Benthic Macroinvertebrate Composition and Diversity in the Mengkibol River, Kluang, Johor, Malaysia.

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ABSTRACT

The study was to identify the Benthic macro-invertebrate species and compositions in the urban river (Mengkibol River) to be used as biological indicators for water quality assessment and also to determine the water quality factor that influence benthic organism compositions and distributions. The study was carried out in Mengkibol River, Kluang, Johor, Malaysia between November 2008 to August 2009. Two sampling points 500 meters apart were fixed by Global Positioning Systems (GPS). Temperature was found to be an important ecological factor, which influence distribution of benthic organisms. Salinity was also considered to be a dominant limiting factor, in the distribution of benthic macro-invertebrate in the present study. In addition, conductivity was also found to be an important factor, in the distribution of benthic macro-invertebrate. DO, pH, and turbidity did not play any considerable role in benthic macro-invertebrate assemblage in this study. A total of 176 genus were identified and of these 137 genus belonged to the insect order, 13 genus to gastropoda and 26 genus to hirudinea (upstreams station). Further, a total of 171 genus were identified and of these 148 genus belonged to the insect order and 23 genus to gastropoda (downstreams station).

Keywords : biodiversity indices, richness, evenness, dominance, macroinvertebrate benthic, land use, water quality, Mengkibol River.

INTRODUCTION

Benthic macroinvertebrates, or more simply "benthos", are animals without backbones that are larger than ½ millimeter. These animals live on rocks, logs, sediment, debris and aquatic plants during some period in their life. The benthos include crustaceans such as crayfish, mollusks such as clams and snails, aquatic worms and the immature forms of aquatic insects such as stonefly and mayfly nymphs.

Benthic macroinvertebrates are good indicators of watershed health because they live in the water for all or most of their life, are easy to collect, differ in their tolerance to amount and types of pollution/habitat alteration, can be identified in laboratory, often live for more than one year; have limited mobility, and are integrators of environmental condition (Lenat and Barbour 1994, Richards and Host 1994, Sivaramakrishnan 2000, Davis 2003, Ajmal Khan, *et al.* 2004, Thompson 2005, Pacific Northwest Aquatic Monitoring Partnership, PNAMP 2007, Dinakaran and Anbalagan 2007 and Everard 2007). Its distribution highly depends on physical nature of the substratum, nutritive content, degree of stability, oxygen content and level of hydrogen sulphide (Anbuchezhian, *et. al.* 2009). The small changes in the environment will have considerable response on the benthic community and it avails to measure the degree of pollution (Coull 1973 and Fernando 1981). The presence and numbers of the different types of benthic macro-invertebrates provide accurate information about the health of a stream and watershed. The water quality, drift of aquatic insects and common dragonflies and damselflies at the Hulu Selai River, Endau-Rompin National park, Johor Malaysia were studied (Fatimah and Zakaria 2005 and Norma and Sofian 2005). As there is no study on benthic macroinvertebrate in Mengkibol River, hence the present study has been undertaken to indentify the community structure, density and diversity of benthic macroinvertebrate in relation to environmental parameters.

MATERIALS AND METHODS

Study Site

The study area was situated in Kluang Town, Johor, Malaysia. The sampling station was located in the Mengkibol River which was flowing through Kluang Town (**Figure 1**). Mengkibol river is actually an urban river with the major source of pollutant are from the domestic waste water discharge. It is also a basin to receive the industrial waste water discharge from two factories located up-stream of the sampling station. The other sources of pollution come from agricultural activities which was also located up-stream of the sampling station.

