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The Effect of Bed-Sediment Quality on Distribution of Macrobenthos in Labu River System and Selected Sites in Langat River, Malaysia

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Abstract : Determination of bed-sediment quality and macrobenthos abundant were carried out in Labu River System and two selected sites in Langat River. The study area is situated in Langat Basin which has a total area of 2938 km^2. Identification and quantitative analysis revealed that only macrobenthos from the family of Tubificidae was dominating along the rivers. Tubificidae was strong correlated (r=0.97) with sediment grain size 125-63 µm compared to 63-38 µm (r=0.90) and < 38 µm (r=0.81). High correlation (r=0.82) was observed between Tubificidae abundant and organic content in the bed-sediments. Labu River System and selected sites in Langat River were polluted with organic constituent for a long period of time based on quantity of Tubificidae acquired.

Key words: Labu River System, Langat River, bed-sediment, Tubificidae abundant

Introduction

Benthos is the organism that inhabit in bottom substrate of lakes, ponds and stream which retained by No. 30 U. S. Series sieve. Macrobenthos plays as an important role in aquatic community consist of involved in mineralization, promoted the mixing of sediments and flux of oxygen into sediments, recycling of organic matter (Lind, 1979) and in effort to assess the quality of inland waters (Milbrink, 1983). The amount of nutrients released by the sediments will depend on the mineralizing capacity of the benthic community (Newrkla and Gunatilaka, 1982). Abundance and distribution of macrobenthos (Oligochaetes) has affected by various physical factor such as deep, flow velocity, sediment grain size, organic content in sediment (Pearson, 1970) and light gradient seasonal. Correlation between sediment grain size and distribution of macrobenthos had observed by Eckman (1979). Contaminations of bed-sediment environmental, toxicity of sediments and rapid sedimentation have appeared to cause shifts toward lower abundances of macrobenthic species.

Tubificidae from the species of *Limnodrilus hoffmeisteri* has been widely used as a biological indicator in United Kingdom (Brinkhurst and Kennedy, 1965), Italy (Duzzin *et al.*, 1988), France (Lafont, 1987), Switzerland (Lang, 1978, 1984, 1985), Israel (Pascar-Gluzman and Dimentman, 1984) and United States (Probst, 1987). *L. hoffmeisteri* is able to live in less oxygenated water (0.5 mg/l) (Fisher and Beeton, 1975) and deeper waters of higher stream orders. Oligochaetes have significant effect on the physico-chemical status of the uppermost sediments and presumably on the overlaying water (Kaster *et al.*, 1984). Focus of this research was to determine the effect of bed-sediment environmental on distribution and abundance of macrobenthos along the Labu River System in Negeri Sembilan Darul Khusus and Selangor Darul Ehsan, Malaysia.

Materials and Methods

Eleven sites were selected along Labu River for quantitative sampling. Two sites in Langat River also been chosen to reveal the impact from Labu River System. Sampling of sediment has been conducted from October 1999 until May 2000. Ponar grap or Surber sampler was used for sediment collection, depending on physical characteristic of sites. The following procedure was carried out to determine the distribution of sediment's size: dry weight, after drying for 24 hours at 105°C on paper plate. Organic compound content in sediment was determined using method proposed by Walkey & Black (Sharifuddin and Dynoodt, 1981). Collection of macrobenthos specimen was conducted from September 2000 to November 2000. Five replicates of sample randomly collected from each site. Standard method proposed by American Public Health Association (APHA) Method 10500c (1995) was employed for the sample processing and analysis (APHA, 1995). Taxonomic identifications were performed to the family level. Total organic content is refers to the sum of organic content in eight fractions of sediment viz >2.0mm, 2.0-1.00 mm, 1.0 mm-500 µm, 500 -250 µm, 250 -125 µm, 125-63 µm, 63 -38 µm and < 38 µm. Sub-total attributes to the sum of organic content in 125 -63 µm, 63 -38 µm and < 38 µm.

Results

Sediment grain size: Sediments with larger grain size were dominating at upper reaches of the assessed rivers. Downstream of Labu River System (St. 9 and St. 10) and St. SLU in Langat River have acquired larger portion for fractions 1.00 mm-500 µm, 500-250 µm, 250-125 µm and 125-63 µm compared to other segments of the rivers which shown higher percentage in grains size >2.0 mm, 2.0 mm-1.0 µm, 1.0 mm-500 µm and 500 µm-250 µm (Table 1).

Total organic content: Total organic content in the sediments measured along the rivers ranged between 1.51 and 15.08%. The highest percentage of organic content was obtained at St. 10 (15.08%) and lowest at St. 7 (1.51%) (Table 2). Higher percentage of total organic content between 4.42 to 15.08% was acquired at St. 1, St. 2, St. 9 and St. 10, St. SLU and St. SLL.

