Serangga 18(2): 61-72
ISSN 1394-5130 © 2013, Centre for Insect Systematics,
Universiti Kebangsaan Malaysia

CIRCADIAN PATTERN OF *CAMPONOTUS SAUNDERSI* (HYMENOPTERA: FORMICIDAE) IN TROPICAL RAIN FOREST OF DANUM VALLEY, SABAH (MALAYSIA)

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ABSTRACT

The exploding ant *Camponotus saundersi* is a rarely studied ant species especially their behaviour. This research mainly composes of observations of the workers' circadian patterns. Observations were made on three colonies of *C. saundersi* in Danum Valley, Sabah, Malaysia. A five day observation period was allocated on each of the colonies. The circadian pattern was observed by counting the number of individuals that enter and leave the nest for one minute each in the interval of 30 minutes. Workers of *C. saundersi* were observed to be active between 0400 and 1900 hrs daily. There were peaks of activities within the active period. However, one of the three colonies showed a slight longer activity.

Keywords: Foraging behavior, *Camponotus saundersi*, tropical rain forest, Danum Valley Sabah

ABSTRAK

Semut kamikaze *Camponotus saundersi* merupakan semut yang jarang dikaji terutamanya kajian yang melibatkan tabiat mereka. Kajian ini bertujuan untuk membuat pemerhatian ke atas pola aktiviti sirkadian *C. saundersi*. Pemerhatian telah dibuat ke atas tiga koloni *C. saundersi*di Lembah Danum, Sabah, Malaysia. Setiap koloni telah dicerap untuk lima hari. Pola aktiviti sirkadian *C. saundersi* diperhatikan berdasarkan bilangan individu yang keluar dan masuk sarang dalam satu minit untuk tempoh 30 minit. Semut-semut *C. saundersi* ini diperhatikan aktif di antara jam 0400 dan 1900 setiap hari. Terdapat tiga masa puncak semut ini aktif. Walaubagaimanapun, terdapat satu daripada tiga koloni yang diperhatikan yang menunjukkan sedikit kelainan di mana keaktifannya adalah lebih panjang.

Kata kunci: kelakuan mencari makanan, *Camponotus saundersi*, hutan hujan tropika, Lembah Danum Sabah

INTRODUCTION

Tropical rain forest is suitable for habitat of ant and termite. Both of these creatures in fact has three times biomass compared to overall mass of other creature living in area thus making ants one of most common forager on tropical rain forest floor (Hölldoblerdan Wilson, 1994). Food collections are variable in each ant species and depend on their foraging strategy and behaviour.

Foraging strategy of each species of ants can be various. Some rely on environmental conditions such as angle of sun or tree canopy orientation for their foraging method (North, 1996). The most common ants foraging strategy is through pheromone (North, 1996). Foraging behaviour is affected by the reward of food, thus if the food resources is depleted, they will change their foraging behaviour in order to adapt environment (Goulson, 1999). Permanent form or specific foraging behavior shown by ant through its entire live known as daily rhythm. This daily rhythm is caused by the internal biological clock in ant itself (Lazzari and Insausti, 2008) in fact there are many other animals possess this mechanism. This internal biological clock is carried genetically known as Poper mRNA. Although, there are mechanism affect foraging behaviour of ant, sometimes the foraging pattern generated by the experience of organism itself to adapt environment better (Ingram *et al*, 2009).

Camponotus ants are associated with their abilitiesto collect honeydew. Honeydew may be *Camponotus* ants' major form of food but not entirely. They balance their diet with protein or lipid based food. Ants are opportunist insect that some of them may have their own strategy to collect food source efficiently (Davidson, 1998).

Camponotus saundersi have been known for their ability to self-destruct when threatened. This ability comes from the huge gland that extends from the head to its gaster. When they explode, sticky fluid emitted will paralyze and immobilize the enemy (Davidson *et al*, 2011).

This study aims at studying the daily activities of *C. saundersi* based on nest inbound and outbound patterns of workers. The effects of air temperature, humidity and light intensity were investigated on *C. saundersi's* behavioural pattern.

MATERIALS AND METHODS

Daily activities of *C. saundersi* based on nest inbound and outbound patterns of workers. This study was conducted from 22nd January to 12th February 2012. Three colonies of *C. saundersi* (hereby marked Colony 1, Colony 2 and Colony 3) have been observed for 24 hours for five days. This foraging behavior study is conducted by counting the number of *C. saundersi* workers that enter and leave the opening of the nest.

The number of ants entering and leaving the nests were recorded in the interval of 30 minutes with 1 minute allocated for each entering and leaving activities.