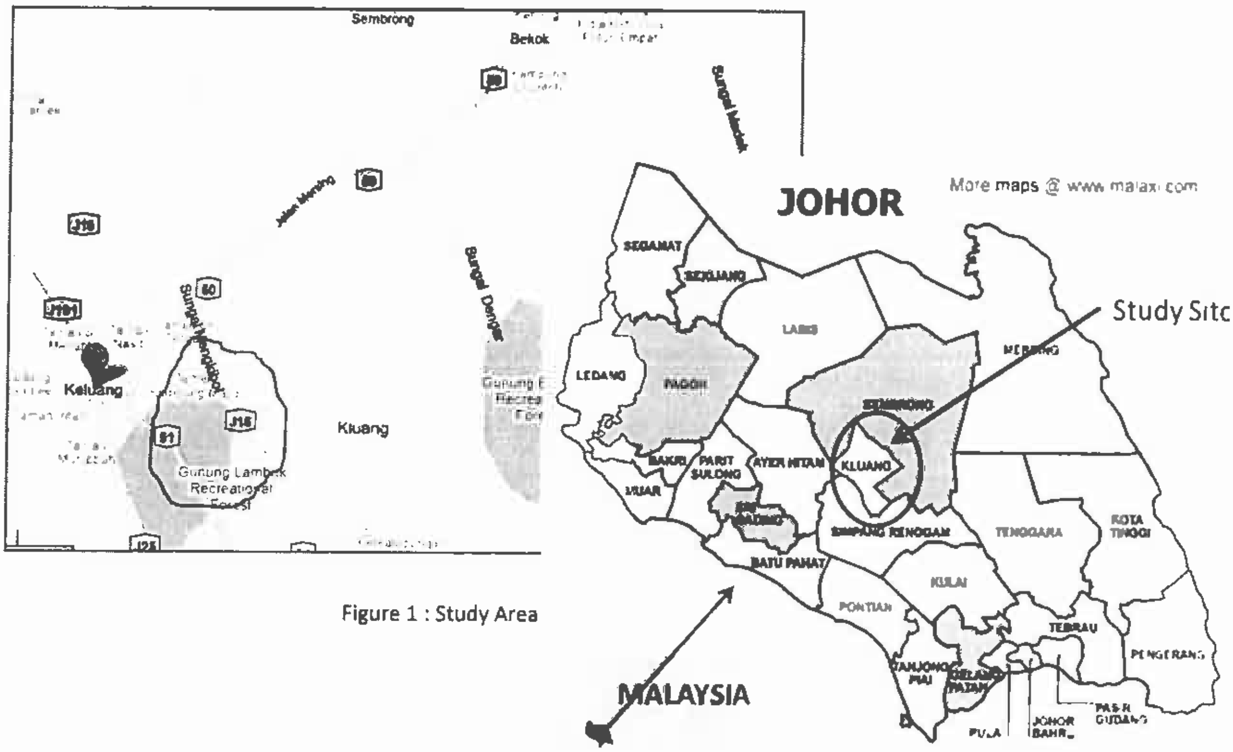

Figure 1 : Study Area

Methods

The sampling was conducted for four (4) times within November 2008 to August 2009. A 500 meter reach representative of the characteristics of the stream was selected for each sampling site or sampling reach. One sampling reach comprises of two sampling stations where one station located at the upper reach, another station at the lower reach. Surber Net with 500 micron mesh size combines a rectangular quadrate with the size of 30 cm x 30 cm (0.09 m^2) was used to sample macroinvertebrate. Each station comprises of three sampling points for macroinvertebrate sampling, one at the right bank, one at the middle and the other one at the left bank; where sampler faces against the river flow. All three samples in each sampling station was composite as one sample, so meaning that two samples for each sampling reach were obtained for macro invertebrate. One sample for upper reach and the other one for lower reach. Benthic macro invertebrate sample was preserved in 20% ethanol before sending to laboratory for identification. In the laboratory the sample was identified up to genus level (Edmondson 1959, Cook *et. al.* 1971, McCafferty 1981, Merritt and Cummins 1984, Needham 1962, Thorp and Covich 1991, Henderson 1989, Wiederholm 1983 and Robert 1953). Biodiversity Indices was analyzed using Shannon-Weiner Index (Jhingran, *et. al.* 1986) with the assistant of *Species Diversity and Richness software* developed by Henderson, P. A from University of Oxford, Department of Zoology and RMH Seaby PISCES Conservation Limited were used. While, Excel Programme were used to calculate Evenness, Richness and Dominance Indices that was based on Hill Index, Margalef Index, and Simpson Index (Loeb 1990 and Davis *et. al.* 2003) respectively. For water quality, at each station, six in-situ parameters were measured following the standard procedure of U. S. Environmental Protection Agency (2007). Preliminary sampling performed in June 2008 have shown that, water quality at upper reach and lower reach does not shows a significance differences and we believed that due the short distance (500 meters). So, in-situ water quality sampling taken only at the upper reach station. The parameters are Temperature, Conductivity, Dissolved Oxygen (DO), pH, Turbidity and Salinity which was measured by using a multi parameters probe Model YSI 6920 with 650 MDS Display/Logger as well as single parameter probe.

RESULTS

Dissolved Oxygen (DO)

The surface water dissolved oxygen content was ranging from 2.62 mg/l to 3.92 mg/l (**Figure 2**). The maximum values of dissolved oxygen content 3.92 was recorded in monsoon (November). The minimum values of dissolved oxygen content 2.62 was recorded in dry season (March).

pH

The pH values was ranged from 6.13 to 6.8 (**Figure 3**). The maximum value was recorded in June and the minimum value in November.

Temperature

The surface temperature varied between 30.7 °C to 34.4 °C (**Figure 4**). The maximum temperature was observed in premonsoon (August) and the minimum temperature was found to occur in monsoon (November).

Conductivity

The conductivity values varied between 235.95 uS/cm to 652 uS/cm (**Figure 5**). The maximum conductivity was recorded in premonsoon (August) and the minimum value in monsoon (November).

Salinity

The salinity of the surface water ranged from 0.1 ppt to 0.3 ppt (**Figure 6**). The salinity values was increased from 0.1 ppt (November 2008) to 0.3 ppt (August 2009).

Turbidity

The turbidity of water ranged from 38.2 NTU to 92.8 NTU (**Figure 7**). The maximum turbidity values was recorded in June and the minimum value in August.

