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The Effects of Light and Height of Building in Attracting *Paederus fuscipes* Curtis to Disperse towards Human Residential Areas

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Abstract: *Paederus fuscipes* Curtis is a nocturnal insect. The attractiveness of artificial light sources from residential premises eventually causes the risk of severe dermatitis effect, once *Paederus* is in contact with human skin. The objective of this study is to investigate whether the light and height factors of residential buildings and its' association to rice cultivation phases are primary reasons for *P. fuscipes*'s mass dispersal into human residential areas. The study site was located in residential premises that were built adjacent to rice field areas (≈ 32–60 m and 164 m) north of the rice field located in Teluk Air Tawar, mainland of Pulau Pinang. Overall, both light sources and rice cultivation phases caused a significant effect for *P. fuscipes* beetles dispersal flight to invade human settlements. More *P. fuscipes* were captured near the bright light source with the highest number of beetles found during harvesting stage. Whereas, significantly higher number of *P. fuscipes* were captured at level 2 and 3 compared to ground and level 1 of the apartment building and *P. fuscipes* was also found significantly affected by the rice cultivation phases at different elevation levels. This indicates that bright light sources and higher elevation levels are the main factors in attracting *P. fuscipes* beetles to disperse and causes infestations in residential areas. This finding could create awareness among the public on *P. fuscipes* dispersal pattern.

Keywords: Rove Beetle, Rice Field, Fluorescent Light, *Paederus* Dermatitis

INTRODUCTION

Rove beetle from the family Staphylinidae is a large family of insects found all over the world with over 47,744 described species in 3,847 genera and 31 subfamilies (Herman 2001). About 650 described species of the *Paederus* rove beetles are extensively distributed globally (Willers 2003) with the exceptions of

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Antarctica (Frank & Kanamitsu 1987). In Asia, outbreaks of acute dermatitis were recently spotted at Egypt (Awad *et al.* 2013), China (Ma *et al.* 2009), India (Toppo *et al.* 2013), Nepal (Panta & Poudyal 2013), Thailand (Ekburanawat & Jakreng 2011), and Malaysia (Bong *et al.* 2013). The prevalent species of *Paederus* in Malaysia is *Paederus fuscipes* and it is locally known as "Charlie" which is normally found in the rice field area (Manley 1977). *P. fuscipes* is an insect of public health concerns as these detrimental small creatures are known to produce pederin compound (Nikbakhtzadeh & Tirgari 2008) which is more potent than cobra venom. Large numbers of *P. fuscipes* infestation has remarkably caused serious public health threat as they swarm during certain rice seasons and caused considerable *Paederus* dermatitis (PD) outbreaks, a skin blistering condition. Massive explosion of *P. fuscipes* into human dominated areas from their natural rice field habitat is due to their attraction towards bright lights from the cities. Not a lot of research has been done on the *P. fuscipes* species in Malaysia. Previous study by Bong *et al.* (2013) revealed that residential premises that are found close to the rice field areas have higher chances of *Paederus* infestation especially during harvesting stage, due to human activities in rice fields. But little are known on the attraction factors for their flight dispersal. Hence, by doing further research on the ecology, biology and behaviour of these rove beetles we could prevent or reduce serious health threat such as the erythematous skin lesion and avoid from being a victim of PD in the future.

MATERIALS AND METHODS

Study Site and Methodology

P. fuscipes sampling started in October 2013 until March 2014 that consisted of five months sampling period (10 times biweekly *Paederus* collection) during the main rice season (ploughing, seeding, growing, and harvesting stage) which was throughout the wet period of the year. The temperature falls between 25°C and 27°C with relative humidity of 80% and 95% at night. The study site was three land houses and in a three storey apartment which were located at Jalan Sejahtera, Teluk Air Tawar, Butterworth, Pulau Pinang (5° 29' 9.3171" N, 100° 23' 1.3012" E).

Effects of Light Intensity

Three sticky traps were placed on each selected different light sources: (1) no light source; (2) low light source; and (3) bright light source in two same level positions: land houses and ground floor of an apartment.

Effects of Building Level

Six sticky traps were fixed on each floor of the three storey apartment building (Level 0, Level 1, Level 2, and Level 3) surrounding the fluorescent light. Overall, sticky traps were fixed surrounding fluorescent lights before nightfall at 6.30 pm. After 24 hours, first reading was taken and the subsequent readings were taken daily for three consecutive day biweekly.

Statistical Analysis

All data were tested for normality using SPSS version 20.0 software. Two-way analysis of variance (ANOVA) was used to examine: (1) the effect of light sources and rice cultivation phases; (2) the effect of building levels and rice cultivation phases on the presence of *P. fuscipes*. Further analysis of Post hoc multiple comparisons were calculated using the Tukey's HSD test at $\alpha = 0.05$.

