

**ASSESSMENT OF FIREFLY ABUNDANCE AT A NEW
ECOTOURISM SITE OF THE BERNAM RIVER,
SELANGOR, PENINSULAR MALAYSIA**

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ABSTRACT

This study provides important baseline information for conservation of the synchronizing firefly (*Pteroptyx* spp.) and its natural habitat along the Bernam River, a new ecotourism site in Selangor, which has never been reported before. Distribution and abundance (Percentage Cover Estimation, PCE) of the firefly colonies were surveyed nightly along the river during two full-moon and two new-moon phases (February to April 2015). Vegetation assemblages at 40 display stations where adult fireflies congregated to mate were also recorded. Firefly abundance showed no significant differences between the full-moon and new-moon phases ($p > 0.05$), indicating that tourists can always view them at any night-time throughout the year. Male to female ratio is 3:1, indicating that the firefly population is unstable and prone to decline because lack of females would lead

to decreasing fecundity and fertility rates. The fireflies congregated mainly on two host species, Berembang (*Sonneratia caseolaris*) and *Ficus* sp. There are no significant correlations ($p > 0.05$) between the PCE of fireflies and some abiotic parameters (i.e. temperature, relative humidity, wind, salinity, total dissolved solids and conductivity). Efforts to develop a new ecotourism site along this river include controlling riverbank degradation and replanting of degraded Berembang trees to increase the firefly population.

Keywords: distribution; abundance; *Pteroptyx* fireflies; Bernam River; *Sonneratia caseolaris*; *Ficus* sp.

ABSTRAK

Kajian ini menyediakan maklumat asas yang penting untuk pemuliharaan kelip-kelip bersinkroni (*Pteroptyx* spp.) dan habitat semulajadi di sepanjang Sungai Bernam, tapak ekopelancongan baru di Selangor yang tidak pernah dilaporkan sebelum ini. Taburan dan kelimpahan (Anggaran Peratus Litupan, PCE) koloni kelip-kelip telah dikaji setiap malam di sepanjang sungai semasa dua bulan penuh dan dua bulan gelap (Februari hingga April 2015). Kelompok vegetasi di 40 stesen di mana kelip-kelip dewasa berkumpul untuk mengawan juga telah direkodkan. Kelimpahan kelip-kelip menunjukkan tidak terdapat perbezaan yang signifikan di antara fasa bulan penuh dengan fasa bulan gelap ($p > 0.05$), menunjukkan bahawa pelancong sentiasa boleh melihat kelip-kelip di mana-mana waktu malam sepanjang tahun. Nisbah jantan kepada betina ialah 3:1, yang menunjukkan bahawa populasi kelip-kelip adalah tidak stabil dan terdedah menyusut kerana kekurangan betina akan membawa kepada kekurangan kadar fekunditi dan kesuburan. Kelip-kelip berkumpul terutamanya pada dua spesies tumbuhan perumah, Berembang (*Sonneratia caseolaris*) dan *Ficus* sp. Tiada perkaitan yang signifikan ($p > 0.05$) antara PCE kelip-kelip dengan beberapa

parameter abiotik (iaitu suhu, kelembapan relatif, angin, kemasinan, jumlah pepejal terlarut dan kekonduksian). Usaha untuk membangunkan tapak ekopelancongan baru di sepanjang sungai ini termasuklah kawalan hakisan tebing sungai dan penanaman semula pokok Berembang untuk meningkatkan populasi kelip-kelip.

Kata kunci: taburan, kelimpahan; kelip-kelip *Pteroptyx*; Sungai Bernam; *Sonneratia caseolaris*; *Ficus* sp.

INTRODUCTION

Fireflies are beetles from order Coleoptera, which includes over 2,000 species or about 40% of the class Insecta (Zahradník and Severa 1991). Worldwide, fireflies are a very diverse taxon and it is believed that more than four genera, i.e. *Pteroptyx*, *Luciola*, *Colophotia* and *Lychnuris* can be found in Malaysia (Gayton 2000). Fireflies are one of the charismatic fauna in the mangrove ecosystem because they are able to attract public interest due to their ability to flash light synchronously. These insects thrive in the humid environment of river estuaries, and are often found congregating on trees or shrubs along the river (Ballantyne and McLean, 1970, Nallakumar 2002, Wong 2001, Zaidi et al 2005).