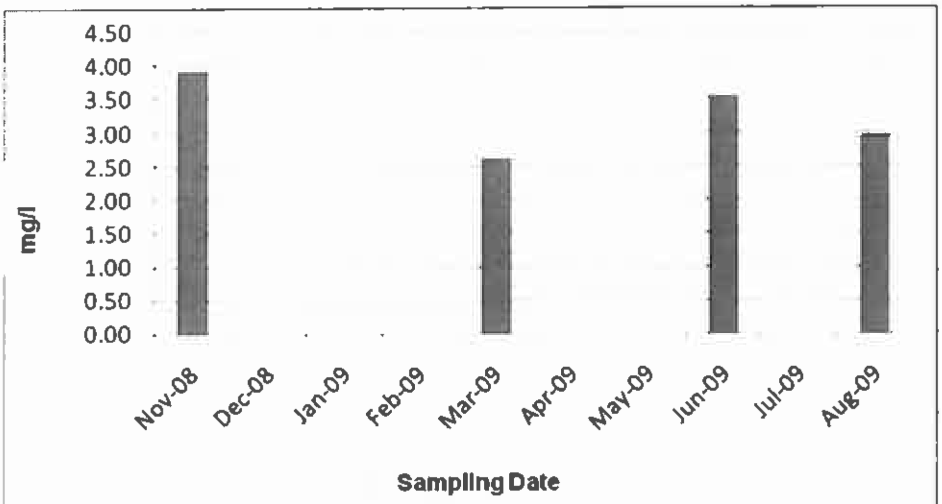

Figure 2: Seasonal variation of Dissolved Oxygen (DO)

