A Preliminary Benthic Macroinvertebrate Survey of the Gunung Belumut Recreational Forest, Kluang, Johor.

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ABSTRACT

The macro invertebrate community structure was surveyed at Sungai Dengar sub-catchment which was located in Gunung Belumut Recreational Forest in Kluang , Johor from 08 to 11 August 2009 by using surber net. River water quality and river features were also identified. The surface water dissolved oxygen content ranged from 7.11 mg/l to 8.06 mg/l. The maximum value of 8.06 dissolved oxygen content was recorded at site C (palm oil plantation area). The minimum value of 7.11 dissolved oxygen content was recorded at site A (Gunung Belumut). The pH values ranged from 7.47 to 7.89. The maximum value was recorded at site B (pristine area) while the minimum value was recorded at site A (Gunung Belumut). The surface temperature varied between 23.6 °C to 25.3 °C. The maximum temperature was observed at site C and the minimum temperature was noted at site A. The conductivity values varied between 27.4 uS/cm to 29.10 uS/cm. The maximum conductivity was recorded at site C and the minimum value at site B. The water turbidity ranged from 9.28 NTU to 22.85 NTU. The maximum turbidity values were recorded at site B and the minimum values were recorded at site A. The dissolved oxygen, pH, temperature and conductivity values did not show any distinct variation between stations except turbidity. Based on the results, it shows that Diptera particularly Chironomidae were abundant at the pristine-pristine site which is the most up-stream (undisturbed) located on the Gunung Belumut and also at the station B2 which was pristine station located at the foot of Gunung Belumut but nevertheless the numbers of individual taxa are much higher at polluted sites (C1 & C2). Pristine-pristine site also recorded an abundant of Mollusca particularly from the family of Atyiedae and Palaemonidae. The results obtained also shows an abundant of the genus of Pseudiron, Potamanthus and Ephemerella from Ephermeroptera order at the polluted sites (C1 & C2), beside Chironomidae. Odonata,

Trichoptera Coleoptera and Mesogastropoda were the orders least found at all the sampling stations. Only five (5) individual Odonata, twelve (12) individual Trichoptera, ten (10) individual Coleoptera and one (1) individual Mesogastropoda were collected. On the other hand, only one (1) family (Perlidae) and one (1) genus (Neoperla) were found from the Plecoptera order at all the sampling stations and one (1) family (Lymnaeidae) from the genus Lymnaea was collected at station B1. Based on the above results, it could be implied that, macro invertebrate community structure was not dependent solely on water quality of the river but it was also dependent on other factors such as habitat characteristics, river morphology, river riparian, canopy cover, etc., especially river substrate compositions.

INTRODUCTION

The concern over river water quality in Malaysia has risen over the last few decades as rivers play an important role in our daily life as well as to other living organisms. In addition, river also has a very fragile ecosystem (Pauzi-Abdullah *et. al*, 2000). Unfortunately, clean fresh water is becoming scarce. This was due to various kinds of land development which have taken a toll on our riverine habitats, the very systems that provide sustenance to our socio-economic well-being and to the natural inhabitants of our forests and aquatic environment (Fatimah and Zakaria-Ismail, 2005). When talking about healthy eco-system in river rehabilitation process, it was not only observing the water quality of the river alone but also river eco-systems. Changes of river quality as well as river eco-systems, depends very much on land use activities in the catchment areas. Various pollutants in a catchment area will determine the extent of river water quality as well as river eco-systems. A healthy river is said to be that which favours aquatic life in the river.

Good physico-chemical quality of river water does not ensure the health of aquatic life in the rivers and clean water itself is not a sufficient indicator for the health of the rivers. The presence and healthy living of aquatic species in the rivers are the key references for river rehabilitation. In order to determine the health of the river not only the physical and chemical qualities of the health of the river must be taken into account but also the biological aspects.

Biological monitoring is an essential element needed to assess the environmental health of aquatic eco-systems. Biological organisms are diagnostic in determining the health of aquatic eco-systems and they can be measured quantitatively. Ecologically, the concept of niche space provides the theoretical framework for understanding the importance of biological monitoring to any evaluation of environmental health. The organisms that inhabit aquatic eco-systems are the fundamental sensors that respond to any stress affecting that system. The health of an aquatic eco-system is reflected in the health of the organisms that inhabit it. Any stress imposed on an aquatic eco-system manifests its impact on the biological organisms living within that ecosystem (Loeb, 1990). Benthic macro-invertebrates are good bio-indicators, since they are very sensitive to changes in their habitat. In polluted water, the tolerant species will survive in abundance but the sensitive species will perish. Under normal clean water condition, more species were found to survive, unlike in polluted water condition where only one or two species can survive but with a higher density (Rahim-Ismail, 1994).

