Food Preferences and Foraging Activity of Field Populations of a Pest Ant, *Tapinoma indicum* (Hymenoptera: Formicidae)

by

Kim-Fung Chong[1] & Chow-Yang Lee[1]

ABSTRACT

Food preference and foraging activity of a pest ant, *Tapinoma indicum* (Forel) were investigated in the field. In choice tests, *T. indicum* demonstrated the highest preference for tuna ($p < 0.05$) among the proteinaceous food candidates, but no preference was recorded towards any of the candidates of carbohydrate foods. In addition, they were not attracted to lipid foods. Periodical changes of food selection study showed that they preferred carbohydrate food, over proteinaceous or lipid food. Foraging activity studies of *T. indicum* over a period of 72 hours revealed that their activities were negatively correlated with environmental temperature, but positively correlated with relative humidity.

Keywords: pest ant, *Tapinoma indicum*, food preference, foraging activity, behavior.

INTRODUCTION

Tapinoma indicum (Forel) is one of the important pest ant species in South East Asia (Lee 2002; Lee & Tan 2004). They resemble the ghost ant, *Tapinoma melanocephalum* (Fabricius) in size and most morphological characteristics, but lacking the light-colored and almost translucent gaster and legs that are present in the latter species. Just like the ghost ant, this species will emit a rotten coconut odor when crushed (Thompson 1990; Lee & Tan 2004) and usually nests outdoors such as beneath flower pots, greenhouses, in soil, rotten wood, leaf axils and under floor cracks (Appel *et al.* 2004). Sometimes, it can also be found nesting indoor under suitable environmental conditions such as when high moisture is present (Lee & Tan 2004). Like *T. melanocephalum*,

[1]Urban Entomology Laboratory, Vector Control Research Unit, School of Biological Sciences, Universiti Sains Malaysia, 11800 Penang, Malaysia.
[2]To whom reprint request should be addressed. Email: chowyang@usm.my

they are easily transported through potted plants, cut flowers and luggage (Appel *et al.* 2004).

Despite its importance in South East Asia, to date, limited information is available on this species especially on food preferences and foraging behavior. A good understanding of its food preference and foraging behavior is essential to the planning of effective management strategies against this pest species. On the other hand, information on its foraging activity will assist in executing better monitoring programs. This study was conducted to determine the food preference and foraging activity of field populations of *T. indicum*.

MATERIALS AND METHODS

Ant food preference

This study was conducted in 5 sites in Universiti Sains Malaysia's Minden campus in Penang Island, Malaysia. Choice tests were conducted using foods from the classes of carbohydrate, protein and lipid. Carbohydrate candidates consisted of 20% sucrose solution (Malayan Sugar Manufacturing Co. Bhd.), 20% honey solution (Jelie Trading (Malaysia) Sdn. Bhd.), 20% glucose solution (LFD Manufacturing Sdn. Bhd.), 20% syrup solution (The Pillbury Co.), pineapple jam (CPA/AJI (M) Sdn. Bhd.), orange jam (Jelie Trading (M) Sdn. Bhd.) and mixfruits jam (Jelie Trading (M) Sdn. Bhd.). For proteinaceous sources, dried anchovy, tuna fish (Rex Trading Sdn. Bhd.), Tubifex worms (Kian Weng Trading Co.), fish protein powder (Triple Nine Fish Protein, Denmark), lobster cockroaches (*Nauphoeta cinerea*), crickets and soy beans were used. On the other hand, sunflower oil (Lam Soon Edible Oil Sdn. Bhd. Malaysia), soy bean oil (Econfood Manufacturing (M) Sdn. Bhd.), rice bean oil (Amornchai Co, Ltd, Thailand), canola oil (Lam Soon Edible Oil Sdn. Bhd. Malaysia), sesame oil (Eng Hup Seng Sesame Oil & Souce), peanut oil, palm oil (Global Palm Products Malaysia), fish oil, and pure cod fish oil (Seren Seas Ltd, England) were evaluated as lipid sources. All proteinaceous candidates were prepared in dried ground powder form. Candidates from each food class were each placed in a plastic petri dish (6-cm diameter) and positioned close to one another in randomized order. They were placed onto a visible ant trail for 30 minutes. After 30 minutes, digital images were captured with a camera (Nikon Coolpix 2500) and the number of ants on each plastic dish was counted on the computer. Only one food class was evaluated per site

per day. Results obtained were subjected to analysis of variance and means were separated with Tukey's HSD (P = 0.05) using Statistix® 7.0 (Analytical Software, Tallahassee, FL).

