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THE RELATIONSHIP BETWEEN WATER QUALITY AND BLACK FLY (DIPTERA: SIMULIIDAE) ABUNDANCE IN TAMBUNAN DISTRICT, SABAH.

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ABSTRACT

Black flies (Diptera : Simuliidae) have been extensively studied almost worldwide (Hamada & Grillet, 2001). This is because blackflies are among the best-known aquatic insects and globally distributed (Adler *et al*., 2004). Black flies in Malaysia are less known and research about this aquatic insect is still scarce especially in Borneo region. Most of the earlier studies on black flies in Sabah were related to taxonomy (Takaoka, 2001). However, studies on ecology and the role of black flies as bio-indicator has so far not been well reported yet. The aim of this study is to determine the relationship of water quality against the abundance of black flies pupa (Simuliidae). Regression test shows that relationship between dissolve oxygen (r^2=0.57, p=0.02), total dissolve substance (TDS) (r^2=0.18,

p=0.04) and conductivity (r^2=0.14, p=0.04) appeared significant to the abundance of black flies pupae. All the study sites (6 rivers) were classified into Class 1 based on Water Quality Index Classification (DOE, 2006).

Keywords: Black flies, water quality

ABSTRAK

Kajian serangga lalat hitam (Diptera: Simuliidae) telah meluas hampir ke seluruh dunia (Hamada & Grillet, 2001). Ini adalah disebabkan, lalat hitam adalah di antara serangga air yang terkenal dan populasinya telah tersebar di serata tempat (Adler *et al*., 2004). Di Malaysia, lalat hitam tidak beberapa dikenali dan penyelidikan mengenai serangga air ini jarang dikaji. Kebanyakan kajian yang melibatkan lalat hitam adalah dari aspek taksonomi lalat hitam (Takaoka, 2001). Walaubagaimanapun, kajian mengenai kepentingan ekologi lalat hitam sebagai indikator biologi air sungai masih kurang dilaporkan. Tujuan kajian ini dijalankan adalah untuk menentukan hubungan antara kualiti air sungai dengan kehadiran pupa lalat hitam. Ujian Regresi menunjukan bahawa kandungan oksigen (DO) dalam air (r^2=0.57, p=0.02), jumlah serapan pepejal (TDS) (r^2=0.18, p=0.04) dan konduktiviti (r^2=0.14, p=0.04) mempengaruhi jumlah individu pupa lalat hitam. Kawasan kajian diklasifikasi sebagai Kelas 1 berdasarkan Indeks Kualiti Air (DOE, 2006).

Kata kunci: Lalat hitam, parameter kualiti air

INTRODUCTION

Black flies sizes ranging between 1 to 15 mm depending to their species (Catherine et al., 2010; Butler & Hossette, 1998). These true flies belong to Simuliidae family and their population are

distributed widely (Zhang et al, 1998). Immature black flies prefer running water habitat which contains high oxygenated sections of waterways such as rivers, streams and waterfalls. The adult females of black flies are blood feeder and for some country such as in North America (Adler et al., 2004), these insect are serious biting pests that can cause ‘river blindness which can affect human and livestock (Adler, 2005; Catherine et al., 2010).

Black flies are important to the lotic ecosystem whether for integral role in organic matter processing in streams (Hart, 1986) or as a prey for food web dynamic in the lotic ecosystems (Cummins, 1988).Black flies are one of thebio-indicator for water quality and according to Vincent & John (1975), *Simulium*is the first insect that appear in the recovery zone. Moreover, some species are often found only in clean water, however, some species can adapt to the water pollution and these species are distributed in a wide range of ecological tolerances (Vincent & John, 1975).

MATERIALS AND METHODS

Study area

This study was conducted from October 2015 until February 2016. Black flies pupae and larvae were sampled once every fortnight at six selected rivers located in Tambunan district (Table 1).

Table 1 Habitat characterization of study areas.

Stations	GPS Location	Habitat Description
Sg. Kerokot	(N05º49’33.1’’ E116º29’39.5’’)	Fast flowing water, clean water, rocky bottom. Open canopy
Sg Lumondou	(N05º42’54.7’’ E116º24’08.8’’)	Fast flowing water, rocky bottom. Open canopy.
Sg. Pegalan	(N05º42’47.1’’ E116º24’28.2’’)	Fast flowing water, rocky bottom. Open canopy.
Sg. Tambunan	(N05º41’42.6’’ E116º22’57.4’’)	Moderate water current, rocky and sandy bottom. Open canopy.
Sg. Malungung	(N05º37’35.2’’ E116º17’12.7’’)	Fast flowing water, rocky bottom. Open canopy.
Sg. Kinabaan	(N05º43’46.9’’ E116º23’27.5’’)	Moderate current, gravelly and rocky bottom. Open canopy

Sampling procedure

At each sampling site, larvae and pupaewere manually collected from all types of substrates such as leaf litter, rocks and artificial substrate (plastics). Physio-chemical water quality was measured *in-situ*by using multi-parameter probe EUTECH PCD-650 for dissolve oxygen (DO),pH, conductivity,temperature and total dissolve solid (TDS). Black flies larvae were removed from the substrate and preserved in 80% ethanol for identification. In the laboratory, mature pupae of black flies were sorted and placed into a vial until the adult black flies emerged. Adult black flies along with its pupae skins were preserved in a vial with 80% ethanol for identification which based on several taxonomic key references (Takaoka 2001; Takaoka *et al*., 2015).

