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Termites of Agropark, Universiti Malaysia Kelantan, Jeli Campus: Diversity and Pest Composition

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Abstract

Termites play important roles in the ecosystem as detritivores and soil engineers. However, alterations of the forest could change the diversity and abundance of termites. The Agropark at Universiti Malaysia Kelantan (UMK), Jeli Campus is an agricultural park that is surrounded by secondary forest and rubber plantations. This study was conducted to determine the diversity and pest species composition of termites at Agropark, UMK. Standardized line transects 100m long × 2m wide and divided into 20 sections (5m long × 2m wide) were conducted at three different sampling sites in May to September 2015. A total of 29 termite species from 13 genera were successfully identified with relative abundance of 128 (total hits). Diversity indices show high diversity and evenness among the termite species in the study area. The termites comprise of family Termitidae (75.9%) and family Rhinotermitidae (24.1%). Subfamily Macrotermitinae recorded higher a number of species (12 species, 78 hits) compared to other subfamilies recorded in this study. Wood feeders and epigeal mound builders dominated the termite assemblages. The total pest termite species collected is 41.4% (12 species) while 58.6% (17 species) of termite species were non-pest species that provide good ecological services to Agropark, UMKKJ. The pests are mainly from genera *Coptotermes*, *Schedorhinotermes*, *Macrotermes*, *Microtermes* and *Globitermes*. The higher number of pest species shows the possibility of pest attacks to the buildings around the Agropark. Precautions against termite attack should be taken earlier to prevent serious damage to buildings in the future.

1. Introduction

Termites are a group of insects that is classified under the order *Blattodea*, formerly classified under the order *Isoptera* (Inward, 2007). According to Krishna et al. (2013), 3106 living and fossil termite species have been recorded worldwide. In Peninsular Malaysia, 175 species of termite from 42 genera were recorded (Tho, 1992). Among 12 recorded families of termites, three families have been identified in Peninsular Malaysia namely, *Termitidae*, *Rhinotermitidae* and *Kalotermitidae* (Tho, 1992; Krishna et al., 2013).

Termites can be classified to lower taxa based on their morphological characteristics, feeding behavior and nesting behavior (Lo et al., 2007). The morphological characteristics indicate characteristics such as shape of the head and mandible, number of antennal segments and measurements of body parts (Thapa, 1981; Tho, 1992). The feeding behaviour grouped the termites into soil feeders, wood feeders, soil-wood interface feeders, micro-epiphyte feeders and litter-foragers (Eggleton et al., 1997). The nesting behaviour can be used to differentiate termite genera such as wood nesters, subterranean nesters, epigeal mound builders and arboreal nesters (Bignell and Eggleton 2000).

Termites are important inhabitants of forest ecosystems as they are the primary detritivore in the forest. They are responsible for decomposition of dead wood, fallen trees and leaf litter on the forest floor. Termites play a vital role as soil engineers in the forest by improving the structure and quality of soil through tunnelling activity (Bignell and Eggleton, 2000; Jones and Prasetyo, 2002). Furthermore, termites contribute to ecosystem processes such as carbon flux and nitrogen cycles (Bignell and Eggleton, 2000; Cox, 2004; Inoue et al., 2006).

Even though they have positive functions in the ecosystem, approximately 10% of world termite species are considered to be pests and cause serious damage to crops, buildings, plantation forests and become a nuisance to humans (Lewis, 1997; Kirton, 2005). In Asia, building and crop pests are mainly from the genus *Coptotermes* of family *Rhinotermitidae* (Kirton, 2005). There are five species of Coptotermes recorded in Peninsular Malaysia (Kirton, 1995), where *Coptotermes travians* is identified as the primary pest species (Tho, 1992). In addition, *Coptotermes gestroi*, C. *kalshoveni* and C. *curvignathus* were also found infesting houses in West Malaysia (Jones

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et al., 1994; Lee et al., 2002). Termites from subfamily *Macrotermitinae*, *Termitinae* and *Heterotermitinae* are also identified as pest species (Anantharaju et al., 2014).

The Agropark, Universiti Malaysia Kelantan, Jeli Campus (UMKKJ) is an agricultural park that is surrounded by secondary forest and rubber plantations. This area was established mainly for agricultural and ecological teaching and learning activities. Currently, the Agropark is in the development stage and is undergoing construction works within the park. As there are few studies on insects, especially termites, in the Agropark, this study was conducted to determine the termite diversity and pest composition in the Agropark.

