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

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Abstract

Benthic macroinvertebrates, or more simply "benthos", are animals without backbones that are larger than ½ millimeter. The identification of benthic population and assemblages can be use as biological indicators to assess the water quality. The index parameters can be useful for assessing the fishery potentials, interaction and intertidal ecologies. The study area is situated in Kluang, Johor, Malaysia. The sampling station is located at the Madek River which flows through a logging area in the Kluang Forest Reserve. The sampling was conducted four (4) times within November 2008 to August 2009. Surber Net measuring 500 micron mesh size combined with a rectangular quadrate of 30 cm x 30 cm (0.09 m^2) were used to sample the macroinvertebrates. Each station comprised of three sampling points for macroinvertebrate sampling; with one situated at the right bank, one in the middle of the river and the third sampling point is located at the left bank. All three samples from each sampling station were composited as one sample. Biodiversity Indices was analyzed using the *Species Diversity and Richness software* developed by Henderson, P. A. from the University of Oxford, Department of Zoology and RMH Seaby PISCES Conservation Limited. For water quality, at each station, six in-situ parameters were measured following the standard procedure of U. S. Environmental Protection Agency. The parameters such as Temperature, Conductivity, Dissolved Oxygen (DO), pH, Turbidity and Salinity were measured using a multi parameter probe Model YSI 6920 with 650 MDS Display/Logger as well as a single parameter probe. A total of 57 genus were identified from the upstream station, where 53 genus were classified as Insecta and 4 genus as Malacostraca. Meanwhile, a total of 47 genus were identified from the downstream station, where 39 genus were classified as Insecta, 6 genus as Malacostraca and 2 genus as Gastropoda. The monthly variations of population density, species diversity, richness, evenness, dominance on benthic macroinvertebrate assemblage and river water quality were investigated within November 2008 to August 2009.

Key words : Macroinvertebrate benthic-Biodiversity indices - Land use - Water quality

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, molluscs 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 [1,2,3,4,5,6,]. The distribution highly depends on physical nature of the substratum, nutritive content, level of stability, oxygen content and level of hydrogen sulphide [7]. The small changes in the environment will have considerable response on the benthic community and it avails to measure the degree of pollution [8,9]. 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 has been studied [10,11]. There are no studies being conducted on the benthic macroinvertebrates in Mengkibol River, hence the present study was undertaken to identify the community structure, density and diversity of benthic macroinvertebrates in relation to environmental parameters.

MATERIALS AND METHODS

Study Site

The study area is situated in Kluang, Johor, Malaysia. The sampling station is located in the Madek River which flows through a logging area located in Kluang Forest Reserve (**Figure 1**). Logging activities were carried out legally and in an appropriate manner, and adhere to international standards and good logging practices. However, there are still possible impacts on the ecology such as, siltation to the receiving river body, habitat disturbances and changes in river morphology.