Sungai Dengar was a suitable river to study macro-benthic community structure and distribution as the river system provide the needed undisturbed and disturbed conditions in the same catchment and in the same river. The river water of Sungai Dengar flows down from Gunung Belumut to join Sungai Sembrong before it flows to the sea. The river is a perennial river with spring fed origin from the top of Gunung Belumut and passes through a palm oil plantation as it flows down stream. The objective therefore, to determine and compare the macro-benthic community structure and distribution in different elevations and different land use types for Sungai Dengar which is located at Gunung Belumut Forest Reserved Area.

MATERIALS AND METHODS

Study Site

This study was conducted within Sungai Dengar sub-catchment located in Gunung Belumut Recreational Forest in Kluang , Johor (**Figure 1**). There were a total of three sampling sites (A, B & C) with two sampling stations per site except for the most up-stream station which was only one station and three sampling points per station were identified for benthic macroinvertebrate. While, for water quality sampling, one sampling station were identified for each sampling site. Station A is the most up-stream station which was located about 300 meters above mean sea level, station B was located at the foot of Gunung Belumut at an altitude of about 75 meters above mean sea level, while the most down-stream station was located in the oil palm estate. The distance between station A and station B was about 2.5 kilometers, while the distance between station B and station C was about 1.5 km.

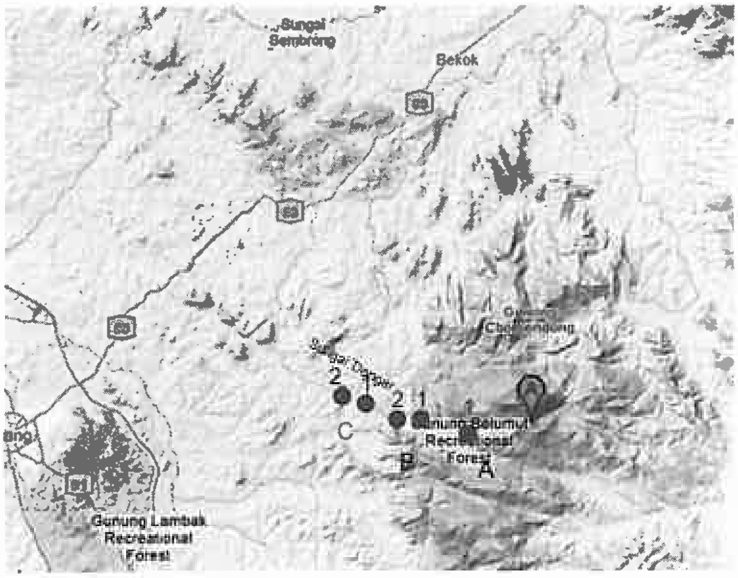

Figure 1 : Sampling Stations at Sungai Dengar

Methods

A 500 meter reach representative of the characteristics of the stream was selected for each sampling site or sampling reach. One sampling reach comprised two sampling stations where one station was at the upper reach, another station was at the lower reach. Each station comprises of three sampling points, at the right, middle and left bank; where the sampler faced against the river flow. All three samples in each sampling station was composite as one sample, meaning that two samples for each sampling reach were obtained for macro invertebrate assessment, one sample for upper reach and the other one for lower reach. The sampling was conducted from 08 to 11 August 2009. Benthic macro invertebrate sample were sent to laboratory for analysis.

Surber Net was used for the purpose of this study. Surber Net with 500 micron mesh size combines a rectangular quadrate with the size of 30 cm x 30 cm (0.09 m^2) to delineate the area of bed to be sampled and a net into which the disturbed benthic invertebrates are swept by the current used. Macro invertebrate sampling with the use of Surber Net can be considered as quantitative sampling. The purpose of two triangular wings of netting, linking the lateral margins of the two frames is to reduce the loss of sample around the sides of the net. Sampling protocols basically followed the Karr Protocol with minor modifications to suit local conditions.

