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Short Notes

Notes on Congregating Fireflies (Coleoptera, Lampyridae) of Binsulok River, Sabah

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Abstract

A brief survey on congregating fireflies of Binsulok River was conducted on September 9 and 16, 2017. Altogether nine sampling stations were selected among the display trees of *Rhizophora apiculata*. Water quality parameters were also recorded close to each sampling station. This is the first record where all five *Pteroptyx* species recorded in Sabah were found in a single area on one species of display tree. *P. bearni* was the predominant species sampled with 33 male individuals, followed by *P. tener* (5 males), *P. valida* (5 males), *P. gelasina* (2 males) and *P. malaccae* (1 male). In terms of water quality, only water pH (which was mostly acidic, mean pH 4.51 ± 0.03), and low dissolved oxygen (D.O., mean 3.36 ± 0.64 mg/L), can be considered as not suitable for aquatic life, which could contribute to the decreasing population of fireflies, as larvae of fireflies feed on river snails. An aerial survey of the area by a drone showed that there was some encroachment and land use change from its original mangrove forest. However, these results could not be quantifiable but this survey suggested that the land usage could contribute to the decline in firefly population.

Keywords: fireflies, *Pteroptyx*, mangrove forest, conservation

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Introduction

Fireflies are beetles (Order Coleoptera) under the family Lampyridae. Beetles in this family have the ability to emit light from luminous organs located at the tip of their abdomen. Fireflies use their flashing signals to attract the opposite sex of the same species (Ohba & Sim, 1994; Ohba, 1999). Their ability to produce rhythmic synchronous flashing light in large population densities has made them an attraction (Buck, 1988). The loss of their natural habitat, the mangrove forests, has caused their extinction in several places, making them a subject for serious studies (Ballantyne et al., 2011). The firefly that has the potential as an ecotourism product is the one from the genus *Pteroptyx* (Mahadimenakbar et al., 2009). There are currently five *Pteroptyx* species, namely *P. bearni*, *P. tener*, *P. malaccae*, *P gelasina*, and *P. valida*, that can be found in Sabah (Mahadimenakbar & Fiffy, 2016). *P. similis* Ballantyne, which was thought to be endemic to Sabah (Ballantyne, 2001) is now synonymised with *P. bearni* (Ballantyne & Lambkin, 2013).

Each species has a unique flashing frequency and their courtship involves an exchange of flashing signals at dusk or once it is dark. In general, they can be divided into three different groups, which are: 1) the congregating synchronous flashing type; 2) the congregating non-synchronous flashing type; and 3) the solitary fireflies. The congregating firefly is commonly found in the mangrove regions of Southeast Asia (Hogarth, 1999). In the Oriental region, the congregation of these magnificent insects can only be found principally at mangrove trees along brackish rivers (Buck & Buck, 1968). All synchronous displays occur in trees or shrubs along tidal rivers in mangrove-nypa swamps (Ballantyne & McLean, 1970).

Malaysia is blessed with an abundance of these congregating species in most of the mangrove inter-tidal rivers where the numbers depend wholly on the health of the riparian forest and the water quality. In order to ensure the fireflies can survive in their natural habitats, it is crucial to conserve the habitats that the insects reside in (Foo & Mahadimenakbar, 2015). Assessments of the area and baseline scientific studies are needed to determine the population status of the fireflies for conservation planning and development (Foo & Mahadimenakbar, 2017).

Methodology

Binsulok River is located in Klias Peninsula. It is a potentially a good destination for nature tourism and environmental education (Mohamed et. al.,

2000). An initial population survey was conducted on 9 September 2017, followed by sampling on 16 September 2017 in Binsulok River. Prior to the sampling, aerial photos were taken from a drone at selected points of the surveyed area to study potential threats to the population of fireflies. In the evening, fireflies were surveyed from the boat berth (N 05°31'27.0" E 115°43'03.2'') where tourists start their journey on the river cruising up to the end point (N 05°31'50.3" E 115°42'05.0'').

The surveyed area was divided into three sections and three display trees (sampling stations) with the highest congregation of fireflies were sampled at each section. Fireflies were sampled by using an aerial net for approximately two minutes. Specimens collected from each display tree were placed in separate plastic bags (Foo & Mahadimenakbar, 2016).