The effects of air humidity, air temperature and light intensity were investigated on *C. saundersi's* behavioural pattern. In order to study the effects of environmental parameters on the foraging behaviour, air temperature, air humidity and light intensity were recorded. Spearmann correlation was used to investigate the relationship between the environmental factors and activity patterns of *C. saundersi.*

This study was conducted at Danum Valley Conservation Area, Sabah, Malaysia (04º 58’ 53" N, 117º 50’ 37"E), 81 km to the north west of Lahad Datu town. This area was gazetted as Class 1 conservation area in 1986. The forest of Danum Valley consists of lowland dipterocarp forest which encompasses of an area of 438 km^2, the largest conservation area in Sabah. This conservation area is managed by the Yayasan Sabah (Sabah Foundation) with several other agencies (eg. local universities, federal and Sabah State government agencies). Danum Valley Field Centre was opened in 1986 for research purposes and recreation.

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RESULTS & DISCUSSIONS

Daily foraging patterns of the three colonies of *C. saundersi* are shown in Figure 1. There are notable points that are observed from the patterns. Foraging activities of these ants were mainly peaked in early morning, noon and late dusk. In generalthe three colonies were most active during the daytime and less active at night time. The activity of the workers of all the three colonies first peaked at 0600 hours, followed at approximately 1300 to 1400 hours. Finally, all activities of the three colonies peaked again approximately around 1700 to 1900 hours.

The foraging activity of the three colonies was not exactly similar especially patterns seen for Colony 1. Colony 1 possesses longer

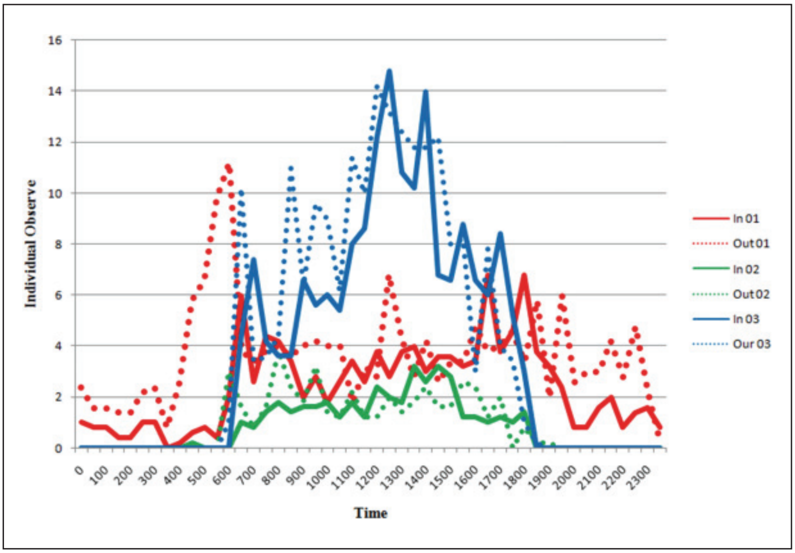

Fig. 1. Graph of "mean" for overall foraging observation on three colonies foraging activities of three colonies of *C. saundersi* foraging activities of three colonies of *C. saundersi*

foraging period compared to Colony 2 and Foraging activities of *C. saundersi* took place at certain hours of the day which was 0400 until 2000. Foraging activity peaked between 0400 until 0600, 1200 until 1500 and 1700 until 1900 (when workers returned to their nest).

Ants of Colony 2 and 3 stopped foraging at night can be explained with the existence of ant internal biological clock in this species (North, 1996). Colony 1 on theother hand showed activities all day long with lower observation between 0000 hour to 0530 hour (Figure 1). The entire pattern of the three colonies suggests the diurnal behaviour of *C. saundersi*.

Mean air temperature, humidity and light intensity for five observations of the three colonies are presented in Table 1. Air temperature, humidity and light intensity significantly affected the number of individuals coming in and out into and from the nest (Appendix 1). Effect of light intensity on ant activities of Colony 1 was strong positive correlation in 1st until 3rd observation, while moderate positive correlation was observed in 5th observation. Air humidity moderately showed negative correlation on activities of Colony 1 ants on 3rd and 5th observation. Air temperature was moderately positively correlated with ants activities as shown from 1st until 4th observations.

Colony 2 and 3 showed stronger correlations between ant activities and the three environmental parametersthan the observations in Colony 1. Activities of the ants were strongly positively correlated with light intensity and air temperature. However, air humidity showed strong negative correlation from 1st until 4th observation.

The weather during the sampling was raining especially at noon. The increase in air humidity will trigger the rain to fall. This ultimately moisten the soil and foraging pattern when moistened or wet soil to cause pheromone trails to dissolve thus making it hard for the ants to forage (Changlu *et al*, 2001).