Although fireflies occur in a wide range of habitats, some are closely associated with mangroves, where their larvae prey on ground dwelling gastropod snails in the intertidal zones. The synchronous firefly species include *Pteroptyx* spp., which are often found congregating in large groups on trees or shrubs in the estuarine mangrove swamps of the wet tropics (Jusoh et al 2010). For example, *Pteroptyx tener* Olivier have been found to congregate on several mangrove species, particularly *Sonneratia* spp., in the mangrove forests of Peninsular Malaysia (Jusoh et al 2009, Zaidi et al 2005).

Malaysia has a booming tourism industry based on its natural resources and rich biodiversity of flora and fauna. One of the popular nocturnal ecotourism pursuits is firefly watching, whereby from dusk until midnight the tourists can cruise leisurely along the river in small rowing boats to watch the fairy light display of the synchronous fireflies in the mangrove trees of the riverbanks. In Malaysia there are many areas that offer firefly-based ecotourism. One of the globally well-known firefly sites is at Kampung Kuantan of Kuala Selangor in the state of Selangor. This particular ecotourism venture is run by the local community with the full support of the local authorities, who provide the boat and jetty facilities, while the boat operators and tour guides are members of the local cooperatives and fishermen.

Recently, a new ecotourism site for firefly watching has been opened up (in the year 2014) at Kampung Sungai Panjang, along the Bernam River, which is a demarcating border between the states of Selangor and Perak. To date, comprehensive and reliable information on the population distribution and abundance of the local fireflies is still lacking (Nada et al 2008, Nallakumar 2002, Zaidi et al 2005). Due to dearth of data on the fireflies of this new site, this study has been conducted to assess the current status of the firefly community and its associated insects, in view of the emerging threats to the fireflies, their host trees and mangrove habitat as a result of river hydrodynamics and human activities. The main objectives of this study are to determine the population distribution and abundance of fireflies at the Bernam river, Selangor; to identify the firefly display trees at various strategic locations along the river; and to find any correlations between the relative abundance of fireflies and some main abiotic factors (i.e. air temperature, relative humidity, wind speed, water salinity, total dissolved solids and conductivity).

MATERIALS AND METHODS

Study site

The Bernam River has been chosen because this location is a new ecotourism site for firefly watching and a sanctuary for fireflies as a tourism product (Marzuki 2015). The length of the Bernam river under the supervision the Department of Irrigation and Drainage (DID) is 121 km with an average width of 50 meters. The first firefly display station is located some 80 km upstream from the coastline (Figure 1).

Field samplings

The riparian trees that display relatively high abundance of fireflies were tagged using a strip of red-white caution tape that was tied to the low branches. The interval between two sampling stations was approximately 500 meters and the location of each sampling site was recorded by Global Positioning System (Model Garmin GPSMAP® 62s). The sex ratio of the fireflies was determined using a non-destructive method (catch and release). Fireflies at each station were collected for twenty seconds using the sweep net, and the gender of each individual specimen caught was rapidly identified by sight.

The vegetation composition was divided into three categories, namely the front vegetation, middle vegetation and rear vegetation. The plant composition was classified within each tagged display station. Sampling for plant species in the display stations was conducted with the assistance of the local boatman, who also acted as our guide. Only specimen samples of those plants that could not be identified in the field were collected and brought back to the Herbarium of Universiti Kebangsaan Malaysia for further taxonomic identification.

Visual estimates

Relative abundance of fireflies at a display station was estimated using a non-destructive estimation method, that is percentage cover estimation (PCE) chart based on firefly flashing (Jusoh et al 2009, Jusoh et al 2010, Terry and Chilingar 1955). Estimates were made at forty display stations along the Bernam River by the same observers on each sampling visit.