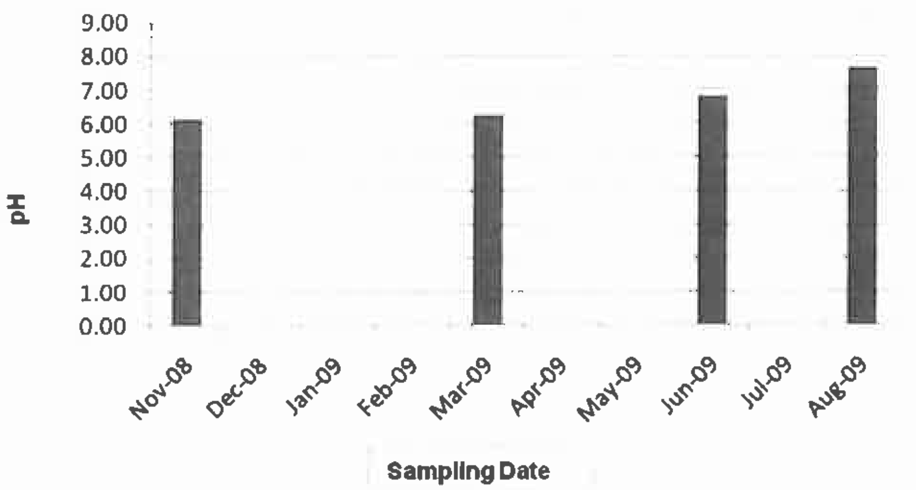

Figure 3: Seasonal variation of pH

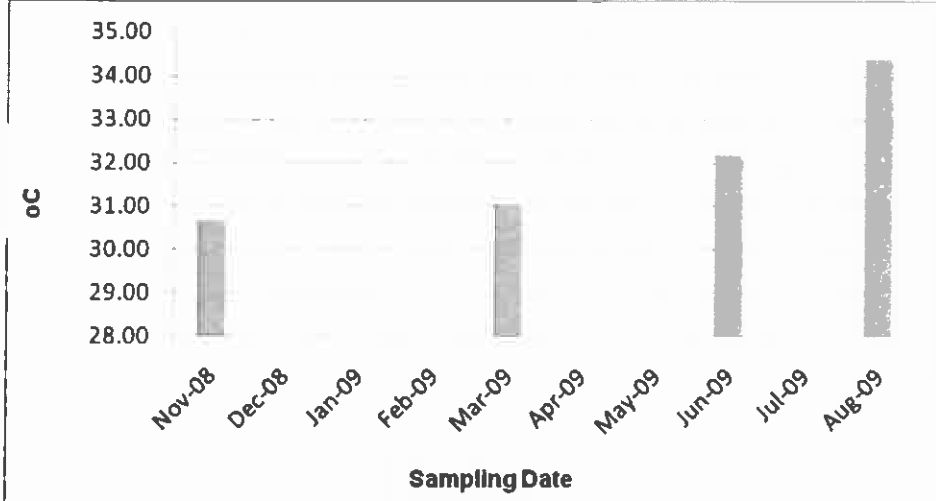

Figure 4: Seasonal variation for Temperature

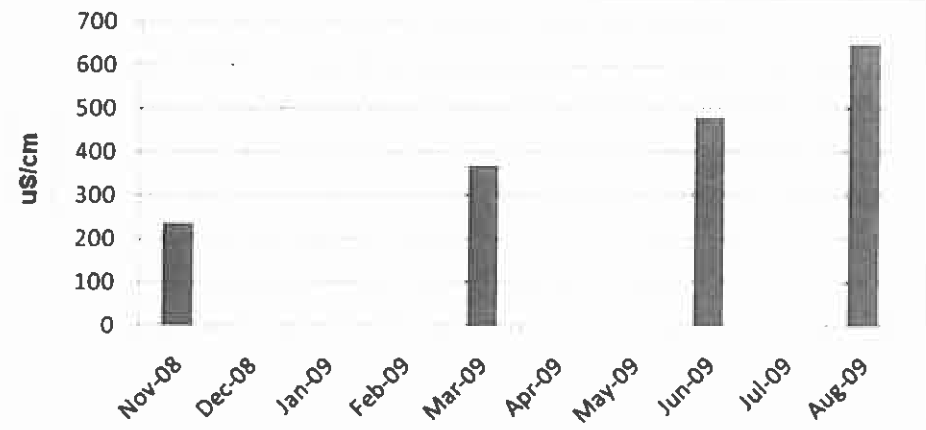

Figure 5: Seasonal variation of Conductivity

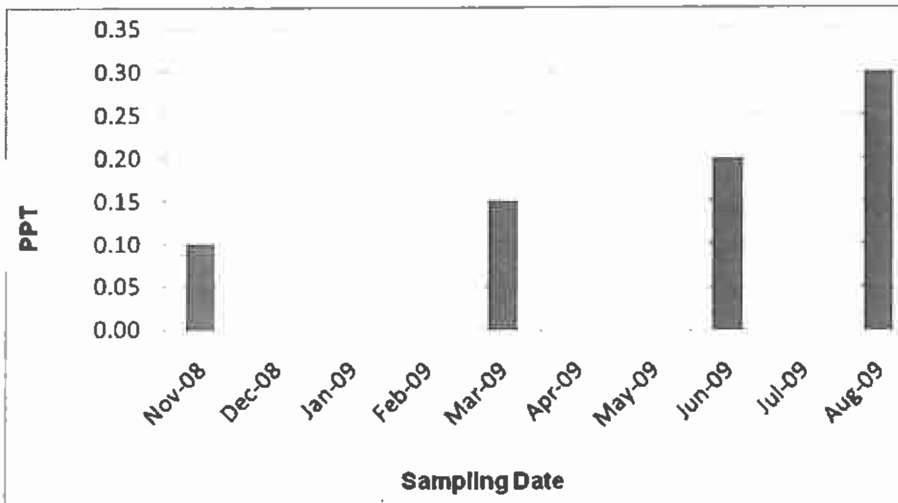

Figure 6: Seasonal variation of salinity

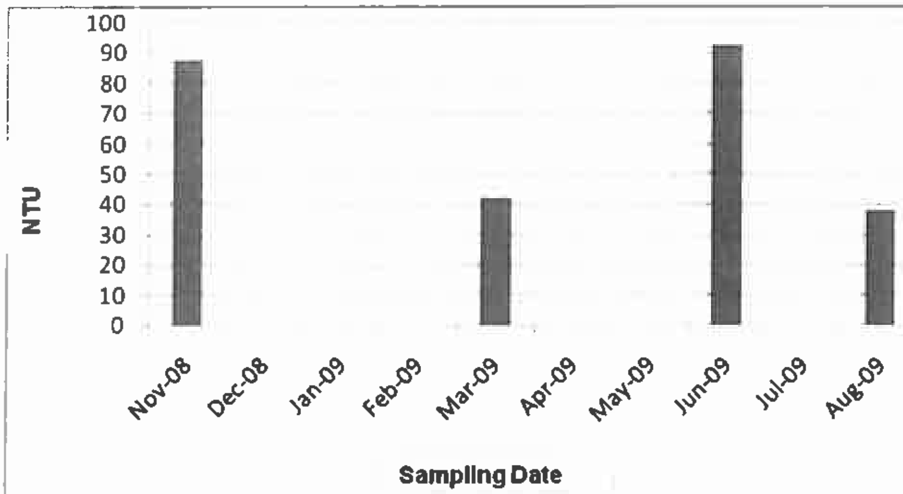

Figure 7: Seasonal variation of turbidity

Population Density

The species diversity which was based on Shannon-Wieners Index (H') varied from 0.6099 to 0.9557 at station KIBOL/U and 0.1692 to 1.3039 at station KIBOL/D respectively (**Figure 8**). High species diversity indices was observed during monsoon (November) and postmonsoon (March) seasons. Meanwhile, lower species diversity indices was observed during premonsoon (June and August) seasons. The results revealed that there was no specific pattern of diversity indices between the stations. The diversity indices for November, March and August was higher at the down stream station compared to upstreams station. However, the diversity indices for June was higher at the upstreams stations, this was believed due to riverbed disturbance resulted from river maintenance and drifted effect.

