Termite Fauna (Blattodea:Termitoidae) of Mahua, Crocker Range Park, Sabah, Malaysia

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Abstract: This research was carried out to determine the termite diversity and assemblages at Mahua .Termites were sampled from Mahua, Crocker Range Park, in October 1999 and 2010, using standardised belt transect method. Twenty six species and morphospecies, representing families of Rhinotermitidae (three species, two genera) with 12% and Termitidae (23 species, 18 genera) with 88%. Overall termite assemblage structure was similar to other forest sites in Sabah of which dominated by family Termitidae (88%), comprising both soil-dwelling species (soil or soil-wood interface, of soil-nesting or epigeal mound building) and wood-dwelling termites. Sub-family Termitinae had high diversity of 14 species in this study. Moreover, soil-feeders and wood-feeders dominated the termite assemblages with 46% and 42%, respectively. These feeding groups play an important role in the forest as soil engineers and wood decomposers respectively. In addition, higher number of hypogeal nesters (15 species) identified in this study which indicated that more termite nests can be found under the soil. This will facilitate more in the improvement of soil structure and also the quality of soil. Termites play an important role in the ecosystem of Mahua. Further research need to be done to identify factor that influence the abundance of termites at Mahua.

Keywords : Diversity, Belt transect, Wood-feeding, Soil-feeding, Hypogeal, Termitidae.

INTRODUCTION

Being a prominent members of the soil macrofauna, termites are predominantly tropical in distribution and achieve their highest diversities in the lowland equatorial rainforests ecosystem ie forests of Africa, South America and Southeast Asia, respectively (Bignell and Eggleton 2000; Eggleton et al. 1994). This is mainly related to their ability to utilize dead plant material rich in cellulose (the most abundant organic matter on the earth) (Abe 1995). The abundance of foodstuffs together with a diversity of feeding sites generally leads to a greater variety of trophic groups in tropical rain forests (Collins 1989). Decomposition of organic materials and recycling of nutrients in tropical forests are closely associated with termite feeding and nesting habits (Wood and Johnson 1986).

Living in large colonies, termites are also known as impressive architects of large thermo-regulated nest. They are often termed as 'ecosystem engineers' due to their role in providing soil ecosystem services which include improving soil structure, redistribution of mineral and organic materials and the enhancement of organo-mineral complex formation (Wood 1996; Brussaard and Juma 1996; Lavelle 1996; Bignell and Eggleton 2000).

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Termite assemblages are very sensitive to environmental variables (Eggleton et al. 1996; Jones et al. 2003; Jones and Prasetyo 2002). Progressive and drastic collapse in termite assemblages are observed after increased land-use intensification such as logging and the conversion of natural forest ecosystems to plantations or subsistence crop fields (Collins 1980; Eggleton et al. 1997, 1999; Bignell et al. 1997). In Southeast Asia especially in Sabah and Sarawak, studies on termite assemblages include work by Collins (1980; 1983; 1984) at Gunung Mulu National Park, Sarawak and Homathevi and Wong (2011) at Lanjak Entimau Wildlife Sanctuary, Sarawak. Documentation on termite assemblages and effect of forest disturbance in Sabah were contributed by Eggleton et al. (1997, 1999) and Homathevi et al. (2000) in Danum Valley Conservation Area (Sabah). Though, some published work in Sabah have mainly covered lowland forest, Homathevi et al. (2002; 2004), and in some instances also lower and upper montane forests (Jones et al. 1998; Jones 2000), information on termite diversity in forest remnants are still needed. Forest remnants have been reported as important reservoirs of diversity assisting the recovery of adjacent logged-over forest (Eggleton et al. 1997; Aiman Hanis et al. 2014).

This paper presents updated information on termite assemblages from Mahua, Crocker Range Park. The studies include the International Scientific Expedition (October 1999) and field survey conducted in October 2010. The results were then compared with other sites in Sabah where the same sampling protocol has already been used.

MATERIALS AND METHOD

Crocker Range National Park is a protected area with 1399 square kms (Phillipps 1988) located at 5°07' to 5°56' N, 115°50' to 116°28' E (Suleiman et al. 2007). This area was gazetted in 1984 mainly to sustain the supply of good quality water to approximately 200,000 populations residing in the West Coast and Interior Districts of Sabah (Murtedza et al. 2001). The park includes five substations, namely, Inobong (Penampang and Tuaran), Ulu Melalap (Tenom), Ulu Kimanis (Papar), Mahua (Tambunan), and Ulu Membakut (Beaufort and Membakut) (Zaidi et al. 2002), which are responsible in managing the ecosystem stability of the park. Mahua is one of the substations chosen for this study (Figure 1). This substation has elevation of around 900-1000m above the sea and cover smaller area compared to other protected areas in Sabah.

