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Buku:

MUELIER-DOMBOIS, D. and H. ELLENBERG 1974. *Aims and methods of vegetation ecology.* John Wiley & Sons Inc. New York : 547 pp.

Journal:

ROCHFORD, D.J. 1969. Seasonal variations in the Indian Ocean along 110 E.I. Hydrological structure of the upper 500 m. *Austr. J. Mar. Freshwat. Res.* 4 (20): 1-50.

Kumpulan Naskah atau prosiding:

SYRETT, P.J. 1962. Nitrogen assimilation. *In*: R.A. LEWIN (ed.) *Physiology and Biochemistry of Algae,* Academic Press, New York: 171-188.

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MACROBENTHIC COMMUNITY AT JAKARTA BAY, NORTH JAVA WATERS

by

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ABSTRACT

Jakarta Bay an area where many activities occur such as support domestic and international sea transportation also as an outlet of domestic and industrial wastes that decreases the water and sediment quality as habitat of macrobenthic fauna. Population condition and distribution pattern were investigated in Jakarta Bay. The aims of this study was to observe the diversity and taxa composition of macrobenthic fauna community at Jakarta Bay. Quantitative samples were collected using Smith McIntyre Grab with covering area of 0.05 m^2, the samples were screened using sieves of 0.5 mm mesh size. Water depth in the sampling areas range from 1 m to 12 m and characterized by muddy, muddy sand and sandy mud sediment. A total of 109 species were identified, belonging of four major taxa, i.e. Polychaeta, Crustacea, Mollusca, Echinodermata and seven minor phyla. The density of macrobenthic fauna was less in the western part (5,767 individuals/m^2 comprising of 33 species), than increased in the centre part (42,427 individuals/m^2 of 85 species) and striking density was in eastern part of the bay (459,100 individuals/m^2 of 48 species). Polychaeta even though was high in the total species, but low in density. In the other hand, those fact contradicted with Mollusca that had high density, but low in the number of species. The striking number of Mollusca initiated by high abundance of population of *Alveinus* sp. (Bivalvia) at Jakarta Bay. An additional predominant species in Jakarta Bay were Polychaeta and Crustacea with high total density during the sampling namely, *Jassa* sp. (Crustacea) and Polychaeta such as *Minuspio* sp., *Polydora* cf *pigidialis*, *Poecilochaetus johnsoni*, *Paraprionospio pinnata*, *Polydora* sp.3, *Phylochaetopterus* sp.1 and *Sigambra* cf *bassi*. In particular high densities of macrobenthic fauna at Jakarta Bay were located at stations adjacent to the mainland area nearby to the estuary to the amount of Small River around the bay. These stations are ecologically important because as source of nutrient for macrobenthic fauna is delivered predominantly passing through the rivers.

Key words : Jakarta Bay, macrobenthic community, spatial distribution.