Figure 9 shows the dominance index (Simpsons Index) where in general, certain species of benthic macroinvertebrate was dominance in June and August. The dominance index was varied between 0.3333 in November to 0.7181 in August at station KIBOL/U and between 0.2949 in March to 0.9217 in June at station Kibol/D respectively.

The species richness varied from 0.7015 to 1.3648, 0.2176 to 1.5595 (**Figure 10**). Species richness was more during March and less during June at the downstreams stations. Meanwhile, the species richness was more during June and less during March at upstream station.

Species evenness varied from 0.3789 to 0.8699, 0.2441 to 0.8102 (**Figure 11**). Species eveness was high during monsoon (November) and postmonsoon or dry seasons (March) and was low during premonsoon (June and August).

Figure 12 shows the benthic macroinvertebrate density, the population density at station KIBOL/U and KIBOL/D was found to be varied from 26 No./m^2 to 267 No./m^2, 48 No./m^2 to 367 No./m^2 respectively. In general, benthic macroinvertebrate was more in June and less in November or during monsoon seasons.

There was only 3 benthic macroinvertebrate classess recorded at the upstream station and 2 classess recorded at downstreams station (**Figure 13 & 14**). A total of 176 genus were identified of this 137 genus belonged to insecta, 13 genus to gastropoda and 26 genus to hirudinea (**Table 1**). Meanwhile, a total of 171 genus were identified of this 148 genus belonged to insecta and 23 genus to gastropoda (**Table 2**).

All the indices have shown the distinct variation between stations and seasons. However, there was a correlation between diversity, richness, eveness and density indices where the higher indices was occcured during the same month (November and March). The season was not influence benthic macroinvertebrate abundance and occurrence.

Table 1 : Macroinvertebrate Taxa for Sungai Mengkibol Upper Reach

						Sampling Date			
Phylum	**Class**	**Order**	**Family**	**Subfamily**	**Genus**	**Nov-08**	**Mar -09**	**Jun -09**	**Aug -09**
Arthropoda	Insecta	Odonata	Corduliidae		Helocordulia	0	0	0	0
Arthropoda	Insecta	Odonata	Gomphidae		Arigomphus	0	1	0	0
Arthropoda	Insecta	Odonata	Gomphidae		Ophiogomphus	0	1	4	1
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae		4	46	29	49
Arthropoda	Insecta	Diptera	Tipulidae		Tipula	1	0	0	1
Mollusca	Gastropoda	Mesogastropoda	Lymnaeidae		Lymnaea	0	0	0	0
Mollusca	Gastropoda	Mesogastropoda	Physidae		Physa	2	0	2	0
Mollusca	Gastropoda	Mesogastropoda	Viviparidae		Tulotoma	0	0	1	5
Mollusca	Gastropoda	Mesogastropoda	Pleuroceridae		Goniobasis	0	0	2	0
Mollusca	Gastropoda	Mesogastropoda	Bulimidae		Tryonia	0	0	1	0
Annelida	Hirudinea		Hirudinidae			0	24	0	2
						7	72	39	58

Table 2 : Macroinvertebrate Taxa for Sungai Mengkibol Lower Reach

						Sampling Date			
Phylum	**Class**	**Order**	**Family**	**Subfamily**	**Genus**	**Nov-08**	**Mar -09**	**Jun -09**	**Aug -09**
Arthropoda	Insecta	Odonata	Corduliidae		Helocordulia	1	2	0	0
Arthropoda	Insecta	Odonata	Gomphidae		Arigomphus	0	0	0	0
Arthropoda	Insecta	Odonata	Gomphidae		Ophiogomphus	0	0	0	0
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae		16	7	95	23
Arthropoda	Insecta	Diptera	Tipulidae		Tipula	4	0	0	0
llusca	Gastropoda	Mesogastropoda	Lymnaeidae		Lymnaea	0	1	0	2
Mollusca	Gastropoda	Mesogastropoda	Physidae		Physa	1	0	0	1
Mollusca	Gastropoda	Mesogastropoda	Viviparidae		Tulotoma	5	2	4	6
Mollusca	Gastropoda	Mesogastropoda	Pleuroceridae		Goniobasis	0	1	0	0
Mollusca	Gastropoda	Mesogastropoda	Bulimidae		Tryonia	0	0	0	0
Annelida	Hirudinea		Hirudinidae			0	0	0	0
						27	13	99	32

