Variation of Food Preference of Black Ants (*Dolichoderus thoracicus)* Smith and Four Antagonistic Ants in Cocoa Plantations in Indonesia

Ahmad Saleh[1], Abu Hassan Ahmad[2] and Che Salmah Md. Rawi[2]
[1]*College of Agricultural Sciences Agrobisnis Plantation (STIPAP), Jl. Willem Iskandar Medan*
[2]*School of Biological Sciences, Universiti Sains Malaysia (USM), Penang, 11800 Malaysia*

www.stipap.ac.id

Keywords: Dolichoderus thoracicus, antagonistic ants, food preference, cocoa pod borer

Abstract: This study was carried to determine the variation of food preferences of black ant, *Dolichoderus thoracicus* Smith, and four antagonistic ants; *Oecophylla smaragdina* (Fabricius), *Anoplolepis gracilipes* (Jerdon), *Techonomyrmex* sp. (Smith) and *Crematogaster* sp. (Smith), (Formicidae: Hymenoptera) in cocoa plantations. Black ant is used in controlling cocoa pod borer (CPB). However, in carrying this biological control of CPB, antagonist ants caused difficulty in establishing black ants. Naturally, black ants are attracted to honeydew produced by mealybug (*Cataenococcus hispidus*). Six variations of food preference were tested i.e; honey, dried salted fish powder, sugar powder, dried egg powder, syrup, and water. *Dolichoderus thoracicus*, *O. smaragdina* and *Crematogaster* sp. preferred salted fish and egg powder while *A. gracilipes* preferred honey and syrup and *Techonomyrmex* sp. preferred sugar powder and honey. The food preferred by antagonists can be used as the components of incoporated into the toxic bait in controlling these ants. Baiting is an efficient method of controlling the antagonistic ants, however, the black ant, *D. thoracicus,* also consumed similar food as the antagonist ants. From the study, salted fish and egg powder could be made as an alternative food of *D. thoracicus* if the cocoa plantations lack mealybugs.

1 INTRODUCTION

Black ants (*Dolichoderus thoracicus* Smith) (Hymenoptera: Formicidae) have been known as biological agents in controlling Cacao Pod Borer, *Conopomorpha cramerella* Snellen (Lepidoptera: Gracillariidae) in a cocoa plantation in Indonesia (Kalshoven, 1981; Ho, 1994; Saleh, 2011,). Cocoa Pod Borer is difficult to be controlled due to the larvae ± 60% of its life cycle is in a cocoa pod and the impact is the cocoa production reduce more than 80% (Wardojo, 1980). High black ant populations are required in controlling attacks of cocoa pod borer (Saleh, 2007). Ants are one of the dominant communities of cocoa fauna (Azhar, 1985). They have been reported to influence the cocoa fauna structure and can be used a control agent for some of the cocoa pests (Entwistle, 1972; Azhar, 1985). There are more than 16 species of ant found in a cocoa plantation in Bah Lias Estate, (Saleh, 2011). However, four species are considered serious antagonists to *D. thoracicus*. There are weaver ants or green tree ants, *Oecophylla smaragdina* (Fabricius); long-legged ant, *Anoplolepis gracilipes* (Jerdon); white-footed ant, *Techonomyrmex* sp (Smith) and acrobat ant, *Crematogaster* sp (Smith). They belong to Order Hymenoptera in the Family of Formicidae (Khoo & Chung, 1989; Saleh *et al*. 2007). Based on their dominance, these ant species prefer to inhabit in cocoa plantations (Saleh *et al.* 2007; Anon. 2009). These antagonist ants compete for the foods and aggressive to drive out black ant from their territories (Entwistle, 1972). Nevertheless, the weaver ant, *O. smaragdina,* is a useful predator for controlling *H. theobromae* and others pests on cocoa trees; however, it is not acceptable in IPM management of cocoa pests because it inflicts painful bites to workers in cocoa plantations and (Way & Khoo, 1991).

