sediment from the study area are diverse and abundant as a normal marine environment of the Sunda Shelf.

In addition, the occurrences some chemical elements (C, CaO, Al_2O_3, FeO, SiO_2, MgO and SO_3) covered or filled abnormal specimens of ostracoda and other particles are interested. It can provide additional information about environmental changes in the study area, such as Carbon may relate to charcoal from land of Kalimantan and Sumatera. This condition was also found by Dewi et al (2011) in the offshore area of Berau Delta, East Kalimantan. They predicted that CaO and MgO may derive from the neutralized component during the environmental management and the other components from coal ash during combustion process or other activities. The occurrences of chemical elements in some abnormal specimens may provide additional usefulness of ostracoda as indicator of environmental changes. In many years, the detection of environmental changes due to marine pollution were mostly based on diversity, population density, assemblage structure, test morphology (abnormal specimen), test chemistry (heavy metal) and biological response (Yanko et al., 1999). The present study was used not only the abnormal specimens but also based on chemical analysis to have more precise result. Last but not least, the present study also provides other information on ostracoda by comparing previous study on ostracoda from surficial sediment of the Karimata Strait (Mostafawi, 1992). He pointed out that the ostracod abundance and diversity was controlled by sediment type. The present study adds information that it is not only sediment type but also other factors such as water depth, sedimentation rate, local environmental variability etc.

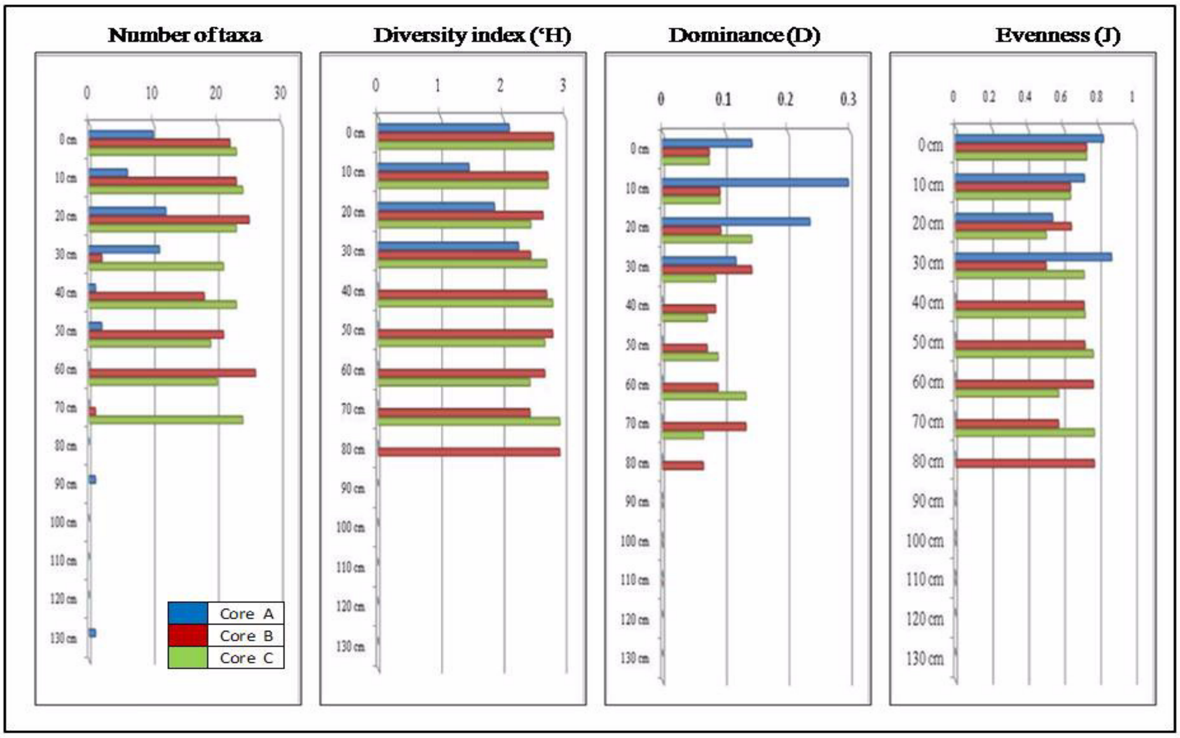

Figure 6 Vertical distribution of community structure of ostracoda from three cores

CONCLUSSIONS

The ostracoda from three short cores sediment below seafloor of Karimata Strait provide several results that can be used as indicator of environmental changes. Ostracoda from the study area are mostly typical species of Sunda Shelf with an exception by finding a species from South China Sea. The ostracoda is found abundantly and diverse in the upper parts of the cores at interval between 0-70 cm below seafloor. This result indicates a marine environment as seen today in a stable condition in Core B that differ to the lower part of the Cores A and C. These parts contain few ostracoda or none among blackish sediment particles. The decreasing or disappearing ostracoda at certain intervals may be related to paleo-environmental changes. It may relate to a wide swampy area and fluvial lowland before the last sea level rise in the Sunda Shelf about 15,000 years ago. Some chemical elements covered or filled abnormal specimens can provide additional information about environmental changes in the study area.

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