

INFLUENCE OF HABITAT CHARACTERISTICS ON THE ASSEMBLAGE AND DISTRIBUTION OF EPHEMEROPTERA, PLECOPTERA AND TRICHOPTERA (EPT) AT SELECTED RECREATIONAL RIVERS IN KELANTAN, MALAYSIA

A. E. Rak¹, S.A. S. Omar¹ and A. A. Kutty^{2,*}

¹Universiti Malaysia Kelantan(UMK), Faculty of Earth Sciences

²Universiti Kebangsaan Malaysia, School of Environmental Science and Natural Resources

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ABSTRACT

This study was carried out to identify the habitat factors that contribute to the variation of EPT at three recreational rivers in Kelantan, Malaysia. Therefore, the further implementation of EPT index as bio-indicator can be standardized and efficient. The results showed that, EPT assemblage and distribution at these rivers varies even though there is no significant difference in the water quality. Water quality of all the rivers are in the range of 'good' level. Therefore, regression analysis was made to confirm the main factors influencing the variation of EPT assemblage within selected recreational rivers in Kelantan, Malaysia. The substrate composition appeared as the main factor influencing the variation in distribution and composition of EPT in good water quality from the analysis. Thus, it is concluded that the substrate composition is the major factor influencing the composition and distribution of EPT in recreational river (good water quality).

Keywords: recreational rivers; EPT; regression analysis; substrate

Author Correspondence, e-mail: abas@ukm.edu.my

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1. INTRODUCTION

1.1. Malaysia's Recreational River

The best spot for recreational activities is at the fast-flowing stream, waterfall and cascade area which usually has clean, clear, and cool water. Therefore, most of the recreational rivers in Malaysia are perennial rivers and located at the uppermost of the river system. However, there is no structured control measures in place at present, due to lack of scientific knowledge on the carrying capacity of the recreational rivers. This condition has indirectly impaired the river quality, which makes them fail to serve as it supposed to be. Therefore, appropriate control measures should be taken to ensure the continuity of rivers to serve nature. In order to decide control measures, one needs to assess and monitor the recreational rivers and come out with a conservation plan.

1.2 Ephemeroptera, Plecoptera and Trichoptera (EPT)

Ephemeroptera, Plecoptera and Trichoptera (EPT) have been used as a biological indicator by many countries to measure the water quality of the streams and river health [1]. Most of the research and biomonitoring used EPT richness and percentage of individual EPT as index [2]. It is believed that EPT index has the potential to represent the water quality and it is easy to sample and explain the findings to the common citizen. Most of the researchers used EPT index as used by [3] or modified EPT index due to lack of reference found about real standard for EPT index implementation. Some researchers used EPT index as one of the biotic indices to assess the quality of water streams in Malaysia. However, the EPT assemblage and distribution were believed to differ in the ecoregion because of the difference in physical habitat and type of land-use.

1.3 Aim of Study

This study was conducted to determine the factors that influence the variations of EPT assemblage and distribution to understand the environmental criteria and habitat's preference of EPT. Therefore, this study aimed to help in the further implementation of EPT index as bio-indicator for a good water quality

2. METHODOLOGY

2.1. Sampling Procedure

Three famous recreational rivers in Kelantan were selected as the study site, namely Bukit Bakar Recreational Forest in Machang; Lata Mengaji and Jeram Pasu in Pasir Puteh. The sampling was conducted at a three-month interval from May 2014 till February 2015. The EPTs from each sampling site were collected by using surber net with 500-micron mesh size combined with a rectangular quadrat with the size of 30 cm x 30 cm (0.09 m²). A microscope was used to visualize and identify the EPT's family by means of analyzing the morphology of benthos [4, 5, 6]. Each of the identified EPT were stored in a 15 ml universal bottle separately, which contains 70% ethanol for preservation.

2.2 Laboratory Analysis

HACH standard procedure was used to measure five in-situ parameters at each of the stations. The parameters evaluated were temperature, dissolved oxygen (DO), pH, turbidity and total dissolved solid (TDS) which were measured via multi parameters probe Model YSI 556 and single parameter probe. In the meantime, HACH water analysis products were used to analyze other parameters in the laboratory such as biochemical oxygen demand (BOD₅), total suspended solid (TSS), ammoniacal nitrogen (AN) and chemical oxygen demand (COD). The estimated percentage of substrate compositions was respectively observed.

