A PRELIMINARY BENTHIC MACROINVERTEBRATES SURVEY OF GUNUNG BELUMUT RECREATIONAL FOREST, KLUANG, JOHOR, MALAYSIA

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ABSTRACT

The macroinvertebrate community in Sungai Dengar sub-catchment which is located at Gunung Belumut Recreational Forest in Kluang, Johor was surveyed in from 8th to 11th August 2009 by using Surber Net. River water quality and river characteristics were also recorded. The surface water dissolved oxygen (DO) 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 ^{o}C to 25.3 ^{o}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 µS/cm to 29.10 µS/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 result, it shows that Diptera particularly Chironomidae were abundant at the 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 foothill of Gunung Belumut but nevertheless the numbers of individual taxon are much higher at polluted sites (C1 & C2). Pristine site also recorded to have abundant Mollusca particularly from Atyiedae and Palaemonidae families. Results obtained also showed an abundant of the genus of *Pseudocleon* and *Potamanthus* from Ephermeroptera order at the polluted sites (C1 & C2), beside Chironomidae. Odonata, Trichoptera and Coleoptera were among the least order found at all the sampling stations. There were only five individual of Odonata taxon, 12 individual Trichoptera and ten individual Coleoptera collected. Only one family (Perlidae) and one genus (*Neoperla*) were found from Plecoptera order at all the sampling stations. Other than that, there were only one Mollusca from the family of Lymnaeidae 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.

Keyword: Stream, Biological indicator, Pollution, Freshwater

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, 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 ecosystem in river rehabilitation process, it was not only observing the water quality of the river alone but also river ecosystems. Changes of river quality as well as river ecosystems, 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 ecosystems. 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 ecosystems. Biological component are diagnostic in determining the health of aquatic ecosystems 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 ecosystems are the fundamental sensors that respond to any stress affecting that system. The health of an aquatic ecosystem is reflected in the health of the organisms. Any stress imposed on an aquatic ecosystem manifests its impact on the biological organisms living within that ecosystem (Loeb, 1990). Benthic macroinvertebrates are good bioindicators, 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 is a suitable river to be studied as the river system provide the needed undisturbed and disturbed conditions in the same catchment and in the same r. 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 macrobenthic community composition and distributionat different elevations and different land use of Sungai Dengar which is located at Gunung Belumut Forest Reserved Area.

METHODOLOGY

Study Site

This study was conducted within Sungai Dengar sub-catchment located in Gunung Belumut Recreational Forest in Kluang, Johor (Figure 1). There is 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 replicates per station were collected for benthic macroinvertebrate survey. While, for water quality sampling, one sampling station were identified for each sampling site. Station A is the most upstream station which is located about 300 meters above mean sea level, station B is located at the foot of Gunung Belumut (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.

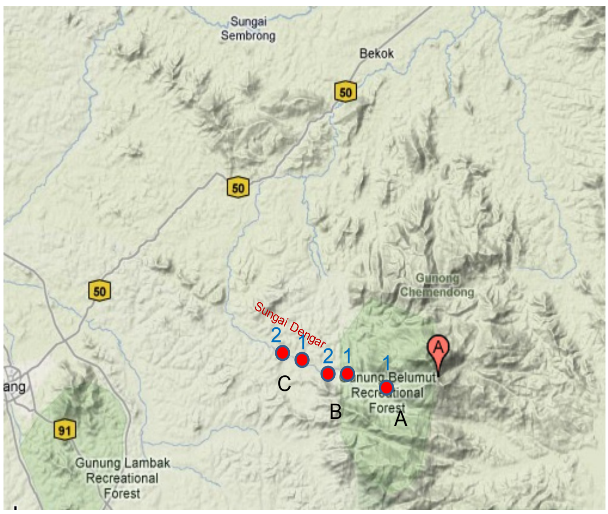

Figure 1. Sampling stations at Sungai Dengar

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. 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 estimation, one sample for upper reach and other one for lower reach. The sampling was conducted from 08 to 11 August 2009. Benthic macroinvertebrate samples were sent to laboratory for identification.