ABSTRAK

KOMUNITAS MAKROBENTIK DI TELUK JAKARTA, PANTAI UTARA JAWA. *Teluk Jakarta merupakan perairan yang mempunyai banyak aktifitas baik transportasi lokal maupun internasional, perairan ini juga menerima limbah domestik dan limbah industri yang menurunkan kualitas perairan maupun kualitas sedimen sebagai habitat makrobentos. Penelitian ini bertujuan untuk mempelajari keragaman dan komposisi taxa makrobentik fauna di Teluk Jakarta. Kondisi dan pola distribusi populasi makrobentik fauna telah dipelajari di perairan Teluk Jakarta. Sampel dikoleksi secara kuantitatif dengan Smith McIntyre Grab dengan area bukaan 0,05 m². Sampel sedimen disaring memakai air laut dengan saringan berdiameter mata saring 0,5 mm dan difiksasi dengan formalin 10%. Lokasi sampling di perairan Teluk Jakarta mempunyai kedalaman dari 1 m sampai 12 m dan tekstur sedimen dicirikan oleh lumpur, lumpur berpasir dan pasir berlumpur. Jumlah spesies makrobentik fauna di Teluk Jakarta adalah 109 spesies yang terdiri dari empat taxa utama yaitu Polychaeta, Krustacea, Moluska, Ekinodermata dan tujuh filum minor. Densitas fauna makrobentik rendah di bagian barat (5,767 individual/m², terdiri 33 spesies), dan naik di bagian tengah (42,427 individual/m², terdiri 85 spesies) kemudian menjadi tinggi di bagian timur teluk (459,100 individual/m², terdiri 48 species). Walaupun Polychaeta mempunyai jumlah spesies tinggi tetapi densitasnya rendah. Berlainan dengan Moluska yang mempunyai densitas tingi tetapi jumlah spesiesnya rendah. Jumlah yang mencolok dari Moluska dicirikan oleh tingginya populasi* **Alveinus** *sp. (Bivalvia), spesies ini berukuran kecil dari 2 mm hingga 7 mm. Spesies predominan lainnya adalah beberapa spesies Polychaeta dan krustasea. Spesies predominan Krustasea dicirikan oleh Jassa sp. dan spesies predominan Polychaeta yaitu:* **Minuspio** *sp.*, **Polydora** *cf* **pigidialis**, **Poecilochaetus johnsoni**, **Paraprionospio pinnata**, **Polydora** *sp.*3, **Phylochaetopterus** *sp.*1 *and*, **Sigambra** *cf* **bassi**. *Tingginya densitas populasi makrobentik fauna khususnya terdapat pada stasiun yang terletak didekat daratan dan didekat estuaria sungai sungai kecil yang bermuara ke Teluk Jakarta. Beberapa stasiun tersebut mempunyai fungsi ekologi yang penting karena merupakan sumber masuknya nutrien ke dalam perairan sebagai sumber makanan organik bagi makrobentik fauna. Tetapi disisi lain kondisi ini membuat kesehatan lingkungan kurang baik.*

Kata kunci : Teluk Jakarta, komunitas makrobentik, distribusi spatial.

INTRODUCTION

The bathymetry of Jakarta Bay that has been described by SUYARSO (1995 a & b), shows that the western part is relatively shallower than in the eastern part. Not less than 13 rivers discharge their freshwater into Jakarta Bay. Four big rivers, including Cisadane at the western part, Ciliwung in the central part and Citarum and Bekasi Rivers in the eastern part flow to the bay and it is not surprising that the sedimentation at the bay is very active.

Jakarta bay is an area where many activities occur such as a fishing ground for local fisher, support domestic and international sea transportation with Tanjung Priuk as the main harbor and also as an outlet of domestic and industrial wastes that decreases the water quality. Such pollutants are accumulated in the sediment at the estuary and surrounding area of Jakarta Bay. Hydro-dynamical condition at the bay brings the river discharge move seawardly and extended to the Seribu Islands (Kepulauan Seribu) in the north (SUYARSO 1995a).

The coastal area of Jakarta Bay also has been transformed into human settlement and industrial facilities causing the disappearance of the natural beaches. The ongoing reclamation of the bay will automatically remove all the benthic fauna that is at present relatively significant and will drive the demersal fishes away. In the last three decades human interference in altering the natural condition of Jakarta is very intense.

During 1987-1993 a number of studies on macrobenthic community studies have been carried out in Jakarta Bay (KASTORO 1994). The condition of the macrobenthic community of Jakarta Bay changed drastically as shown also in the work of ASWANDY *et al.* (1991). Some species that have striking number in Jakarta Bay in 1987 were *Paraprionospio pinnata* and *Polydora* sp. (Polychaeta), *Alveinus* sp. (Mollusca), *Jassa* sp., *Photis* sp., *Ampelisca* sp., *Apseudeus chilkensis, Erictonius* sp. and *Byblis* sp.(Amphipoda, Crustacea) (KASTORO *et al.* 1991; ASWANDY *et al.*1991 and AL-HAKIM 1994). There are some organisms that survive in the polluted region, and can even attain extremely high densities in such environment. These species may act as pollution indicators species (REISH 1979). The eutrophication of inshore waters has become one of the serious environmental problems in various countries. Inflow of organic waste and inorganic nutrients (N, P) discharge to estuarine and inshore waters can cause outbreaks of harmful phytoplankton (red tide) in the pelagic system. Accumulation of particulate organic matter that facilitates microbial decomposition in the bottom water layers reduced oxygen resulting in the deterioration of the benthic environment and fauna (KIKUCHI 1987). Jakarta Bay is of eutrophic waters an example ADNAN (1984) and PRASENO (1995) reported blooming of some species fitoplankton. AFDAL & RIYONO (2008) reported eutrofication on July 2003 base on horizontal distribution of chlorophyll-a content at surface layer in Jakarta Bay, with average value of chlorofil-a 31,37 mg.m^3 and ranges from 7,44 to 119,00 mg.m^3.