2. Materials and Methods

Three different sampling sites were randomly selected at the Agropark (E101°51′54", N5°44′42") namely, rubber plantation (T1), a mix of rubber trees and secondary forest trees (T2) and Bukit Gaharu (T3). A Standardized line transect (100m long × 2m wide) method was used in order to identify the termite diversity as described by Eggleton et al. (1997; 1999) and Nivaarani and Homathevi (2015) (Figure 1). A total of three transects were conducted in this study with each in a sampling site. Each transect was divided into 20 contiguous sections where each section is 5m long × 2m wide. Two people sampled each section for 30 minutes. Casual collections were also conducted around the study area. Ten worker and soldier castes were collected per hit (number of encounters) for further identification in the laboratory. Collected samples were preserved in 80% of ethanol (Watson and Sewell, 1985) together with locality labels. Further identification was done using image analyzer software (Motic Images Plus 2.0) with the aid of Thapa (1981) and Tho (1992). Termite pests were identified using previous studies such as Tho (1994), Eggleton et al. (1996), Lee et al. (2003), Chey (2012) and Krishna et al. (2013).

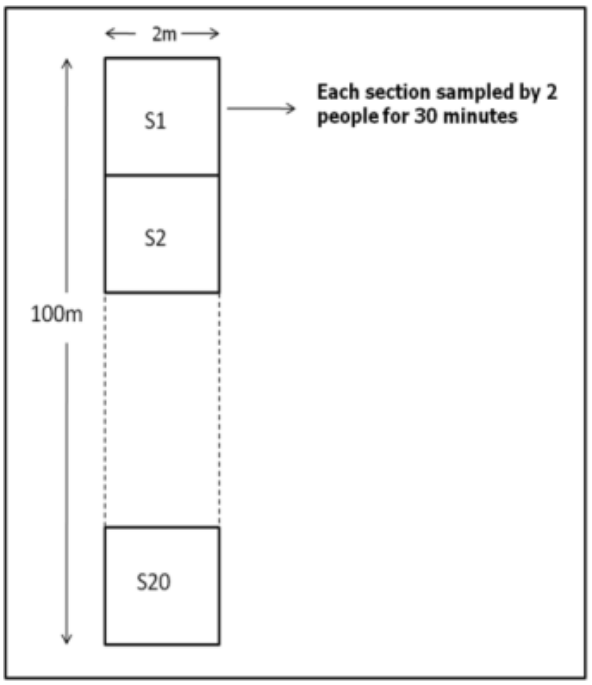

Figure 1: Standardized line transect method

3. Results and Discussion

3.1. Termite Assemblage

A total of 29 termite species from 13 genera, two families and five subfamilies were identified in this study (Table 1). This comprises 16.6% of Peninsular Malaysia's total termite species recorded by Tho (1992). The collected termite species were recorded with relative abundance of 128 hits. The Shannon-Wiener Diversity index shows high termite diversity with value of H'=2.846 (H'max = 3.401). The collected termites were evenly distributed among the three sampling sites. This was proved with Pielou's Evenness Index, J=0.837, nearest to the value 1.

Sampling site T1 recorded 16 species with 36 hits from four subfamilies (*Rhinotermitinae*, *Termitinae*, *Macrotermitinae*, and *Nasutitermitinae*). Next, sampling site T2 recorded 20 species with 59 hits from five subfamilies (*Coptotermitinae*, *Rhinotermitinae*, *Termitinae*, *Macrotermitinae*, and *Nasutitermitinae*). The last sampling site, T3 recorded 13 species with 33 hits from three subfamilies (*Rhinotermitinae*, *Termitinae*, and *Macrotermitinae*) while the casual collection recorded 8 species with 28 hits from four subfamilies (*Coptotermitinae*, *Rhinotermitinae*, *Macrotermitinae* and *Nasutitermitinae*).

The termite assemblage of the Agropark, UMKKJ is dominated by *Microtermes pakistanicus* with 28 hits, followed by *Nasutitermes longinasus* with 12 hits. The least found species was *Globitermes sulphureus* (1 hit).