Surber Net was used to sample macroinvertebrates. 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. 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 (ref) with minor modifications to suit local conditions.

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 which consists of fine sediments and unwanted materials were washed. Remaining materials in the sieve were poured into plastic sample to which 20% ethanol was added 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 20% ethanol for preservation and identification.

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 ensured 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. 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 foothill 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 very 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 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 ^{o}C to 25.3 ^{o}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 °C	COND uS	TUR NTU
DENGAR	8.06±0.66	7.56±1.19	25.30±0.68	29.10±2.66	22.85±0.86
ULU DENGAR	7.43±0.43	7.89±0.58	24.60±1.23	27.40±1.88	26.2±0.76
G. BELUMUT	7.11±0.46	7.47±0.64	23.60±1.03	28.90±1.68	9.28±0.08

Table 2 shows the number of taxon found at all the sampling stations with the use of Surber Net. Chironomidae was the dominant taxon at the stations A, B2, C1 and C2. Results indicated that not always was the case for Chironomidae and other dipterants were found to be abundant at severely polluted sites as discussed by Davis, *et. al.* (2003). Results of the study showed that Chironomidae was abundant at the pristine sites, 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 taxon was much higher at polluted sites.

Clean water indicator taxon were found at pristine station was only the Ephermeroptera of the genus *Pseudiron*. *Pseudiron* was also found to dominate pristine station (B1), whereas *Pseudocloen* dominated the pristine station (B2). On the other hand, Diptera (Chironomidae) dominated the most polluted site at stations C1 & C2.

Pristine sites also contains high density of Mollusca particularly from Atyiedae and Palaemonidae families. Results obtained also showed an abundance of the genera *Pseudocleon* and *Potamanthus* from the Order Ephermeroptera at the polluted sites (C1 & C2), besides Chironomidae. Odonata, Trichoptera and Coleoptera were orders least found at all the sampling stations, where only five individuals from Order Odonata, 12 individuals from Trichoptera and ten individuals from Coleoptera were sampled. Only one family (Perlidae) and one genus (*Neoperla*) were found from the Order Plecoptera at all the sampling stations. Meanwhile, it was only one Mollusca from the family of Lymnaeidae was sampled 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	Heptageniidae	Pseudironinae	*Pseudiron*	1	22			
Arthropoda	Insecta	Ephermeroptera	Leptophlebiidae		*Leptophlebia*		6	3	7	2
Arthropoda	Insecta	Ephermeroptera	Baetidae		*Pseudocloen*		3	6	21	5
Arthropoda	Insecta	Ephermeroptera	Potamanthidae		*Potamanthus*				18	3
Arthropoda	Insecta	Plecoptera	Perlidae		*Neoperla*		13	2	4	
Arthropoda	Insecta	Trichoptera	Hydropsychidae		*Diplectrona*		3			
Arthropoda	Insecta	Trichoptera	Hydroptilidae		*Leptocella*			1	3	3
Arthropoda	Insecta	Trichoptera	Hydropsychidae		*Hydropsyche*			1		1
Arthropoda	Insecta	Odonata	Gomphidae		*Progomphus*	1				
Arthropoda	Insecta	Odonata	Gomphidae		*Hagenius*			1		
Arthropoda	Insecta	Odonata	Gomphidae		*Ophiogomphus*				1	
Arthropoda	Insecta	Odonata	Lebellulidae		*Somatochlora*					2
Arthropoda	Insecta	Odonata	Lebellulidae		*Neurocordulia*					
Arthropoda	Insecta	Coleoptera	Elmidae		*Stenelmis*	1	2	1		4
Arthropoda	Insecta	Coleoptera	Chrysomelidae		*Donacia*		2			
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Chironomus*	41	2	4	131	10
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae	*Anatopynia*		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

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 abundance 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. The highest turbidity reading was recorded at station B which has the highest EPT species. Other than that, the dissolved oxygen 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.

They need to explore correlation test or PCA to confirm environmental factors influence benthos.

Based on the above results, it could be deduced that macroinvertebrate 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, riparian zone conditions, canopy cover, etc. This was also in-agreement with Richard's and Host (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 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 and 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. The 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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