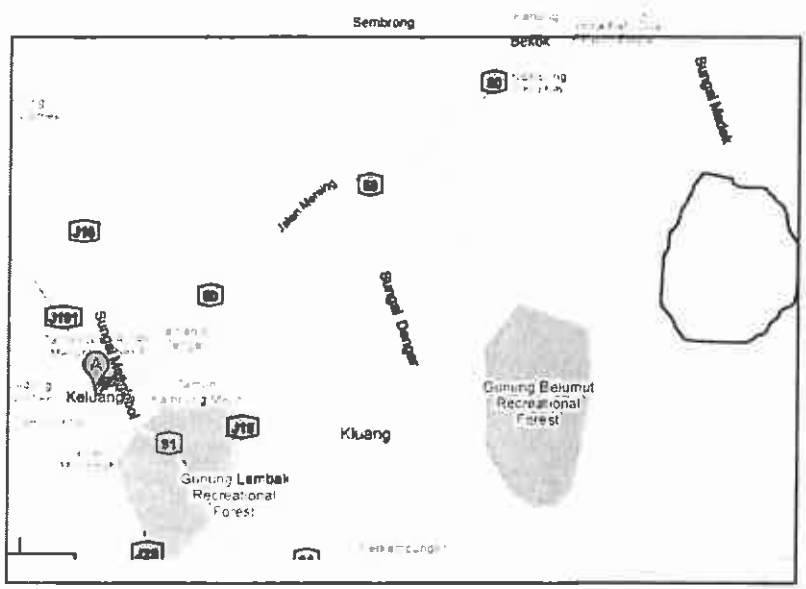

Figure 1 : Study Area

Methods

The sampling was conducted 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 is located at the upper reach, while the other station is situated at the lower reach. Surber Net measuring 500 micron mesh size combined with a rectangular quadrate of 30 cm x 30 cm (0.09 m^2) was used to sample macroinvertebrates. Each station comprised of three sampling points for macroinvertebrate sampling; with one situated at the right bank, one in the middle of the river and the third sampling point is located at the left bank. While collecting the samples, the sampler faced against the river flow. All three samples from each sampling station were composited as one sample. Hence, there are two composited samples of macro invertebrate for each sampling reach, with one composite sample representing the upper reach and lower reach each. The benthic macro invertebrate samples were preserved in 20% ethanol before sending to laboratory for identification. In the laboratory the sample was identified up to genus level [12,13,14,1516,1718,19,20]. Diversity Indices was analyzed using Shannon-Weiner Index, Evenness, Richness and Dominance Indices based on Hill Index, Margalef Index, and Simpson Index respectively 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 and Excel Programme [21,22,4]. For water quality, at each station, six in-situ parameters were measured following the standard procedure of U. S. Environmental Protection Agency [23]. Preliminary sampling performed in June 2008 have shown that, water quality at both the upper reach and lower reach did not show significant differences and we believe this is due to the short sampling distance (500 meters). So, in-situ water quality sampling was taken at the upper reach station only. The parameters such as Temperature, Conductivity, Dissolved Oxygen (DO), pH, Turbidity and Salinity were measured using a multi parameter probe Model YSI 6920 with 650 MDS Display/Logger as well as a single parameter probe.

RESULTS

The surface water dissolved oxygen content ranged from 7.25 mg/l to 8.36 mg/l (**Figure 2**). The maximum value of 8.36 dissolved oxygen content was recorded during monsoon period (November). The minimum value of 7.57 dissolved oxygen content was recorded during the pre-monsoon season (August). The dissolved oxygen values did not show any distinct variation between stations.

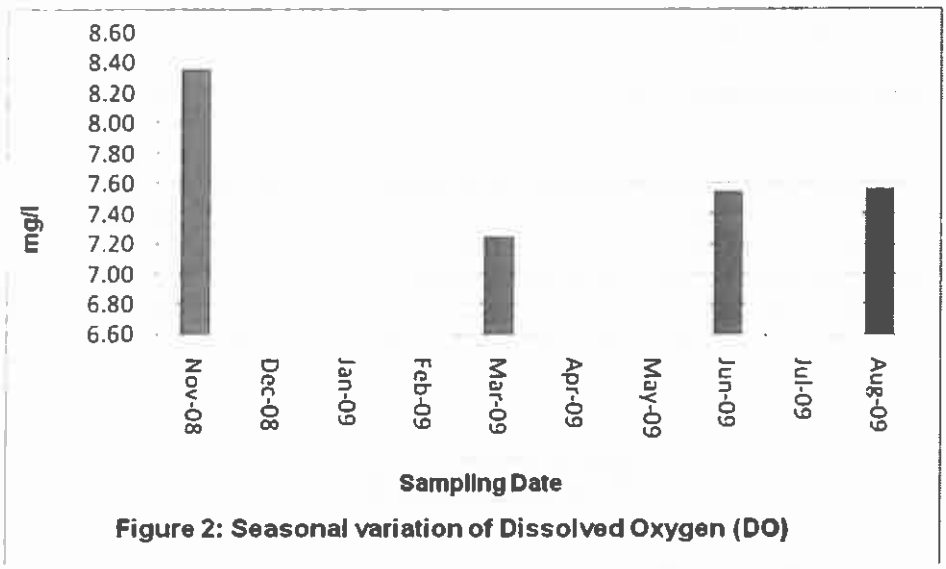

Figure 2: Seasonal variation of Dissolved Oxygen (DO)

The pH values ranged from 5.48 to 7.49 (**Figure 3**). The maximum value was recorded in August while the minimum value was recorded in March.