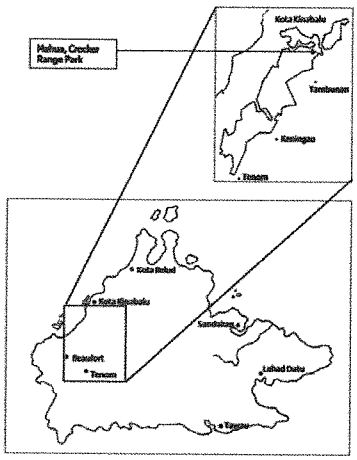

Figure 1. Map of Sabah showing Mahua at Crocker Range Park. (Modified from Phillipps, 1988).

This paper includes data from studies conducted in October 1999 (International Scientific Expedition) and October 2010 at Crocker Range National Park, Sabah (CRNP) (Figure 1). The vegetation of the CRNP consists of many sizeable patches of lowland forest that have been cleared for agricultural and human settlements (Isa et al. 2001). The remaining larger portion of the undisturbed forest includes mixed dipterocarp forests and a stretch of pristine montane and upper montane moss forests, mainly at peaks (Isa et al. 2001). As for Mahua substation, the vegetation is of mixed dipterocarp forest with moderate diversity of tree species, supporting a rich and diverse animal community (Isa et al. 2001).

Termite sampling was conducted using 100m x 2m, standardised belt transect method with protocol described by Eggleton et al. (1997; 1999). During the sampling periods, four transects (two per sampling periods) were run within the study area taking into account the moist forest, interior part of the forest, slightly drier and middle of the forest, adjacent to partially disturbed area. Termite collections were done manually using forceps. All microhabitats known to contain termite species were explored. These include carton runways on tree trunks and above-ground vegetation, dead wood in all stages of decay, root mats, tree root systems and buttresses, surface soil, subterranean and epigeal nests, nests inside wood and arboreal nests up to 2 m above ground level. The samples collected were preserved in 80% ethanol and subsequently identified or assigned to morphospecies by referring to Thapa (1981), Collins (1984), and Tho (1992). Feeding and nesting group were allocated according to Collins (1984), Eggleton et al. (1997), Jones and Brendell (1998) and Donovan et al. (2001).

RESULTS

A total of 26 species, comprising 20 genera and four subfamilies were collected from the transects run at Mahua Substation (Table 1). Of these, 21 were described species and five were morphotypes which could be assigned to genus and matched with existing specimens in the insect collection of BOREENSIS, Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah. Termite species richness in Mahua comprises 22% of total termite species recorded by Thapa (1981) in Sabah.

The termite assemblage at Mahua represented by two families, Rhinotermitidae and Termitidae. Higher termites which include single family, Termitidae (88%), dominated the assemblages with the subfamilies Termitinae being the largest subfamily (14 species) followed by Nasutitermitinae (six species) and the fungus-growing Macrotermitinae (three species) (Figure 2). Two genera comprising three species of lower termites were collected from the transects *Parrhinotermes buttel-reepeni* Holmgren, *Schedorhinotermes sarawakensis* (Holmgren), and *Schedorhinotermes tarakanensis* (Oshima).

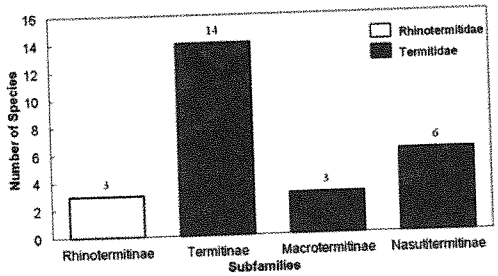

Figure 2. Number of termite species in subfamilies collected at Mahua.

Table 1. Termite species collected at Mahua, Crocker Range Park, Sabah using standardised line transect: Feeding groups, w = wood feeders, s = soil feeders, s/w = soil-wood interface feeders, epy = epiphyte feeders, (f) = fungus growers. Nesting groups, a = arboreal, w = in dead wood, h = hypogeal.