In this study, a high number of termite species was identified from family *Termitidae*. Subfamily *Macrotermitinae* recorded the highest number of species among collected subfamilies with 12 species. This is similar to the result found in Pasoh Forest Reserve and Belum-Temengor Forest Reserve (Abe, 1978; Aiman et al., 2014). The family comprises of genera *Macrotermes*, *Odontotermes* and *Microtermes*. The lowest number of species recorded in subfamily *Coptotermitinae* (family: *Rhinotermitidae*) with three species (*Coptotermes kalshoveni* Kemner, C. *sepangensis* Krishna and C. *gestroi* Holmgren).

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Table 1: Termite assemblages at Agropark, UMKKJ, where feeding group are: W= wood feeder, I=soil/wood interface feeder, S= soil-feeder, L=litter-forager. Nesting groups are: W= wood nester, H= hypogeal or subterranean nester, E= epigeal mound builder, A= arboreal nester.

Scientific Name	T1	T2	T3	Casual Collection	Feeding group	Nesting group
Family Rhinotermitidae						
Sub-family Coptotermitinae						
Coptotermes kalshoveni Kemner	-	1	-	-	W	W
Coptotermes sepangensis Krishna	-	3	-	7	W	W
Coptotermes gestroi Holmgren	-	1	-	4	W	W
Sub-family Rhinotermitinae						
Schedorhinotermes sp.1	-	2	1	-	W	W
Schedorhinotermes sp.2	1	1	5	3	W	W
Schedorhinotermes sp.3	1	-	2	-	W	W
Schedorhinotermes sp.4	-	1	1	2	W	W
Family Termitidae						
Sub-family Termitinae						
Globitermes sulphureus (Haviland)	1	-	-	-	S/I	E
Termes rostratus Haviland	-	2	-	-	I	W
Mirocapritermes connecten Holmgren	1	-	-	-	S	W
Pericapritermes nitobei (Shiraki)	-	1	1	-	S	H
Sub-family Macrotermitinae						
Macrotermes carboanrius Hagen	1	4	-	3	WL	E
Macrotermes gilvus (Hagen)	1	-	3	4	WL	E
Macrotermes malaccensis Holmgren	1	7	1	-	WL	E
Odontotermes denticulatus Holmgren	2	-	1	-	W	E
Odontotermes gandiceps Holmgren	3	3	1	-	W	E
Odontotermes javanicus Holmgren	1	-	-	-	W	E
Odontotermes mathuri Thapa	1	-	1	-	W	E
Odontotermes oblongatus Holmgren	3	-	2	-	W	E
Odontotermes sarawakensis Holmgren	3	3	-	-	W	E
Odontotermes prodives Thapa	-	3	1	-	W	E
Microtermes pakistanicus Ahmad	8	7	13	-	L	E
Microtermes obesi Holmgren	4	-	-	-	L	E
Sub-family Nasutitermitinae						
Havilanditermes proatripennis Ahmad	-	1	-	-	W	A
Nasutitermes longinasus (Holmgren)	-	12	-	-	W	A
Bulbitermes constrictus (Havilandi)	-	1	-	-	W	A
Bulbitermes contrictiformis (Holmgren)	4	1	-	2	W	A
Bulbitermes singaporiensis (Haviland)	-	3	-	-	W	A
Longipeditermes longipes (Haviland)	-	2	-	3	WL	A
Number of species					29	
Relative abundance (hits)	36	59	33	28	128	

Wood feeders (68.8%) dominated the termite assemblage in this study. The microhabitat of sampling sites observed with more dead and decaying wood which may lead to the high number of wood feeders in this study. The least collected sample is from soil feeding group with only 2.3% compared to other feeding groups. Soil feeders are sensitive to habitat disturbance and prefer soil with high moisture content with dense canopy cover in the forest (Eggleton et al., 2002). Moderately covered canopies in the sampling site may cause less abundance of the soil feeding group.

Epigeal mound builders recorded a higher number of species compared to wood, arboreal and hypogeal nesters. However, during sampling the species were collected mainly from dead or decayed wood and leaves litters. Hypogeal nesters were least collected in this study. Only *Pericapritermes nitobei* from subfamily Termitinae was recorded as a hypogeal nester. This species consumes soil and uses soil to build their nest.