Sub-total organic content: The average of sub-total organic content ranged between 0.29 and 6.06%. Linear correlation was observed between total organic content and sub-total organic content in the sediments. Sub-total organic content forms important composition in the sediments at most segments of the rivers. The highest percentage of sub-total organic content was recorded at St. 10 (6.06%) and lowest at St. 3 (0.29%) (Table 3).

Macrobenthos: Investigation on the response of selective macrobenthos community to natural variability and on the bed-sediment environmental revealed that Tubificidae was dominating and presence in large quantity. A significant ($p<0.01$) increasing abundance of Tubificidae per unit area was exhibited from upperstream (12.5 individual m^{-2}) to downstream (15090.0 individual m^{-2}) of Labu River System.

Discussion

Macrobenthos and sediments: The distribution of sediments grain size in Labu River System and Langat River were affected by erosion process and flow velocity. The relation of sediments grain size, degree of flow velocity and deep of an aquatic system was

Table 1: Mean and standard deviation (±) (%) of the sediments grain size. Sampling was based on 3 replicates. The abbreviation 'St.' refers to station

St. No	Sediment fraction (%) > 2.0 mm	> 2.0- 1.0 mm	1.0mm- 500 μm	500- 250 μm	250- 125 μm	125- 63 μm	63- 38 μm	< 38 μm
1	22.55±21.78	29.56±1.08	30.94±16.28	13.63±5.09	2.78±1.08	0.35±0.18	0.09±0.04	0.09±0.05
2	21.04±6.22	25.34±4.62	29.76±8.41	20.69±11.02	2.90±1.64	0.17±0.04	0.05±0.02	0.05±0.02
3	24.50±11.18	32.05±5.03	28.94±7.97	12.79±8.06	1.49±0.19	0.16±0.05	0.04±0.02	0.03±0.02
4	33.08±9.83	29.19±8.33	19.14±2.83	11.39±6.80	5.98±8.07	0.99±1.51	0.16±0.21	0.06±0.05
5	27.33±23.33	34.01±4.35	30.45±19.52	5.58±2.94	1.54±0.48	0.78±0.99	0.26±0.38	0.06±0.07
6	26.44±14.05	27.48±5.49	21.19±3.70	16.49±11.26	7.72±5.44	0.50±0.39	0.11±0.08	0.08±0.07
SBN	22.45±11.17	27.14±6.89	25.71±12.66	12.44±4.25	6.82±5.11	2.62±4.04	2.23±2.11	0.59±0.69
7	14.58±4.56	24.88±7.71	39.66±2.56	18.31±3.42	2.35±1.39	0.14±0.05	0.04±0.02	0.04±0.03
8	15.56±0.26	20.06±17.11	23.04±11.28	23.23±13.15	18.27±18.33	3.62±3.97	1.13±1.59	0.27±0.24
9	NA	1.34±1.06	9.58±14.59	18.80±17.06	54.40±30.46	10.70±5.26	4.52±2.97	0.65±0.35
10	3.26±-	14.24±-	20.23±4.13	17.87±4.77	24.56±10.69	18.83±9.23	12.85±3.02	6.57±7.03
SLU	NA	6.72±3.78	9.81±4.51	19.12±4.71	25.31±14.45	17.69±7.15	13.98±4.35	7.37±6.81
SLL	NA	0.41±0.19	1.17±1.27	3.08±3.05	54.71±16.58	30.36±11.53	8.12±6.37	2.29±2.10

Note: NA – Not Available

Table 2: Mean and standard deviation (±) (%) of the organic content in sediments. Sampling was based on 3 replicates. The abbreviation 'St.' refers to station.

St.No	Sediment fraction (%) > 2.0mm-	1.0 mm- 1.0 mm	500 μm- 500 μm	250 μm 250 μm	125um- 63um	125um 63um	63um- 38um	<38um
1	0.12±0.02	0.13±0.13	0.72±0.56	0.59±0.81	0.45±0.46	0.60±0.30	0.90±0.43	0.91±-
2	0.17±0.18	0.36±0.45	0.81±1.14	0.49±0.67	0.40±0.35	0.59±0.24	1.03±-	1.40±-
3	0.23±0.12	0.46±0.60	0.15±0.15	0.22±0.19	0.26±0.35	0.29±0.07	NA	NA
4	0.28±0.31	0.23±0.30	0.49±0.60	0.10±0.07	0.29±0.35	0.20±0.06	0.39±-	0.79±-
5	0.34±0.28	0.15±0.12	0.13±0.03	0.57±0.81	0.35±0.39	0.52±0.67	0.49±-	0.72±-
6	0.15±0.08	0.21±0.20	0.17±0.08	0.34±0.34	0.18±0.06	0.23±0.11	0.69±0.13	0.98±0.27
SBN	0.20±0.23	0.16±0.08	0.45±0.48	0.13±0.04	0.43±0.20	0.52±0.21	1.46±0.83	1.38±0.83
7	0.18±0.08	0.21±0.22	0.22±0.18	0.14±0.03	0.32±0.32	0.44±0.24	NA	NA
8	0.16±0.11	0.18±0.11	0.13±0.01	0.17±0.20	0.24±0.23	0.35±0.34	0.52±0.21	0.51±0.02
9	NA	2.50±1.96	2.90±1.34	0.91±0.49	0.23±0.15	0.51±0.30	1.26±1.04	1.43±1.10
10	1.35±-	1.44±-	2.00±0.88	2.94±1.13	2.01±1.18	2.12±1.54	1.97±1.47	1.97±1.17
SLU	NA	1.31±0.75	1.43±0.51	1.51±0.85	1.23±1.24	1.69±1.63	1.75±1.19	1.84±1.09
SLL	NA	2.25±0.15	1.67±1.26	1.83±1.09	0.82±0.47	0.37±0.21	1.06±0.59	1.44±0.91