Macrobenthic fauna are commonly being used in applied environmental research to monitor and evaluate ecological condition at the bottom environments. BORJA *et al.* (2000) evaluate soft bottom benthos of European estuarine and coastal environment by using macrobenthos for biotic index base on feeding behaviors. The aims of this study is to observe the diversity and taxa composition of macrobenthic fauna community at Jakarta Bay.

MATERIAL AND METHODS

The study was conducted at Jakarta Bay in June 2003 (east monsoon). Based on the bathymetry, sampling sites were grouped into three sub areas at Jakarta Bay within station code tj = Teluk Jakarta: a. western part (9 stations: tj1,2,3,4,5,6,7,8,and 30), b. Central part (8 stations : tj 9,10,11,12,13,14,15,16 and 29) and c. eastern part (9 stations: tj 17,18,19,20,22,21,23,24,25,26,27 and 28) that is shown in Figure 1.

Figure1. Map of Jakarta Bay showing sampling sites of macrobenthic fauna.

The depth of sampling sites ranged from 1 m to 12 m. The slope at Western part was relatively shallower than Eastern part (SUYARSO 1995 a & b) and the bottom sediment was characterized by muddy, muddy sand and sandy mud having brownish, black and grayish color.

Samples were collected using Smith McIntyre Grab bottom sampler with an opening of 0.05 m². The grab was operated on board of a fishing boat. Three replicates at each station were sampled to assess the patchiness of macrobenthic fauna. Samples were screened on board using sieves of 0.5 mm mesh size, and immediately transferred into plastic bottles of 1 liter volume and preserved in 10% formaldehyde diluted with seawaters.

The samples were sorted out in the laboratory that then divided into four groups of taxa and identified to the species level, then transferred into 70% ethanol for preservation and kept at the Laboratory of Macrobenthic Fauna - RCO – LIPI (Research Centre for Oceanography – Indonesian Institute of Sciences), Jakarta.

Data analyses included Shannon-Wiener and the Heip evenness index calculated using $\log_2$ values measure. Species abundance was transformed by square root, fauna assemblages were initially elucidated by cluster analysis using Bray Curtis similarity coefficient with group average fusion adopted the Plymouth Routines in Multivariate Ecological Research /PRIMER version 5 (WARWICK 1993; CLARKE & GORLEY 2001; CLARKE & WARWICK 2001).

RESULTS

A total of 76.093 individuals of macrobenthic fauna belonging to 55 families were identified. (Table 1 and Appendix 1). The numerous macrobenthic fauna were predominantly infauna and several epifauna. Infauna were dominated by Bivalvia (Mollusca), Polychaeta and Crustacea, while epifauna consisted of Echinoderms and several Crustacea. Among the infauna, mollusc was the most common on the coarse sediment and deposit feeder and tube dweller polychaetes occupied the soft sediment.

Polychaeta was found to be the highest number of family followed by Crustacea, Mollusca and Echinodermata (Table 1). Polychaeta was represented by Spionidae (13 species), Ampharetidae (5 species), Nereidae (5 species), Capitellidae (4 species), Pilargidae (4 species) and Polynoidae (4 species), Mollusc is represented by Tellinidae (4 species), and decapods crustaceans was represented Portunidae (4 species) which is shown in Appendix 1.

The density of macrobenthic fauna was less in the western part (5.767 individuals/m², 33 species), than increase in the central part (42.427 individuals/m², 85 species) and highest density was found in eastern part of the bay (459.100 individuals/m², 48 species) (Figur 2). Although the smaller individual number in the central part was smaller than that of the eastern part but it has higher number of species.

In general, Polychaeta has the highest in the total species (70 species, 64%) although characterized by low density (23.120 individuals/m², 4.56%). In the other hand, Mollusca has the highest in density (472.620 individuals/m², 93.17%) but low in the number of species (15 species, 13.64%), characterized by striking number of individual of *Alveinus* sp. at central and eastern part of the bay.

Table 1. Percentage of total families, species and individual of macrobenthic fauna at Jakarta Bay.