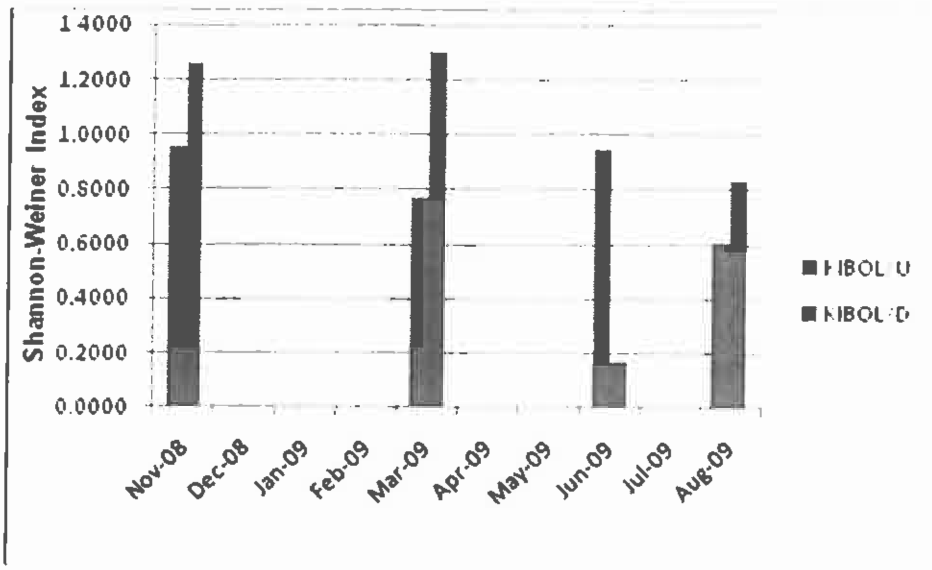

Figure 8: Seasonal Variation-Benthic macroinvertebrate Diversity

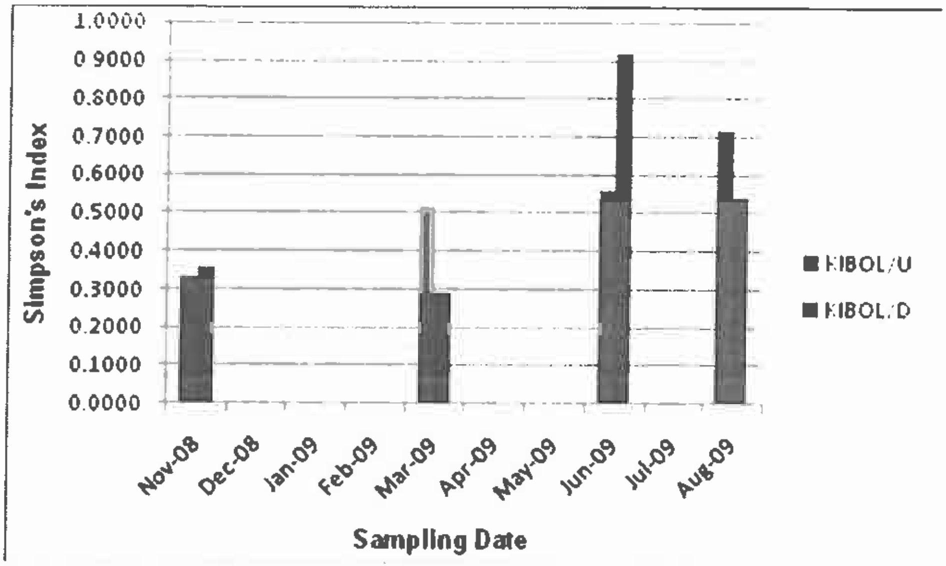

Figure 9: Seasonal Variation-Benthic macroinvertebrate Dominance

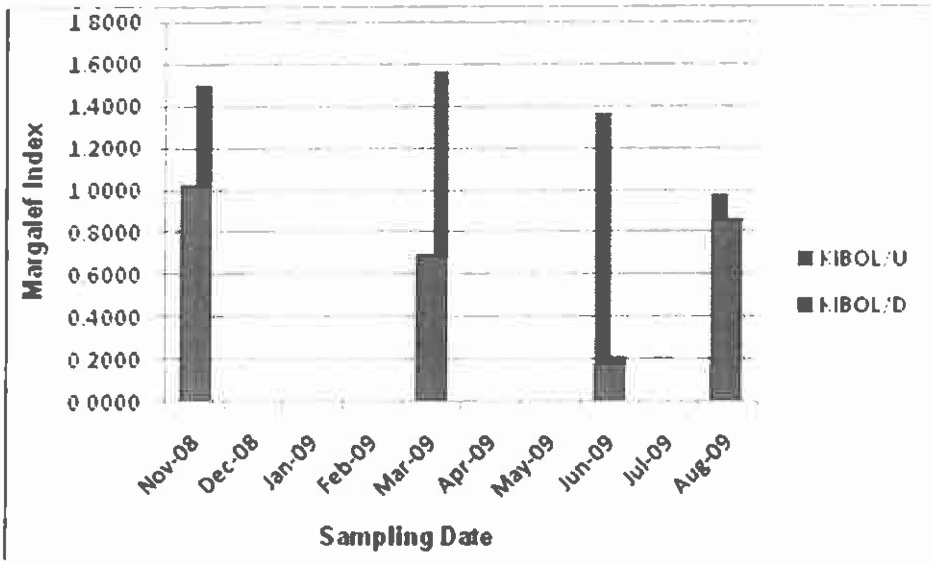

Figure 10: Seasonal Variation-Benthic macroinvertebrate Richness