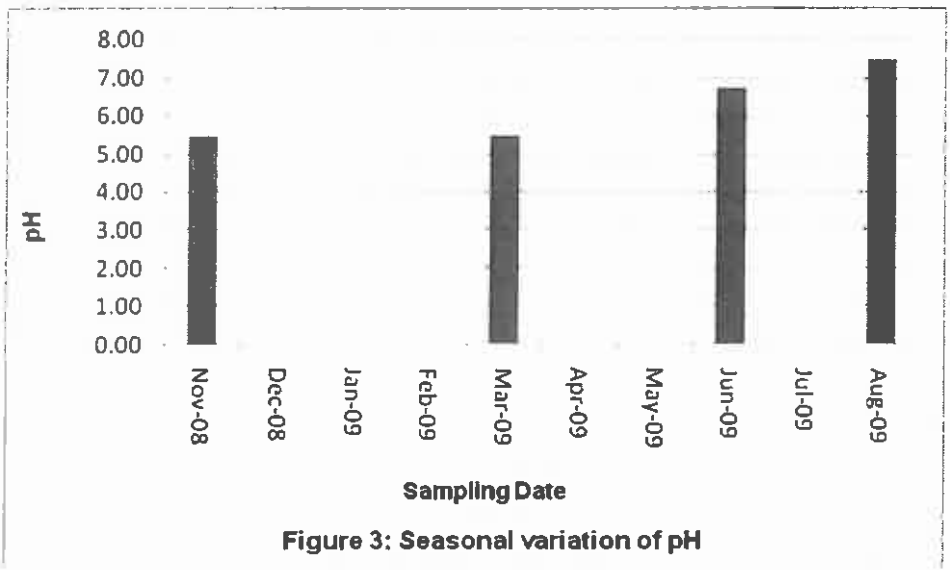

Figure 3: Seasonal variation of pH

The surface temperature varied between 24.5 °C to 27.0 °C (**Figure 4**). The maximum temperature was observed during the pre-monsoon (August) and the minimum temperature was noted during the drought season (March).

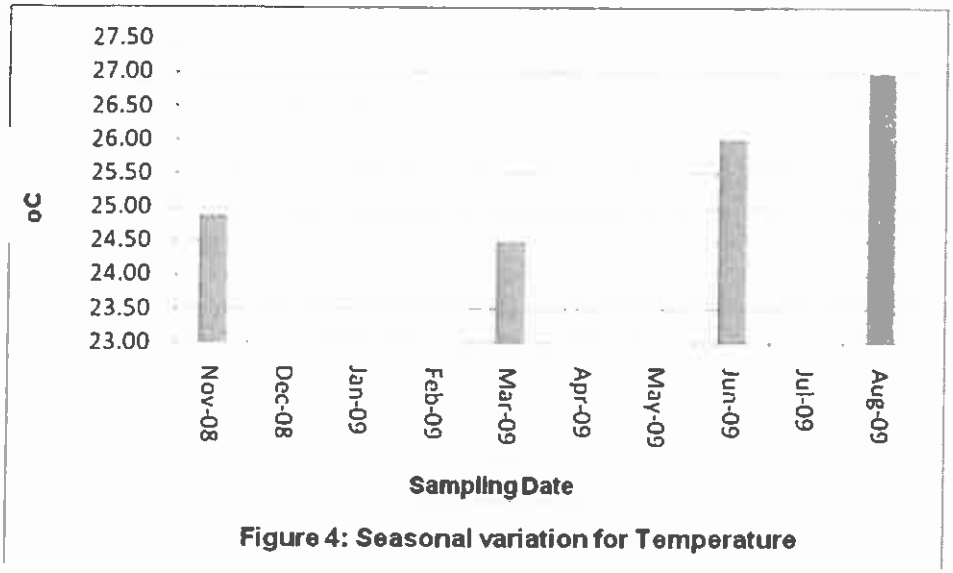

Figure 4: Seasonal variation for Temperature

The conductivity values varied between 24.3 uS/cm to 28.7 uS/cm (**Figure 5**). The maximum conductivity was recorded during the pre-monsoon period (August) and the minimum value during the drought season (March).

