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The Aquatic Insect Communities of Universiti Malaysia Sabah (UMS), Sabah, Malaysia

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Abstract

A s tudy was conducted to investigate the aquatic insect communities in Universiti Malaysia Sabah (UMS), Sabah, Malaysia. Two sampling sites were selected: lakes at School of Science and Technology (SST), and another near College E (CE) (student accommodation). Each lake consisted of four sampling stations. Aquatic insects were sampled using dip net from November 2013 to January 2014. Four water quality parameters were measured at each station. Shannon-Weiner's diversity index and biotic indices (BMWP) were used in this study. Student's t-test was used for testing the significant difference of water quality parameters, Shannon-Weiner's diversity index and BMWP between these lakes. Pearson's correlation was used to investigate relationships between aquatic insect assemblage and water quality parameters. A total of 1987 individuals composed of five orders that representing eleven families were recorded in this study. Baetidae (56.67%) was the dominant family in UMS, where Diptera order had least abundant with only 0.4% of overall sample. Aquatic insect abundance were significantly higher ($P<0.05$) in CE Lake. Bray-Curtis Similarity index showed 53.75% similarity between these two lakes. Pearson's correlation showed that aquatic insect abundance and richness had significant relationships with water temperature, dissolved oxygen, salinity and pH ($P<0.05$ or 0.01), except for salinity with taxa richness. Based on Malaysia's INWQS, water quality parameters of these two lakes were categorized as Class I, but with dissolved oxygen the CE and SST lakes were classified as Class IIA and III respectively. The BMWP index showed similar results as dissolved oxygen, where SST Lake (score=40) had poor water quality.

1. Introduction

Freshwater macroinvertebrates consist of wide range of taxonomic groups are ubiquitous in freshwater systems like rivers, lakes and wetlands. They are vital in nutrient processing and cycling in freshwater ecosystem due to their functional feeding roles as shredders, filter feeders, and collectors [1]. In this few decades, freshwater macroinvertebrates had been the attentions for their utilization in stream quality assessments. However, most studied were conducted for temperate or developed countries. As a part of freshwater fauna, aquatic insects are sensitive toward pollution and responds to spectrum of perturbations, which made them one of the candidates for freshwater biological assessment [2]. In addition, they are easy to sample and detailed methods had been developed for this particular field [3].

As one of the developing countries, rapid development had increasingly pressuring our

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freshwater natural ecosystem that provided invaluable resources on our population welfare. Land clearance for oil palm plantation, industrial area and residential area could lead to the increase of runoff or input of sewage effluence. Lakes that are typically closed ecosystem are more vulnerable toward anthropogenic impacts.

Until recently, most of the study on aquatic insects had been focusing on stream and rivers. Scarce information can be found on aquatic insects of lentic system in Malaysia. Mohmad [4] previously investigated the diversity and composition of aquatic insects in one of the Universiti Malaysia Sabah's Lake during the construction works. Since then no further aquatic insect study was conducted. Therefore, a study was conducted to investigate aquatic insect communities in UMS and their use in water quality assessment.

2. Materials and Methods

Study Area. The study site was located in Universiti Malaysia Sabah, Kota Kinabalu, Sabah, Malaysia. Two main lakes located at School of Science and Technology (SST) and at College E (CE, for student accommodation) were selected. The SST Lake had about 3.5 to four acres area with depth up to three meter. This lake composed of aquatic plants like Nymphae sp. and Graminae sp. While CE Lake partly surrounded by secondary forest and consisted of aquatic plants like Graminae sp.

Data Collection. The study was conducted from November 2013 to January 2014. Samples were taken from four corners of both lakes within an area of 10 m2 [5]. Three replicates were taken for each corner. At each corner, before aquatic insect collection, four water quality parameters included water temperature, dissolved oxygen (DO), pH and salinity were measured using a HANNA Multiparameter Meter (HI-9828). Aquatic insects were collected using a dip net (40 x 40 cm frame and 60 µm mesh size). One meter squared area on the bottom of lake was disturbed while the dip net was swept continuously for six minutes to collect the floated sediments. These replicates were pooled into one sample. Specimens were sorted out from the sediment, leaf litters or substrates inside the net. Sorted specimens were stored in 95% ethanol. Identification was done with family-level taxonomic keys [6] [7] in laboratory.

Data Analyses. Total abundance, taxa richness, Shannon-Weiner diversity index and Bray-Curtis Similarity index were calculated for comparison of aquatic insect communities between the lakes. Biological Monitoring Work Party (BMWP) index was used for biological quality assessment. Student's t-test was conducted to test the significant difference between the measurements of two lakes. Lastly, Pearson's correlation analysis was used to determine the association degree between aquatic insect assemblage and water quality parameters.