3.2. Pest Composition

Out of 29 termite species collected in this study, 12 species (41.38%) were identified as forest pests, while 58.62% of recorded termite species are providing good ecological services in Agropark. The major destructive pests are from genus *Coptotermes* (Lee, 2002), which is responsible for almost 85% of total infestations of wooden structures in Malaysia (Lee et al., 2007). Three *Coptotemes* species were collected at Agropark namely, *C. kalshoveni* Kemner, *C. sepangensis* Krishna and *C. gestroi* Holmgren with total hits of 16. These species were recorded in rubber plantation areas. In general, *Coptotermes gestroi* have been recorded attacking leaving trees and damaging wooden buildings (Anantharaju et al., 2014; EkoKuswanto et al., 2015) while, *C. kalshoveni* and

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C. sepangensis are pest species that feed on living trees in agricultural areas, lowland dipterocarp forest, beach forest and also dead logs (Tho, 1992). Hence, *Coptotermes* is able to attack leaving trees and cause damage to wood products.

Other than that, pest species were also identified from subfamily Rhinotermitinae (*Schedorhinotermes* spp.). These species were recorded at all sampled areas, with the highest population at T3. They are able to attack hardwood and are known as one of the most destructive termite species in Asia (Eko EkoKuswanto et al., 2015). *Microtermes pakistanicus*, the dominant species in Agropark is one of the major agricultural pests and can be found in rubber plantations (Lee et al., 2003). Other pest species collected in this study were *Macrotermes* spp. and *Globitermes sulphureus*. According to Lee (2002), these species have been recorded around urban areas and cause damage to buildings.

Termite pest species are commonly from wood feeders that attacking living trees. As pest species they had tolerance to feed on dead and decaying wood on the forest floor in disturbed area (Aiman et al., 2014). The limited food resources may force this species to attack wooden structures as alternative food. Furthermore, most of the collected termite pest species in this study are from living tree and decaying tree trunks.

4. Conclusion

There is a high diversity of termite fauna at the Agropark Universiti Malaysia Kelantan, Jeli Campus (UMKKJ) with a high percentage (41.4%) of termite pest species. The recorded pest species show the possibility of pest attack to the buildings around Agropark. Detailed pest studies can be done in the future to determine termite attack to UMKKJ buildings. This is important in managing the forest around the Agropark and future development activities in UMKKJ. Precautions should be taken earlier in order to prevent termite attack to buildings.

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References

Abe, T. (1978). Studies on the distribution and ecological role of termites in a lowland rain forest of west Malaysia. 1. Faunal composition, size, colouration and nest of termites in Pasoh Forest Reserve. Kontyu, 46, 273-290.

Aiman, H. J., Abu, H. A. Nurita, A. T., Che Salmah M. R. (2014). Community structure of termite in a hill dipterocarp forest of Belum-Temengor Complex, Malaysia. Emergance of pest species. Raffles Bulletin of Zoology, 63, 3-11.

Anantharaju, T., Kaur, G., Gajalakshmi, S., Abbasi, S.A. (2014). Sampling and identification of termites in Northeastern, Puducherry, Journal of Entomology and Zoology Studies, 2 (3), 225–230.

Bignell, D.E., Eggleton, P. (2000). Termites in Ecosystems, in: Abe, T., Bignell, D.E., Higashi, M. (Eds). Termites: Evolution, Sociality, Symbioses, Ecology, Kluwer Academic Publishers , London, pp.363-387.

Chey, V.K. (2012). Major timbers of Sabah and their insect pests. Sepilok Bulletin, 15 and 16, 85-95.

Cox, C. (2004). Protecting your home from subterranean termite damage. Journal of
Pesticide Reform, 24 (3), 6-7.

Eggleton, P., Bignell, D. E, Hauser S, Dibog L, Norgrove L., Madong, B. (2002). Termite diversity is a cross an anthropogenic disturbance gradient in humid forest zone of West Africa. Agricultural Ecosystem and Environment, 90, 189–202.

Eggleton, P., Bignell, D. E., Sands, W. A., Mawdsley, N. A., Lawton J. H., Wood, T. G., Bignell, N. C. (1996). The diversity, abundance and biomass of termites under differing levels of disturbance in the Mbalmayo Forest Reserve, southern Cameroon. London. Phil. Trans. R. Soc. B, 351, 51-68.

Eggleton, P., Homathevi, R., Jeeva, D., Jones, D. T., Davies, R. G., Maryati, M. (1997). The species richness and composition of termites (Isoptera) in primary and regenerating lowland dipterocarp forest in Sabah, East Malaysia. J Ecotrop, 3, 119–128.

