Influences of Temperature, Relative Humidity and Light Intensity on the Foraging Activity of Field Populations of the Longlegged Ant, *Anoplolepis gracilipes* (Hymenoptera: Formicidae)

by

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ABSTRACT

This study was carried out to determine the relationship between the foraging activity of field populations of the longlegged ant, *Anoplolepis gracilipes* (Fr. Smith) and environmental parameters such as temperature, relative humidity and light intensity. Results revealed that foraging activity of *A. gracilipes* was weakly, but significantly ($P < 0.05$) correlated to ambient temperature ($r^2 = 0.2025$) and relative humidity ($r^2 = 0.2105$). However, light intensity did not significantly ($P > 0.05$) affect their foraging activity. The ants foraged most intensively between the temperatures of 26°C and 30°C with the peak foraging activity at 1000h (10:00 AM).

Key words: *Anoplolepis gracilipes*, foraging activity, temperature, relative humidity, light intensity

INTRODUCTION

Formerly known as *Anoplolepis longipes* (Jerdon), *Anoplolepis gracilipes* (Fr. Smith) is an important invasive pest ant species in many parts of the world. It has been categorized as one of the world's top hundred worst invaders (ISSG 2001). The common names of this species include the long-legged ant and yellow crazy ant. They normally nest outdoors in soil, below rocks, bamboo sections placed on the ground and underneath accumulated leaf litter on the forest floor (Haines & Haines 1978; Lee & Tan 2004). The origin of *A. gracilipes* is still unknown but it probably originated from either Asia or Africa (Wetterer 2005). It has successfully spread throughout the moist lowlands of tropical Asia and tropical islands of the Indian and Pacific Oceans. It is also found in subtropical Asia, Northern India, Southern China and Southern

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Islands of Japan (Wetterer 2005). They are able to form multi-queen super colonies over a large area (O'Dowd *et al.* 2003). *A. gracilipes* has a broad diet. They are scavengers as well as predators. They prey on isopods, earthworms, arachnids, insects, crabs, birds, mammals and reptiles (Lewis *et al.* 1976). They also obtain carbohydrates and amino acids from plant nectaries and honeydew excreted by Homopterans.

The activity rhythm of ants is controlled by both endogenous and exogenous factors. An endogenous rhythm is a self-sustained or 'free-run' periodic system in the absence of temporal cues like daily cycles of light and temperature (Saunders 1982). On the other hand, an exogenous rhythm is a rhythm of activity which is a direct response to environmental cues such as temperature and cycles of light (Saunders 1982). Understanding the foraging activity of ants is crucial in ant management because it helps to locate nest sites, provides cues for bait placement and the ideal time to manage the ants, especially when treating with residual spray. In this paper, we focused on exogenous rhythms to determine the influence of environmental parameters, which include temperature, relative humidity and light intensity, on the foraging activity of *A. gracilipes*.

MATERIALS AND METHODS

This study was conducted on field populations that were found in the Universiti Sains Malaysia's Minden campus in Penang Island, Malaysia. Nine field populations were used. Brown cane sugar 50% (w/w), prawn meat 20% (w/w) and egg yolk 50% (w/w) which served as carbohydrate, proteinaceous and lipid food, respectively, were used as food attractants. The food was placed in plastic petri dishes (6 cm diameter) and placed on a visible ant trail. The food attractant was replaced every 24 hours. The experiment started at 0800h. Digital images of the foraging ants were captured on a camera (Nikon Coolpix 2500) at 2-hour intervals up to 72 hours, except between 1800h and 2000h and between 0600h and 0800h where digital images were captured hourly. Temperature, relative humidity and light intensity were recorded at the respective intervals. The number of ants visiting the food was manually counted on a computer. The relationship between the foraging activity of the longlegged ant and environmental parameters (temperature, relative humidity and light intensity) was determined with regression test by using SPSS 11.0.

RESULTS AND DISCUSSION

The consistent temperature and relative humidity observed in the first 24 hours revealed no distinct pattern in the foraging activity of *A. gracilipes* (Fig. 1). However, on the second and third days, the number of foragers was higher during scotophase. This may be due to the higher temperature and lower relative humidity during photophase. There was a peak foraging time at 1000h where the number of foragers was highest. After 1000h, the number of foragers decreased significantly ($P<0.05$) as the temperature increased (Fig. 1). The foraging activity of *A. gracilipes* was the lowest at 1400 - 1600h where the temperature was the highest and the relative humidity was the lowest. After 1600h, the number of foragers gradually increased until the next morning, and decreased again after 1000h (Fig. 1).