Based on the choice test, 3 candidates from each food class (carbohydrate, protein and lipid) were chosen for experiment to study the periodical changes of food preference of the field populations. All candidates from the three food classes were positioned closely in randomized order on ant trails. Digital images were captured after 30 minutes, and the number of ants on each image was counted on the computer. This study was conducted weekly up to 20 weeks.

Ant foraging activity

For this study, two sites were chosen in Universiti Sains Malaysia, namely site A and B. Pineapple jam was used as food attractant and placed inside a 9-cm petri dish. The dish was placed at 0730, and digital images were captured every 2 hours up to 72 hours. The temperature and relative humidity were recorded at the same time. To ensure freshness, the food attractant was replaced every 24 hours during the 72-hour experimental period. The numbers of ants in each petri dish was counted from the image captured on the computer. The experiment was replicated 3 times.

RESULTS AND DISCUSSION

There appeared to be no significant feeding preference among the candidates of carbohydrate foods (Table 1) by the *T. indicum* populations evaluated. Volk *et al*. (1999 in Warner & Scheffrahn 2004) reported that *Lasius niger* Foerster preferred 10% sucrose over 10% glucose while Argentine ants preferred 25% sucrose (Baker *et al.* 1985; Krushelnycky & Reimer 1998). However, *T. indicum* significantly preferred to feed on tuna ($p < 0.05$) over the other 6 proteinaceous food candidates (Table 2). On the other hand, like *Ochetellus glaber* (Cornelius *et al.* 1996; Cornelius & Grace 1997), *T. indicum* was not attracted to lipid foods.

The number of ants found foraging to the three candidates within each food class was combined and plotted over a period of 20 weeks (Fig. 1). Results revealed that *T. indicum* populations were more attracted to carbohydrate foods, followed by proteinaceous ones, but they were not interested

Table 1. Mean percentage of *T. indicum* attracted to candidates of carbohydrate food.

Food	Mean % ants (%) ± S. E. M
Pineapple jam	25.72 ± 8.11 a
20% sucrose solution	23.73 ± 10.70 a
20% honey solution	18.98 ± 5.87 a
Mixfruit jam	11.83 ± 2.89 a
20% syrup solution	6.50 ± 2.75 a
Orange jam	7.69 ± 2.50 a
20% glucose solution	5.56 ± 2.39 a

Mean values followed by the same letter are not significantly different ($p > 0.05$; Tukey's HSD)

in lipid foods. However, they did not alternate their preference between different food classes (i.e. carbohydrate and proteinaceous foods). This was in contrast with earlier study by Edwards & Abraham (1990) who found that *Monomorium pharaonis* (L.) alternated their feeding between honey and peanut butter. Stein *et al.* (1990) reported that food preference changed with time, weather, caste composition, colony age, long-term feeding history, stage and presence of brood. Rust *et al.* (2000) reported that Argentine ants continued to prefer carbohydrate over a one-year period although proteinaceous food was given as choice.

However, when compared among those different food candidates in the same food class, *T. indicum* showed alternate food preference towards sucrose

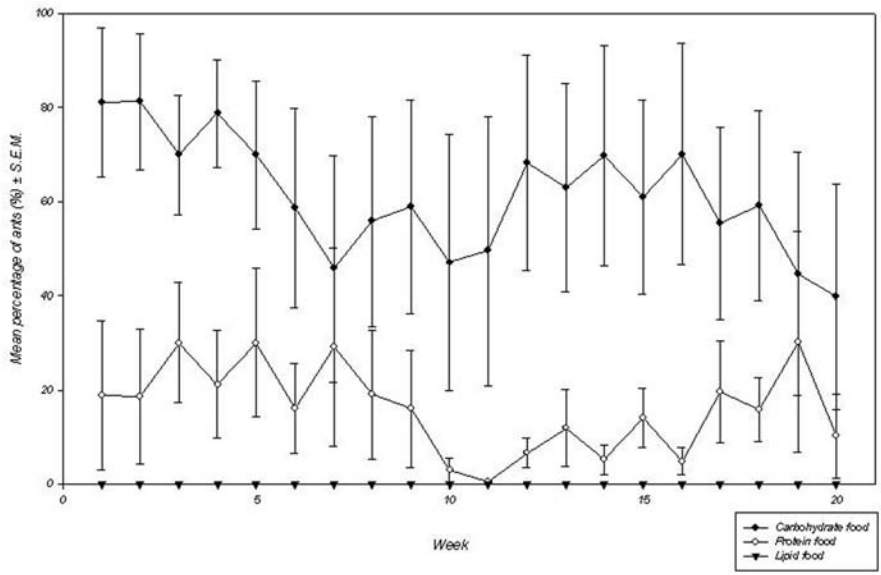

Fig. 1. Periodical changes in food preference of *T. indicum* over 20 weeks.

