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Research Article

Diversity, Composition and Distribution of Aquatic Insects in Liwagu Water Catchment, Tambunan, Sabah

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Abstract

A study was carried out from 10-14 November 2011 to determine the diversity, composition and distribution of aquatic insects in the streams of Kisolong, Molongis and Hatob waterfalls. Six stations were selected in each stream with one station located at the upper reach and another situated at the lower reach. A 100 metre reach of the stream was selected for each sampling site. Surber net measuring 500 micron mesh size rectangular quadrat of 30 cm X 30 cm (0.09 m^2) was used. A total of 2163 individuals representing 61 families from eight orders were successfully recorded. Heptageniidae (Ephemeroptera), Perlidae and Peltoperlidae (Plecoptera) and Hydropsychidae (Trichoptera) were the most abundant families collected in each stream. Based on biotic indices, all streams were undisturbed and had good water quality.

Keywords: Freshwater Stream, Aquatic Insects, Diversity, Biotic Index, Water Quality, Liwagu Water Catchment

Introduction

Tropical Asian streams are renowned for their diverse fauna, although specific knowledge about the taxa inhabiting them is scarce (Dudgeon, 1999). Several fauna lists of macroinvervetebrates are available for Southeast Asia including for Indonesia, Philippines, Thailand, Myanmar and Papua New Guinea which were done by Ulmer (1951, 1955, 1957), Banks (1937,1939), Kimmins (1962), Neboiss (1984, 1987, 1989), Neboiss & Botosaneanu (1988) and Malicky & Chantaramongkol (1989, 1991). In Malaysia, studies on the ecology and taxonomy of aquatic insects has been carried out by Banks (1934, 1938), Bishop (1973), Ismail (1992), Che Salmah (1996), Jongkar (2000), Abu Hassan et al. (2001), Yap et al. (2006) and Wahizatul et al.(2011).

Very few studies on aquatic insects in Borneo have so far been reported. In Sabah, Yang et al. (1998) conducted a preliminary study on aquatic and semi-aquatic bugs in Maliau Basin during the Maliau Basin Expedition in 1996, where

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samples were collected from pools, waterfalls and streams. A study was conducted by Chessman & Chang (2000) to assess the macroinvertebrates in Sungai Moyog, Sabah in order to provide data on indicator group in the stream. Fikri & Mohamed (2003) investigated aquatic insect distribution and diversity in Tabin Wildlife Reserve, Lahad Datu. Another study by Fikri (2004) in Tabin Wildlife Reserve was to determine the composition and distribution of aquatic insects in different forest types. Fikri et al. (2005) and Harun et al. (2010) also recorded the diversity of aquatic insects from Mesisilad stream, Melalap, Keningau, Sabah and the streams of Maliau Basin Conservation Area, Sabah.

As one of the most threatened ecosystems, freshwater habitats have been subject to water quality deterioration due to modification of natural riverine landscapes for anthropogenic activities. In the US Endangered Species List, freshwater invertebrates are known to be the least studied of listed vertebrate (Strayer, 2006). This clearly shows that freshwater invertebrates as well as aquatic insects have received insufficient attention from scientists and conservationists.

In addition, using freshwater invertebrates for freshwater biological monitoring is increasingly popular and provides comprehensive water quality assessment combined with physical and chemical aspects. In Malaysia, water quality assessment focuses more on physic-chemical approaches which has its limitations. In general, studies on aquatic insects as biological indicators are still lacking in Malaysia.

Our primary objective was to record the diversity, composition and distribution of aquatic insects in the streams of Liwagu Water Catchment and the results presented will serve as baseline documentation on the current status of aquatic invertebrates from the rivers of Liwagu, Tambunan, Sabah.

Materials and Methods

The sampling was conducted during the Liwagu Scientific Expedition 2011 at the Liwagu river catchment tributaries. The sampling area was at the vicinity of Crocker Range Park. The Liwagu water catchment area is composed of two main tributaries, Nukakatan River and Mensangoh River of Liwagu River. Certain areas of the water catchment were cleared for planting crops by nearby villagers (Figure 1).