Ants can be categorized into nocturnal, diurnal and crepuscular species according to their circadian rhythm of foraging activity. *A. gracilipes* could be considered a nocturnal species as they forage more intensively at night. Other nocturnal species include *Lasius alienus* (Foerster) (Baroni Urbani 1969), *Solenopsis saevissima* Smith, *Camponotus melanoticus* Emery, *Iridomyrmex cordatus* (Smith) and *Pheidole megacephala* (Fabricius) (Greenslade 1971). Examples of diurnal species are *Tetramorium caespitum* (Linnaeus) (Baroni Urbani 1969), *Pseudomyrmex termitarius* Smith, *Camponotus blandus* (Smith), *O. smaragdina* (Greenslade 1971), *Ocymyrmex barbiger* Emery (Marsh 1985), *Pogonomyrmex pronotalis* Santschi and *Pogomyrmex rastratus* Mayr (Pol and de Casenave 2004) while crepuscular species include *Aphaenogaster albisetosus* Mayr, *Aphaenogaster cockerelli* Andre (Whitford *et al.* 1980) and *Camponotus pennsylvanicus* De Geer (Nuss *et al.* 2005).

Ants are poikilothermic. They are very sensitive to climate fluctuations (Fellers 1989). Their foraging activities are strictly controlled by environmental factors such as ambient temperature or soil temperature (Bernstein 1974; Peakin & Josens 1978; Whitford *et al.* 1980; Traniello 1989; Porter & Tschinkel 1993), water stress (Traniello 1989), moisture, radiation and wind (Pol & de Casenave 2004). Regression tests showed that foraging activity of *A. gracilipes* was significantly correlated to temperature with $r^2 = 0.2025$ ($P = 0.0025$) (Fig. 2). Temperature plays a very important role in the energy balance and metabolism of ant societies (Roces and Núñez 1995), as it directly

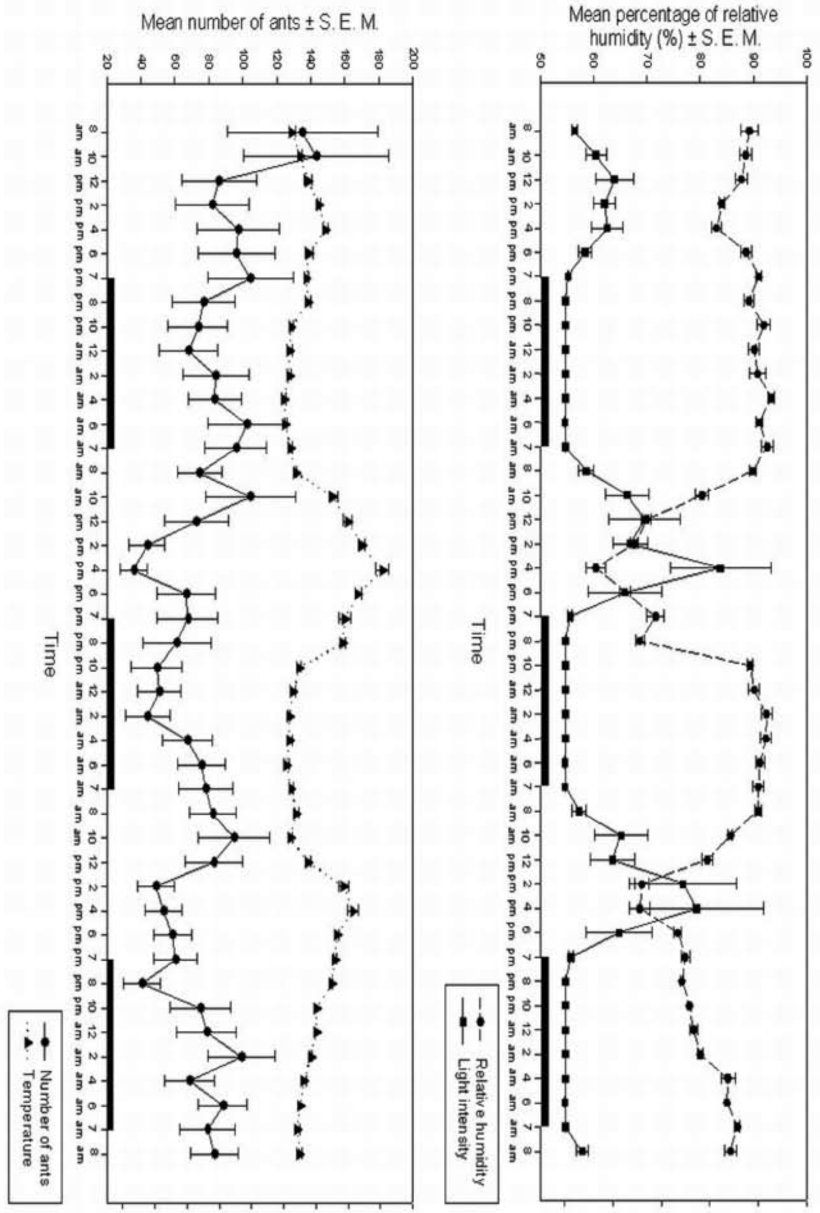

Fig. 1 Foraging activity of *A. gracilipes*. The black line on the abscissa represents night time.