RESULTS AND DISCUSSION

In total, 1,279 individuals of *P. fuscipes* beetles were collected throughout the course of 5 months sampling period. A significant different was found among all three different light intensity sources ($F = 123.393$; df = 2, 48; $p = 0.000$). *P. fuscipes* showed significantly higher attraction towards the bright light source ($p<0.05$; Fig. 1). The number of *P. fuscipes* captured at the bright light was with a total mean ± SD of 20.4 ± 25.92 individuals compared to low (0.6 ± 0.84) and no (0.3 ± 0.15) light sources. Bright light captured significantly higher number of *P. fuscipes* for all rice cultivation phase compared to the other two light sources ($p<0.05$; Table 1). Beetles were commonly captured near the bright light source due to the brightness (light intensity) and illumination (light flux density) that the beetles received most in the area surrounding the bright light. Our results, also found that during growing and harvesting stages, the number of *P. fuscipes* was significantly increased in all types of light sources ($p<0.05$; Table 1). However, greatest number of beetles was captured at the bright light source with mean of 21 ± 2.14 during rice harvesting stage. In contrast, the number of captured individuals near low and no light sources at harvest was with means of 0.67 ± 0.33 and 0.17 ± 0.17 respectively. Generally, most *P. fuscipes* was captured during the harvesting stage due to the disturbance in the rice fields by human activities such as cutting of rice stalks and straw burning (Bong *et al*. 2013). As *P. fuscipes* are predators of leafhoppers (Manley 1977), planthoppers and other small insects found in the rice fields, disruption to the insect's habitat causes food/prey deprivation which ultimately caused them to migrate to areas nearby in search of food supply.

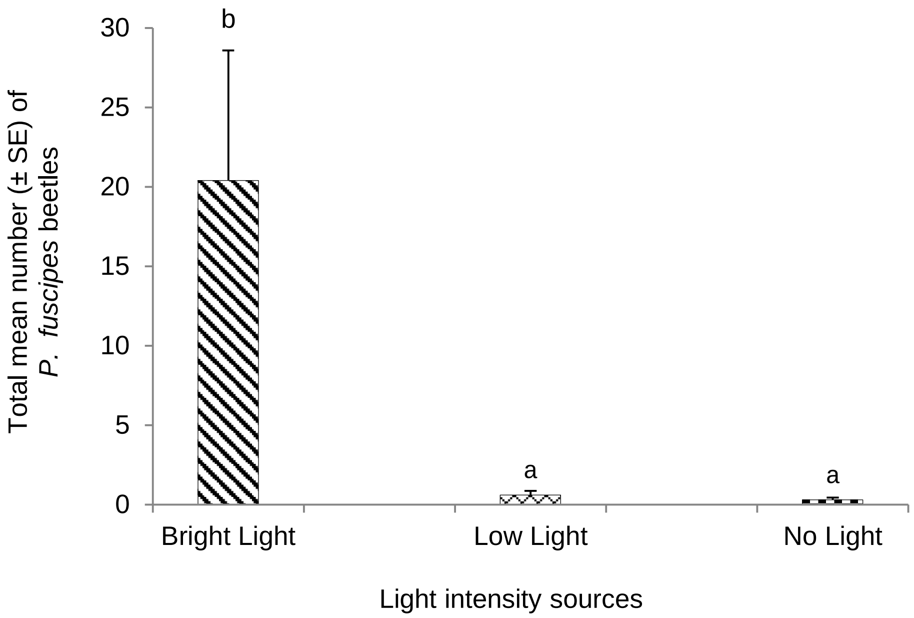

Figure 1: Attraction of *P. fuscipes* beetles towards three different light intensity sources. Data were given in mean ± SE; bright light (n = 24), low light (n = 12), and no light (n = 24).
Note: Scale bars with same letters are not significantly different (Tukey's HSD; p>0.05).

Table 1: Effects of three different light intensity sources and four rice stages on the dispersion of *P. fuscipes* beetles.

Rice cultivation phase	Mean ± SE		
	No light source	Low light source	Bright light source
Ploughing	0.17 ± 0.17^{aA}	0.00^{aA}	1.00 ± 0.52^{bA}
Seeding	0.00^{aA}	0.00^{aA}	0.17 ± 0.17^{bA}
Growing	0.17 ± 0.17^{aB}	1.33 ± 0.67^{aB}	11.83 ± 1.38^{bB}
Harvesting	0.17 ± 0.17^{aB}	0.67 ± 0.33^{aB}	21.00 ± 2.14^{bB}

Notes: The lowercase letter refers to the comparison between three different light intensity sources, whereas the uppercase letter refers to the comparison between four rice stages on the dispersion of *P. fuscipes* towards human habitations.
Mean values followed by the same lowercase letter within a row are not significantly different (Tukey's HSD test; α = 0.05).
Mean values followed by the same uppercase letter within a column are not significantly different (Tukey's HSD test; α = 0.05).