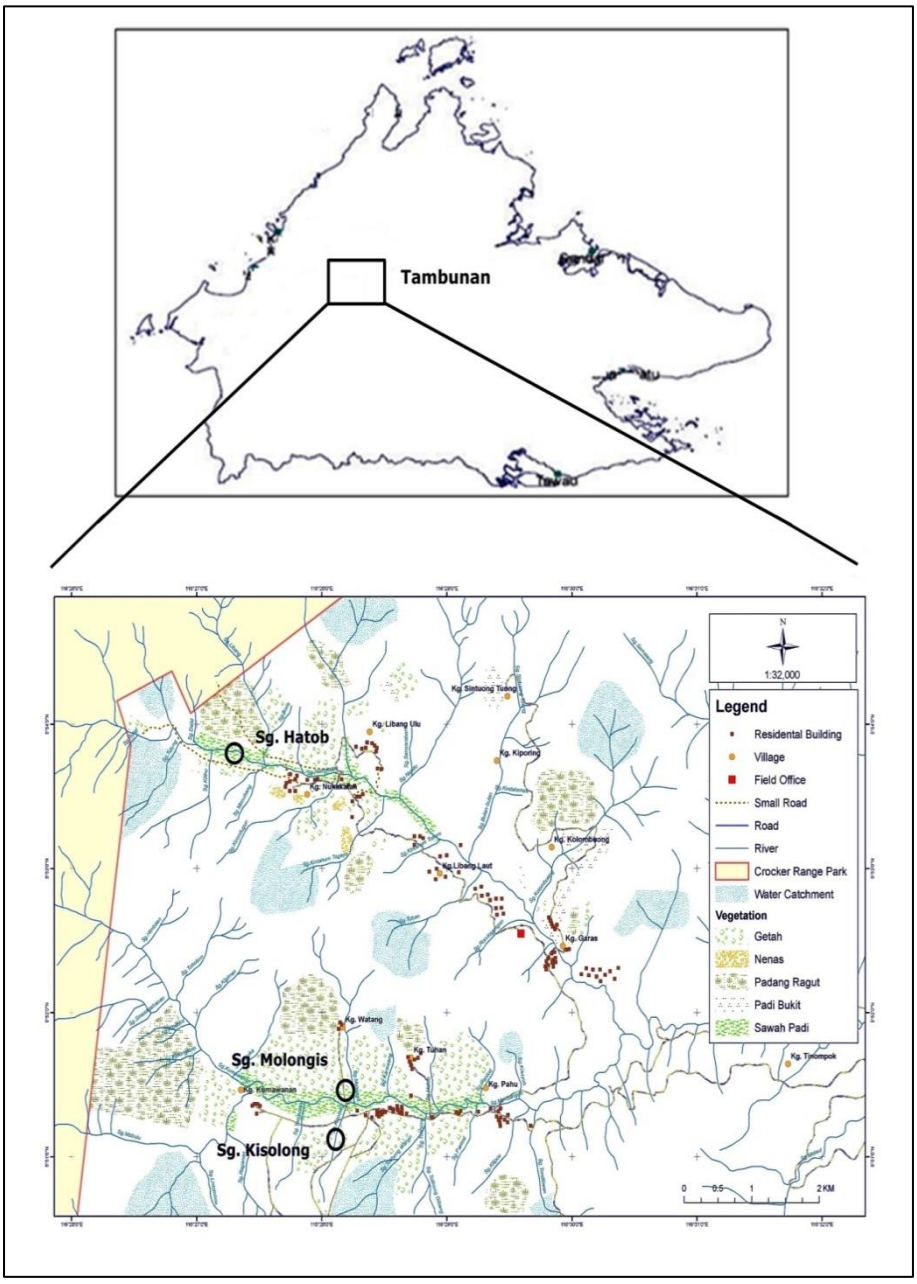

Figure 1. Three sampling streams that located in Liwagu water catchment, Tambunan, Sabah.

Table 1. Site description of the three sampling areas.

Stations	Habitat Description
Sg. Kisolong	Flows through rubber tree plantation area. Some riffles and abundant runs. Substrate rock and some gravel.
Sg. Molongis	Flows through paddy fields. Abundant shallow riffles and mixtures of gravel and fast flowing runs. Substrate bed rock and sand.
Sg. Hatob	Flows through secondary forest. Abundant riffles and some small pools. Substrate cobbles, pebbles with some gravel.