affects oxygen consumption, water loss and transport costs of the foraging ants (López *et al*. 1992). According to Peakin & Josens (1978), respiration rates of ants double with every 10°C increase in temperature. Markin (1970) reported that foraging activity of *Linepithema humile* (Mayr) was strongly correlated with temperature where the optimum foraging activity was between 15°C and 30°C. For *A. gracilipes*, the highest level of activity was between 26°C and 30°C. *C. pennsylvanicus* would travel faster as temperatures increased and their foraging activity was significantly correlated with temperature, night length and wind speed (Nuss *et al*. 2005).

Similar to *Tapinoma indicum* Forel (Chong & Lee 2006), foraging activity of *A. gracilipes* was positively correlated with ambient relative humidity and negatively correlated with ambient temperature. Regression tests showed that relative humidity significantly ($P < 0.05$) influenced the foraging activity of *A. gracilipes* ($r^2 = 0.2105$, $P = 0.002$) (Fig. 3). Our results also corresponded with earlier reports by Greenslade (1971) where the foraging activity of *A. longipes* (= *A. gracilipes)* was limited by low humidity. Foraging activity of

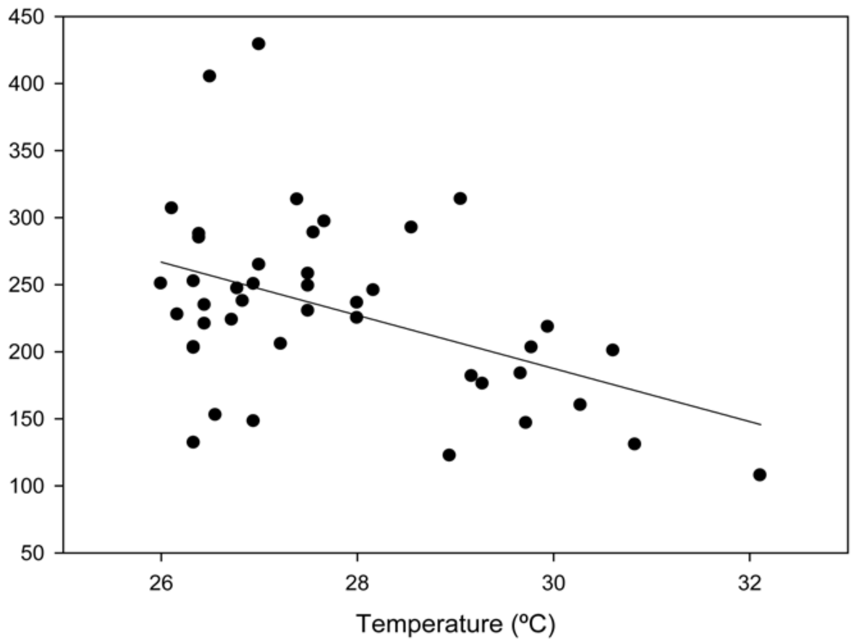

Fig. 2 Relationship between foraging activity of *A. gracilipes* and ambient temperature. Unbroken line represents the best fit line ($y = -19.8189\,x + 782.1053$. $r^2 = 0.2025$, $P = 0.0025$).

Cephalotes atratus (Latreille) was positively correlated with ambient relative humidity as well (D'avila *et al.* 2005). According to Lee (2002), the activity rhythms of *Paratrechina longicornis* (Lattreille), *Monomorium pharaonis* (Linnaeus) and *Solenopsis geminata* Fabricius were negatively correlated with ambient temperature. The foraging schedule of *Prenolepis imparis* and *Formica subsericea* Say was limited by light (Fellers 1989). However, we found that light intensity did not affect the foraging activity of *A. gracilipes* (r^2 = 0.0731, P = 0.0795) (Fig. 4). *L humile* also showed no response to light when foraging for food (Markin 1970).