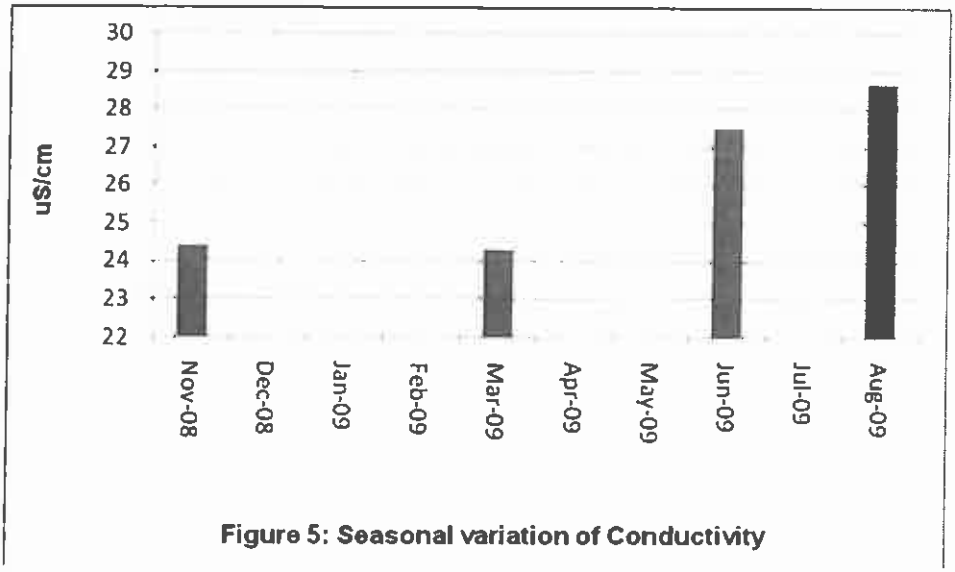

Figure 5: Seasonal variation of Conductivity

Salinity was not detected at every sampling occasions. While, the water turbidity ranged from 4.5 NTU to 26.2 NTU (**Figure 7**). The maximum turbidity values were recorded in March and the minimum values were recorded in August.

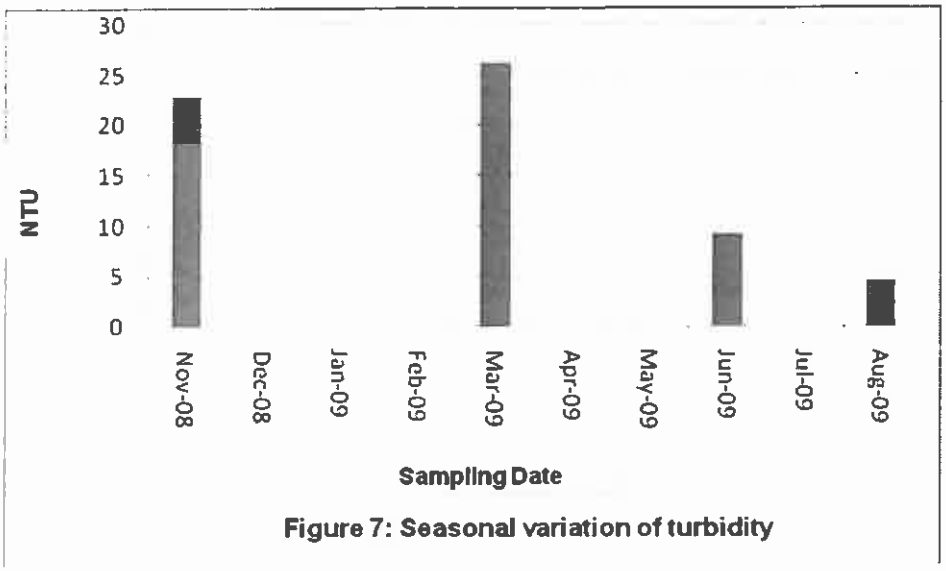

Figure 7: Seasonal variation of turbidity

Population Density

The species diversity analysis based on Shannon-Wieners Index (H') varied from 0 to 1.80 at station MADEK/U and 0 to 1.68 at station MADEK/D respectively (**Figure 8**). High species diversity indices were observed during the pre-monsoon (August) and monsoon (November) seasons. Meanwhile, no species diversity indices was recorded during the drought season (March) and in June (station MADEK/U) because there was only one species caught. The results revealed that there were no specific pattern of diversity indices between the stations. The diversity indices for August and November were higher at the up stream station compared to down-stream station. However, the diversity indices for June was higher at the down-stream station. This is believed to be due to riverbed disturbances from river maintenance and drifted effects.