Areas to be established with *D. thoracicus* must be free or a few population of antagonistic ants. Suppression of antagonist ants is needed in the establishment of black ant, especially in new areas (Entwistle, 1972; Saleh *et al.* 2006; 2007). Three out of four antagonist ants (*O. smaragdina, A. gracilipes* and *Technomyrmex* sp) are severe prevent the establishment of black ant. Practice in the estate, ant antagonists are controlled by the application of Fipronil insecticide (Saleh. 2011; Saleh *et al.* 2006; 2007). The future control of antagonistic ants could be baiting method which safe to human and cocoa environment. Ants that nest in protected harborages are often unaffected by sprays but will emerge from cryptic, protective habitats to feed on toxic baits. Baits are easy to apply and require no mixing by the applicator. Baits do not unduly affect non-target insect species that are not attracted to the bait matrix, and they can

Saleh, A., Ahmad, A. and Md. Rawi, C.
Variation of Food Preference of Black Ants (Dolichoderus thoracicus) Smith and Four Antagonistic Ants in Cocoa Plantations in Indonesia.
DOI: 10.5220/0010036000050009
In *Proceedings of the 3rd International Conference of Computer, Environment, Agriculture, Social Science, Health Science, Engineering and Technology (ICEST 2018)*, pages 5-9
ISBN: 978-989-758-496-1

be placed in containers which only allow access to target species (Warner. *et. al*. 2004).

The objectives of the study were to determine the food preference of the antagonistic ants and will not impact to *D. thoracicus* population.

2 MATERIAL AND METHODS

The studies were conducted in June 2006 to December 2007 in the cocoa plantation located in Bah Lias Estate PT.PP.London Sumatra Indonesia Tbk (Lonsum). Bah Lias Estate is located at 99° 15' 36" - 99° 21' 36" East and 3° 8' 24" - 3°13" 12" North, in the province of North Sumatera, Indonesia. The altitude of Bah Lias Estate is 32 m above sea level and the distance from Medan is 139 km. The average rainfall at Bah Lias Estate in 2006 and 2017 were 1940 and 1502 mm, with 113 and 94 rain days/ year (BLRS. 2006. 2007). The 26-year-old cocoa field which consists of 700 trees and 50 coconut palms as permanent shade per ha was chosen for this study area. The *D. thoracicus* ant was not establish for all area and some plots of areas were occupied by antagonistic ants. For this study**,** a plot for each kind of ants was 400 trees (20x20) which occupied by *O. smaragdina*, *A. gracilipes*, *Techonomyrmex* sp and *Crematogaster* sp, then selected 5 trees sample/plot for placing the food preference.

This study was to determine the kinds of foods preference for 4 antagonistic ants (including *Crematogaster* sp).

The six kinds of foods attractant were tested i.e; honey, dried salted fish powder, sugar powder, dried eggs powder, syrup, and water. The powder of salted fish and sugar and chicken egg were dried under the sun for few days before use and Solution of 10% honey bee and Syrup Kurnia (contains; sugar, citric acid, Karmoisi Cl 14720 and Raspberry aroma, (Syrup. 2014).

Twenty g powder of salted fish, sugar and eggs and 20 ml for the solution of honey and syrup were prepared and placed in a Petri dish of 3.7 cm diameter and 1.0 cm high and then each Petri dish was placed in a larger Petri dish, 9.3 cm diameter and 0.7 cm height.

The experiment design was use Randomized Block Design with five replicates (5 trees were selected in each plot) and six treatments (food preference) for each kind of ants.

The bait (food preference) were placed on the ground 10 - 20 cm from the base of each of their trunks as shown in Figure.1.

Figure 1. Food baits are placed on ground 10- 20 cm from the cocoa trunk.

The population of ants was counted monthly during the observation. The observation started at 07.00 hr and ended at 13.00 hr. There were six hourly observations in each month. At the end of each hour, the Petri dishes were collected and placed separately in a plastic bag and the ants were killed, and all foods were replaced hourly. Then the number of antagonist ants found in the Petri dish was counted in the laboratory. The mean number of ants on each food was analyzed by using one-way ANOVA with SPSS 22 program.

3 RESULTS

The result of determinating the variation of food preference the black ant and antagonistic ants from June 2006 to December 2007 as shown in Table 1.