Foraging schedules of ants may change according to season, altitude and weather (Bernstein 1974). For example, *Prenolepis imparis Emery* forages diurnally during cooler parts of the year but changes to nocturnal foraging in late spring and early summer and then ceases entirely during midsummer (Fellers 1989). Additionally, competition for food and space between species can also induce changes in activity schedules (Carrol & Janzen 1973). Subordinate species change their foraging times in order to avoid foraging together

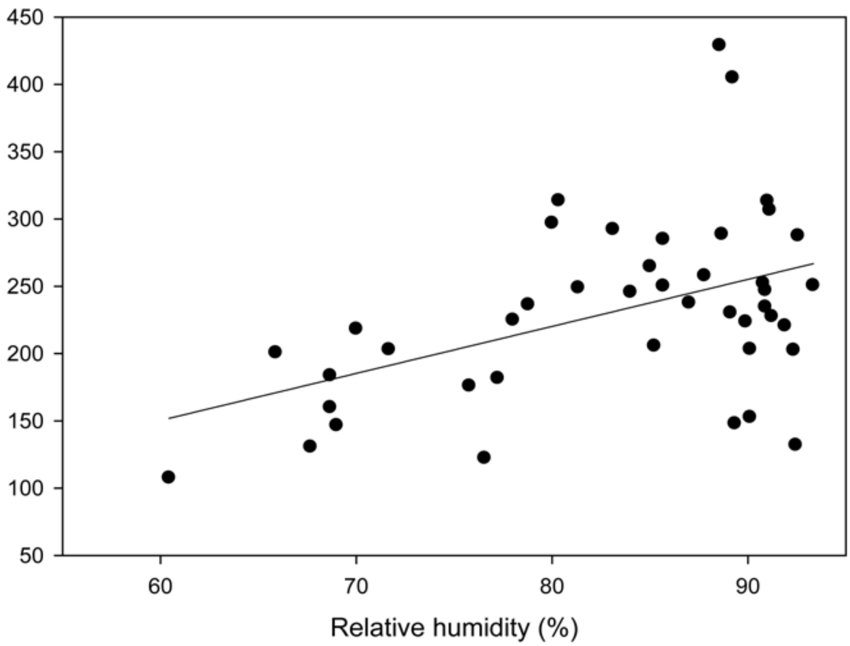

Fig. 3 Relationship between foraging activity of *A. gracilipes* and ambient relative humidity. Unbroken line represents the best fit line (y = 3.4922 x – 59.1678. r^2 = 0.2105, P = 0.0020).

with the dominant species. On the other hand, interaction among dominant species could also be avoided by separated peak periods (Fellers 1989).

In conclusion, foraging activity of *A. gracilipes* was significantly affected by both ambient temperature and relative humidity. *A. gracilipes* foraged most intensively between 26 °C and 30 °C, with the peak time at 10 a.m. However, light intensity did not affect their foraging activity.

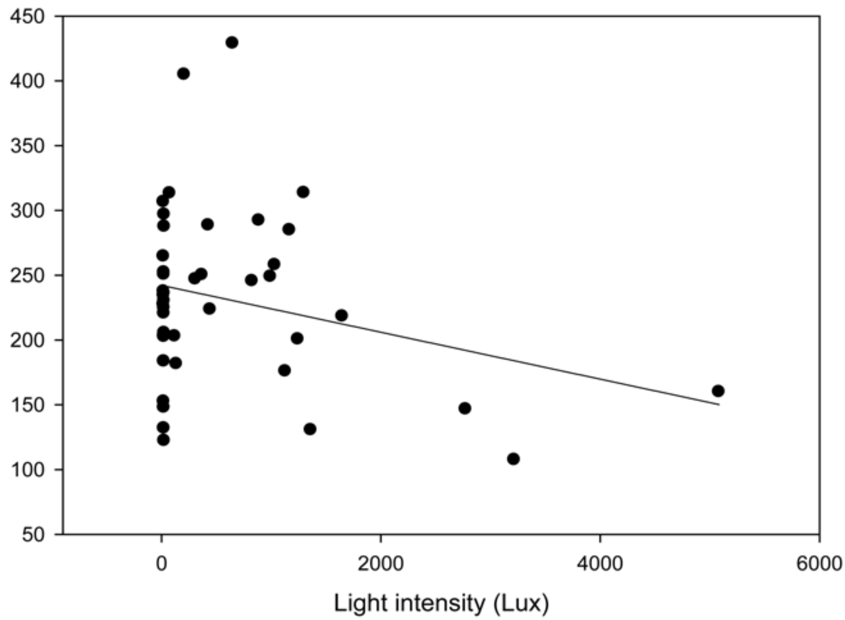

Fig. 4 Relationship between foraging activity of *A. gracilipes* and ambient light intensity. Unbroken line represents the best fit line (y = -0.0181 x + 242.1882. r^2 = 0.0731, P = 0.0795).

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