Figure 9 shows the dominance index (Simpsons Index) where in general, certain species of benthic macroinvertebrates were dominant in August and November. The dominance index varied between 0 in March and June to 0.19 in August at station MADEK/U and between 0 in March to 0.33 in August at station MADEK/D respectively.

The species richness varied from 0 to 2.50 at station MADEK/U and 0 to 2.28 at station MADEK/D respectively (**Figure 10**). Species richness was higher during November and lesser during March and June at the up-streams stations. Meanwhile, the species richness was higher during June and lesser during March at down-stream station.

Species evenness varied from 0 to 0.92 at station MADEK/U and 0 to 0.95 at station MADEK/D respectively (**Figure 11**). Species eveness was high during monsoon (November) but was recorded at a lower rate during the drought season (March and June).

Figure 12 shows the benthic macroinvertebrate density, where the population density at station MADEK/U and MADEK/D were found to vary from 3.7 No./m^2 to 151.85 No./m^2, 3.7 No./m^2 to 103.7 No./m^2 respectively. In general, benthic macroinvertebrate was higher in August and lesser in March or during drought seasons.

There were only 2 benthic macroinvertebrate classess recorded at the upstream station and 3 classess recorded at downstream station (**Figure 13 & 14**). A total of 57 genus were identified from the upstream station, where 53 genus were classified as Insecta and 4 genus as Malacostraca. Meanwhile, a total of 47 genus were identified from the downstream station, where 39 genus were classified as Insecta, 6 genus as Malacostraca and 2 genus as Gastropoda. Species diversity, dominance, richness, evenness and density indices result shows similar patterns where higher indices were recorded during November and August. There were no species diversity, dominance, richness, evenness and density indices recorded for March (drought season) and only down stream station recorded the indices values for June.