[redacted]

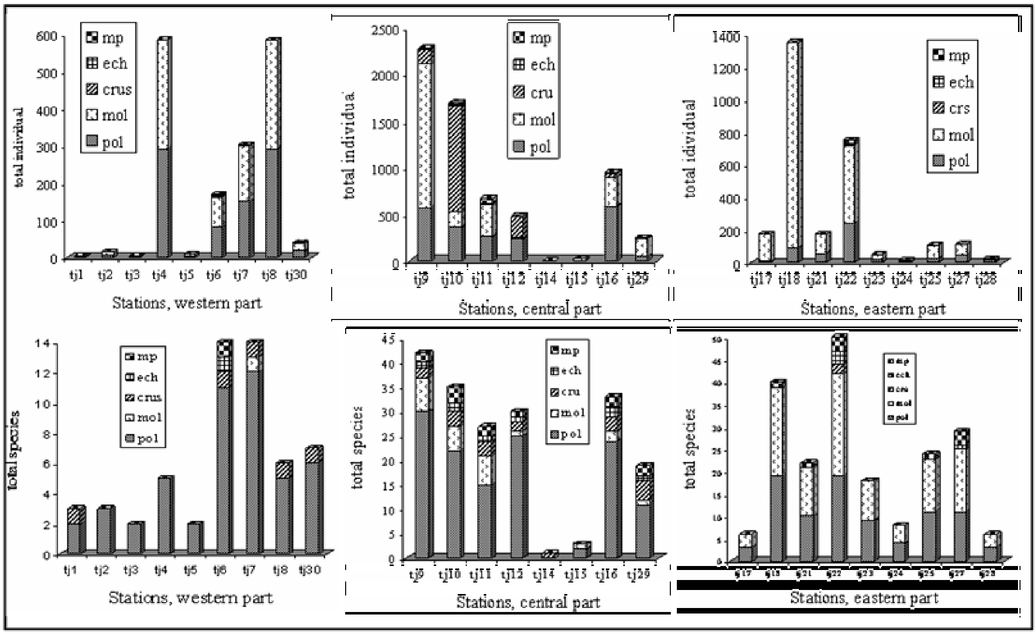

Figure 2. Species and individual composition of macrobenthic community at Jakarta Bay.

Table 2. Population Ranked of macrobenthic fauna at Jakarta Bay.

Ranked population	Percentages	Western part	Centre part	Eastern part
Rare, < 1 individual s/grab	12%	tj 1, tj 3	tj 14	-
Frequent, 2-10 individual s/grab	27%	tj 2, tj 5, tj 30	tj 5	tj 17, tj 24, tj 28
Common, 11-100 individual s/grab	30.50%	tj 4, tj 6, tj 7, tj 8	tj 29	tj 18, tj 25, tj 27
Abundance, > 100 individual s/grab	30.50%	-	tj 9, tj 10, tj 11, tj 12, tj 13, tj 16	tj 21, tj 22, tj 23

Echinoderm was only sparse at western and eastern parts of the bay, and quite frequent at the central part with sandy bottom substrate, Crustacea showed similar pattern with Echinoderm. Polychaeta on the other hand, was present in all stations during the study, ranging from a few individuals to very abundant. Species number of Mollusc was higher at central part with smaller individual numbers, contrast to those at eastern part, which showed small species numbers but high individual numbers (Figure 2**).**

The data of population rank of macrobenthic fauna at each station showed fewer species at the western part. Abundant species occurred at central part (St. tj9, 10, 11, 12, 16) and at the eastern part (tj21, 22 and 23). The less number of individuals were observed in three stations, tj1, tj3 and tj14. The maximum individual number of mollusc was due to the abundance of population of *Alveinus* sp. (Bivalvia) in stations tj9 (10.134 individuals/m^2) at the central part of the bay and tj21 (135467 individuals/m^2) and tj22 (315567 individuals/m^2) at the eastern part. (Table 2).

Species diversity (H) and Pielou evenness (J) ranged from 0.035 to 3.526, and evenness index ranges from 0.009 to 0.830. In general, species diversity and species evenness values was the lowest at stations close to the mainland, than increase at stations in the coastal area, where the bottom consisted of soft mud and sand. In the other hand, species richness of Margalef ranged from 0.62 to 5.30 with great variety. The fluctuation of species richness values gradually increase from station close to the mainland in the direction of the coastal area (Figure 3 and Table 2).