3. Results and Discussion

A summary of water quality parameters of UMS lakes was presented in Table 1. Water temperature, salinity and pH showed significantly higher values ($p<0.05$) in SST Lake. But regard to Malaysia's Interim National Water Quality Standard (INWQS), salinity and pH for both lakes were classified as Class I. In contrast, dissolved oxygen that showed no significant difference ($p>0.05$) categorized SST Lake as Class III, which was lower than CE Lake with Class IIA.

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Table 1: Mean and standard deviation values of four water parameters in CE and SST Lakes, their classification with Malaysia's INWQS and Student's t-test significance.

Parameters	CE			SST			
	Mean	SD	INWQS	Mean	SD	INWQS	Significance
Temperature	27.22	±0.33	-	29.26	±1.37	-	P<0.05
DO	5.15	±0.08	IIA	4.82	±0.34	III	P>0.05
Salinity	0.05	±0.00	I	0.17	±0.01	I	P<0.05
pH	7.33	±0.03	I	7.73	±0.14	I	P<0.05

A total of 1987 individuals composed of five orders and eleven families were recorded in this study (Table 2). Baetidae was the dominant taxon (56.67%) recorded in this study, followed by Notonectidae (17.16%) and Corixidae (12.93%). Past research [8] reported the Baetidae on the aquatic plants in lakes and slow water had broader gills that assist in oxygen diffusion. Davanso and Henry [9] also found Baetidae appeared in low oxygenated area that was polluted by domestic waste. These showed the capability of this taxon to adapt to low oxygenated environments, which explain the occurrence of this taxon in these two lakes. Meanwhile, both taxa from Diptera appeared to be least abundant in UMS lakes, which contributed only 0.4% of overall aquatic insect collection.

In this study, the lowest order recorded was Diptera (0.45%) that consisted of Chironomidae and Ceratopogonidae. Chironomidae and Ceratopogonidae are common inhabitants from small seeps to large rivers and from temporary pools to deep lakes [7]. They live in soft sediment, on rock and aquatic vegetation. High abundance and density of Chironomidae usually indicates polluted water bodies [10].

Table 2: Aquatic insect diversity and composition in CE and SST lakes.

Order	Family	CE	%	SST	%	All	%
Ephemeroptera	Baetidae	876	62.84	250	42.16	1126	56.67
Odonata	Coenagrionidae	98	7.03	35	5.90	133	6.69
	Libellulidae	54	3.87	9	1.52	63	3.17
Hemiptera	Corixidae	176	12.63	81	13.66	257	12.93
	Gerridae	2	0.14	7	1.18	9	0.45
	Naucoridae	4	0.29	0	0.00	4	0.20
	Nepidae	19	1.36	12	2.02	31	1.56
	Notonectidae	144	10.33	197	33.22	341	17.16
Coleoptera	Scirtidae	14	1.00	1	0.17	15	0.75
Diptera	Ceratopogonidae	0	0.00	1	0.17	1	0.05
	Chironomidae	7	0.50	0	0.00	7	0.35
		1394		593		1987	

Previous study of aquatic insects in SST Lake [11] [4] showed different diversity compared with current study (Table 3). According to UMS-EIA report in 1995 [11], six orders of aquatic insects were recorded, which is similar with current study except for Orthoptera. In the year 2000, construction works occurred near the SST Lake and two orders were absent. After 14 years of development in UMS, Ephemeroptera reappeared and recorded in this study. This difference clearly showed that anthropogenic activities influence the aquatic insect communities, since Ephemeroptera is pollutant intolerant taxa [13]. In addition, order Orthoptera that were recorded in past researches was absent in this study. This might due to the different sampling sizes of previous study.

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Table 3: Occurrence of aquatic insects before (1995), during (2000) and after (2014) the construction works in SST Lake.

Order	Before construction work (1995)	During construction work (2000)	After construction work (2014)
Ephemeroptera	+	-	+
Hemiptera	+	+	+
Odonata	+	+	+
Coleoptera	+	+	+
Diptera	+	-	+
Orthoptera	+	+	-

Note: (+) Present, (-) Absent

Generally, aquatic insect abundance and taxa richness was higher in CE lake (1392 individuals, 10 taxa) compared to SST lake (593 individuals, 9 taxa). Nine taxa were common in UMS lakes, except Naucoridae, Ceratopogonidae and Chironomidae. The results from Student's t-test showed that only aquatic insect abundance were significantly higher ($P<0.05$) in CE lakes. Based on Shannon-Weiner Diversity Index in Table 4, aquatic insect diversity showed no significant difference ($P>0.05$) between CE ($H'=1.258$) and SST lakes ($H'=1.386$). Bray-Curtis Similarity index showed 53.75% similarity between the aquatic insect compositions between these two lakes. This showed that aquatic insect diversity and composition between CE and SST Lakes were varied in term of taxa richness and taxa relative abundance.