A total of six sampling stations were selected from Sg. Kisolong, Sg. Molongis and Sg. Hatob, which are the tributaries of Nukakatan River and Mensangoh River (Table 1). A 100 metre reach of the stream was selected for each sampling site. Surber net measuring 500 micron mesh size rectangular quadrat of 30 cm X 30 cm (0.09 m^2) was used to sample aquatic insects. Each station comprised three sampling points represented by three different habitats such as riffle, run and pool.

Surber net was used at all these stations. The net was placed against the current and about one square metre substrates in front of the net was disturbed for approximately two minutes (by using legs). The aquatic insects were preserved in 80 % ethanol before laboratory identification was made. In the laboratory, the sample was then rinsed with tap water to remove the preservative and sorted into a 10 ml bottle containing 70 % ethanol for preservation and for subsequent identification.

All aquatic specimens collected during the study period were deposited in the BORNEENSIS, Institute for Tropical and Conservation Biology, Universiti Malaysia Sabah. Identification until family level was done using taxonomic keys from McCafferty (1981) and Thorp & Covich (2009). River morphology and the characteristics of habitat chosen were recorded for all stations. The data sampling for non-conservative and non-preservable (conductivity, salinity, dissolved oxygen, temperature and pH) were measured by using a multi-parameter water quality meter, HANNA model HI9828. The checker was placed in the middle of the stream and allowed to stabilize before readings were taken. The checker was calibrated to ensure the accuracy of the data collected. The width and depth of the river were recorded with a measuring tape.

Aquatic insect diversity of Liwagu water catchment were calculated with Shannon-Weiner's Diversity Index (H') and Evenness Index (E). Shannon-

Wiener's Diversity Index is commonly used to calculate aquatic and terrestrial diversity (Mandaville, 2002). The Evenness Index is modified from the Shannon-Weiner Diversity Index, and shows evenness or equitability insects individual across species.

Five biotic indices were calculated to assess the biological quality of the Liwagu water catchment. These indices were Ephemeroptera, Plecoptera and Trichoptera (EPT) richness, Biological Monitoring Work Party (BMWP) index, Average Score Per Taxon (ASPT), and Thailand adapted BMWP ($BMWP^{Thai}$) and ASPT ($ASPT^{Thai}$).

Results and Discussion

The physico-chemical water parameters were used to classify the streams in accordance to the Interim National Water Quality Standards (INWQS, 2000) developed by the Department of Environment, Malaysia. The water parameters for the rivers surveyed are summarised in Table 2.

Table 2. Water quality parameters in the sampling stations

Parameters	Streams	Value	INWQS	Class
Temperature (°C)	Sg. Kisolong (Upper reach)	20.28	Normal	-
	Sg. Kisolong (Lower reach)	20.27	Normal	-
	Sg. Molongis (Upper reach)	21.16	Normal	-
	Sg. Molongis (Lower reach)	20.18	Normal	-
	Sg. Hatob (Upper reach)	19.37	Normal	-
	Sg. Hatob (Lower reach)	19.03	Normal	-
Conductivity (ms/cm)	Sg. Kisolong (Upper reach)	136	1000	I
	Sg. Kisolong (Lower reach)	133	1000	I
	Sg. Molongis (Upper reach)	151	1000	I
	Sg. Molongis (Lower reach)	149	1000	I
	Sg. Hatob (Upper reach)	58	1000	I
	Sg. Hatob (Lower reach)	57	1000	I
pH	Sg. Kisolong (Upper reach)	6.97	6.50-8.50	I
	Sg. Kisolong (Lower reach)	6.84	6.50-8.50	I
	Sg. Molongis (Upper reach)	7.33	6.50-8.50	I
	Sg. Molongis (Lower reach)	6.2	6.00-9.00	IIA
	Sg. Hatob (Upper reach)	7.14	6.50-8.50	I
	Sg. Hatob (Lower reach)	7.16	6.50-8.50	I
Salinity	Sg. Kisolong (Upper reach)	0.06	0.5	I
	Sg. Kisolong (Lower reach)	0.06	0.5	I
	Sg. Molongis (Upper reach)	0.07	0.5	I
	Sg. Molongis (Lower reach)	0.07	0.5	I
	Sg. Hatob (Upper reach)	0.03	0.5	I
	Sg. Hatob (Lower reach)	0.03	0.5	I

The water temperature ranged from 19.03 to 21.16 °C. The pH of the stream was neutral and ranged from 6.2 to 7.33, whereas conductivity values were rather uniform. Based on INWQS, parameters measured mostly classified these stations into Class I. These results were consistent with the other group of researchers (Fera et al., 2013) that indicated the Liwagu River tributaries had excellent water quality. Dissolved oxygen reading was unavailable due to equipment problem. However, study conducted by Fera et al. (2013) recorded dissolved oxygen that ranged 6.19 to 7.79 mg/l that classified stream in Liwagu water catchment as Class IIA.