Cluster at the western part of the bay was characterized by two sub unit assemblages, then joining within stations tj30 and tj1. Sub unit assemblage A consisted of stations tj3, tj5 and tj2, with low abundance of *Minuspio* sp. and *Paraprionospio pinnata*. These stations were not abundantly occupied by macrobenthic community and low species number. Sub unit assemblage B consisted of stations tj 6,7,4 and 8, characterized by high number of individuals of *Minuspio* sp., *Polydora pigidialis*, *Spiochaetopterus* sp., *Hesione* sp., *Polydora* sp.1 and *Poecilochaetus* cf *johnsoni*.

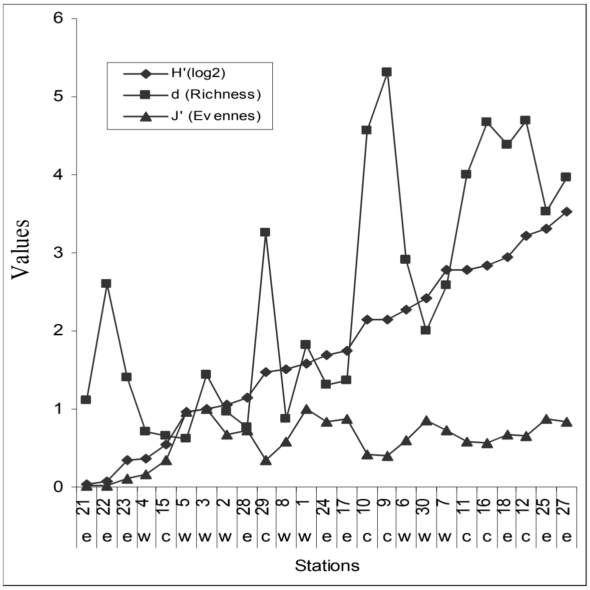

Figure 3. Species diversity indices of macrobenthic fauna at Jakarta Bay.
Note : e = eastern part , w = western part, c = centre part of the stations.

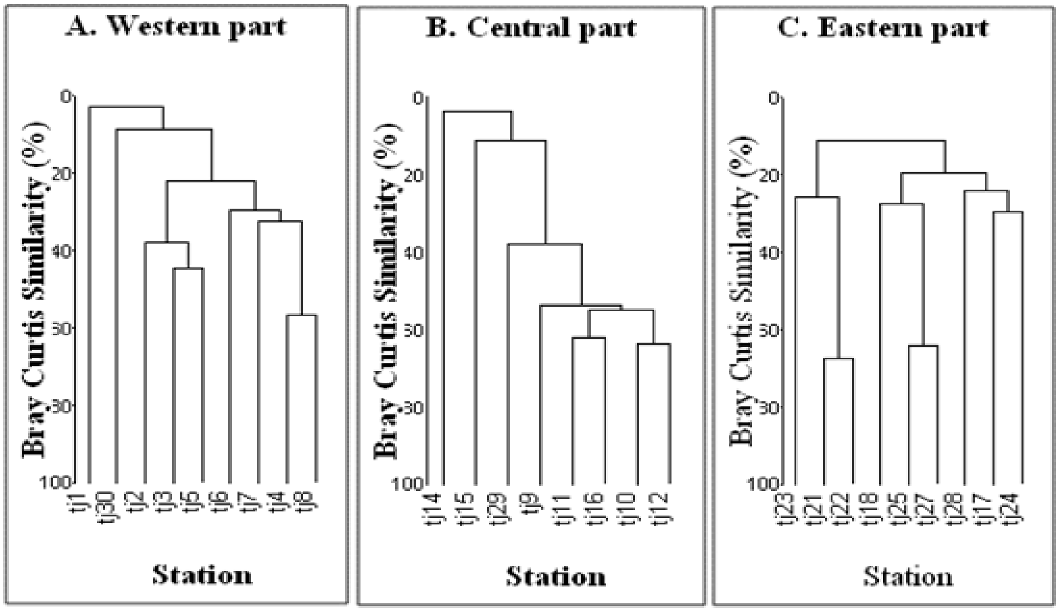

Figure 4. Clusters in benthic community of Jakarta Bay, showed assemblages at each location.