Table 4: Total abundance, taxa richness, Shannon-Weiner diversity index, and BMWP values of CE and SST lakes, with the t-test results.

	CE	SST	Significance
Total abundance	1394	593	$P<0.05$
Taxa richness	10	9	$P>0.05$
Shannon's diversity	1.258	1.386	$P>0.05$
BMWP	45	40	$P>0.05$
Bray-Curtis Similarity	0.5375		-

Table 5: Pearson's correlation analysis of aquatic insect diversity and water quality data of the UMS lakes; N=8.

	Water temperature	Dissolved Oxygen	Salinity	pH
Total abundance	-0.719*	0.752*	-0.745*	-0.793*
Taxa richness	-0.943**	0.896**	-0.594^{ns}	-0.804*
Shannon's diversity	0.216^{ns}	-0.004^{ns}	-0.612^{ns}	0.451^{ns}

Notes: * $P<0.05$; ** $P<0.01$; ^{ns} $P>0.01$, ns = not significant.

Pearson's correlation test showed that aquatic insect abundance and richness had significant relationships with water temperature, dissolved oxygen, salinity and pH ($P<0.05$ or 0.01), except for salinity that had no significant relationship with taxa richness (Table 5). Meanwhile, Shannon-Weiner's diversity index showed no significant correlation with all four water quality parameters. These results showed that water temperature, dissolved oxygen, and pH were influential factors on aquatic insect assemblage in UMS lakes except salinity. Water temperature, dissolved oxygen and pH had been influential factors in structuring the aquatic insect species richness and diversity [14].

BMWP index scores for CE and SST lakes were 45 and 40 respectively (Table 4). Based on Mason [12], score between 41-70 is categorized as "moderately water quality". CE Lake's BMWP score fall into this category. SST Lake had slightly lower score, but fall

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in category of "poor water quality", which means organic pollution might occur (score 11-40). BMWP were developed to evaluate water bodies based on the sensitivity of aquatic macroinvertebrates to oxygen depletion [12]. The results were consistent with the INWQS classification based on dissolved oxygen (Table 1), where water quality of SST Lake was lower compared to CE Lake.

5. Conclusion

In conclusion, the aquatic insect communities had low diversity in UMS. This study demonstrated the usage of aquatic insects for water quality assessment in lotic environments. In general, the water quality and biological quality in UMS lakes were moderate condition.

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References

[1] S. Gupta, S. Dey, and P. Purkayastha: Submitted to International Research Journal of Environment Science 2(7), 15-19. (2013)

[2] C. Balachandran, S. Dinakaran, B. Alkananda, M. Boominathan, T.V. Ramachandra: Submitted to International Journal of Advance Life Sciences 5. (2012).

[3] M.B. Rawda, Iman El Hoseny and Mohamed Talal: Submitted to Egypt Academic Journal Biology Sciences 6(1): 47-66. (2013).

[4] A.H.Mohmad. Unpublished Thesis. (2000).

[5] M. Joydeb, K.D. Rajib, M. Prasanta, D. Ghosh, and B.K. Agarwala: Submitted to Middle-East Journal of Scientific Research 13(1): 25-32. (2013)

[6] W.P. McCafferty: In Sc. Book International. (1981)

[7] R.W. Jr. Bouchard: In Guide to Aquatic Macroinvertebrates of the Upper Midwest. Water Resources Centre, University of Minnesota. (2004)

[8] S. Eino, K.D. Marcus, H. Per-Ola, and S. Anssi. Submitted in Entomologica Fennica 18(3): 160-167. (2007)

[9] R.C.S. Davanso, and R.Henry: Submitted to Acta Limnologica Brasiliensia 19(2). (2007)

[10] U.G. Abhijna, R.Ratheesh, and A. Biju Kumar: Submitted to Journal of Environmental Biology 34: 605-611. (2012)

[11] Biro Rundingan dan Kembangan Universiti Kebangsaan Malaysia. EIA Report. (1994)

[12] C.F. Mason: In Biology of Freshwater Pollution, Fourth Edition. Prentice Hall. (2002)

[13] J.V. Ward: In Aquatic Insect Ecology, John Wiley & Son, Inc. (1992)

[14] S.O. Ngodhe, P.O. Raburu, and A. Achieng: Submitted to Journal of Ecology and the Natural Environment 6(1), 32-41. (2014)

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