Table.1. Food preference *of D.thoracicus* and its antagonists

Food preference	Mean ± SE of ants per bait				
	A. gracilipes	*Crematogaster*	*O. smaragdina*	*Technomyrmex* sp	*D. thoracicus*
Honey	24.9 ± 1.7 b	3.3 ± 0.3 de	2.1 ± 0.0 d	26.9 ± 1.2 b	13.1 ± 0.6 d
Salted fish (*)	4.8 ± 0.4 d	53.9 ± 4.7 a	15.0 ± 0.3 a	21.5 ± 1.4 c	137.2 ± 2.2 a
Sugar (*)	16.6 ± 1.8 c	10.5 ± 0.5 cd	1.8 ± 0.1 de	41.6 ± 1.1 a	29.7 ± 1.4 c
Eggs (*)	4.0 ± 0.3 d	28.3 ± 1.9 b	12.3 ± 0.5 b	15.3 ± 1.0 d	81.6 ± 4.3 b
Syrup	43.9 ± 1.9 a	12.6 ± 0.9 c	3.8 ± 0.3 c	41.2 ± 1.0 a	27.0 ± 2.1 c
Water	0.8 ± 0.0 d	0.5 ± 0.1 e	0.4 ± 0.0 e	1.4 ± 0.2 e	1.9 ± 0.1 e
Means in the same column followed by a different letter are significantly different (LSD test, P = 0.05).					

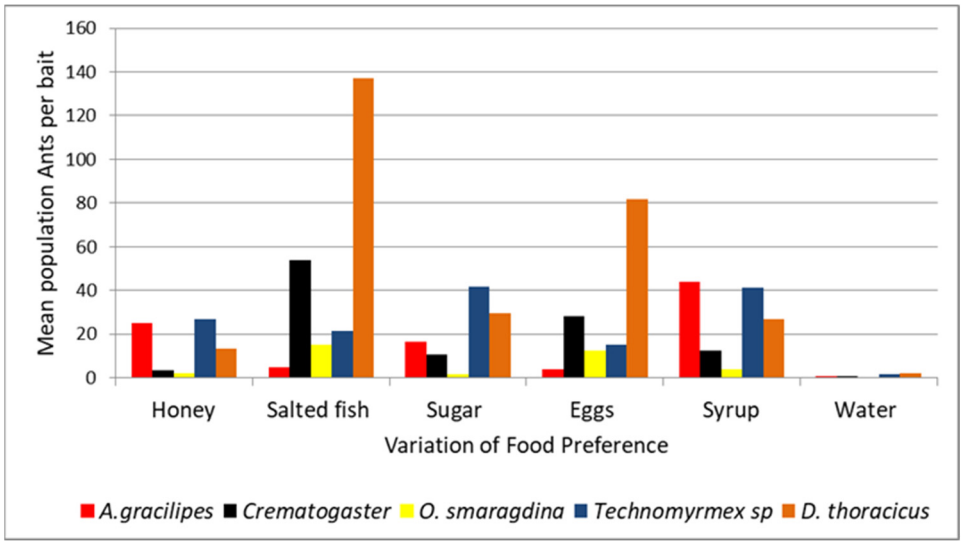

Figure 2: Variation of Food Preference of *D. thoracicus* and antagonistic ants

Table 1 and Figure 2 indicate that *A. gracilipes* preferred to consume syrup, honey and sugar powder than salted fish powder, egg powder, and water. Statistically, these preferences were significantly different ($F=138.9$; $P < 0.001$). Among the three most preferred food, *A. gracilipes* preferred syrup the most. *Crematogaster* sp strongly preferred salted fish and eggs powder continuously as depicted and significantly different to others food ($F= 108.7$; $P < 0.001$). *O. smaragdina* showed a strong preference for powder of salted fish and followed by egg powder and other food types such as syrup, honey and sugar powder ($F= 466.2$; $P < 0.001$). *Technomyrmex* sp preferred to eat with a similar amount of sugar, and syrup then followed by honey, salted fish and egg powder. These food preferences were significantly different ($F= 290.7$; $P < 0.001$). The alternative of food preferred by *D. thoracicus* was salted fish powder followed by egg powder and honey. They were statistically significantly different to sugar powder and syrup and control (water) ($F= 573.2$; $P < 0.001$).

