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To cite this article: Alia Diyana Mohamed Hassim *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **549** 012053

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Termite Species and Structural Pest Identification in Selected Rural Areas of Kelantan, Malaysia

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Abstract. Termites (order: Blattodea) are insects that playing huge role in organic decomposition, consuming dying wood materials and plants remains. They are commonly found in forest and rural area, where the rural area species are less documented in Malaysia, especially in Kelantan state. This preliminary survey had been done to identify the termite species and also determine the termite that act as a structural pest in the rural area of Kelantan. The aim of this study also to reveal the damages caused by the structural pest termites in rural area of Kelantan. Termite samplings were conducted at Jeli, Pasir Mas, Tanah Merah, and Bachok areas. The methods used were a casual collection of termites using forceps and a survey regarding the pest conflict related to termites at selected houses. A total of seven species of termites were recorded at the rural area of Kelantan. The highest presence of termite species at the study area was *Macrotermes gilvus* (four locations), followed by *Globitermes sulphureus* (three locations). Among the species, *M. gilvus*, *G. sulphureus* and *Odontotermes javanicus* were identified as the species that attack the houses in rural areas of Kelantan. The attacks took place in both wooden and concrete houses. This study provides the details of termite species and termite pest that attack houses in the rural area of Kelantan. The information obtained from this study will be a reference for future research in rural area of Kelantan.

1. Introduction

Termites (order: Blattodea) are known as the most distributed species in the world [1]. They are 3106 living and fossil termites species from 12 families have been recorded in the world [2]. The study of termites species was started by [3], followed by [4] that help to gather knowledge of Indo-Malayan termites. The study was continued by [5] on termites of Ceylon, Peninsular Malaysia, Sumatra, and Java. Malaysia has more termites species as compared to Myanmar, Thailand, Indonesia, and other ASEAN countries [6]. In Peninsular Malaysia, 175 termite species were recorded by [7]. Termites colony mainly consist of a queen, king, soldiers and workers. The caste can be differentiated based on their morphological structures [8]. Their major roles are maintaining the soil fertility, act in decomposition process, carbon and nitrogen cycles [9,10,11,12,13,14,15].

However, some species are pest where they chew on the floor, wall or even wallpapers [16]. The presence of termites attack was recognised in the 20th century during 1907 in Portuguese [17]. Then, researchers have started to consider the subterranean termites as pests that caused severe damages in the region starting from 1936 [18]. Based on the early survey in 1998 by Tho and Kirton in Malaysia,



Coptotermes curvignathus was recognized as the main species that attack Bahau Conifer Plantation. Along the years, seven termite species were found attacking the *Araucaria cunninghamii* (hoop pine) plantation of Teluk Bahang Forest Park (TBFP) [19]. From the study, three termites species (*Coptotermes curvignathus*, *Schedorhinotermes medioobscurus*, and *Odontotermes sarawakensis*) were reported as the key pest species meanwhile *Coptotermes curvignathus* was the most dominant pest species held the responsibility for about 74% of the total infestation of *Araucaria* (family: Araucariaceae) trees in TBFP plantation [19].

A report by [20] showed that 12% of wooden houses in Kg. Sireh, Kelantan were damaged due to the termite's attack. According to [21], major termite control cost about USD 20 billion that involved repairing the damages around the world. Meanwhile, the cost for Malaysian termite control in 2003 was approximately USD10-12 million, and the cost of repairs after the attack was estimated to be much higher [6]. Study of termite species in the rural area, especially in Kelantan state, is still scarce [22]. Most of the termite studies are focusing either on termites assemblages in forest area or on the method of termite control [23,24,25,26]. Hence, this study was conducted to identify the termite species in rural area and also to determine the major pest species of termites in the rural area of Kelantan, Malaysia.

2. Materials and Methods

Two methods were conducted in this study to achieve the objectives. First method involved in collection and identification of termites at each study sites. Second, a survey on pest attack was done using a set of questionnaire.

2.1 Study Area

This study was conducted in rural area of four different districts at Kelantan, Malaysia as shown in Table 1 and Figure 1. The sampling sites were chosen randomly. The sampled microhabitats were unwooded mounds, isolated trees located near to mounds, mounds connected to wood, and wooded mounds at inside and around the house. The sampling sites were surrounded by varies area including rubber plantation, palm plantation, paddy field and secondary forest area. Data was collected on March 2018.