Flight activity of *P. fuscipes* differed significantly towards different building level of the three storey apartment (F = 41.290; df = 3, 32; p = 0.000) with significantly higher numbers on the highest level (46.9 ± 49.04) compared with the lowest level (11.8 ± 13.08) of the apartment (p<0.05; Fig. 2). More beetles captured at the top floor of the apartment were due to the flying adults regulating their flight height to evade impending obstacles. However, *P. fuscipes* flights were also affected by the wind. According to Chapman *et al*. (2003), most insects particularly those passive fliers take benefit of the wind factor to fly at heights of more than a few hundred meters above the ground level that inadvertently involved them in high-altitude flights. The number of *P. fuscipes* was found affected by the rice cultivation phase on each elevation level with highest number of beetles captured was during the harvesting stage (p<0.05; Table 2).

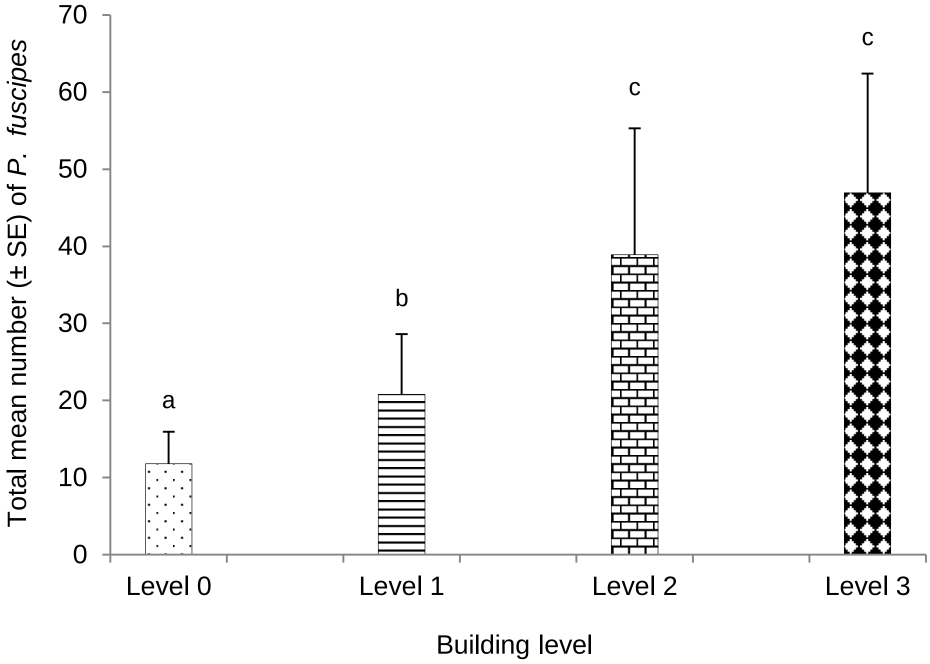

Figure 2: Attraction of *P. fuscipes* beetles towards different building level of a three storey apartment. Data were given in mean ± SE (n = 12).
Note: Scale bars with same letters are not significantly different (Tukey's HSD; p>0.05).

Table 2: Effects of different building level and four rice stages on the dispersion of *P. fuscipes.*

Rice cultivation phase	Mean ± SE			
	Level 0	Level 1	Level 2	Level 3
Ploughing	2.00 ± 0.58^{aA}	3.67 ± 1.76^{bA}	5.00 ± 1.00^{cA}	14.33 ± 0.33^{cA}
Seeding	0.33 ± 0.33^{aB}	0.67 ± 0.33^{bB}	1.67 ± 0.33^{cB}	1.67 ± 0.33^{cB}
Growing	14.67 ± 0.33^{aC}	28.33 ± 2.96^{bC}	50.00 ± 7.37^{cC}	50.33 ± 5.78^{cC}
Harvesting	22.33 ± 3.33^{aD}	36.67 ± 3.18^{bD}	73.00 ± 10.02^{cD}	89.67 ± 7.31^{cD}

Notes: The lowercase letter refers to the comparison between different building levels, whereas the uppercase letter refers to the comparison between four rice stages on the dispersion of *P. fuscipes* towards human habitations.
Mean values followed by the same lowercase letter within a row are not significantly different (Tukey's HSD test; α = 0.05).
Mean values followed by the same uppercase letter within a column are not significantly different (Tukey's HSD test; α = 0.05).

CONCLUSION

P. fuscipes dispersion from the rice field towards human residential areas was primarily stimulated during the rice's harvesting stage. Other than that, residential premises nearby rice fields caused *P. fuscipes* to disperse towards the bright fluorescent light and as their flight course were found at a higher altitude to avoid impending obstacles, more beetles were captured at the higher building level. Further studies need to be conducted to determine the effects of abiotic factors on *P. fuscipes* onset flight period and the spectral light wavelength to which *P. fuscipes* is most receptive, to understand their preference for the types of artificial light sources that are commonly used by Malaysian residents.

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