Out of the existing ten orders of insects that contain aquatic species, a total of eight orders belonging of 61 families and 2163 individuals were encountered in the three different streams of Liwagu (Table 3 & Table 4). The eight orders consisted of Ephemeroptera, Plecoptera, Trichoptera, Odonata, Megaloptera, Coleoptera, Diptera and Hemiptera.

The families of Ephemeroptera, Plecoptera, Trichoptera and Coleoptera were the most diverse collected in each station. Out of 61 families yielded, Trichoptera contributed the highest with 12 families (20 %), while Megaloptera recorded two families (3 %) (Figure 2).

Diversity indices values showed that aquatic insect were diverse in these three streams (Table 4). The diversity of aquatic insects in the streams of Liwagu water catchment was high probably due to the heterogeneous nature of the in-stream habitats, good water quality as well as the availability of food sources. In addition, almost 50 % of the dominant taxa were representative of the Ephemeroptera, Plecoptera and Trichoptera (EPT) (Figure 2). EPT are the insect orders used for biological monitoring as indicators for clean water quality (Che Salmah et al., 2001).

EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa richness indicated that three streams were in good water quality categories (non-impacted streams) in which the EPT taxa value is greater than 10 (Table 5). The high EPT taxa showed that the streams were well-oxygenated and clean, since the EPT taxa is highly sensitive to pollution (Azrina et al., 2006). Both BMWP and $BMWP^{Thai}$ scores indicated the stream had very high water quality (score >100). For ASPT and $ASPT^{Thai}$, the score indicated all sampled streams were categorised in rather clean water except for ASPT score in Sg. Kisolong which indicated better water quality. Overall, all streams had good water quality.

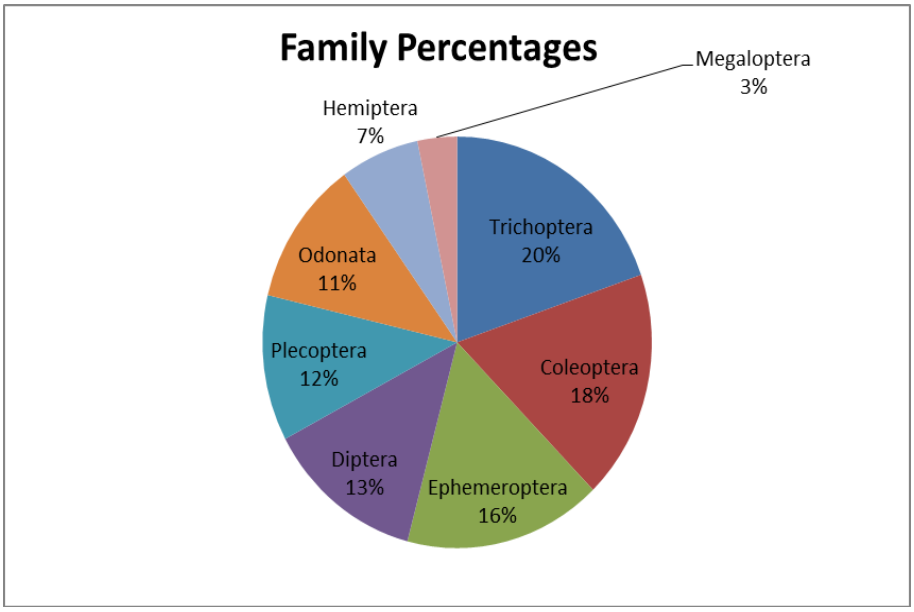

Figure 2. Percentage of families recorded from the streams of Liwagu water catchment.

BMWP and ASPT indices were originally developed for temperate countries (Armitage et al., 1983). Therefore, the Thailand adapted indices ($BMWP^{Thai}$ and $ASPT^{Thai}$) were used in this study. Both indices showed the same results except for Sg. Kisolong, where a higher score indicated better water quality. This difference was mainly due to the reassigned score of most Odonata taxa to lower tolerance score (from 8 to 6) and higher Odonata taxa recorded in Sg. Kisolong.