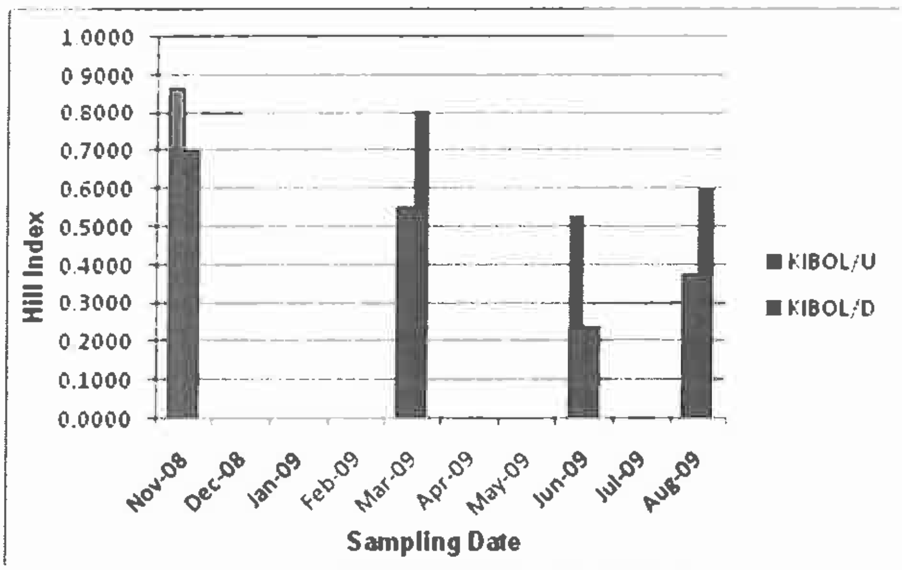

Figure 11: Seasonal Variation-Benthic macroinvertebrate Evenness

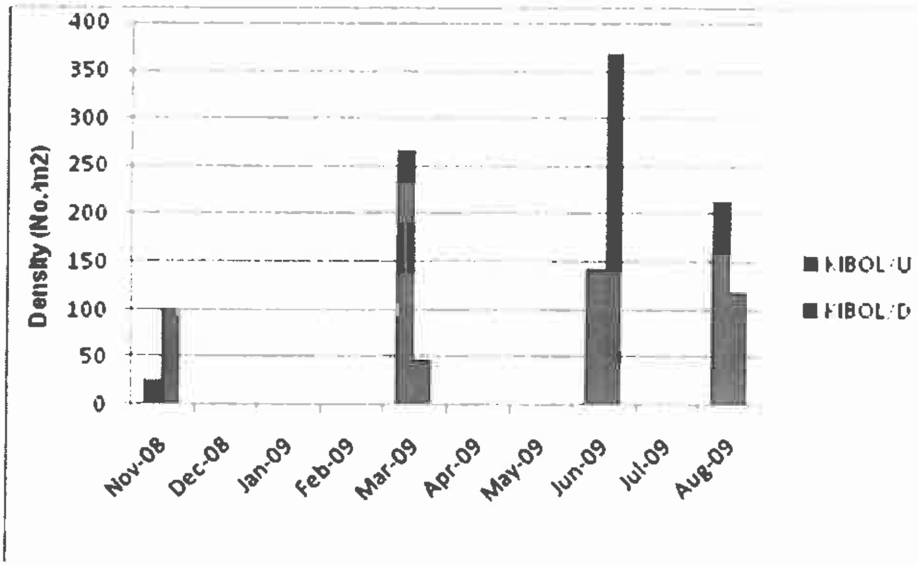

Figure 12: Seasonal Variation-Benthic macroinvertebrate Density

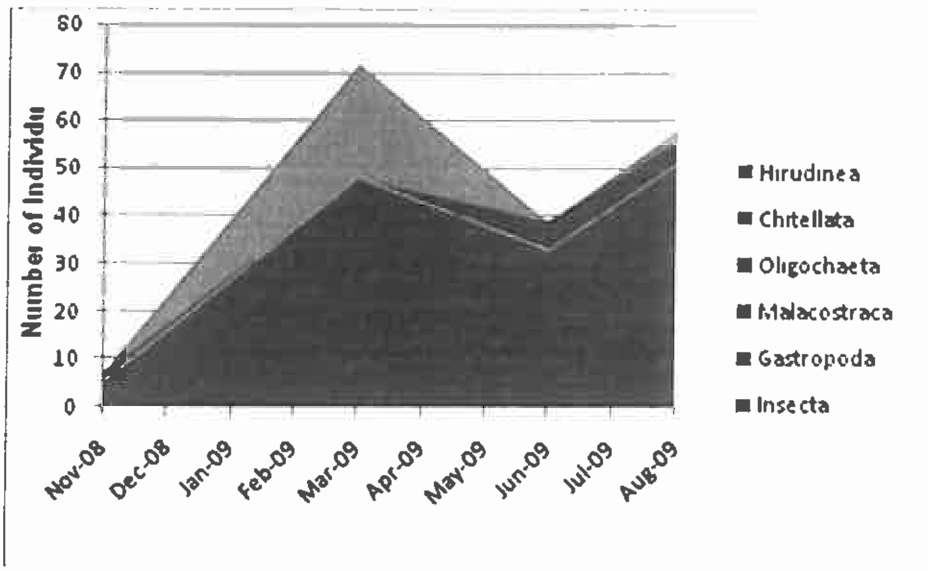

Figure 13: Contribution of Benthic macroinvertebrate at Station Mengkibol (Upper)