Table 1. General mean parameter (light intensity, air humidity and air temperature)

Colony			**Air temperature (ºC)**	**Air humidity (%)**	**Light intensity (lx)**
Mean	**Colony 1**	Observation 1	24.2	95.9	10.1
		Observation 2	24.9	94.0	23.7
		Observation 3	24.9	93.5	23.7
		Observation 4	24.9	92.9	27.0
		Observation 5	25.1	90.6	18.7
	Colony 2	Observation 1	24.8	93.2	13.6
		Observation 2	25.6	88.5	10.0
		Observation 3	24.8	91.5	14.4
		Observation 4	25.4	90.4	10.5
		Observation 5	24.7	92.3	12.0
	Colony 3	Observation 1	24.7	94.5	5.4
		Observation 2	25.3	91.0	5.3
		Observation 3	25.0	93.5	6.8
		Observation 4	25.0	93.6	4.6
		Observation 5	24.7	92.7	4.1

Table 2. Generalized relationships between ant activities and environmental parameters (+ means positive correlation; - means negative correlation. 2, 3 and 4 indicates level of correlation)

Colony 1	1st observation	2nd observation	3rd observation	4th observation	5th observation
Light intensity	3+(Go in)	3+ (Go in)	3+(Go in) 1+(Go out)		2+(Go in)
Air humidity			2-(Go in) 2-(Go out)		2-(Go in)
Air temperature	2+(Go in)	2+(Go in)	2+(Go in)	2+(Go in)	
Colony 2	**1st observation**	**2nd observation**	**3rd observation**	**4th observation**	**5th observation**
Light intensity	4+(Go in) 4+(Go out)	4+(Go in) 4+(Go out)	3+(Go in) 4+(Go out)	4+(Go in) 3+(Go out)	4+(Go in) 4+(Go out)
Air humidity	3-(Go in) 3-(Go out)	3-(Go in) 2-(Go out)	3-(Go in) 3-(Go out)	3-(Go in)	
Air temperature	3+(Go in) 3+(Go out)	3+(Go in) 3+(Go out)	3+(Go in) 3+(Go out)	3+(Go in)	2+(Go in) 3+(Go out)
Colony 3	**1st observation**	**2nd observation**	**3rd observation**	**4th observation**	**5th observation**
Light intensity	4+(Go in) 4+(Go out)	4+(Go in) 4+(Go out)	4+(Go in) 4+(Go out)	4+(Go in) 4+(Go out)	4+(Go in) 4+(Go out)
Air humidity	3-(Go in) 2-(Go out)	3-(Go in) 3-(Go out)	4-(Go in) 4-(Go out)	2-(Go in) 2-(Go out)	
Air temperature	4+(Go in) 3+(Go out)	3+(Go in) 3+(Go out)	4+(Go in) 4+(Go out)	4+(Go in) 3+(Go out)	3+(Go in) 3+(Go out)

CONCLUSIONS

This study has shown that the workers of *C. saundersi* were found to forage actively from 0400 until 1900 daily. This suggests the diurnal behaviour of *C. saundersi*. Foraging activities of *C. saundersi* were positively correlated with light intensity and temperature. However, air humidity had negative relationship with the species's foraging activities.

ACKNOWLEDGEMENTS

First of all, we wish to express our gratitude to the Institute for Tropical Biology and Conservation (ITBC) UMS for financially supporting this study. Yayasan Sabah is also specially thanked for granting us the permission to conduct the study in Danum Valley. We also thank staff and friends at ITBC namely Musa bin Muchtar, Hasrin Rosley Kho, and the Danum Valley Field Station for their assistance.

REFERENCES

Changlu, W., Strazanac, J.S. and Butler, L. 2001. *Association Between Ants (Hymenoptera: Formicidae) and Habitat Characteristics in Oak-Dominated Mixed Forests*. Division of Plant Sciences, West Virginia University, Morgantown, WV. Collingwood, C.A. 1962. *Some ants (Hym. Formicidae) from North-East Asia*. Minitry of agriculture, fisheries and food, Westbury-on-Trym, Bristol, England.

Davidson, D.W. (1998). *Resource discovery versus resources domination in ants: a functional mechanism for breaking the trade-off*. Ecological Entomology, 23: 484-490. doi: 10.1046/j.1365-2311.1998.00145.x

Davidson, D.W., Salim, K.A. and Billen, J. (2011). *Histology of structures used in territorial combat by Borneo's 'exploding ants'*. The Royal Swedish Academy of Sciences and The Royal Danish Academy of Sciences and Letters.

Goulson, D. 1999. *Foraging strategy of insects for gathering nectar and pollen, and implication for plant ecology and evolution*. Division of biological sciences, University of Southampton.