4 DISCUSSIONS

In natural the long-legged ants, *A. gracilipes* feed on honeydew from coccid, jassids, and mealybugs (Entwistle, 1972; Kalshoven, 1981), and the result of this study indicated that *A. gracilipes* preferred to consume syrup, honey. There are sometimes aggressive towards other ant species such as the useful black ant (*D. thoracicus*) in cocoa capturing individuals of the latter species and spraying them with formic acid. The presence of the long-legged ant in cocoa, unlike black ant, does not favor the white mealybugs (Entwistle, 1972; Kalshoven, 1981).

Day (1986) and (Kalshoven, 1981) said that for *Crematosgaster* habitually feeds on the sugary substances produced by sucking insects and plants, on animal refuse and are occasionally carnivorous, while this study *Crematosgaster* consume more salted fish and egg powder.

In actual *O. smaragdina* feed on the honeydew from coccids, Membracidae and Lycaenidae, moreover, they feed on dead animal material and attack living insects (Kalshoven, 1981). It is mostly similar to the result of this study that its preference the salted fish and egg powder. *Techonomyrmex* feeds on plant nectars and honeydew, which is a sweet substance produced by many sap-sucking insects such as aphids, mealybugs, and scales, and it is known to protect honeydew producers, which has caused problems in agricultural production in some areas of the world (Warne, et al. 2016). Food of *D. thoracicus*, black ant is largely derived from the honeydew of its mutualism, the mealybug, *C. hispidus* (Ho & Khoo, 1997). Species of mealybugs attended by *D. thoracicus* include *Cataenococcus hispidus, Planococcus lilacinus, Pseudococcus elisae,* and *Maconellicoccus hirsutus* (Khoo & Chung, 1989). The black ant also regularly tend the long-tailed mealybug of cocoa (*Planococcus lilacicus*), the green scale (*Coccus viridis*), the whitefly of jambu (*Psidium guajava*), some small tree hoppers (Membracidae) and Psyllidae (Kalshoven, 1981; Azhar, 1988). Kalshoven (1981) added that besides attending the mealybugs, black ants also feed on nectar which produced by flower resinous secretion of bamboo, pollen and fungal fructification. It has been observed that when the mealybug of cocoa is scarce, the black ants also feed on the peel of the fruits of a small weed, wellcresses (*Paperomia pellucida*) (Kalshoven, 1981). It is known that the presence of the ants favors the development of white cocoa mealybugs (the survival of these coccids may depend on the ants) and that of green coccid. The mealybugs (which cover the colonies with the papery material) are protected by ants (Ho & Khoo, 1997; Khoo & Ho, 1992; Azhar, 1994).

Baiting is one of the effective control methods widely used in ants, such as yellow crazy ant (long-legged ant), white food ant and acrobat ants (Abbott *et al.* 2009; Harris,

2009). However, Warner (2003) said that the main requisites for a successful ant bait are 1) Preferred bait base must endure long enough to achieve control, 2) Non-repellent active ingredient, 3) Active ingredient must acts slow enough to circulate within the colony and/or to allow the recruitment of new foragers, 4). Active ingredient must be transferable to nestmates and brood, and 5) Has low mammalian toxicity.

Using baits to control antagonistic ants in the sporadic areas where black ant, *D. thoracicus* has established well must be carefully decided because the food preference for bait materials will be consumed by black ant. This can be disastrous to the black ant population later on. This study indicates that some the food preferred by antagonistic ants, *A. gracilipes* and *Technomyrmex* sp, were similar, namely syrup and sugar powder, while *Crematogaster* sp. and *O. smaragdina* preferred the powdered salted fish and egg, which was also preferred by *D. thoracicus.* However, *D. thoracicus* consumes all of the food preference are tested. The life history of *A. gracilipes* this species in detail, since it plays an important role in tending pests such as mealybugs, scales and jassids, unlike the black ant (*D. thoracicus*), this species is therefore considered to be a pest of several crops, such as coffee, cocoa, mango, etc (Saleh, 2011).

5 CONCLUSIONS

Salted fish and egg powder are food preferenced by Black ant (*D. thoracicus*), *O. smaragdina* and *Crematogaster.*

For *A. gracilipes* and preferred honey and syrup, while *Technomyrmex*. sp preferred sugar powder and honey.

D. thoracicus consumes most all food is tested, in consequence, Salted fish and others could be used for alternative food when establishing of black ant especially if the cocoa areas lack mealybug.