2.3 Data Analysis

An established water quality index was used to interpret the river classification based on "Water Quality Index Classification" and "Water Quality Classification Based on Water Quality Index". EPT family taxon was calculated to identify variation of EPT compositions. Statistical Package of Social Science (SPSS) version 16 was used to test the normality of the data and other univariate statistical tests which includes descriptive, uniformity, correlation and analysis of variance test. Regression analysis was done to identify the habitat factors that influence the variation and distribution of EPT family taxon.

3. RESULTS AND DISCUSSION

The temperature was recorded ranged from 24°C to 27 °C at Bukit Bakar Recreational River; 23 °C to 27 °C at Jeram Pasu and 23 °C to 26 °C at Lata Mengaji. The velocity of the river's

water flow was ranged between 0.0233 m/sec and 1.651m/sec. Turbidity reading was recorded less than 10 NTU. Table 1 shows the mean for water quality parameters and substrate composition. The Kruskal-waliss test showed no significant difference between site and station, except for BOD₅ ($p<0.05$) and pH ($p=0.018$). WQI of the rivers was ranged between 83 and 97, indicating that all river were classified as Class 1 and Class II (Clean River).

The substrate was classified into two categories which are sand (sand and fine sand) and stone (pebble and cobble). Bukit Bakar composed more stone compared to sand with an average of $89\pm 7\%$ of stone and $11\pm 7\%$ of sand. Similarly, at Lata Mengaji, the substrate composition was dominated by more stone with an average of $71\pm 10\%$ and $29\pm 10\%$ of sand. Whereas, at Jeram Pasu, it was found to be composed of more sand substrate than stone; $83\pm 21\%$ of sand and $18\pm 21\%$ of stone. Therefore, it was found that there was a significant difference in substrate composition between the streams ($p<0.05$). Based on the analysis of variance for Mann-Whitney test, it was observed that stone and sand significantly differed between all streams. This is possibly due to the fact that sand are highly dispersed at most of the stations in Jeram Pasu, particularly from Station 3 until Station 4. Figure 1, 2 and 3 shows the picture of river habitats for all rivers.

It was found that approximately 11,965 specimens of EPT were collected which were identified to belong to 33 families. Lata Mengaji site contained the highest EPT abundance of 5400 specimens collected. This was followed by Hutan Lipur Bukit Bakar site with 4768 specimens and Jeram Pasu site with 1797 specimens, respectively. Table 2 shows the presence and absence of the various family groups at the three differ streams. Jeram Pasu recorded the least EPT percentage at several stations compared to Bukit Bakar and Lata Mengaji.



Fig. 1. Hutan Lipur Bukit Bakar

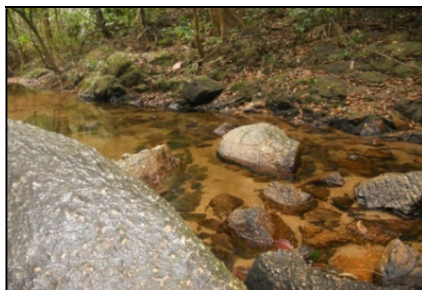


Fig. 2. Jeram Pasu



Fig. 3. Lata Mengaji

Table 1. Result for mean of physicochemical water quality and substrate compositions

Parameters	Site	Mean \pm SD
Dissolve Oxygen, DO(%)	BB	86.03 \pm 24.16
	JP	77.72 \pm 11.27
	LM	79.38 \pm 7.63
Dissolve Oxygen, DO(mg/l)	BB	7.03 \pm 2.26
	JP	6.12 \pm 0.90
	LM	6.51 \pm 0.64
Biological Oxygen Demand 5, BOD5 (mg/l)	BB	0.99 \pm 0.44
	JP	2.28 \pm 1.00
	LM	1.63 \pm 0.31
Chemical Oxygen Demand, COD (mg/l)	BB	12.62 \pm 7.20
	JP	15.97 \pm 9.39
	LM	17.83 \pm 14.61
Total Suspended Solid, TSS (mg/l)	BB	0.01 \pm 0.03