Table 1. Area of termite sampling at Kelantan.

District	Sampling Sites
Jeli	Kampung Kalai Kuala Balah Lakota
Pasir Mas	Rantau Panjang Panglima Bayu
Tanah Merah	Pulau Raya
Bachok	Gunong

2.2 Collection and Identification of Termites

In each sampling site, casual collection method was conducted by collecting termite soldiers using forceps. Collected termites were preserved in 2mL microcentrifuge tube containing 80% ethanol with the appropriate locations and dates labeled [25]. The collected specimens were brought back to the Postgraduate Lab, Faculty of Earth Science, Universiti Malaysia Kelantan, Jeli Campus for further identification. The identification was done based on [7] by identifying the features of the soldiers including morphological characteristics and measuring the size of soldiers head with the aid of Moticam 2 (CMOS) (Motic Asia; Kowloon, Hongkong) attached to a stereo microscope. The ruler had been calibrated beforehand.

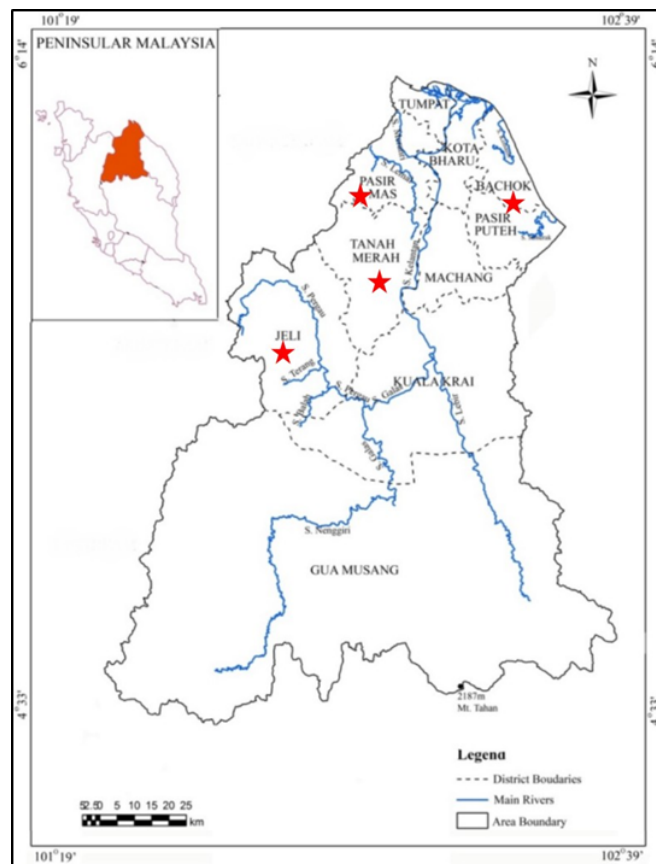


Figure 1. The map of Kelantan showing the location of Jeli, Pasir Mas, Tanah Merah, and Bachok districts.

2.3 Questionnaire

A survey on damages caused by termites was conducted for the houses near the termite presence areas at each sampling site using a set of questionnaire. The questions were about the presence of termite attack, approximate total economic damage, type of damaged facilities, termite treatment method, and type of house material. Twelve respondents in a different location were obtained in this survey.

3. Results and Discussions

3.1 Termite Species and Pest Identification at Rural Area of Kelantan

A total of seven termite species from family Termitidae were recorded in this study (Table 2). Identified species were comprises of three subfamilies namely, Macrotermitinae, Nasutitermitinae, and Termitinae. Macrotermitinae recorded the highest number of species (five species) compared to other subfamilies. From the identified seven species only three species recorded as structural pest in rural area of Kelantan namely, *Globitermes sulphureus*, *Macrotermes gilvus* and *Odontotermes javanicus*.