Appendix 1 showed population not less than 85 species and high number of individuals lived in several stations of the central part. Cluster of stations consisted of two sub unit assemblages, A and B. Sub units assemblage A and B were predominated by the same species, their differences were characterized by gradation of total individuals. Indvidual abundance at sub unit A (tj 11 and 16) was lower than sub unit B (tj 10 and 12) respectively. Abundance at stations tj 9, 29, 15 and 14 gradually decreased. The species with highest individual count characterizing the sub unit assemblage A were *Alveinus* sp., *Minuspio* sp., *Poechilochaetus johnsoni*, *and Polydora pigidialis*. The main species characterized sub unit assemblage B were *Alveinus* sp., *Jassa* sp., *Minuspio* sp., *Polydora pigidialis* and *Paraprionospio pinnata.* Based on the distribution abundance and species domination of these stations, cluster at the western part formed one community (Figure 4).

Community of macrobenthic fauna at the eastern part was dominated by *Alveinus* sp., in which sand or sand with shelly sand predominated the substratum. This species mutual habitat with *Pulliella* sp., *Paraprionospio pinnata*, *Sigambra* sp. and *Cirratulus* sp. Cluster analysis resulted three assemblages with clear separation. Assemblage A consisted of stations tj 21, 22 and 23 were dominated by *Alveinus* sp. followed by *Pulliella* sp., *Paraprionospio pinnata*, *Polydora heterochaeta*, *Cirratulus* sp., *Sigambra bassi* and *Minuspio* sp. Only small clam, *Alveinus* sp., had striking abundance at this assemblage. Assemblage B that consisted of stations tj 25, 27 and 18. was predominantly occupied by *Poecilochaetus johnsoni, Paraprionospio pinnata*, *Alveinus* sp. and *Mactra* sp. The abundance in assemblage B was low compared to assemblage A. Assemblage C consisted of stations tj 17, 24 and 28, the top species of having number of individuals at assemblage C were *Phyllochaetopterus* sp.1, *Polydora* sp.1 and *Alveinus* sp. Abundance at assemblage A was the highest.

DISCUSSION

The rare species were important in the aspects of faunistics biodiversity and species richness for adjacent area of Jakarta Bay. The dynamic nature of the sediment transport areas in comparison with the relatively stable depositional areas is a major factor governing their faunal composition (WARWICK & DAVIES 1977).

KASTORO *et al.* (1991) found high population of *Alveinus* sp. that was recorded only in the estuaries of Jakarta Bay. This small clam is an estuarine inhabitant and is not found offshore around Seribu Islands. SONGSANJINDA *et al.* (2006) reports that factor controlling the composition and abundance of living organisms is difficult to define because the elements cycle of the ecosystem is very complicated with all these living things. The roles of each group of living organism are different. Equally, it was the case of the macrobenthic fauna population condition of Jakarta Bay. The high ranges of organic content in several locations did not coincided with high population of macrobenthic that may naturally depend on the organic matters for their food. According to SANDERS & HESLER (1969) organic carbon in the sediment is not good index to estimate the available food in the sediment. The presence of layers carbon associated with turbidity current deposits indicates that organics have been moved, they are never made available to any organism. That was seen at the eastern part of Jakarta Bay, that had low dissolved oxygen (3.69 ml/l), but high number of *Alveinus* sp. The average of dissolved oxygen at both western part (3.94 ml/L) and central part (4.07 ml/L) of the bay was higher than eastern part (3.69 ml/L) (MOCHTAR 2003) but no striking individual species was found.

Species abundance at all stations was sparse, characterized mostly by low number of individuals of each species. Patchy habitats is the nature of the distribution macrobenthic fauna caused sparse population. With the exception of a few stations having striking number of *Alveinus* sp. and other minor predominant species. The predominant species were only a few, namely *Jassa* sp., *Minuspio* sp., *Polydora* cf. *pigidialis*, *Poecilochaetus johnsoni*, *Paraprionospio pinnata, Polydora* sp.3, *Phylochaetopterus* sp.1 and *Sigambra* cf *bassi.* Stations at the central and eastern parts of Jakarta Bay with abundant species were located close to the mainland in which pollutant from domestic and industrial wastes has been accumulated. These stations were ecologically important as a resource of organic carbon nutrient for macrobenthic fauna that was predominantly loading through the river. Beside, condition of bottom topography also important for larval recruitment.