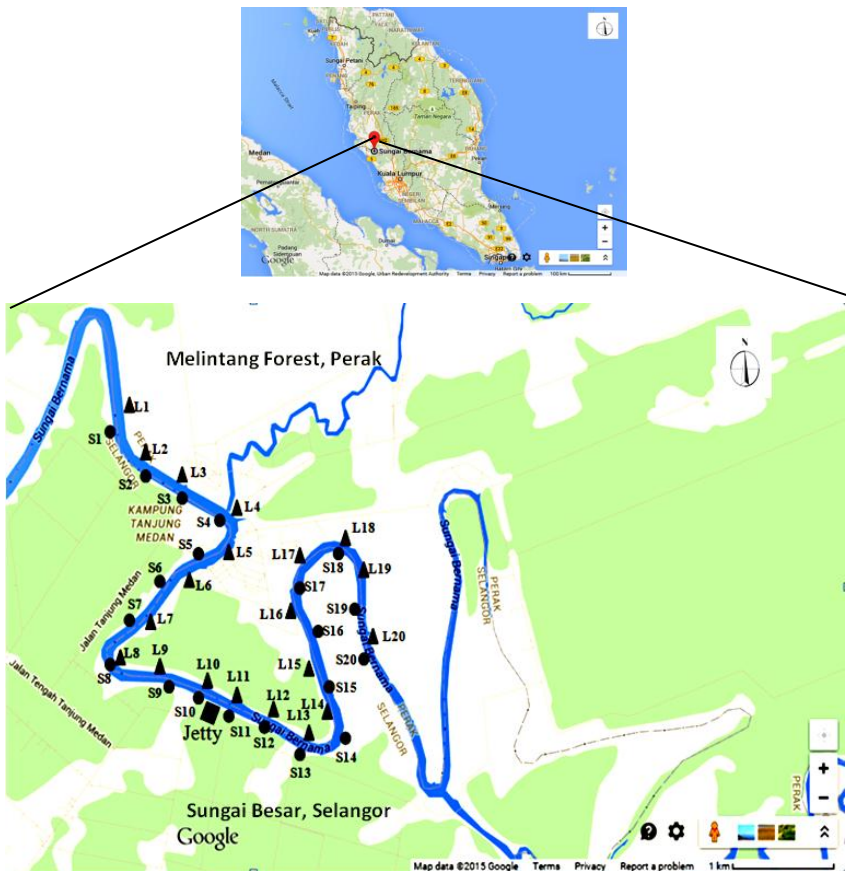


Figure 1. Location of the sampling stations along the Bernam River, Selangor

Statistical analysis

For statistical analysis, the Mann-Whitney Test was used to compare: PCE of fireflies between two moon phases; PCE of fireflies between two sites (right and left); and percentage cover of fireflies between two front vegetation groups (Group1: *Sonneratia caseolaris*, Group 2: *Ficus* sp.). Paired t-Test was used to determine the sex ratio of *Pteroptyx tener* while Kruskal–Wallis mean rank test was used to test differences of the percentage cover occupied by *Pteroptyx* colonies in different vegetation assemblage types. Spearman's correlation tests were carried out to determine the correlation between percentage cover estimation of fireflies and the abiotic parameters.

RESULTS AND DISCUSSIONS

Percentage Cover Estimation of *Pteroptyx tener*

The percentage cover estimation of fireflies during new moon nights was higher compared to during full moon nights (Figure 2 and Figure 3). There were brighter sources of light during full moon nights and the fireflies might be light sensitive and were confused in the bright moonlight. This could explain why more of them are often found on those nights when the moon is not bright or when light sources are limited (Minoru 1986). However, the Mann-Whitney test indicates that PCE of fireflies between the full and new moon phases are not significantly different (R: $U=165.5$, $p=0.35>0.05$, L: $U=151.5$, $p=0.19>0.05$). Thus, there was no definite pattern to differentiate the abundance of fireflies between the new moon and full moon phases.

The Bernam river is wide (between 8 to 12 meters) and the right side of the river belongs to Selangor state while the left side belongs to Perak state, each with its own characteristics. The Mann-Whitney test indicates that the PCE of fireflies shows no significant difference between site R (right bank) and site L (left bank) ($U=173.5$, $p=0.48>0.05$).

Sex Ratio of the Fireflies

The male fireflies were much more abundant than the females, with a sex ratio of 3 males to 1 female. There are significant differences in the number of male and female fireflies between site R ($p=0.04<0.05$) and site L ($p=0.05\leq 0.05$) as shown by paired-t test. The male to female ratio (3:1) is not stable because it is skewed towards more males. In Southeast Asia, male fireflies usually display (flashes) at certain trees along the river bank while female fireflies lay eggs during the night, on the moist and cold soil or leaf litter (Copeland and Moiseff 1994, Yajima 2007). Thus, the possible reason why the number of males is higher than that of females in this study can be explained by these two possibilities:

1. Since most of the female fireflies descend onto the moist substrate of cold ground or leaf litter to lay their eggs during the night, therefore, less of them are encountered or congregated upon the trees.
2. The firefly samples were collected only from the riparian trees at the river banks, while the female fireflies were more likely to be found laying their eggs on the damp soil (ground).