Based on the survey results, *M. gilvus* present in more sampling sites compared to other identified species. This species was collected from the mound near houses in Gunong, Kg. Kalai and Lakota. The higher presence of *M. gilvus* is supported by [24] who found *M. gilvus* is a mound-building species that commonly found in the rural and suburban area. *Macrotermes gilvus* also was identified as the species that attack the houses as their mound was found under porous wooden floor, continue to porous wall and cupboard (Table 2). In Kg. Kalai and Lakota, the mound were found under the old Malay style house and located in the plantation area. This is supported by [27] that postulate termite attacks usually occurred in formerly forested land and plantation. Termites attack by *M. gilvus* is less

frequent compared to other species such as *Coptotermes* sp. although it listed as a major pest (2). Termite attack happened when the untreated wood of houses in contact with soil, stump and decayed wood which are the foraging area for *M. gilvus* [24]. This is because of stump and litters are often left after clearing of plantation land for human settlement which became the abundant source for the termites. This is also coupled with the anthropogenic activity that occurred in the unoccupied land. This land usually transformed into mini garden which were undermaintained thus attract termites [28] [29]. This shows that land use effected species composition of insects [30].

Table 2. Identified termite species at selected rural area of Kelantan where, KK= Kampung Kalai, KB = Kuala Balah, L = Lakota, RP = Rantau Panjang, PB = Panglima Bayu, G = Gunong, PR = Pulau Raya.

Scientific Name	Location						
	KK	Jeli KB	L	Pasir Mas RP	PB	Bachok G	Tanah Merah PR
Family: Termitidae							
Sub-family: Macrotermitinae							
<i>Macrotermes malaccensis</i>						X ²	
<i>Macrotermes carbonarius</i>			X	X			
* <i>Macrotermes gilvus</i>	X ¹		X	X		X ²	
* <i>Odontotermes javanicus</i>	X ¹						
<i>Odontotermes grandiceps</i>		X					
Sub-family: Nasutitermitinae							
<i>Nasutitermes havilandi</i>							X
Sub-family:							
* <i>Globitermes sulphureus</i>		X	X	X			

*termite pest species
X¹ / X² same house

Globitermes sulphureus was another identified species that infested the rural area in Jeli and Pasir Mas (Table 2). This species has been considered as one of the species that widely distributed in the Jeli and Pasir Mas districts. Then, this species also had the highest distribution in Pasir Mas followed by Jeli according to the marked location from the survey. This is because of the rubber and palm plantation area in Pasir Mas district which can be found along the roadside of Rantau Panjang and Panglima Bayu compared to Jeli (Kuala Balah) that has forested areas. This is supported by [31] that stated that *G. sulphureus* is known as a significant pest in coconut and palm oil plantation. Although *G. sulphureus* commonly known as pest in agriculture sector, it can also attack building structure especially around the perimeter of the house and contributed to 36% of infestations in semi-urban areas in Peninsular Malaysia [18,23,32,33]. Thus, the occurrence of the structural attack is varies and depending on the soil type and the location of those building. Hence, early recognition of the termites in these areas can prevent the infestation from getting severe and reduces the economic impact if residential area attacked.

Odontotermes javanicus was found as one of the species that attack houses from this survey. *Odontotermes javanicus* was collected from Kg. Kalai where the tunnel into the houses have been discovered. This species usually found forest area such as in Agropark of Universiti Malaysia Kelantan, Jeli [22]. It less reported as a major structural pest in Malaysia. However, [34] found that *O. javanicus* had severely damaged structures in Sungai Paloh Nature Camp, Temenggor Lake. Less termite attack in residential area from this species had been reported in Malaysia but this study find that it can attack structural building when observed from Kg. Kalai. Meanwhile, in recent study by [35] in neighbouring country with similar temperate climate, Indonesia, reported that *O. javanicus* is already listed as one of the species that mainly attack buildings. Although the species occurrence is unfrequent as strcutural pest building in Malaysia, this study finding and previous study showed that

O. javanicus can be considered as emerging major house pest species. If no prevention of this species is taken in advance, severe economical damage will occur.

In contrast, four identified termites was confirmed as non-pest species because the species mound was found only near the houses but does not show any sign of building attack. The species include *M. carbonarius*, *M. malaccensis*, *N. havilandi* and *O. grandiceps*. Those species usually frequent in secondary forest and plantation vegetation [36,37]. Previous study by [38] found these species in Belom, Temenggor [38]. In this study, *Nasutitermes havilandi* also was found from the tunnel made on a durian tree in Pulau Raya, Tanah Merah. For *M. carbonarius*, the species was found in the perimeter house area that surrounded by dead leaves and litter that become their food resource. *Odontotermes grandiceps* also was found in the old wooden house perimeter but no attack was reported. The reason that these woods feeder were found in this vegetation type because they play vital role in forest ecology as nutrient enhancer, reduce wood density and reduction of toxic allelochemicals [39]. The area of those four species was once a secondary forest that had been cleared for permanent housing. Hence, these species are not identified as structural pest and only three structural pest species are identified at rural area of Kelantan which are *Globitermes sulphureus*, *Macrotermes gilvus* and *Odontotermes javanicus*.