Consideration of qualitative data normally confirmed the view that the deeper coastal with muddy sand had the highest species richness value than muddier stations. The condition of diversity indices at three locations has variable values. According to the experiences of JOHNSON *et al*. (2006) species diversity rises when many species are present in comparable abundances and falls when a few species are present in numbers far greater than the other species. The difference in diversity between the study area simply reflects a greater number of species enjoying comparable success and thus comprising more similar proportion of the community.

KASTORO *et al.* (1991) and ASWANDY *et al.* (1991) in their study show higher species diversity than the result of this present study. There is, of course, no purpose why high total number of species should be considered to represent population distribution. The true range of a number species can only be determined by wide range of sampling area. The present study area was located around the bay and their study area was located from Jakarta Bay to the offshore around Seribu Islands. We might postulate that generally the rare species and striking species depend on settling biota than originally because of supply of nutrient from the river around Jakarta Bay.

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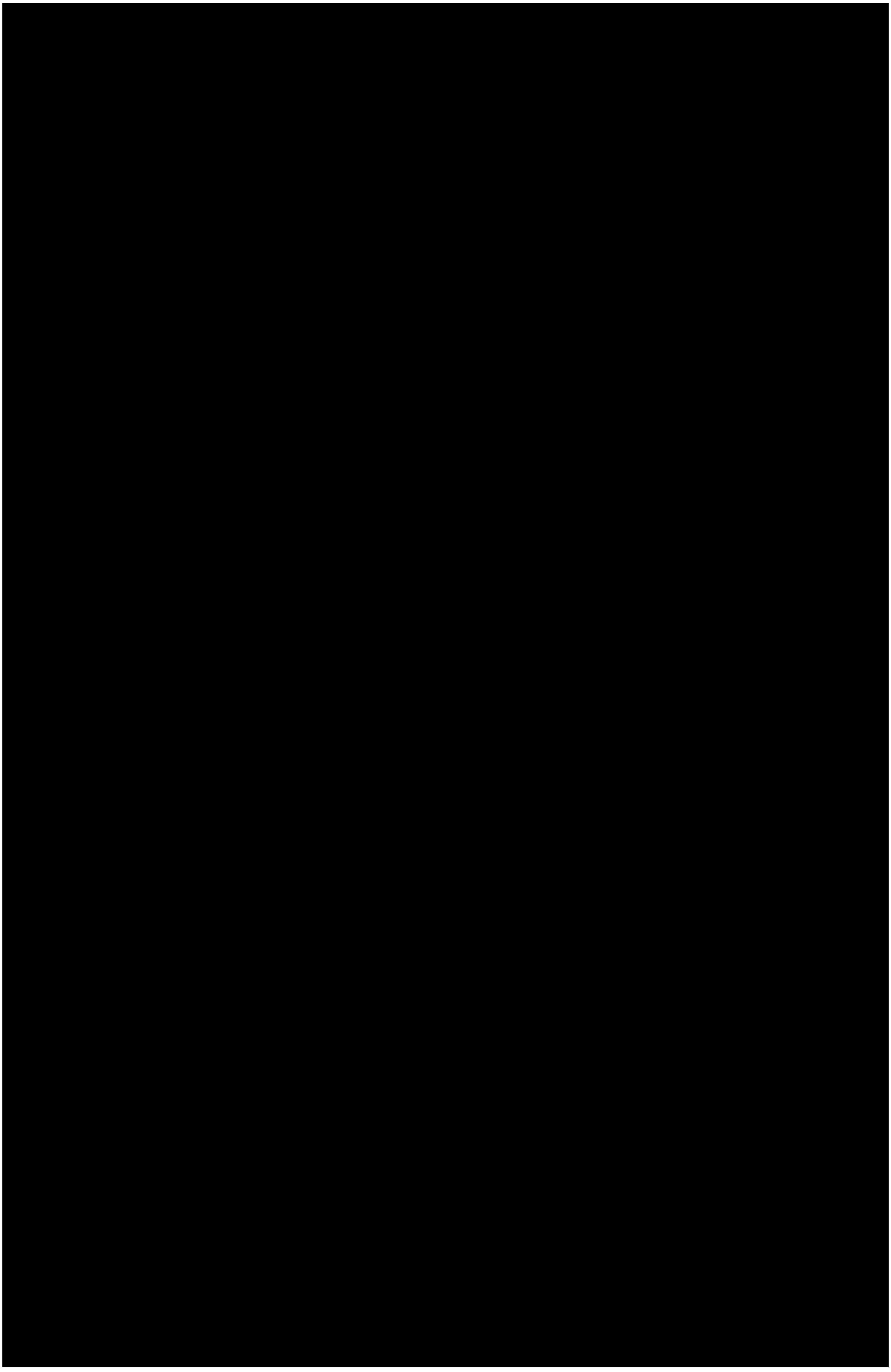