Vegetation Composition

This study recorded a total of 14 vegetation species occupying the firefly habitat area with different physical characteristics. Firstly, the river front assemblage that was occupied by the Berembang trees (*Sonneratia caseolaris*) and Fig trees (*Ficus* sp.). Secondly, the middle section consisting of the riparian vegetation like *Sonneratia caseolaris*, *Calamus* sp., *Macaranga* sp. and other tree species that are submerged during high tide. These plants can thrive here due to their ability to adapt to constantly changing environmental conditions. Lastly, the rear belt assemblage, comprising oil palm trees (*Elaeis guineensis*), Sago palm (*Metroxylon sagu*) Nipah palm (*Nypha fruticans*) and other

species that can survive on higher and dryer ground located further away from the river.

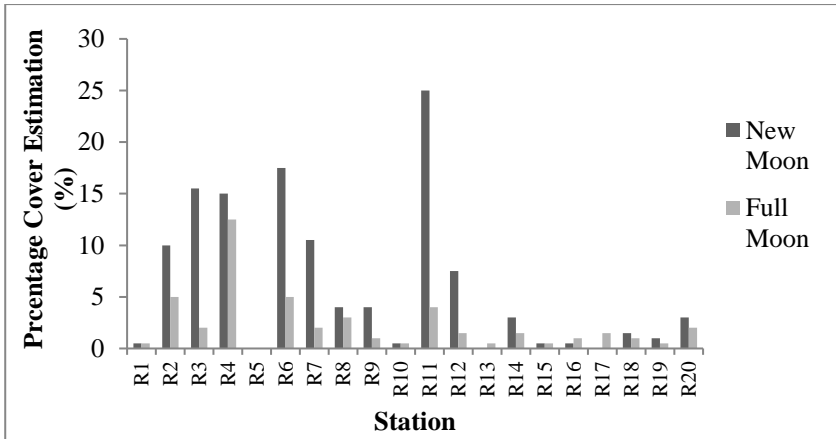


Figure 2. PCE of fireflies at site R (right bank) of the Bernam River

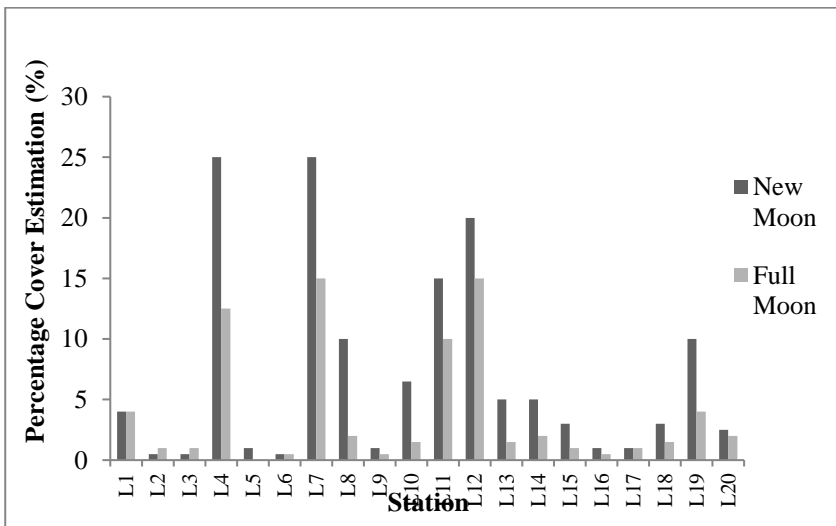


Figure 3. PCE of fireflies at site L (left bank) of the Bernam River

Statistical analysis of vegetation assemblages versus firefly PCE using the Kruskal-Wallis test indicates that the PCE of fireflies do not differ significantly by vegetation assemblage classification ($p = 0.56 > 0.05$). However, there are significant differences in the PCE of fireflies between the two fronts vegetation groups (i.e. between *Sonneratia caseolaris* and *Ficus* sp.) (Mann-Whitney $U = 14.0$, $p = 0.03$).