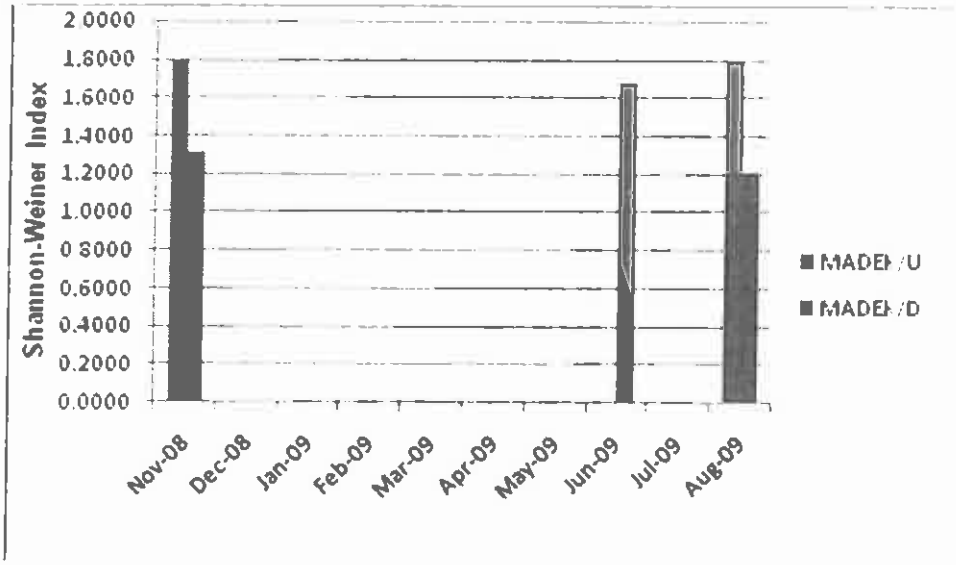

Figure 8: Seasonal Variation-Benthic macroinvertebrate Diversity

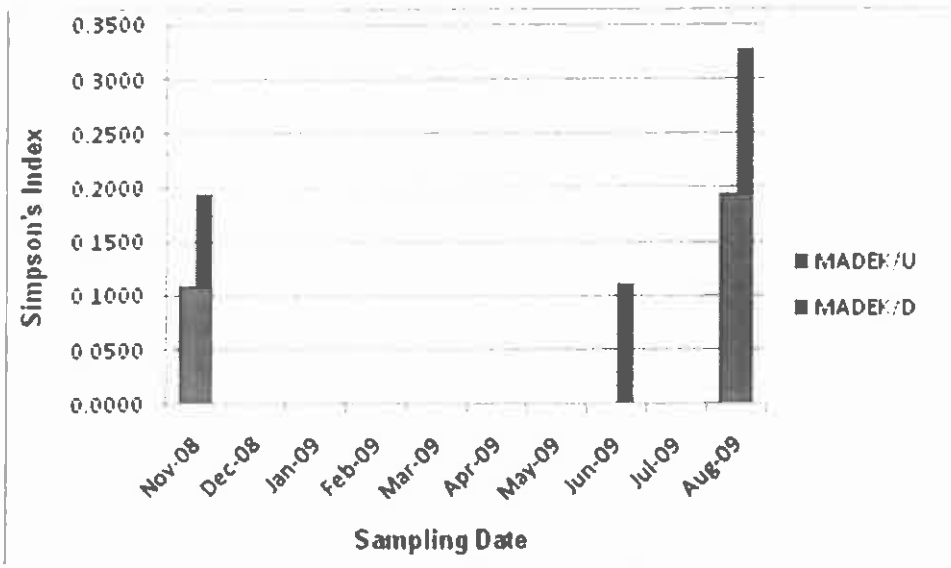

Figure 9 Seasonal Variation-Benthic macroinvertebrate Dominance

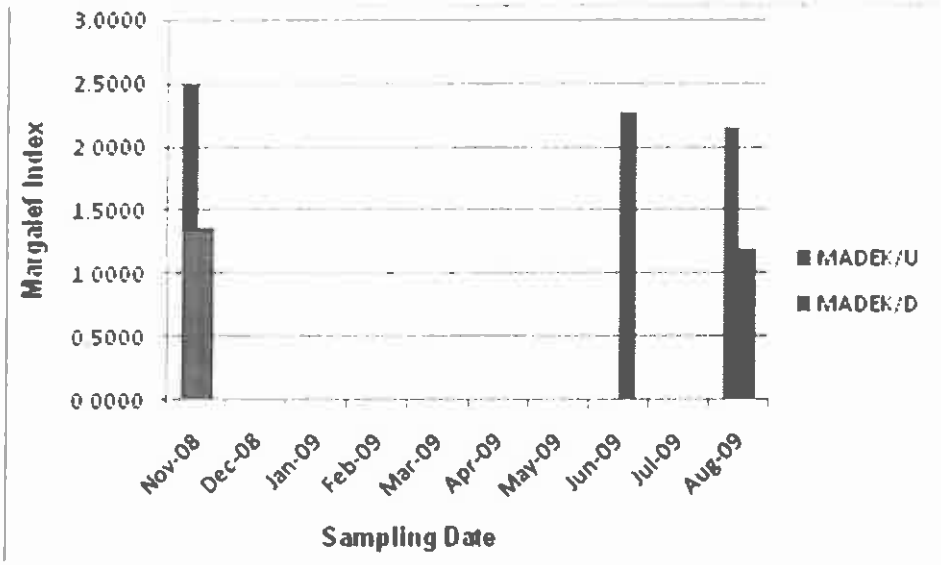

Figure 10: Seasonal Variation-Benthic macroinvertebrate Richness

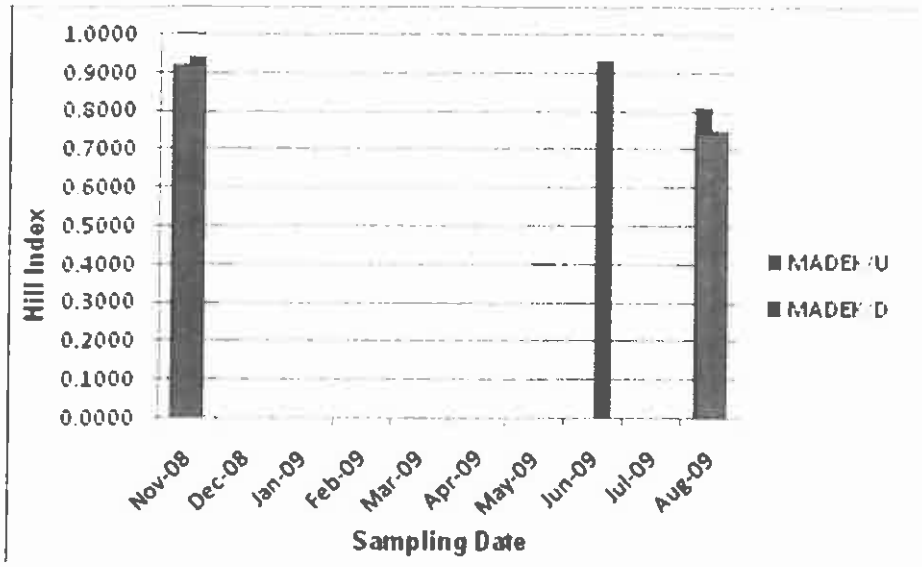

Figure 11: Seasonal Variation-Benthic macroinvertebrate Evenness

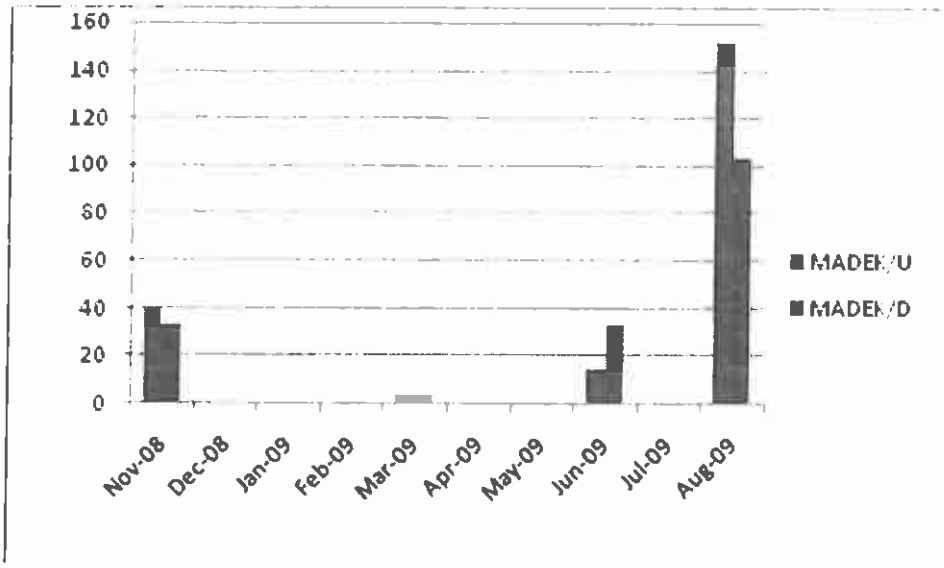

Figure 12: Seasonal Variation-Benthic macroinvertebrate Density

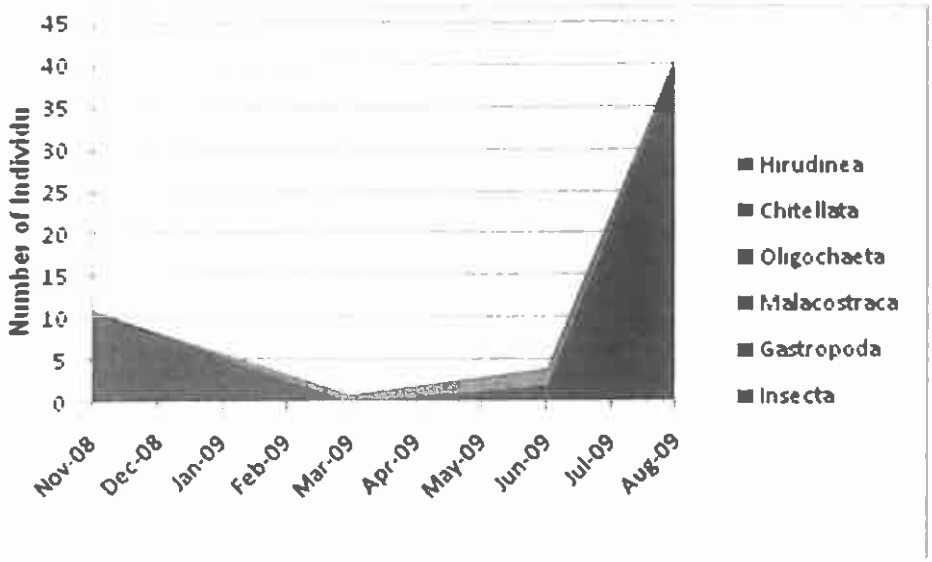

Figure 13: Contribution of Benthic macroinvertebrate at Station Madek (Upper)

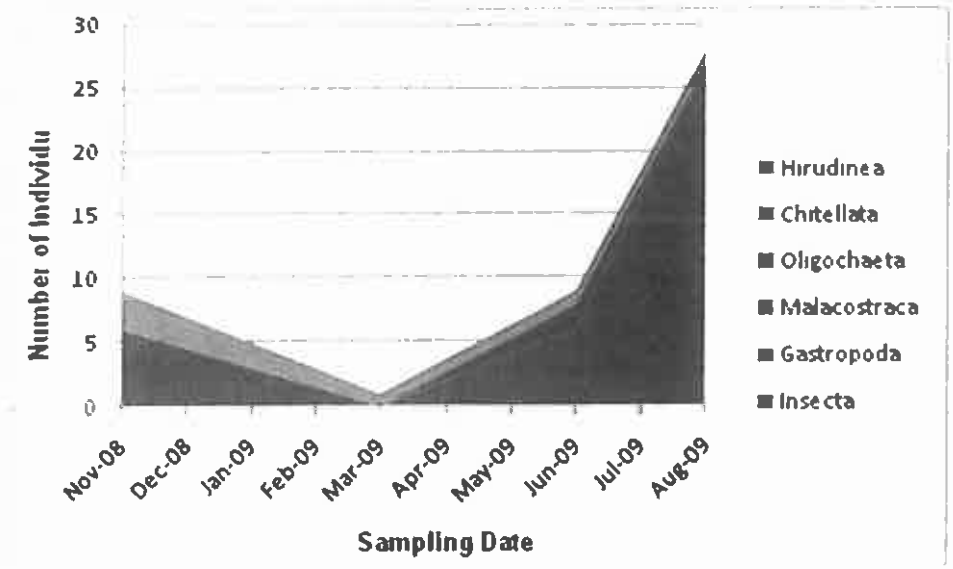

Figure 14: Contribution of Benthic macroinvertebrate at Station Madek (Lower)

DISCUSSION