	JP	0.0001 ± 0.0004
	LM	0.002 ± 0.003
pH	BB	6.59 ± 0.21
	JP	6.82 ± 0.31
	LM	6.87 ± 0.29
Ammoniacal Nitrogen, AN (mg/l)	BB	0.09 ± 0.06
	JP	0.16 ± 0.33
	LM	0.11 ± 0.08
WQI	BB	91.40 ± 3.48
	JP	89.33 ± 2.92
	LM	90.27 ± 4.42
Stone (%)	BB	0.89 ± 0.07
	JP	0.18 ± 0.21
	LM	0.71 ± 0.10
Sand (%)	BB	0.11 ± 0.07
	JP	0.83 ± 0.21
	LM	0.29 ± 0.10
*Notes: BB – Bukit Bakar; JP – Jeram Pasu and LM – Lata Mengaji		

Table 2. Absence/presence of EPT's taxa (family) at all streams

Order	Family	BB	JP	LM
Ephemeroptera	Heptageniidae	+	+	+
	Baetidae	+	+	+
	Leptophlebiidae	+	+	+
	Caenidae	+	+	+
	Neophemeridae	+	+	+
	Teloganodidae	+	+	+
	Potamanthidae	+	-	-
	Emphemeridae	+	+	+

	Isonychidae	-	-	+
Plecoptera	Peltoperlidae	+	-	+
	Perlidae	+	+	+
	Nemouridae	+	-	+
	Leutridae	+	-	+
Trichoptera	Hydropsychidae	+	+	+
	Calamoceratidae	+	-	+
	Psychomyiidae	+	-	+
	Xiphocentronidae	+	+	+
	Phryganopsychidea	+	-	-
	Phryganeidae	-	+	+
	Dipseudopsidae	+	+	+
	Ecnomidae	+	+	+
	Philopotamidae	+	+	+
	Hydroptilidae	+	+	+
	Polycentropodidae	+	+	+
	Leptoceridae	+	+	+
	Limnephilidae	+	+	+
	Molannidae	-	+	+
	Lepidostomatidae	+	-	+
	Odontoceridae	+	+	-
	Glossosomatidae	+	+	+
	Stenopsychidae	-	-	-
	Sericostomatidae	+	-	-
Helicopsychidae	+	+	+	
*Notes: - BB – Bukit Bakar, JP – Jeram Pasu and LM – Lata Mengaji				

Figure 4, 5 and 6 shows several families having difference in their relative abundance between months and site. Heptageniidae, Caenidae, and Hydropsychidae were found to be

less abundant at Jeram Pasu than Bukit Bakar and Lata Mengaji. However, more Perlidae were found and collected at Lata Mengaji and Jeram Pasu than Bukit Bakar. Thus, it is believed that there is a variation of EPT distribution between the streams. Apart from that, the coefficient of variation between each EPT's taxa showed higher variability of Trichoptera in all sites with CV's ranging from 12% to 58% and Plecoptera at Bukit Bakar and Lata Mengaji with CV's ranging between 37% and 56%. It is also supported by other research whom stated that Trichoptera was found to be more diverse than Ephemeroptera and Plecoptera [7, 8, 9] The ANOVA test on EPT distribution showed that there are significant difference among four families of Ephemeroptera (Heptageniidae, Caenidae, Teloganodidae, and Emphegeridae), five families of Trichoptera (Hydropsychidae, Xiphocentronidae, Ecnomidae, Hydroptilidae, and Leptoceridae) and a family of Plecoptera (Perlidae) between three streams.

The variability and variation of EPT taxa assemblage in 'good' water quality streams were believed to be influenced by other physical factors such as stream order, stream width, altitude, velocity, food availability, canopy cover and substrate composition [10, 11, 12]. Therefore, EPT was grouped into different functional feeding groups (FFG) due to their different survival rate in different habitats with different substrate and food availability [4, 5, 6].