Preferred display trees or habitat for fireflies in the study area along the Bernam River were *Sonneratia caseolaris* and *Ficus* sp. Other studies disclosed that *Pteroptyx tener* preferred to congregate on several mangrove species, in particular, *Sonneratia* spp., in the Peninsular Malaysian mangrove forests (Jusoh et al 2009, Zaidi et al 2005). In contrast, Mahadimenakbar et al 2003 reported from their firefly surveys along Sungai Klias river that *Sonneratia caseolaris* was not commonly found along its banks. Therefore, the preferred tree or plants of the fireflies remain uncertain. Distribution and abundance of fireflies also depend on other vegetation such as the Sago palm (*Metroxylon sagu*). The gastropod snail *Cyclotropis carinata* that serves as the main food source for the firefly larvae could be found largely near or under the *Metroxylon sagu* or Nipah palm groves (Nallakumar 2002).

Effects of Some Abiotic Factors on Firefly PCE

The average temperature and relative humidity readings at the study site were 27 ± 4.8 °C and 74 ± 11.5 %, respectively, while the average of wind speed was 00.4 ± 00.3 knots. Salinity recorded at each sampling station was at a constant value of 0.1 ppm. The salinity is considered low because the location of the study site is relatively far inland from the sea. The average of total dissolved solids and conductivity were 0.084 ± 0.036 g/L and 171.2 ± 72.7 uS/cm, respectively. Spearman test indicated no significant correlations between the firefly PCE and all the abiotic factors measured at sites R and L (p -value of abiotic factors > 0.05). However, further confirmation on the relationships between the abundance of fireflies and the main abiotic factors

could be elucidated by conducting controlled studies under laboratory or greenhouse condition.

Table 1. Vegetation composition of fireflies at all stations along the Bernam River

Vegetation Assemblage	Front (preferred tree for fireflies)	Middle (Submerged at high tide)	Rear (Inland area)	Station List	Number of stations
A	<i>Sonneratia caseolaris</i>	<i>Sonneratia caseolaris</i>	Other tree	R7, R12, R13, R15, L10, L11, L14, L16, L17, L18, R16, R18,	10
B	<i>Ficus</i> sp.	<i>Ficus</i> sp.	Other tree	L6, L12, L15, L19	6
C	<i>Sonneratia caseolaris</i>	<i>Pandanus</i> sp.	Other tree	R8, L3, L5, L9, L13	5
D	<i>Sonneratia caseolaris</i>	<i>Paspalum</i> sp.	Other tree	R4, R10, L7, L8	4
E	<i>Ficus</i> sp.	<i>Cerbera odollam</i>	Other tree	R9, L2, L4, L20	4
F	<i>Sonneratia caseolaris</i>	<i>Calamus</i> sp.	Other tree	R1, R3, R5	3
G	<i>Sonneratia caseolaris</i>	<i>Cerbera odollam</i>	Other tree	R14, R19, L1	3
H	<i>Sonneratia caseolaris</i>	<i>Ficus hispida</i>	Other tree	R17, R20	2
I	<i>Sonneratia caseolaris</i>	<i>Macaranga</i> sp.	Other tree	R2	1
J	<i>Sonneratia caseolaris</i>	<i>Caladium</i> sp.	Other tree	R6	1
K	<i>Ficus</i> sp.	<i>Macaranga</i> sp.	Other tree	R11	1

Note:R,right bank; L,left bank

Table 2. Spearman test (p-value) between firefly PCE and abiotic factors

		Abiotic Factors					
		Temperature	Relative humidity	Wind speed	Water salinity	Total dissolved solids	Water conductivity
PCE of Fireflies	R	0.337	0.289	0.863	0.358	0.096	0.231
	L	0.484	0.61	0.912	0.787	0.792	0.783

CONCLUSION

The dominant firefly species recorded from 40 sampling stations is *Pteroptyx tener* and the number of males to females is significantly higher with the ratio of 3:1. There was no significant difference in the firefly abundance (PCE) between the full moon and new moon phases. The firefly colonies were distributed mainly on the Berembang trees (*Sonneratia caseolaris*) and *Ficus* sp., trees. Different sites (right and left banks) did not significantly affect the PCE value of the fireflies. The relationship between the main abiotic factors (i.e. temperature, relative humidity, wind speed, water salinity, total dissolved solids and conductivity) and firefly PCE of both the right and left river banks showed very weak and insignificant correlations. Specific conservation programme is needed to protect the firefly habitat of the Bernam river because this location has a great potential to become a new firefly eco-tourism site in the near future. The natural riparian vegetation along the Bernam River should be protected and nurtured for the long-term survival of the firefly colonies.

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