In this study it could be seen that the measured parameters were influenced by the physico-chemical, biological characteristics and land uses as well as the seasons. The species composition of the benthic macroinvertebrates in the study revealed that, Insecta is the dominant genus, followed by Malacostraca and Gastropoda. Ephermeroptera and Diptera are the most abundant under the genus Insecta with a small number of Decapoda and Odonata.

Davis found out that EPT, Crustacea, and Isopoda 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 [4]. Azrina did a similar study in Langat River and found that the upstream of the Langat River was dominated by Ephemeroptera and Chironomid dipterans, while downstream was mainly inhabited by the resistant Oligochaeta worms *Limnodrilus* spp. and *Branchiodrilur* sp. and Hirudinea [24].

Temperature is an important ecological factor, which influence distribution of benthic organisms. Very low temperature in March(less than 24.5°C) resulted in zero benthic macroinvertebrate diversity, dominance, richness and evenness index. Low density of benthic macroinvertebrate recorded in November could be due to heavy downpour and low temperature. Low density of benthic macroinvertebrate recorded in March and June could be due to low temperature, low dissolved oxygen, and high turbidity. High density of benthic macroinvertebrate recorded in August may be due to the appropriate temperature (27°C), high dissolved oxygen, and low turbidity. Other than that, the conductivity and pH were found to be weak influential factors, in the distribution of benthic macroinvertebrates in this study. It was strengthened by Norma-Rashid and Sofian-Azirun through a survey at 12 riverine localities in Selai area on dragonflies and damselflies, where they found out that there is a clear trend of tolerance for high pH values among damselflies [11].

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