The plastic bags were later brought to the lab and kept in a freezer overnight to kill the specimens. Specimens were later transferred to vials containing ethanol solution 75%. Specimens were then identified based on reference collections in Universiti Malaysia Sabah. In addition, there were six aquatic (pH, water temperature, dissolved oxygen (DO), conductivity, salinity and total dissolved solid (TDS)) and four terrestrial parameters (wind speed, relative humidity (RH), ambient temperature and light intensity (LI) from 3 sections (1) Boat berth – Starting point (N 05°31'27.0" E 115°43'03.2''), (2) Midpoint (N 05°31'34.9" E 115°42'34.2'') and (3) Endpoint (N 05°31'50.3" E 115°42'05.0'') were recorded with three replicates (A-I) for each section. Aquatic variables were recorded using Eutech Instruments PCD650 Multiparameter Meter while other terrestrial variables were recorded using the Kestrel 5500 Portable Weather Meter.

Results and Discussion

Species Diversity

In terms of firefly species, all five *Pteroptyx* fireflies that are recorded in Sabah were found in the area and these are *P. bearni*, *P. tener*, *P. malaccae*, *P gelasina*, and *P. valida*. This was the first record in Sabah where all five *Pteroptyx* species were recorded in the same area (Table 1). Binsulok can be considered a good place for congregating fireflies as in this short study, (one sampling occasion on nine display trees) can generate all five *Pteroptyx* species found in Sabah. The display trees were all from the same species, *Rhizophora apiculata* (Nilus et al., 2010).

Table 1. The number of samples collected on each display tree

Station		*P. bearni*	*P. tener*	*P. valida*	*P. gelasina*	*P. malaccae*
	A	5	0	3	0	0
1	B	5	0	0	0	0
	C	2	0	0	1	0
	D	3	0	0	1	0
2	E	2	0	2	0	0
	F	0	1	0	0	1
	G	3	1	0	0	0
3	H	10	0	0	0	0
	I	3	3	0	0	0
Total		**33**	**5**	**5**	**2**	**1**

This result suggested that Binsulok River has the highest number of species in one area in Sabah compared to other firefly sites reported earlier such as Klias, Paitan, Sepilok, Tuaran, Beaufort, and Pulau Sakar (Chey, 2004; Chey, 2006; Chey, 2008; Chey, 2009; Chey, 2010; Chey, 2011).

Throughout Malaysia, there are only seven species of *Pteroptyx* recorded, and in Sabah, only five have been confirmed. All five *Pteroptyx* species in Sabah can be found in Binsulok River. This result also suggests that Binsulok River has the richest species of congregating fireflies in Sabah, hence the need to conserve the area.

Land Use

The drone survey showed that there is a small patch of oil palm, a poultry farm, a few small watermelon farms and disused village garden patches. The drone survey also revealed that there is significant construction of roadwork in the pristine area of the mangrove across the Binsulok Nature Resort. These results could not be quantified but this survey suggests that these land use changes could contribute to a decline in the population of fireflies. However, from the researchers' point of view, this only has a small effect, as the visibility of fireflies sighted during research was still high compared to other fireflies research sites in Sabah.

Aquatic and Terrestrial Parameters

The survey for aquatic and terrestrial parameters suggest that most organisms living in estuaries prefer a pH of between 6.5 and 8.5. If the pH drops below 5.0 or goes above 9.0, many marine organisms will have trouble surviving (Robertson-Bryan, 2004). In Binsulok, the water pH recorded from all stations

were below 5.0. Water temperature recorded was between 28.2-28.4°C and this is considered normal in tropical areas (Table 2).

Table 2. The results of the aquatic and terrestrial parameters. Standard error of the means were calculated.