Hölldobler, B. and Wilson, E.O. 1994. *Journey to the Ants*. The Belknap press of Havard University press Cambridge, Massachuotts, London, England.

Ingram, K.K., Krummey, S. and Leroux, M. 2009. *Expression patterns of circadian pattern clock gene are associated with age related polyethism in harvester ants*, *Pogonomyrmex occidentalis*. BMC ecology.

Lazzari, C.K. and Insausti, T.C. 2008. *Circadian ryhthms in insects*. Transworld research network.

North, R. 1996. *World wildlife series ANTS*.whittet books.

Appendix 1.
Correlation analysis of foraging pattern (in and out of nest) of *C. saundersi* with light intensity, air humidity and temperature

Colony 1	1st observation	2nd observation	3rd observation	4th observation	5th observation
Light intensity	r=0.525 sig-p=0.000 (Go in)	r=0.667 Sig-p=0.000 (Go in)	r=0.547 sig-p=0.000 (Go in) r=0.292 sig-p=0.044 (Go out)	–	r=0.306 sig-p=0.035 (Go in)
Air humidity	–	–	r=-0.335 sig-p=0.020 (Go in) r=-0.328 sig-p=0.023 (Go out)	–	r=-0.302 sig-p=0.037 (Go in)
Air temperature	r=0.396 sig-p=0.396 (Go in)	r=0.429 Sig-p=0.002 (Go in)	r=0.519 sig-p=0.000 (Go in)	r=0.340 sig-p=0.018 (Go in)	–

Colony 2	1st observation	2nd observation	3rd observation	4th observation	5th observation
Light intensity	r=0.780 sig-p=0.000 (Go in) r=0.744 sig-p=0.000 (Go out)	r=0.811 sig-p=0.000 (Go in) r=0.736 sig-p=0.000 (Go out)	r=0.615 sig-p=0.000 (Go in) r=0.766 sig-p=0.000 (Go out)	r=0.795 sig-p=0.000 (Go in) r=0.560 sig-p=0.000 (Go out)	r=0.729 sig-p=0.000 (Go in) r=0.791 sig-p=0.000 (Go out)
Air humidity	r=-0.554 sig-p=0.000 (Go in) r=-0.614 sig-p=0.000 (Go out)	r=-0.494 sig-p=0.000 (Go in) r=-0.342 sig-p=0.017 (Go out)	r=-0.616 sig-p=0.000 (Go in) r=-0.657 sig-p=0.000 (Go out)	r=-0.485 sig-p=0.000 (Go in)	–
Air temperature	r=0.462 sig-p=0.001 (Go in) r=0.443 sig-p=0.002 (Go out)	r=0.601 sig-p=0.000 (Go in) r=0.439 sig-p=0.002 (Go out)	r=0.511 sig-p=0.000 (Go in) r=0.655 sig-p=0.000 (Go out)	r=0.721 sig-p=0.000 (Go in)	r=0.343 sig-p=0.017 (Go in) r=0.447 sig-p=0.001 (Go out)

Colony 3	1st observation	2nd observation	3rd observation	4th observation	5th observation
Light intensity	r=0.959 sig-p=0.000 (Go in) r=0.917 sig-p=0.000 (Go out)	r=0.929 sig-p=0.000 (Go in) r=0.919 sig-p=0.000 (Go out)	r=0.893 sig-p=0.000 (Go in) r=0.898 sig-p=0.000 (Go out)	r=0.878 sig-p=0.000 (Go in) r=0.837 sig-p=0.000 (Go out)	r=0.821 sig-p=0.000 (Go in) r=0.834 sig-p=0.000 (Go out)
Air humidity	r=-0.472 sig-p=0.001 (Go in) r=-0.345 sig-p=0.016 (Go out)	r=-0.543 sig-p=0.000 (Go in) r=-0.409 sig-p=0.004 (Go out)	r=-0.772 sig-p=0.000 (Go in) r=-0.729 sig-p=0.000 (Go out)	r=-0.382 sig-p=0.007 (Go in) r=-0.327 sig-p=0.023 (Go out)	–
Air temperature	r=0.721 sig-p=0.000 (Go in) r=0.597 sig-p=0.000 (Go out)	r=0.658 sig-p=0.000 (Go in) r=0.504 sig-p=0.000 (Go out)	r=0.839 sig-p=0.000 (Go in) r=0.747 sig-p=0.000 (Go out)	r=0.754 sig-p=0.000 (Go in) r=0.577 sig-p=0.000 (Go out)	r=0.477 sig-p=0.001 (Go in) r=0.622 sig-p=0.000 (Go out)