Sampling method employed was as follows: (i) placing Surber Sampler on the selected spot with the opening of the nylon net facing upstream by bracing and holding the frame firmly on the creek bottom, (ii) lifting the larger rocks resting within the frame and brushing off crawling or loosely attached organisms so that they will drift into the net. Once the larger rocks are removed, the substrate will be vigorously disturbed (only on the surface) with a trowel or large spike for about 60 seconds to loosen organisms in the interstitial spaces, washing them into the net. The final step is lifting the Surber Net out of water, tilting the net up and out of the water while keeping the open end upstream. Substrates dominated by rocks larger than 50 cm in diameter will be avoided.

Sampling points that was closed to the bridges and other large human-made structural features were avoided. If it is unavoidable, sampling will be made at least 50 meters upstream and 200 meters down stream of a bridge. Chosen sampling points did not include major tributaries discharging to the stream in the study area. The next point of sampling was approached from down stream, or in other words, the movement of investigator was from down stream to up stream and not the other way round. This sampling technique serves as the quality assurance and quality control to ensure sample representativeness and reliability. The sample in the Surber Net was then poured into a sieve with the same mesh size (500 micron) and then all the fine sediments and unwanted materials were washed. Remaining sample in the sieve was then poured into plastic sample to which was added 20% ethanol for preservation and subsequently for identification purposes. In the laboratory, the sample was then rinsed with tap water to remove the preservative and then sorted out into major taxa. The sorted organisms were stored in 10 ml glass bottle containing 70% ethanol for preservation and identification later.

In order to keep the collected data representative and reliable at all times, quality assurance and quality control of the sampling techniques were strictly followed. This was ensures by carrying out all the samplings from the lower parts of the rivers to minimize the possible effect of benthic macro invertebrate drift by currents. Sampling duration always remained within one hour and involved the same number with the same investigators in order to keep sampling constant. To ensure sediment agitation time was consistent, stop watch was used. In addition a close visual inspection of the sample net before each sampling was performed to ensure that the net was clean of organisms. Sieve was also inspected thoroughly to ensure that all the organisms were in the sampling bags, left over organisms in the sieve were picked up by forceps.

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 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

Table 1 shows the in-situ water quality data measured by the in-situ multi parameter and single parameter probe. Site A was located on the Gunung Belumut with an altitude of 300 meters above mean sea level, whereas site B was located at the foot of Gunung Belumut with an altitude of 75 meters and the last site which was site C was located further down-stream at the oil palm plantation area. Site A was basically representing a pristine-pristine area, whereas site B for pristine area and site C was for disturbed area. The surface water dissolved oxygen content ranged from 7.11 mg/l to 8.06 mg/l. The maximum value of 8.06 dissolved oxygen content was recorded at site C (palm oil plantation area). The minimum value of 7.11 dissolved oxygen content was recorded at site A (Gunung Belumut). The pH values ranged from 7.47 to 7.89. The maximum value was recorded at site B (pristine area) while the minimum value was recorded at site A (Gunung Belumut). The surface temperature varied between 23.6 °C to 25.3 °C. The maximum temperature was observed at site C and the minimum temperature was noted at site A. The conductivity values varied between 27.4 uS/cm to 29.10 uS/cm. The maximum conductivity was recorded at site C and the minimum value at site B. The water turbidity ranged from 9.28 NTU to 22.85 NTU. The maximum turbidity values were recorded at site B and the minimum values were recorded at site A. The dissolved oxygen, pH, temperature and conductivity values did not show any distinct variation between stations except turbidity.

Table 1 : In-situ Water Quality Data for Each Sampling Station

STATION	DO mg/l	PH	TEMP oC	COND uS	TUR NTU
DENGAR	8.06	7.56	25.30	29.10	22.85
ULU DENGAR	7.43	7.89	24.60	27.40	26.2
G. BELUMUT	7.11	7.47	23.60	28.90	9.28

Table 2 shows the number of taxa found at all the sampling stations with the use of Surber Net. Chironomidae was the dominant taxa at the stations A, B2, C1 and C2. The results shows that not always was the case for Chironomidae and other Dipterant were found to be abundant at severely polluted sites as discussed by Davis (2003). The results within study showed that Chironomidae was also abundant at the pristine-pristine site which is the most up-stream part (undisturbed) on Gunung Belumut. Similar occurrence was found at station B2 which was a pristine station located at the foot of Gunung Belumut, however, nonetheless, the number of individual taxa was much higher at polluted sites.