Station		Parameters									
		pH	Water Temp (°C)	DO (mg/L)	EC (µS/cm)	Salinity (mg/L)	TDS (mg/L)	Wind Speed (m/s)	RH (%)	Ambient Temp (°C)	LI (lux)
1	A	4.77	28.3	4.14	92.76	130	59.22	0.0	82.9	28.3	0.0
	B	4.54	28.2	4.82	92.54	150	60.15	0.0	82.0	28.2	0.0
	C	4.53	28.3	7.75	91.49	180	58.55	0.0	82.9	28.3	0.0
2	D	4.48	28.4	2.29	104.6	170	66.94	0.0	85.8	27.9	0.0
	E	4.47	28.4	1.44	115.1	110	73.66	0.0	85.8	27.8	0.0
	F	4.47	28.4	2.14	109.4	170	70.01	0.0	85.8	27.9	0.0
3	G	4.46	28.4	2.69	116.4	140	74.49	0.0	88.7	27.3	0.0
	H	4.46	28.4	2.69	118.5	130	75.84	0.0	87.2	27.6	0.0
	I	4.45	28.4	2.31	115.8	150	74.11	0.6	86.7	27.7	0.0
Mean ± SE		**4.51 ± 0.03**	**28.36 ± 0.02**	**3.36 ± 0.64**	**106.29 ± 3.77**	**147.78 ± 7.60**	**68.11 ± 2.37**	**0.07 ± 0.07**	**85.3 1 ± 0.75**	**27.89 ± 0.11**	**0.00**

Data on dissolved oxygen DO (mg/L) showed that dissolved oxygen in Sungai Binsulok was quite low. Most stations gave readings lower than 5 mg/L. Only station 1 C gave a reading above 5 mg/L. This indicated that Binsulok River has low dissolved oxygen which is crucial for aquatic organisms to survive. Dissolved oxygen above 5 mg/l is needed for most marine plants and animals to survive as they need plenty of oxygen to breath. When the dissolved oxygen is low, below 3 mg/l, the water is called hypoxic. If all the dissolved oxygen is used up and is below 0.5 mg/l, the water is called anoxic. Under hypoxic conditions, many marine plants and animals may not survive. No marine plants and animals that require oxygen can survive in anoxic conditions. However, further water quality analysis has to be done in order to ensure the status of water quality of the river as the data obtained from this study was too minimal to determine the status.

Electric Conductivity (µS/cm) readings showed Binsulok River is not very salty since readings from all stations were between 118.5 (max) – 91.49 (min) µS/cm. The more ions that are present, the higher the conductivity of water.

Most fresh drinking water will have less than 100 µS/cm conductivity. Very brackish water could be around 27,000 µS/cm. Seawater has conductivity of around 54,000 µS/cm.

The average ocean salinity is 35ppt (35,000 mg/L) and the average river water salinity is 0.5ppt (500 mg/L) or less. Due to the fact that water in estuaries is a mix of fresh and sea water, the salinity in most estuaries is less than in the open sea. The salinity of Binsulok River was between 110 to 180 mg/L. Total dissolved solids (TDS) is defined as all inorganic and organic substances contained in water that can pass through a 2 micron filter. TDS is anything—other than the pure water—in water that cannot be seen. This could include any salt, metal or mineral, and the lower the TDS level is, the purer the water. The range of TDS of Sungai Binsulok was between 58.88 - 75.84 mg/L and this level is considered excellent.

All other terrestrial parameters (wind speed, relative humidity, air temperature and light intensity) did not show any peculiar patterns. Light intensity did not show readings because measurements were made at night, indicating that there was no light pollution at the display trees. Only two tests out of 10 came back with negative results. The low pH (acidic) and the low dissolved oxygen (hypoxic) of the river water could contribute to a decrease in the population of fireflies. Since the eight other tests have shown positive results, this means the river is still healthy hence the high visibility of firefly sightings.

Conclusions

Binsulok River has the highest species richness of congregating fireflies compared to other studied areas in Sabah. All five species are available and were recorded in a short study period. From the water quality study, two variables, pH and dissolved oxygen (DO) showed a range of values that are of concern as these variables are important for the survival of many species. Photos taken from the drone showed that there were some anthropological disturbances of the natural habitat. This, if not controlled, could give a considerable impact to the firefly population as fireflies are very dependent on their natural habitat for survival since they need swampy areas as breeding grounds, good and healthy mangrove trees as their display trees and a high abundance of snails as source of food for the firefly larvae.

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