3.2 Damages Caused by Termites

The total estimated damage caused from-termite attack by the three species (*M. gilvus*, *O. javanicus* and *G. sulphureus*) was approximately RM 4700 in Jeli (Kg. Kalai, Lakota, and Kuala Balah) and Bachok (Gunong). The damages included the wood of houses, the wooden bed, the wooden wall, the cupboard, and books. The termites' mound of *M. gilvus* and *O. javanicus* from two wooden houses were found right under the houses, where the search for food occurs within the patch consists of the exploratory tunnel around the central point of the nest complex [40]. The same occurrence was observed by *G. sulphureus* attack but the location of the small mound was found near the kitchen wall. After the food resources is located, then the food is examined [41,42]. If the food accepted by the termites and consumed, the forager will lay a pheromone trail back to the nest. Then, a primary gallery will be constructed around this recruitment trail [40]. Soon after the food reduced, the exploration of the environment will begin again with the current food resource as the new center of activity [40,42,43]. The likelihood of a food resource being discovered is near to previously of its exploited resources [42].

According to Table 3, out of twelve respondents, only four houses were attacked. Three of the attacked houses are made of wood, and only one of the house is made of concrete. This showed that concrete houses are not exempted from termite attack. This is due to the exploratory tunnel ability to discover new food sources.

The ability of termite attack such as exploratory tunnel causes high cost of treatment. However, the survey shows that the termite treatment was not implemented in most of the houses attacked by termites. Only a house had performed the treatment by using standard purchased pesticide, and no severe control measures when a termite mound identified in the house (Table 3). The conventional method that had been implemented ever since the discovery of pesticide formulation in 1952 was using soil injection that consists of two cyclodienes followed by other active ingredients such as bifenthrin, imidacloprid, fipronil and the chemicals spinosad [44,45]. This treatment had been used over the years, but the user of future technologies demand a new treatment with no chemical contamination that has less effect on the environment. The new product introduced is termite baiting system with the first formula used is diflubenzuron, triflumuron, and subsequently, a new formula was discovered which is hexaflumuron, that belong to the benzoylphenyl formulation that cannot be used for all species of termites [45]. Thus, it proves that standard purchased pesticide have less effect in controlling termite attack if no serious treatment implement by the owner of the house.

Table 3. Information on damages caused by termites at rural area of Kelantan.

Location	Jeli			Bachok
	Kg. Kalai	Lakota	Kuala Balah	Gunong
Scientific Name	a) <i>Macrotermes gilvus</i> b) <i>Odontotermes javanicus</i>	<i>Macrotermes gilvus</i>	<i>Globitermes sulphureus</i>	<i>Macrotermes gilvus</i>
Total estimated damage	RM 3000	RM 500	RM 200	RM 1000
Damaged facilities	House wood, bed, cupboard	House wood	Kitchen wall	Bed, cupboard, books
Termite treatment method	None	None	None	Pesticide
Type of house material	Wooden	Wooden	Wooden	Concrete

4. Conclusion

Seven termite species were identified at rural area of Kelantan with a higher presence of *M. gilvus* and *G. sulphureus*. However, only three species were identified as pest namely *M. gilvus*, *O. javanicus* and *G. sulphureus* that caused a total of RM 4700 damage cost. The identification of termite species in Kelantan can help to determine which species of termite that has the potential to become a major pest in the future. Thus, the prevention from termites attack can be done thus can reduce the economic impact over time.

Acknowledgements

We would like to give our gratitude to the lecturers and lab assistant of Faculty of Earth Science, Universiti Malaysia Kelantan Jeli Campus for providing needed facilities to conduct this study. We also would like to thank the Ministry of Higher Education for providing FRGS Grant (R/FRGS/A08.00/01330A/002/2016/000375) to enhance this study.

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