Clean water taxa that was found abundant at pristine-pristine station is Ephermeroptera of the genus Pseudocloen and Plecoptera of the genus Neoperla. Ephemerella was also found to dominate the clean water taxon at pristine station (B1), whereas Pseudiron dominated the pristine station (B2). On the other hand, Diptera (Chironomidae) dominated the most polluted site at stations C1 & C2.

Pristine-pristine site also recorded an abundance of mollusca particularly from the family atyiedae and palaemonidae. The results obtained also showed an abundance of the genus Pseudiron and Potamanthus from the Ephermeroptera order at the polluted sites (C1 & C2), besides Chironomidae. Odonata, Trichoptera Coleoptera and Mesogastropoda were the orders least found at all the sampling stations. Only five (5) individual Odonata, twelve (12) individual Trichoptera, ten (10) individual Coleoptera and one (1) individual Mesogastropoda were collected. On the other hand, only one (1) family (Perlidae) and one (1) genus (Neoperla) were found from the Plecoptera order at all the sampling stations and one (1) family (Lymnaeidae) from the genus Lymnaea was collected at station B1.

Table 2 : Macroinvertebrate Taxa for Each Sampling Station

						Stations				
Phylum	**Class**	**Order**	**Family**	**Subfamily**	**Genus**	**A**	**B1**	**B2**	**C1**	**C2**
Arthropoda	Insecta	Ephermeroptera	Baetidae		Pseudocloen	1	22			
Arthropoda	Insecta	Ephermeroptera	Ephemerellidae		Ephemerella		6	3	7	2
Arthropoda	Insecta	Ephermeroptera	Heptageniidae		Pseudiron		3	6	21	5
Arthropoda	Insecta	Ephermeroptera	Potamanthidae		Potamanthus				18	3
Arthropoda	Insecta	Plecoptera	Perlidae		Neoperla		13	2	4	
Arthropoda	Insecta	Trichoptera	Hydropsychidae		Macrostemum		3			
Arthropoda	Insecta	Trichoptera	Hydroptilidae		Leptocella			1	3	3
Arthropoda	Insecta	Trichoptera	Hydropsychidae		Hydropsyche			1		1
Arthropoda	Insecta	Odonata	Gomphidae		Dromogomphus	1			1	
Arthropoda	Insecta	Odonata	Gomphidae		Hagenius			1		
Arthropoda	Insecta	Odonata	Lebellulidae		Somatochlora					2
Arthropoda	Insecta	Coleoptera	Elmidae		Stenelmis	1	2	1		4

Arthropoda	Insecta	Coleoptera	Gyrinidae		Gyrinus		2			
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae		41	2	4	131	10
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae			3	11	6	7
Arthropoda	Insecta	Diptera	Tipulidae		Tipula				1	2
Arthropoda	Insecta	Diptera	Tabanidae		Tabanus				1	
Mollusca	Malacostraca	Decapoda	Atyiedae		M. Pillimanus	8				
Mollusca	Malacostraca	Decapoda	Palaemonidae		Macrobrachium	5				
Mollusca	Gastropoda	Mesogastropoda	Lymnaeidae		Lymnaea		1			

DISCUSSION

The water quality results didn't shown any distinct variation between stations. But it was believed that temperature is an important ecological factor, which influence distribution of benthic organisms. Very low temperature at station A resulted in low EPT species, low density, low richness, low evenness and abundant of Diptera taxa. Conductivity was believed also to influence the benthic macroinvertebrate populations. The lowest conductivity was recorded at station B which has the highest EPT species. Other than that, the dissolved oxygen, turbidity 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 (2005), 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.

Based on the above results, it could be deduced that macro invertebrate community structure was not dependent entirely on water quality of the river but was also dependent on other factors such as habitat characteristics, river morphology, river riparian, canopy cover, etc. This was also in-agreement with Richard's (1994) finding where he found that distribution of particles sizes for river substrate was crucial for determining macro-invertebrate structure. This statement can be visualize through the results obtained from pristine-pristine station (A) which had a very high water quality with good canopy and river riparian buffers but with the substrate composition mostly of bedrock and boulders, attest to the fact that very low number of clean water taxa was found as opposed to that at pristine stations B1 & B2 which had smaller substrate sizes of varying compositions ranging from sand to cobble had a diverse taxa. On the other hand, there was a clear demarcation between reference station B and impacts station C.

Reference station has the most numbers of clean water taxa, while station C has the least because the reference station is a station with a good water quality, river canopy and substrate sizes.

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