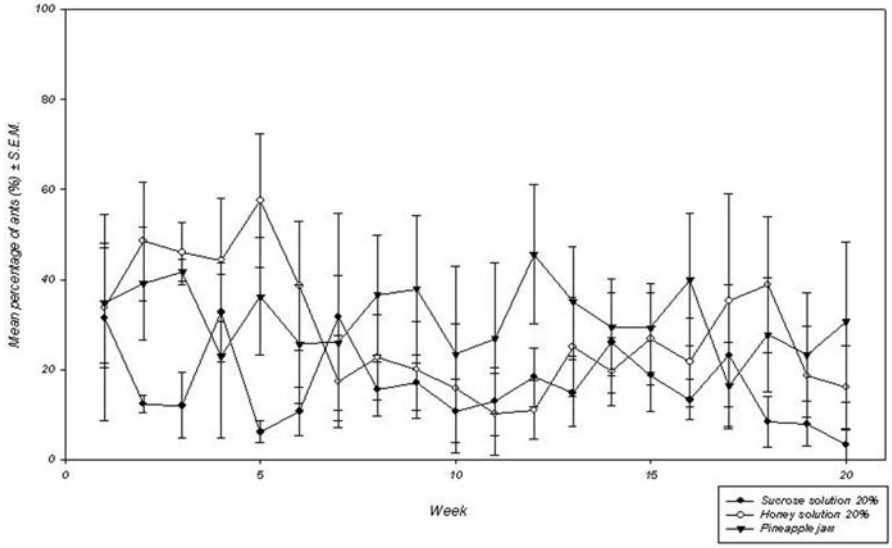

Fig. 2. Periodical preference of *T. indicum* for three carbohydrate foods over 20 weeks.

solution, honey solution and pineapple jam (Fig. 2). They preferred 20% honey solution during the first 6 weeks and at week 17 to 18, but they foraged more towards pineapple jam at week 8 to 16 and from week 19 to 20. For proteinaceous food, tuna was the most preferred one throughout the ex-

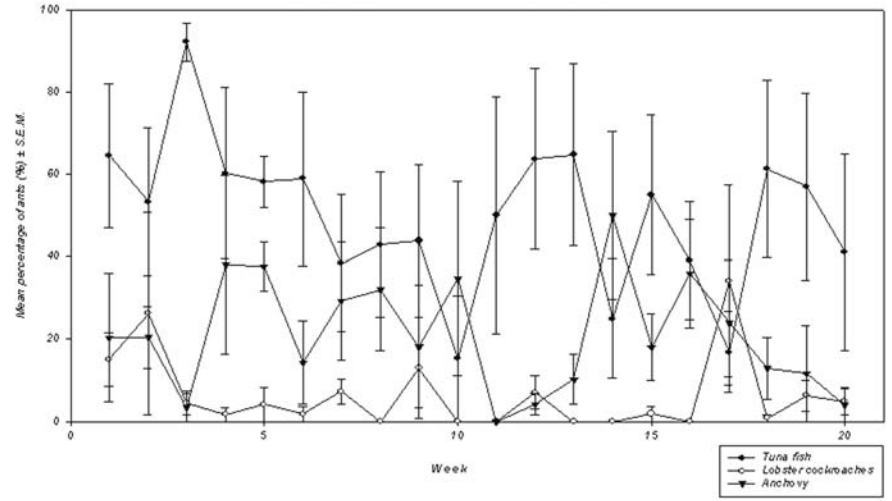

Fig. 3. Periodical preference of *T. indicum* for three proteinaceous foods over 20 weeks.