Eggleton, P., Homathevi, R., Jones, D.T., MacDonald, J.A, Jeeva, D., Bignell, D.E., Davies, R.G., Maryati, M. (1999). Termite assemblages, forest disturbance and greenhouse gas fluxes in Sabah, East Malaysia. Phil. Trans. R. Soc. Lond. (B), 354 (1391), 1791-1802.

Eko Kuswanto, Ahmad, I., Dungani, R. (2015). Threat of subterranean termites attack in the Asian countries and their control: A review. Asian J Appl Sci, 8, 227–239.

Inoue, T., Takematsu, Y., Yamada, A., Hongoh, Y., Jojima, T., Moriya, S., Sornnuwat, Y., Vongkaluang, C., Ohkuma, M., Kudo, T. (2006). Diversity and abundance of termites along an altitudinal gradient in Khao Kitchagoot National Park, Thailand. Journal of Tropical Ecology, 22, 609-612.

Inward, D., Beccaloni, G., Eggleton, P. (2007). Death of an Order: A comprehensive molecular phylogenetic study confirms that termites are eusocial cockroaches. Biology Letter, 3, 331-335.

Jones, C.G., Lawton J.H., M. Shachak, (1994). Organisms as ecosystem engineers. Oikos, 69, 373-386.

Jones, D. T., Prasetyo, A. H. (2002). A Survey of the Termites (Insecta: Isoptera) of Tab Along District, South Kalimantan, Indonesia. National University of Singapore, 50 (1), 117-128.

Kirton, L. G. (2005). The importance of accurate termite taxonomy in the broader perspective of termite management. In Proceeding of Fifth International Conference on Urban Pests, pp. 1–7. P&Y Design Network, Penang.

Kirton, L. G. (1995). Habitat and host associations of *Coptotermes* (Isoptera: Rhinotermitidae) in Peninsular Malaysia. Ph.D. Dissertation, University of London (Imperial College of Science, Technology and Medicine).

Krishna, K., Grimaldi, D.A., Krishna, V., Engel, M.S. 2013. Treatise on the Isoptera of the world: Introduction (Part One), 377. Bulletin of the American Museum of natural history , New York.

Lee, C. Y. (2002). Control of foraging colonies of subterranean termites, *Coptotermes travians* (Isoptera: Rhinotermitidae) in Malaysia using hexaflumuron baits. Sociobiology, 39, 411 – 416.

Lee, C.Y., Ngee, P.S., Lee, L. C. (2003). Foraging population and territories of a mound-building subterranean termite, *Microtermes pakistanicus* (Isoptera:Macrotermitinae). Sociobiology, 41 (2), 307-316.

Lee, C. Y., Vongkaluang, C., Lenz, M. (2007). Challenges to

eISSN Number: 2462-2389

subterranean termite management of multi-genera faunas in Southeast Asia and Australia. Sociobiology, 50, 213–221.

Lewis, V. R. (1997). Alternative control strategies for termite. J. Agric. Entomol., 14, 291-307.

Lo, N., Engel, M. S., Cameron, S., Nalepa, C. A., Tokuda, G., Grimaldi, D., Kitade, O., Krishna, K., Klass, K. D., Maekawa, K., Miura, T., Thompson, G. J. (2007). Save Isoptera: A comment on Inward et al. Biology Letters, 3 (5), 562–563.

Nivaarani, A., Homathevi, R. (2015). Termite Fauna (Blattodea:Termitoidae) of Mahua, Crocker Range Park, Sabah, Malaysia. Malayan Nature Journal, 67 (4), 403-411.

Thapa, R. S. (1981). Termites of Sabah. Sabah Forest Record, 12, 1-374.

Tho, Y. P. (1974). The termite problem in plantation forestry in peninsular Malaysia. Malaysian Forester, 37, 278–283.

Tho, Y.P. (1992). Termites of Peninsular Malaysia. Malayan Forest Record No. 36. Forest Research Institute Malaysia, Ampang.

Watson, J. A. L., Sewell, J. J. (1985). Caste development in *Mastotermes* and *Kalotermes*: which is primitive, in: Watson, J. A. L., Okot-Kotber, B. M., Noirot, C. (Eds.), Caste Differentiation in Social Insects. Oxford, Pergamon, pp. 27–40.

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