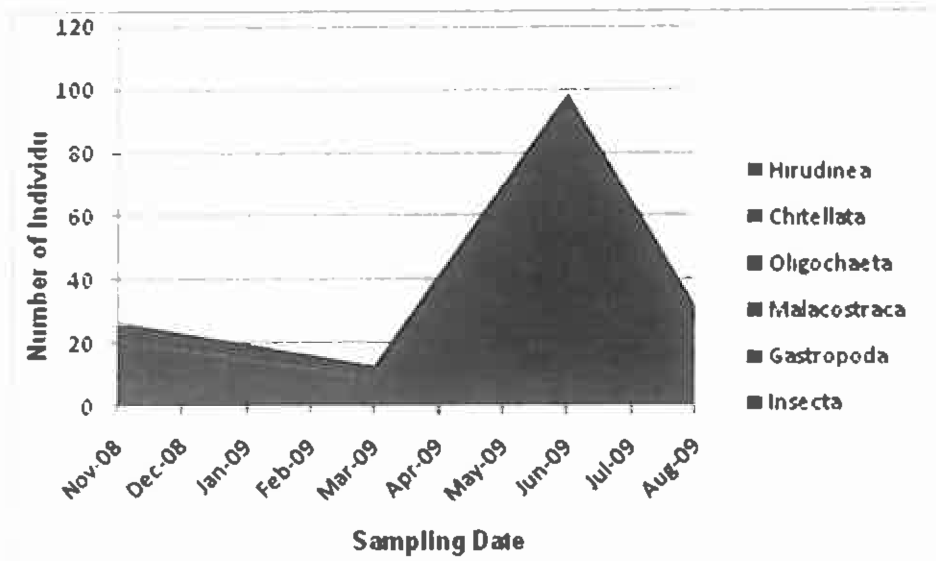

Figure 14: Contribution of Benthic macroinvertebrate at Station Mengkibol (Lower)

DISCUSSION

In this study it could be seen that there are characteristics seem to have influenced by physico-chemical, biological characteristics and land uses. The species composition of the benthic macroinvertebrate in the study showed the dominants of insecta followed by gastropoda and hirudinea. Diptera especially Chironomidae are the most abundance interms of insecta and a small numbers of odonata. This result was in-agreement with Morse, *et. al.* (2003) finding where they found that density of Chironomidae and *Hydropsyche* was higher in the more urbanized catchments. This is because some taxa of the Chironomidae and *Hydropsyche* are known to tolerate high levels of silt. The finding from Davis (2003) also in-line with the result obtained from this study where he found out that Ephemeroptera, Plecoptera and Trichoptera (EPT), Crustacea, and Isopoda order were much higher at the reference site or unpolluted area, while Blood-red chironomids and other dipterans (e.g, Psychodidae and Eristalis) were abundant at severely polluted sites. So, it could be deduced that Chironomidae is an indicator of urban or polluted river, while EPT species for clean river. Meanwhile, Hirudinea can also be use as an indicator for urban or polluted river. This was in-agreement with Azrina *et. al.* (2006) finding where they found that the up-stream of Langat River was dominated by Ephemeroptera and

Chironomid dipterans, while donstream of the river was mainly inhabited by the resistant Oligochaeta worms *Limnodrilus* spp. and *Branchiodrilur* sp. and Hirudinea.

The results obtained have shown that temperature is an important ecological factor, which influence distribution of benthic organisms. High temperature in August resulted in low benthic macroinvertebrate diversity, richness and evenness index. Low density and dominance of benthic macroinvertebrate recorded in November due to heavy downpour. Salinity is also considered to be a dominant limiting factor, in the distribution of benthic macroinvertebrate of the present study. This was in-agreement with Anbuchezhian, *et. al* 2009 where they found in their study in Coastal Belt of Thondi, Southeast Coast of India that the salinity determines the distribution of benthic macroinvertebrate in the area. Similarly in this study, the lowest salinity level in November caused low benthic macroinvertebrate density in November. Further, the conductivity also found to be an important factor, in the distribution of benthic macroinvertebrate of the present study. High conductivity in August resulted in low benthic macroinvertebrate diversity, richness and evenness index. DO, pH and turbidity did not play any considerable role in benthic macroinvertebrate assemblage of this study.

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