Note: NA – Not Available

Table 3: Mean and standard deviation (±) of the Tubificidae abundance at sampling sites. Observations were based on 2 replicates. Mean (%) for organic content was carried out for 3 replicates. The abbreviation 'St.' refers to station.

St. No.	Total organic content in sediment (%)	Sub-total organic content in sediment (%)	Average abundance (Individual m^{-2})
1	4.42	2.4100	12.5±3.5
2	5.25	3.0200	32.5±10.60
3	1.61	0.2900	65.0±21.20
4	2.77	1.3800	105.0±21.20
5	3.27	1.7300	134.0±22.60
6	2.95	1.9000	167.5±46.00
SBN	4.73	3.3600	1131.5±1002.0
7	1.51	0.4400	674.0±446.90
8	2.26	1.3800	1405.0±332.30
9	9.74	3.2000	2810.0±466.70
10	15.80	6.0600	15090.0±42.400
SLU	10.76	5.2800	13040.0±353.60
SLL	9.44	2.8700	18725.0±1180.9

discussed by Pearson (1970). Smaller grain size such as 500-250μm, 250-125 μm, 125-63 μm, 63 -38 μm and < 38 μm may related with the flow velocity. Smaller sediments grain size were transported by high flow velocity and subjected to deposition as flow velocity decreases in downstream of Labu River System. Higher percentage of clay was observed in the area with the maximum or minimum current (Pearson, 1970). This explained high percentage of acquires smaller grains size in downstream of Labu River System. Bedload was observed along Labu River System which consists of large sediment particles that move by bouncing along the bottom. Sediment may also be eroded from banks during high flows and resuspended from the substrate by changes of speed or direction of the water current (NCSU, 2001). Strong correlation between macrobenthos and sediment grains size 125-63 μm, 63-38 μm or < 38 μm may due to the natural habit of Tubuficidae. Tubificidal feed anterior end down with the posterior end extending a few millimeters to several centimeters above the sediment water interface where the defeacted material is deposited (Kaster *et al.*, 1984). As a result, higher individual per unit area was acquired associated with 125-63 μm.

Tubificidae and organic content: An excess of organic matter decomposing in the sediments has lead to anoxia and toxicity that formed reduced elements. The presence of toxic constituents play an important factor in limiting the numbers and community of macrobenthos found in the sediments. Tubicids is considered an indicator of organic pollution; especially the water is between 10 and 60% saturated with oxygen (Pennack, 1978). Bed-sediment in the study rivers which content high level of organic content have promoted to the large abundance of Tubificidae. Statistical test performed indicates that abundance of macrobenthos was strong correlated (r=0.82) with organic content. The relationship between organic pollution and a high abundance of aquatic oligochaetes has long been recognized (Verdonschot, 1989). Mandaville (1999) cited Tubificid is commonly found concomitant with a precipitous reduction and exclusion of most other benthic animals. The existence of Tubificidae also induced by feeding habit that is gatherers and feeding on detritus in the sediments.

Sediment grain size and organic content: Sediment with fractions 63-38 μm and < 38 μm are considered as silt component that associated with organic content. Organic content exhibited strong correlation with 63 μm-38 μm (r=0.90) and < 38 μm (0.84). Depletion of slit and clay were lead to decrease of the organic content in an area (Palacin *et al.*, 1991). Hence, the result showed organic content tends to be adsorbed to clay minerals (Hamouda and Wilson, 1989). Direct effluent released by industrial and domestics, decomposition of plant at river bank, surface runoff from agriculture land and waste dumping site are the main contributor for organic content recorded in the sediments.
Contaminated sediments has posed an important view in aquatic ecosystem management and are issues concerned in perpetuate of healthy benthic organisms. Organic polluted bed-sediments in Labu River System and selected sites in Langat River were a suitable environment to provide an ideal condition for development and reproduction of Tubificidae. High abundance of Tubificidae indicated the study aquatic system has polluted by organic matter for a long time. Distribution of sediments grain size and organic content largely depend on the physical phenomena of erosion process and flow velocity.

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