	Feeding group	Nesting group	Year 1999	Year 2010
Family : Rhinotermitidae				
Subfamily : Rhinotermitinae				
Parrhinotermes buttel-reepeni Holmgren	w	w		/
Schedorhinotermes sarawakensis (Holmgren)	w	w		/
Schedorhinotermes tarakanensis (Oshima)	w	w		/
Family : Termitidae				
Subfamily : Termitinae				
Prohamitermes hosei minor Thapa	s / w	h		/
Amitermes minor Holmgren	w	e		/
Labritermes kistneri Krishna and Adams	s	h		/
Microcerotermes serrula (Desneux)	w	w	/	/
Pericapritermes dolichocephalus (John)	s	h		/
Pericapritermes paraspecious Thapa	s	h		/
Pericapritermes semarangi (Holmgren)	s	h	/	
Pericapritermes nitobei (Shiraki)	s	h	/	
Dicuspiditermes nemorosus (Haviland)	s	e	/	
Mirocapritermes connectens Holmgren	s	h	/	
Coxocapritermes sp.	s	h		/
Oriencapritermes sp.	s	h	/	/
Procapritermes neosetiger Thapa	s	h		/
Procapritermes sp.1	s	h		/
Subfamily : Macrotermitinae				
Macrotermes malaccensis (Haviland)	w/ l(f)	h	/	/
Hypotermes xenotermitis (Wasmann)	w(f)	h	/	
Odontotermes grandiceps Holmgren	w(f)	h	/	
Subfamily : Nasutitermitinae				
Hirtitermes spinocephalus (Oshima)	w	w		
Nasutitermes neoparvus Thapa	w	a	/	/
Bulbitermes flavicans (Holmgren)	w	a	/	/
Bulbitermes constrictiformis (Holmgren)	w	a		/
Hospitalitermes sp.	epy	a	/	
Sabahitermes sp.	s	h		/
Total number of species = 26				

Five feeding groups were recognized within Mahua assemblage but varied in species composition (Figure 3). The soil-feeders made up 46% of the termites sampled followed by wood-feeders (42%). Three other feeding groups, soil/wood interface feeder, litter-feeder and epiphyte-feeder were represented by single species, *Prohamitermes hosei minor, Macrotermes malaccensis* and *Hospitalitermes* sp., respectively. A clear dominance of soil-feeding and wood-feeding species was seen in Mahua assemblage.

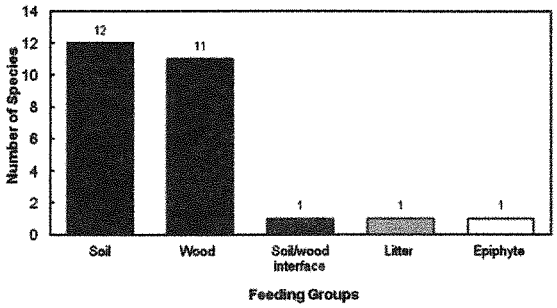

Figure 3. Overall termite distributions in feeding groups collected at Mahua.

Three types of nesting groups were identified among termite species collected at Mahua (Figure 4). Hypogeal nest-builders dominated the assemblages with 58%, followed by wood nesters (19%) and arboreal nesters (15%). Higher number of hypogeal nesters indicates that more termite nest could be found under the soil compared to other places.

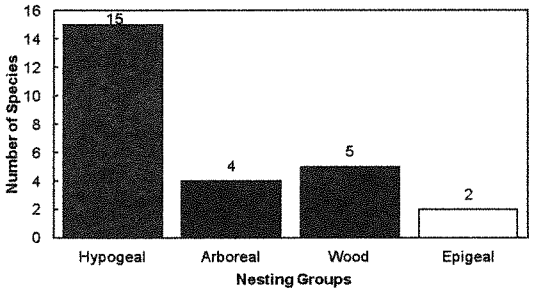

Figure 4. Overall termite distributions in nesting groups collected at Mahua.

In comparison of sampling periods, only five species (19%) were similar while 81% of termite species differ between both collections in the year 1999 and 2010 (Table 1). There were nine genera newly recorded at Mahua during the second survey: *Parrhinotermes*, *Schedorhinotermes*, *Prohamitermes*, *Amitermes*, *Labritermes*, *Procapritermes*, *Coxocapritermes*, *Hirtitermes* and *Sabahitermes*. Fourteen termite species were newly recorded during the second survey meanwhile, seven termite species which were collected in the initial inventory were not recorded in the latter study. The genus *Pericapritermes* was collected in both sampling but different types of species were found in both survey. *Pericapritermes semarangi* (Holmgren) and *Pericapritermes nitobei* (Shiraki) were recorded at Mahua in 1999 while *Pericapritermes paraspeciosus* Thapa and *Pericapritermes dolichocephalus* (John) were recorded in 2010.