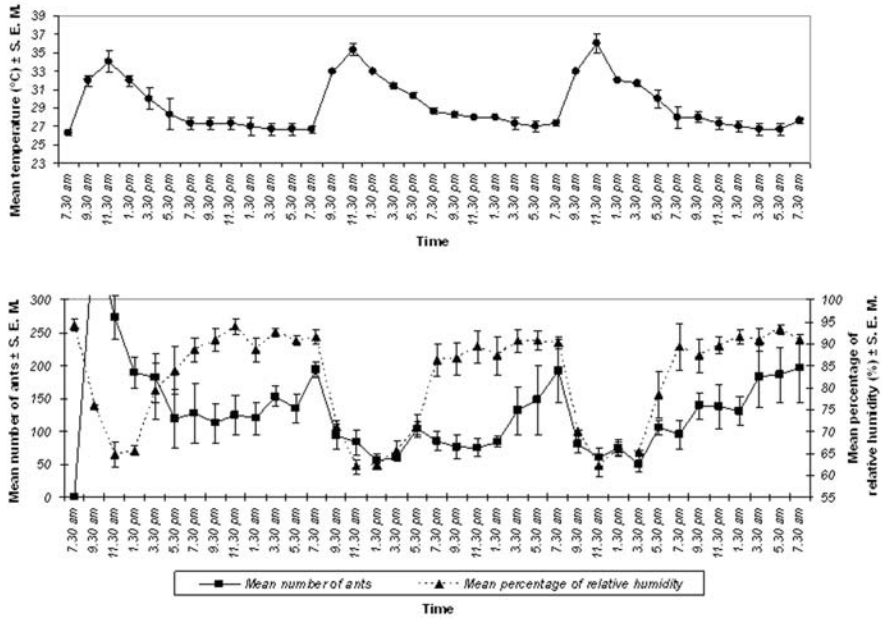

Fig. 4. Foraging activity of a *T. indicum* population at site A over 72 hours.

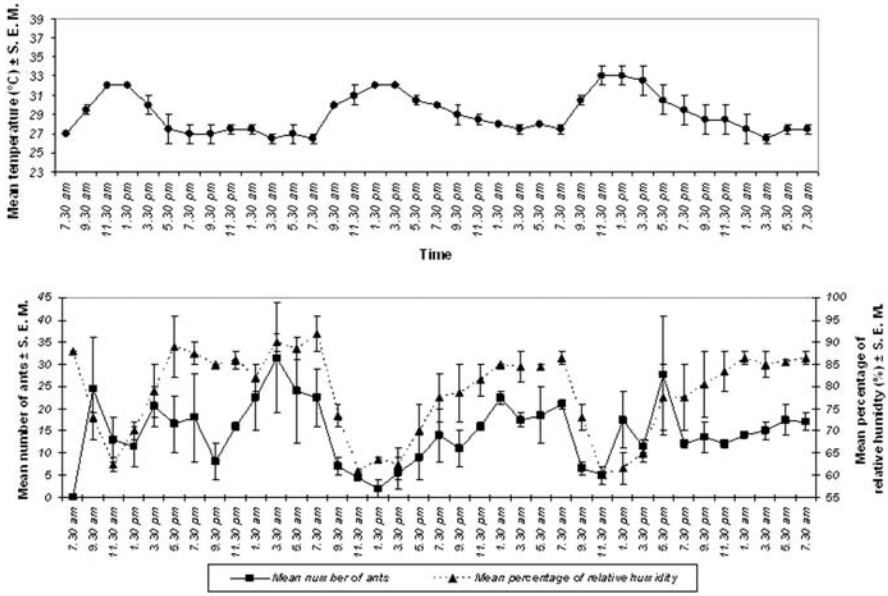

Fig. 5. Foraging activity of a *T. indicum* population at site B over 72 hours.

Table 2. Mean percentage of *T. indicum* attracted to candidates of proteinaceous food.

Protein food	Mean ants (%) ± S. E. M
Tuna fish	61.64 ± 18.05 a
Anchovy	9.53 ± 5.00 b
Lobster cockroaches	5.22 ± 5.22 b
Cricket	1.74 ± 1.74 b
Fish protein powder	0.87 ± 0.87 b
Tubifex worms	1.00 ± 1.00 b
Soy bean	0.00 ± 0.00 b

Mean values followed by the same letter are not significantly different ($p > 0.05$; Tukey's HSD)

periment, except at week 10, 14 and 17 (Fig. 3). Edwards & Abraham (1990) also reported that bait switching may be due to 'satiation' and 'alternation' to ensure the colonies receive varied and balanced diet.

Foraging activity studies in the field revealed that *T. indicum*'s activity was negatively correlated with ambient temperature, and positively correlated with ambient relative humidity (Figs. 4 & 5). There were more ants that foraged during night time because of a lower temperature and higher relative humidity. For the ant population in site A, peak foraging activity was at 0730. After 0730, the number of foragers decreased drastically. Our findings corresponded well with that reported earlier in Lee (2002) on foraging activity patterns of *M. pharaonis, Paratrechina longicornis* (Latrielle) and *Solenopsis geminata* (Fabricius) that were also negatively correlated with ambient temperature. According to Markin (1970), the foraging rate of Argentine ants was high at temperatures between 15 and 30°C, but decreased when temperature exceeded 30°C. A similar situation was observed for *T. indicum* in this study when the environmental temperature exceeded 30 °C (from 0930 to 1730). Francke & Cokendolpher (1986) reported that smaller ants often had a higher desiccation rate than bigger ants. As *T. indicum* is tiny in size (1.3 – 1.5 mm), it is susceptible to dessication. Appel *et al.* (2004) reported that *T. melanocephalum* tolerated the greatest range of temperature at high relative humidity (97%) with mortality of less than 30% between 15 and 35°C in 24 hours. However, as the R.H. decreased to 75%, more than 50% of test ants died after exposure to 35°C for only 7 hours.