Table 3. Composition of Aquatic Insects in Sg. Kisolong, Sg. Molongis and Sg.Hatob

Orders	Families	Rivers		
		Sg. Kisolong	Sg. Molongis	Sg. Hatob
Ephemeroptera	Caenidae	17	11	0
	Leptophlebiidae	13	16	5
	Heptageniidae	60	72	44
	Potamanthidae	37	35	1
	Siphlonuridae	12	4	6
	Baetidae	10	24	19
	Ephemerllidae	4	2	3
	Palingeniidae	0	0	2
	Oligoneuridae	0	0	5
	Neoephemeridae	0	1	0
Plecoptera	Perlidae	36	123	131
	Perlolidae	25	13	2
	Pteronarcyidae	1	0	0
	Chloroperlidae	2	0	0
	Peltoperlidae	158	58	111
	Capniidae	1	0	0
	Neumoridae	0	1	0
Trichoptera	Hydroptilidae	14	6	2
	Hydropsychidae	185	43	167
	Leptoceridae	1	0	1
	Brachycentridae	8	0	0
	Lepidostomatidae	3	0	1
	Philopotamidae	0	0	5
	Rhyacophilidae	2	2	3
	Calamoceratidae	0	0	1
	polycentropodidae	0	11	10
	Phryganeidae	0	1	1
	Helicopsychidae	3	18	0
	Glossosomatidae	0	1	0
Odonata	Gomphidae	3	2	1
	Aeshnidae	2	0	2
	Corduliidae	4	0	1
	Coenagrionidae	1	1	0
	Cordulegastridae	1	0	2
	Calopterygidae	2	0	1
	Macromiidae	0	0	1
Megaloptera	Corydalidae	42	11	7
	Sialidae	0	1	1
Coleoptera	Hydrophilidae	44	14	4
	Elmidae	31	46	70
	Gyrinidae	1	1	2
	Amphizoidae	3	0	0
	Psephenidae	11	35	15
	Hydraenidae	1	0	0
	Chrysomelidae	1	0	0
	Ptilodactylidae	0	1	2
	Dytiscidae	0	0	9
	Dryopidae	0	2	14
	Haliplidae	0	1	3
Hemiptera	Pleidae	13	11	3
	Belostomatidae	8	2	1
	Gerridae	12	31	6
	Naucoridae	6	0	35

(continued on next page)

Table 3. (continued)

Diptera	Tipulidae	12	29	12
	Simuliidae	3	1	3
	Dixidae	1	1	0
	Chironomidae	5	3	3
	Cerotopogonidae	0	3	1
	Athericidae	0	0	1
	Stratiomyidae	0	1	2
	Blephariceridae	0	0	3
	TOTAL	**799**	**639**	**725**

Table 4. Aquatic Insect Diversity in the three streams of Liwagu water catchment

	Sg. Kisolong	Sg. Molongis	Sg. Hatob	Total
No of Order	8	8	8	8
No of Family	42	41	43	61
Total Individuals	799	639	725	2163
Shannon, H'	2.73	2.85	2.57	-
Evenness,*E*	0.73	0.78	0.67	-

Table 5. Biotic Indices Scores and stream water quality category of Sg. Kisolong, Sg. Molongis and Sg. Hatod.

Streams	Sg. Kisolong	Sg. Molongis	Sg. Hatob
EPT	20 (Non impacted)	19 (Non impacted)	20 (Non impacted)
BMWP	240 (Very high water quality)	185 (Very high water quality)	235 (Very high water quality)
ASPT	8.28 (Very clean)	6.61 (Rather clean)	6.91 (Rather clean)
$BMWP^{Thai}$	215(Very high water quality)	185(Very high water quality)	229(Very high water quality)
$ASPT^{Thai}$	6.72(Rather clean)	6.38(Rather clean)	6.54(Rather clean)

Conclusions

Based on this study, we concluded that the diversity of aquatic insects in three different streams of Liwagu water catchment were high and could be higher if identification was done at species level. Both INWQS and biotic indices indicated that the Liwagu water catchment has minimal anthropogenic disturbance and very good water quality.

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