ACKNOWLEDGEMENT

The author is thankful to Head of College of Agricultural Sciences Agrobisnis Plantation (STIPAP) to publish this paper and provide needed facilities. And also thanks to Bah Lias Research Station PT. Lonsum to help and give facilities for this study.

REFERENCES

Abbott, K. L., 2006. Spatial dynamics of supercolonies of the invasive yellow crazy ant, *Anoplolepis gracilipes*, on Christmas Island, Indian Ocean. The Author DOI: 10.1111/j.1366-9516.2006.00193.x. 101 Journal compilation © 2006 Blackwell Publishing Ltd. www.blackwellpublishing.com/ddi. http://www.owlnet.rice.edu/~bios563/Abbott.pdf. June 9, 2009. 101-110.

Abbott, K.L., Harris, R., Lester, P., 2009. Invasive ant. http://www.biosecurity.govt.nz/files/pests/invasive-ants/ yellow-crazy-ants/yellow-crazy-ant-risk-assessment.pdf. October 6, 2009. 72 pp.

Anon., 2009. *Anoplolepis gracilipes* (Smith,1857). Available from: http://www. itis.gov/ servlet/SingleRpt/ SingleRpt ?search_topic=TSN&search_value=575523. January 9, 2009.

Atmawinata, O. (1993). Hama penggerek buah kakao (PBK) suatu ancaman terhadap kelestarian perkebunan kakao di Indonesia. Warta Pusat Penelitian Kopi dan Kakao 15: 1-3.

Azhar, I. (1985). Natural and cultural control in the management of selected cocoa pests. In Integrated Pest Management in Malaysia. eds. Lee B.S et al. Malaysia Plant Protection Society (MAPPS). Kuala Lumpur. p. 255 -267.

Azhar, I. (1988b). Mengenal pasti serangga perosak koko melalui kesan dan simptom serangan (Identification of cocoa insect pests through damage and attacked Symptoms). Laporan MARDI No 122: 1 - 25.

Azhar, I. (1990a). Postharvest management of cocoa pods borer (Pengaruh lapisan tuai pengorek buah kakao). MARDI Res. J. 18 (1): 71 - 80.

Azhar, I. (1990b). Studies on sclerotic layer hardness of cocoa pods. Kajian kekerasan lapisan sklerotik buah koko. MARDI Res. J. 18 (1): 63 - 69.

Azhar, I. (1994a). Ants-mealybugs interactions in cocoa: Density-dependent mutualism? 4th International conference on plant protection in the tropics. Kuala Lumpur. March 28-31. p. 88 - 89

Azhar, I. (2009). The ways towards sustainability of cocoa industry in Malaysia. Available from: http://www.round table cocoa.org/documents/1a%20-%20Dr. %20I.%20 Azhar%20-%20Malaysian%20Cocoa%20Board.pdf. March 31, 2009. 1-6 pp.

Azhar, I. & Lee, M. T. (2004). Perspective for cocoa cultivation in Malaysia: re-look at the economic indicators. Malaysia Cocoa Journal. 1. 1-18.

BLRS. (2006). Annual Report. Bah Lias Research Station. PT.PP.London Sumatra Indonesia Tbk (un published). 1. 332 pp.

BLRS. (2007). Annual Report. Bah Lias Research Station. PT.PP.London Sumatra Indonesia Tbk (un published). 1. 335 pp.

Day, R. K. (1986). Population dynamics of cocoa pod borer *Acrocercops cramerel*la, Importance of host plant cropping cycle. In Pushparajah, E & Chew, P.S (eds.) Cocoa and coconut, Progress and outlook. Incorporated Society of Planters, Kuala Lumpur. 255 - 263.

Entwistle, P. F. (1972). Pest of cocoa. Longman group. Limited ed. London. 779 pp.

Harris, R. (2009). Invasive ant risk assessment project: Over view. Available from: http://issg.appfa.uackland.ac.nz/database/species/reference_files/ant_RA/ overview.pdf. October 5, 2009. 7 pp.

Ho, C. T. (1994). Relationship between black cocoa ant, *Dolichoderus thoracicus* (Hymenoptera: Formicidae) abundance and cocoa borer, *Conopomorpha cramerella* (Lepidoptera: Gracillariidae) damage in a cocoa plantation. In: Proceedings of 4th International Plant Protection in Tropics. (Eds: A. Rajan & Y.B. Ibrahim). Malaysian Plan Protection Society, Kuala Lumpur. p. 214 -215.