DISCUSSION

Termite assemblage of Mahua is dominated by soil-feeders and wood-feeders with 46% and 42% respectively. Mahua is a primary forest with less disturbed areas. The soil condition in the forest was good. This may lead to the presence of high nutrients in the soil. Hence, soil feeders such as genera *Pericapritermes* and *Procapritermes* were recorded at Mahua. These species also act as soil engineers which increase soil fertility while feeding the organic matters and nest in soil. This finding is also similar with termite assemblage at Sayap-Kinabalu of which soil feeders were dominant (56%) (Homathevi et al. 2002). Previous studies showed that soil-feeders are very successful in primary forest as they require organic-rich soil and a humid condition for colony survival and development (Eggleton et al. 1995; 1996).

Though termites are important in processing dead wood and other cellulosic material, different species specialize at different stages of the humification process (Homethevi et al. 2000). Observation in Mahua during sampling showed the presence of higher number of dead woods with different stages of decaying. This give support to the presence of more wood feeders (beside soil-feeders) compared to other types of feeders. Wood feeders such as *Microcerotermes serrula* (Desneux) and *Bulbitermes constrictiformis* (Holmgren) play an important role in the decomposition of the woods. Their abundance and presence of other wood-feeders ensure the decomposition process at forest of Mahua occur faster without any difficulties. This result is similar to the number of wood feeders identified at Kimanis-Keningau Road, Crocker range Park (45%) (Homathevi et al. 2004). However, this result contrasts with the percentage of wood-feeding termites in Maliau and Belum-Temengor Forest Complex (BTFC) where the wood-feeders were dominant with 60% (Jones et al. 1998) and 67.5% (Aiman Hanis et al. 2014) respectively compared to other feeders.

The soil-wood interface-feeders (*Prohamitermes hosei minor* Thapa), litter-feeders (*Macrotermes malaccensis* (Haviland)) and epiphyte feeders (*Hospitalitermes* sp.) were present with lower percentage of 4% respectively where only one species identified in their respective genus during the sampling. The presence of these feeders is important for the decomposition of other organic matters. Factor that restricted abundance of these feeders need to be given priority for future research.

The lower montane forest of Maliau Basin Conservation Area has similar altitude as of Mahua (Jones et al. 1998). Higher number of species were recorded at Mahua compared to the species recorded at Maliau. There were only 16 species collected using two transects at Maliau. Termite families collected were similar but family Kalotermitidae was an addition at Maliau. As in Maliau, sub-family Termitinae dominated in Mahua. Even though these sites have similar species richness, *Pericapritermes dolichocephalus* (John), *Procapritermes neosetiger* Thapa, *Coxocapritermes sp.* and *Amitermes minor* Holmgren were not recorded in lower montane forest of Maliau.

Mahua also recorded higher species richness compared to lower montane forest of Sayap Substation, Kinabalu Park (16 species, ten genera), which had similar altitude with Mahua (Homathevi et al. 2002). Similar families found in both areas with higher number of species recorded in family Termitidae. As in Mahua and Maliau, sub-family Termitinae also dominated Sayap. This shows that sub-family Termitinae dominated in most of the primary forest.

However, the total number of termite species and genera of Mahua were less compared to the species richness identified (31 species, 21 genera) in a study conducted at Kimanis-Keningau Road, Crocker Range Park using the same method (Homathevi et al. 2004). Similar sub-families of Termitidae were found at both areas, with Termitinae being the largest sub-family. Termitinae of Mahua have similar number of species (14 species) with Termitinae of Kimanis- Keningau Road, Crocker Range Park.

CONCLUSION

This study contributes information on termites from one of the forest remnants in Sabah. The termite assemblage in Mahua is dominated by species of higher termite, particularly Termitinae and Nasutitermitinae. The subfamily Termitinae is represented mainly by soil-feeders which play an important role in the ecosystem as soil engineers and in decomposition process, whereby it has to be conserved. However, factors that might influence in the destruction of the species do exist in nature. In order to avoid that, further research need to be done to identify the factor for the less abundance of the litter feeders, soil-wood interface feeders and epiphyte feeders also need to be studied in the future.

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