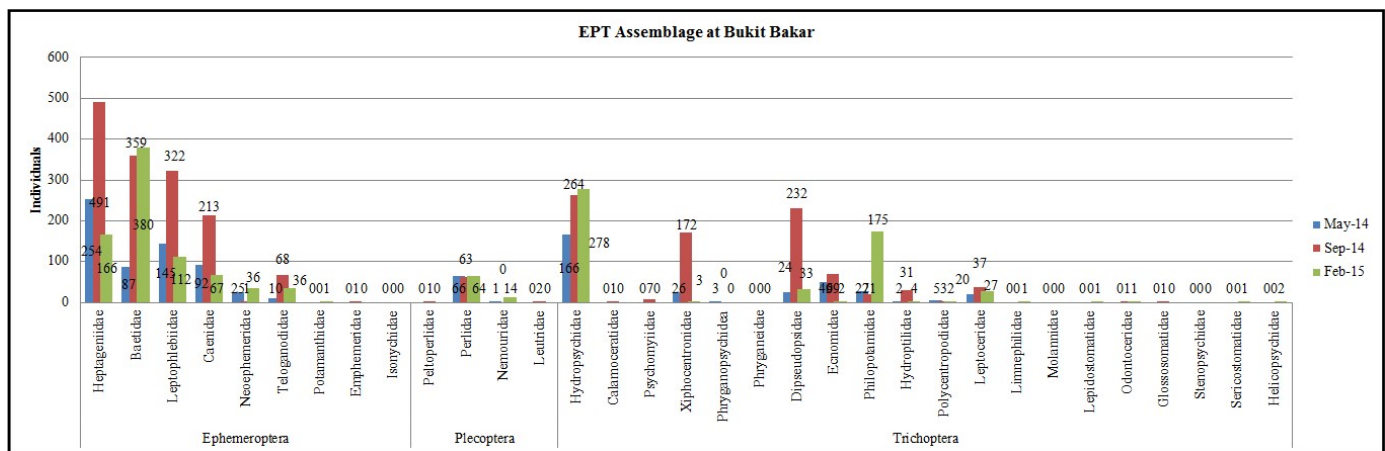


Fig.4. Abundance of EPT at Bukit Bakar

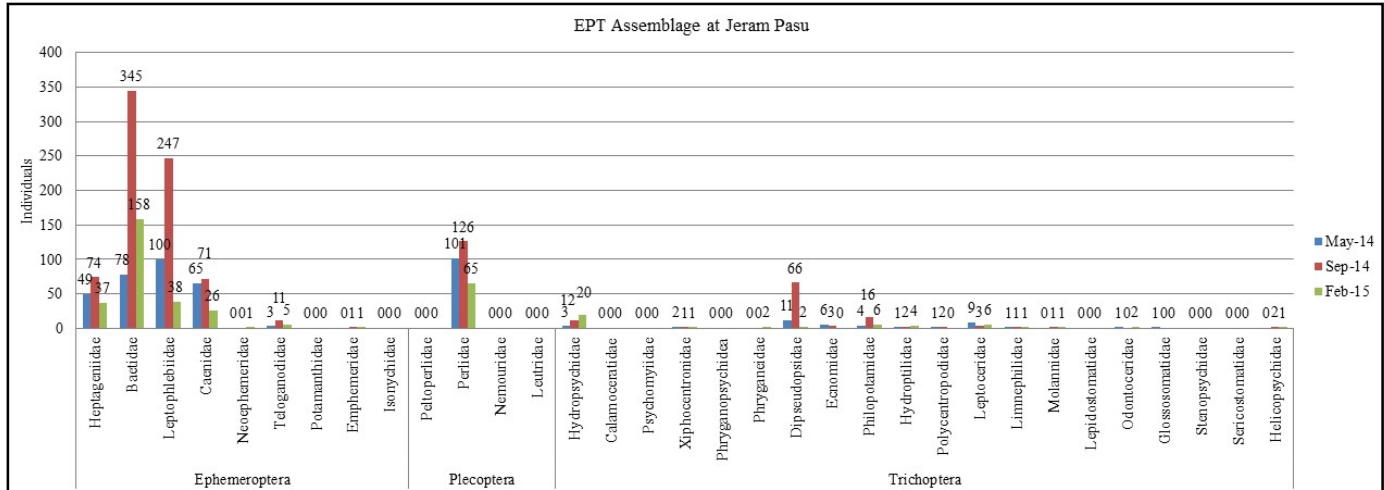


Fig.5. Abundance of EPT at Jeram Pasu

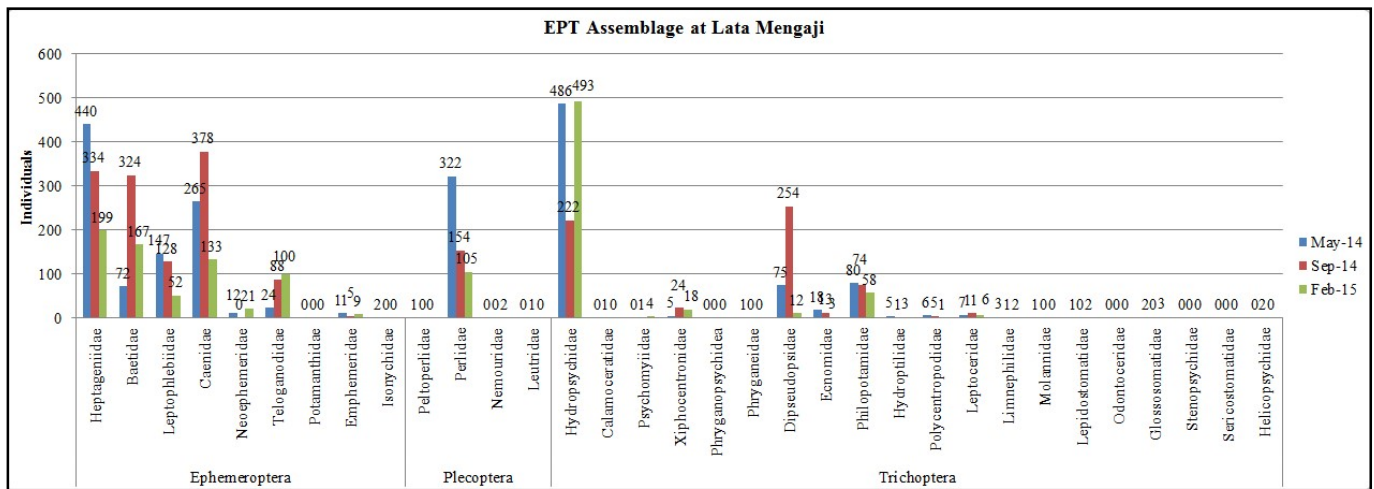


Fig.6. Abundance of EPT Lata Mengaji

Regression analysis result showed that only stone and sand variables were moderately influence the assemblage of EPT by 40%. Aforementioned, the substrate of Jeram Pasu streams at several station were more to sandy composition than Bukit Bakar and Lata Mengaji. Substrate was one of the important factors that influenced EPT distribution and composition. Substrate was also helped in the formation of EPT habitat and niche, as they use it to trap food and also to protect and shelter their body from the fast flowing water current. [13] has conducted similar research on the correlation between substrates composition and benthic macroinvertebrate composition in Bukit Bakar, Jeram Pasu, and Lata Mengaji. Her research unveiled findings that support the present study, where high correlation between substrate and benthic macroinvertebrates composition was found at Hutan Lipur Bukit Bakar. This signifies

that, the high variability of the substrate composition results in high variability of benthic macroinvertebrates [14].

4. CONCLUSION

In conclusion, the monitored recreational streams in Kelantan were evaluated and found to be within the category of 'good' water quality stream. However, different substrate composition leads to variation in EPT's distribution and composition where Jeram Pasu reportedly had fewer EPT taxa as compared to the other two streams. The regression analysis showed that the percentage of stone and sand had significantly contributed to the variation of EPT assemblage within recreational river in Kelantan, Malaysia.

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