No	Family name	No	Species name	West	Centre	East	Total	Frequency
71	Lucinidae	1	*Anodontia sp.*	1	-	-	1	1
72	Mactidae	2	*Mactra sp.*	-	1	-	1	1
73	Scaphander	3	*Scaphander sp.*	-	1	-	1	1
74	Veneridae	4	*Lioconcha sp.*	-	-	2	2	1
75	Tellinidae	5	*Tellina sp. 2*	-	2	-	2	1
76	Arcidae	6	*Anadara antiquata*	-	3	-	3	1
77	Tellinidae	7	*Tellina sp. 1*	-	-	3	3	1
78	Tellinidae	8	*Tellina sp. 4*	-	3	-	3	1
79	Undidentified	9	*Bivalvia Juvenile*	-	6	-	6	1
80	Arcidae	10	*Barbatia decussata*	-	8	-	8	1
81	Tellinidae	11	*Tellina sp. 3*	-	6	2	8	2
82	Veneridae	12	*Gafrarium tumidum*	-	14	-	14	2
83	Mytillidae	13	*Brachidontes sp.*	-	15	-	15	2
84	Mactidae	14	*Mactra sp.*	-	-	22	22	2
85	Kaliellidae	15	*Alveinus sp.*	-	2539	68264	70803	2
			Total	**1**	**2598**	**68293**	**70892**	

No	Family name	No	Species name	West	Centre	East	Total	Frequency
86	Portunidae	1	*Larvae decapod*	1	-	-	1	1
87	Alpheidae	2	*Alpheus sp.*	-	1	-	1	1
88	Portunidae	3	*Charybdis sp.*	-	1	-	1	1
89	Anthuridae	4	*Cyathura sp.*	-	1	-	1	1
90	Penaeidae	5	*Metapenaeus sp.*	-	-	1	1	1
91	Portunidae	6	*Portunus pelagicus*	-	1	-	1	1
92	Portunidae	7	*Portunus trilobatus*	-	-	1	1	1
93	Xanthidae	8	*Pilumnus sp.*	-	3	-	3	1
94	Palaeminidae	9	*Pontonides sp.*	-	4	-	4	1
95	Caprellidae	10	*Caprella sp.*	-	18	-	18	1
96	Squillidae	11	*Oratosquilla repa*	1	1	-	2	2
97	Ischyroceridae	12	*Jassa sp.*	5	1527	-	1532	2
			Total	**7**	**1557**	**2**	**1566**	

No	Family name	No	Species name	West	Centre	East	Total	Frequency
98	Ophiactidae	1	*Opiiactis sp.*	2	-	-	2	1
99	Ophiuroidae	2	*Amphiura sp.*	-	2	1	3	2
100	Ophiuroidae	3	*Amphioplus sp.*	-	16	3	19	2
101	Holothuroidae	4	*Holothuria sp.*	-	15	10	25	2
			Total	**2**	**33**	**14**	**49**	

No	Family name	No	Species name	West	Centre	East	Total	Frequency
102	*Sipunculidae*	1	*Sipunculidae*	-	1	-	1	1
103	*Tunicata*	2	*Tunicata*	-	-	1	1	1
104	*Turbellaria*	3	*Turbellaria*	-	-	1	1	1
105	*Bryozoa*	4	*Bryozoa*	5	-	-	5	1
106	*Cnidaria*	5	*Cnidaria*	-	9	-	9	1
107	*Brachiopoda*	6	*Brachiopoda*	-	-	10	10	1
108	*Nematoda*	7	*Nematoda*	-	78	4	82	2
109	*Nemertina*	8	*Nemertina*	2	4	2	8	3
			Total	**2**	**66**	**18**	**117**	

Note:
pol=polychaeta
mol=mollusca
cru=crustacea
ech=echinodermata
mp=minor phylla