Ho, C. T. & Khoo, K. C. (1997). Partners in Biological control of cocoa pests: mutualism between *Dolichoderus thoracicus* (Hymenoptera: Formididae) and *Cataenococcus hispidus* (Hemiptera: Pseudococcidae). Bulletin of Entomological Research 87: 461 - 470.

Holldobler, B. & Wilson, E. O. (1990). The ants. Harvard University Press. 732 pp.

Kalshoven, L. G. E. (1981). Pests of Crops in Indonesia. (Revised by van der Laan, P.A. 1981). P.T. Ichtiar Baru. Jakarta, Indonesia. 701 pp.

Khoo, K. C. (2009). Controlling cocoa pests in Southeast with the black cocoa ant. http://www.oardc.ohio-state.edu/cocoa/ants.htm. October 2009.

Khoo, K. C. & Chung, G. F. (1989). Use of the black cocoa ant to control mirid damage in cocoa. The Planter. 65: 370 - 383.

Khoo, K. C. & Ho, C. T. (1992). The influence of *Dolichoderus thoracicus* (Hymenoptera: Formicidae) on losses due to *Helopeltis theivora* (Heteroptera: Miridae), black pod disease and mammalian pests in cocoa in Malaysia. Bulletin of Entomological Research 82: 485 - 491.

Saleh, A. (2003). Lonsum's experience in controlling the cocoa pod borer. 6th International Conference on Plant Protection in the Tropic. Kuala Lumpur, Malaysia. August, 11 - 14. p 1-7.

Saleh, A., Abu Hassan, A. & Che Salmah, M. R. (2006a). Establishment of *Dolichoderus thoracicus* Smith to control *Helopeltis theobromae* Miller and *Conopomorpha cramerella* Snellen in Lonsum cocoa plantations Indonesia. IMT-GT Conference. Medan, Indonesia. June, 22 - 23. p.1-5.

Saleh, A., Abu Hassan, A. & Che Salmah, M. R. (2007a). Elimination of antagonist ants for establishment of black ant (*Dolichoderus thoracicus* Smith) in controlling *Helopeltis theobromae* Miller and *Conopomorpha cramerella* Snallen in cocoa plantations. Malaysia Applied Biology Symposium. P. Penang, Malaysia. May, 30 - 31. p.1-4.

Saleh, A., Abu Hassan, A. & Che Salmah, M. R. (2007b). Susceptibility of various developmental stages of cocoa pod, *Theobromae cocoa* Linnaeus to *Conopomorpha cramerella* Snellen. Kongres VII dan Seminar Nasional (PEI). Denpasar, Bali, Indonesia. Juli 25-27. p.1-3.

Wardojo, S. (1980a). The cocoa pod borer- A major hindrance to cocoa development. Indonesia Agriculture Research and development 2 (1): 2 - 4.

Warner, J. R. (2003). Bait preferences and toxicity of insecticides to white-footed ants *Technomyrmex albipes* (Hymenoptera: Formicidae). The University of Florida. Master of Science. 59 pp.

Way, M. J. & Khoo, K. C. (1991). Colony dispersion and nesting habits of the ants, *Dolichoderus thoracicus* and *Oecophylla smaragdina* (Hymenoptera:

Formicidae) in relation to their success as biological control agents on cocoa. Bulletin of Entomological Research 81: 341 - 350.

Warner.J., and Scheffrahn, R.H. (2004). Feeding preference of white-footed ants, *Technomyrmex albipes* : (Hymenoptera: Formicidae), to selected Liquids. Scheffrahn Fort Lauderdale Research and Education Center University of Florida, Institute of Food and Agricultural Sciences 3205 College Avenue, Fort Lauderdale, FL 33314. http://shalompest.homestead.com/warner_scheffrahn_2004_feeding_pref_wfa.pdf.

Warner.J., Scheffrahn, R.H and Cabrera,B (2016)White-Footed Ant, *Technomyrmex difficilis* (=*albipes*) Forel (Insecta: Hymenoptera: Formicidae: Dolichoderinae. http://entnemdept.ifas.ufl.edu/creatures/.