Data Analysis: Linear regression was used to analyse the relationship between water quality parameter and the abundance of black flies using PAST Software.

RESULT AND DISCUSSION

A total of 8026 individual (pupa) of black flies were collected from October 2015 until February 2016. Results show a total of six black flies species were identified in the selected rivers at Tambunan district. Sg Lumondou recorded the highest abundance of black flies' pupae (2918 individual; 36.36% total abundance), meanwhile Sg. Tambunan recorded the lowest pupae abundance with 191 individuals (2.38% total abundance) of pupae (Table 2). Among the six species, *Simulium sabahense, S. keningauense* and *S. beludese* were recorded as a common species in all the six selected rivers (Table 3).

During data sampling, most of specimens were collected from leaf litter which submerged and stuck in between rocks at depths less than 100 cm and other substrate such as twigs and plastics. Mostly, abundant of immature black flies was found in the velocity between 0.3 to 0.5 m/sec.

Table 2 Abundance of individual black flies and mean of water quality parameters

Stations	N (Total pupa)	Velocity (m/sec)	DO (%)	pH	TDS (ppm)	Conductivity (µS/cm)	Temp (ºC)	River Classification (DOE, 2006)
S1	191	0.2±0.15	82.7±3.32	6.83±0.24	125.3±9.59	127.5±10.1	24.2±1.47	Class I (Notes : Class I – Conservation of natural environment; Water Supply I – practically no treatment (only boiling needed) Fishery I – very sensitive aquatic)
S2	347	0.2±0.15	88.7±1.05	6.87±0.32	75.85±8.39	81.9±8.92	24±1.21	
S3	529	0.44±0.19	85.6±3.21	6.6±0.32	52.15±10.4	55.61±10.9	21.1±0.3	
S4	1275	0.2±0.55	85.8±2.61	6.7±0.26	40.9±15.01	35.2±15.03	22.2±0.82	
S5	2766	0.29±0.18	84.1±3.25	6.76±0.36	101.8±15.0	112.4±18.4	24±0.76	
S6	2918	0.36±0.28	82.8±3.90	6.68±0.33	63.87±9.22	61.94±8.79	23.6±1.5	

S1: Sg Tambunan; S2: Sg. Kinabaan; S3:Sg. Kerokot; S4:Sg. Pegalan; S5: Sg.Malungung; S6: Sg.Lumondou

Table 3 The composition and distribution of black flies in the selected rives in Tambunan district.

Subgenus/ Species	Sg. Kerokot	Sg. Lumondou	Sg. Pegalan	Sg. Malungung	Sg. Tambunan	Sg. Kinabaan
Subgenus : *Simulium*						
S.sabahense	+	+	+	±	+	+
S.keningauense	+	+	+	+	+	+
S.aureohirtum	-	-	-	-	-	+
Gomphostalbia						
S.beludense	±	±	+	±	+	±
S.parahiyangum	+	-	-	-	+	+
S.sheilae	-	-	-	-	+	-

+: Present; ±: Common; -: absent

The relationship between black flies abundance and water quality parameter

Results in Table 4 shows that, dissolved oxygen (DO) appeared to be significantly related (r^2=0.57, p=0.02) to the black flies abundance. According to Doisy et al (1986), majority of black flies larvae required at least 78% saturation of dissolve oxygen and some species required between 92 to 98% of saturation. This is because most aquatic insects including black flies larvae need high concentration of oxygen to breed (Adler *et al*., 2004).

Table 4. Regression value of water quality parameter against abundance of black flies' pupa

Parameters	**Velocity (m/sec)**	**DO (%)**	**pH**	**TDS (ppm)**	**Conductivity (µS/cm)**	**Temp (ºC)**
r^2 value	0.52	0.63	0.01	0.14	0.18	0.01
p value	0.08	0.03*	0.11	0.04*	0.04*	0.06*

*significant value at p<0.05

On the contrary, conductivity (r^2=0.14, p=0.04) and total dissolve solids (r^2=0.18, p=0.04) showed a significantlynegative correlation with the abundance of black flies (Table 4). Both, conductivity and total dissolve solid (TDS) which indicates the presence of ions concentration that can determine the quality of water (Tariq *et al*., 2006). Increasing conductivity indicates that there is a source of dissolve ions in the water (Siddaramu & Puttaiah, 2013). Therefore, results from this study shows that black flies abundance is affected by conductivity and total dissolve oxygen. From this study, all six selected river were classified as Class 1 river according to Water Quality Index Classification (DOE,2006).

Limitations of study: From this study, there were some limitations to face such as changing of weather which affected the sampling activities especially during raining seasons. Besides that, there was restricted river "*tagal*" in Sabah which cannot be simply accessed without the permissions of local people in the village.

CONCLUSION

In conclusion, total dissolve solids and conductivity affected the abundance of black flies pupae. Some of the water quality parameter influences the abundance of black flies pupae since black flies pupae require certain condition of water quality to breed. Results from these study shows that black flies were easily found in Class 1 Rivers. Further studies will be conducted to monitor the effect of seasonal changes against black flies abundance in Sabah.

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