In summary, *T. indicum* preferred both carbohydrate and proteinaceous food over a 20-week evaluation period, but did not show any special preference towards any carbohydrate food candidate. Tuna was the most preferred

choice amongst the proteinaceous foods. Foraging activities were negatively correlated with ambient temperature, but positively correlated with ambient relative humidity.

ACKNOWLEDGMENTS

We thank B.-H. Yeoh, E. Quah, and Y.-F. How (Universiti Sains Malaysia) for reviewing early versions of the manuscript. This study was partially supported by DuPont Professional Products (USA).

REFERENCES

Appel, A.G., J.P.S. Na & C.-Y. Lee. 2004. Temperature and humidity tolerances of the ghost ant, *Tapinoma melanocephalum* (Hymenoptera: Formicidae). Sociobiology 44: 89-100.

Baker, T.C., S. E. Van Vorhis Key & L.K. Gaston 1985. Bait-preference tests for the Argentine ant (Hymenoptera: Formicidae). J. Econ. Entomol. 78: 1083-1088.

Cornelius, M.L. & J.K. Grace 1997. Influence of brood on the nutritional preferences of the tropical ant species, *Pheidole megacephala* (F.) and *Ochetellus glaber* (Mayr). J. Entomol. Sci. 32: 421-429.

Cornelius, M.L., J.K. Grace & J.R. Yates 1996. Acceptability of different sugars and oils to three tropical ant species (Hymen., Formicidae). Anz. Schädlinsde 69: 41-43.

Edwards, J.P. & L. Abraham 1990. Changes in food selection by workers of the Pharaoh's ant, *Monomorium pharaonis*. Med. Vet. Entomol. 4: 205-211.

Francke, O.F. & J.C. Cokendolpher 1986. Temperature tolerances of the red imported fire ant. p. 104-103. In: Fire ants and leaf-cutting ants, biology and management. C. S. Lofgren and R. K. Vander Meer (eds), Westview Press, Boulder, CO.

Krushelnycky, P.D. & N.J. Reimer 1998. Bait preference by the Argentine ant (Hymenoptera: Formicidae) in Haleakala National Park, Hawaii. Environ. Entomol. 27: 1482-1487.

Lee, C.-Y. 2002. Tropical household ants - pest status, species diversity, foraging behavior and baiting studies. pp. 3-18. In: Proceedings of Fourth International Conference on Urban Pests. S.C. Jones, J. Zhai and W.H. Robinson (eds), Pocahontas Press, Blacksburg, VA.

Lee, C.-Y. & E.-K. Tan 2004. Guide to Urban Pest Ants of Singapore. Singapore Pest Management Association. 40 pp.

Markin, G.P. 1970. Foraging behavior of the Argentine ant in a California citrus grove. J. Econ. Entomol. 63: 740-744.

Rust, M.K., D.E. Reierson & L.J. Blum 2000. Seasonal activity and bait preferences of Argentine ant (Hymenoptera: Formicidae). J. Agric. Urban Entomol. 4: 201-213.

Stein, M.B., H.G. Thorvilson & J.W. Johnson 1990. Seasonal changes in bait preference by red imported fire ant, *Solenopsis invicta* (Hymenoptera: Formicidae). Fla. Entomol. 73: 117-123.

Thompson, C.R. 1990. Ants that have pest status in the United States. pp. 51-67. In: Applied myrmecology - A world perspective. R. K. Vander Meer, K. Jaffe and A. Cedeno (eds), Westview Press, Bourder, CO.

Volk, W., J. Woodring, M. Fischer, M.W. Lorenz & K.H. Hoffman 1999. Ant-aphid mutualisms: The impact of honeydew production and honeydew sugar composition on ant preferences. Oecologia 118: 483-491.

Warner, J. & R.H. Scheffrahn 2004. Feeding preferences of white-footed ants, *Technomymex albipes* (Hymenoptera: Formicidae) to selected liquids. Sociobiology 44: 403-412.