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TERMITES OF OIL PALM ON PEAT SOIL: A 10-YEAR COLLECTION FROM ENDAU ROMPIN

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ABSTRACT

In 2003, we published the first list of termites (20 species) from an ex-felled peat soil oil palm plantation located to the northeast of Endau Rompin National Park. In this paper we present an annotated checklist from the same site based on collections of a decade (October 2001 to October 2011). The list provided here was generated from collections using various sampling methods in addition to only transect method where the first list was made. We can be certain that a total of 35 species of termites from five functional taxonomic groups can be found at this site. Status of the species from the initial list were revised and updated. The current list suggested that the total number of species known so far from a single oil palm plantation site converted from peat

swamp forest in Malaysia was considerably higher compared to collections made by researchers from other sites.We propose comparative collections be made on termite assemblages from the natural forests particularly the peat swamp forest to contrast andunderstand the rate of species turnover from such forests converted to oil palm plantation.

Keywords: Isoptera, Blattodea, Termitoidae, oil palm, peat soil, inventory

ABSTRAK

Pada tahun 2003, kami telah menerbitkan senarai pertama anai-anai (20 spesies) dari kawasan penanaman sawit yang ditukar daripada hutan bertanah gambut yang terletak di timur laut Taman Negara Endau Rompin. Dalam kertas ini kami persembahkan satu senarai semak bernota dari kawasan yang sama berdasarkan koleksi yang dibuat selama sedekad (Oktober 2001 hingga Oktober 2011). Senarai yang diberikan di sini telah dijana daripada koleksi menggunakan pelbagai kaedah pensampelan sebagai tambahan kepada kaedah transek sahaja yang mana senarai pertama tersebut dihasilkan. Kami kenal pasti sejumlah 35 spesies anai-anai daripada lima kumpulan taksonomi berfungsi boleh ditemui di kawasan ini. Status spesies daripada senarai awal tersebut telah disemak dan dikemaskini. Senarai terkini ini memberi gambaran bahawa jumlah spesies yang diketahui setakat ini dari sesebuah kawasan penanaman sawit yang ditanam semula daripada hutan paya gambut di Malaysia adalah lebih tinggi berbanding koleksi yang dibuat oleh penyelidik dari kawasan lain. Kami mencadangkan koleksi dibuat ke atas kumpulan anai-anai daripada hutan semulajadi terutamanya hutan paya gambut sebagai bandingan

Kata kunci: Isoptera, Blattodea, Termitoidae, penanaman sawit, tanah gambut, inventori.

INTRODUCTION

In agroecosystems like rubber, oil palm and coconut, incidences of termite infestation were alarming with often a single pest species of concern (Sudharto et al. 1991; Khoo et al. 1991; Mariau et al. 1992; Cheng 2002; Faszly et al. 2003a, 2004; Lau et al. 2011). There had never been any studies that comprehensively assess the composition of termites from various habitats within the agroecosystems to identify the significance of each species encountered (Faszly & Idris 2008; Faszly 2008). The challenge was that studies should be able to include all known niches of termites to enable preparation of a reliable checklist assessing the overall termite assemblages occurring in the area. This often requires combination of several methods of sampling (Dawes-Gromadzki 2003; Jones et al. 2005) including passive and active ones and often require an additional casual sampling (e.g. Jones & Brendell 1998; Eggleton et al. 1999)to be included in a sampling program.

Previous research on termite sampling from oil palm on peat areas had been attempted with labour intensive but with small species turnover (Mariau et al. 1992; Khoo et al. 2001; Pasaribu et al. 2001; Cheng 2002). The reason for such poor results was because most studies concentrated on identifying the distribution of pest species whilst encountering the other species by chance. Without knowing the distribution pattern in the field and appropriate sampling methods, the overall assemblages of termites might never be illuminated (Jones & Eggleton 2000; Roisin & Leponce 2004; Jones et al. 2006).

We began collecting termites in the oil palm plantations on peat in October 2001. The initial list was published (Faszly et al. 2003b) based on collection from several units of standardized transect protocol runs. Examinations of the collections identified that there were 20 species of termites altogether from the site, representing the assemblages from an oil palm plantation on peat soil. However, the list was not revised or corrected until we decide to consolidate new record of species retrieved from multiple sampling methods made throughout the plantation site for a decade.

In this paper, we present an annotated checklist of the species from the oil palm plantation site with revision and corrections to the previous list. We consider the number of species presented in the new checklist to be comprehensive and an up-to-date list of the termites from oil palm agroecosystem on peat.

MATERIALS & METHODS

Study site

The study was conducted at a plantation complex owned by the Yayasan Pahang Plantation Holdings Sdn. Bhd (YPPH). The plantation complex is progressing southward in development to cover an area of more than 20,000 ha. The plantation areas were converted from the compartments of Endau Rompin Forest Reserve that were gazetted for logging concession and oil palm development thereafter by the Pahang State Government (YPPH management, pers. comm.).

We sampled the termites in one of the earliest established estate named Ladang Endau Rompin (LER), where formerly it was named Ladang Yayasan Pahang Endau Rompin (LYPER) with its first planted commencing in 1995. The geo-reference point for the estates logged at its centre is 2º36'N, 103º32'E. The estate was planted on two types of soil – clay and peat soil, where the clay sites occur only to the southeast part of the estate.

Termite sampling

Our initial checklist was generated from collections made througha single method only i.e. the standardized transect protocol (Jones & Eggleton 2000; Roisin & Leponce 2004; Jones et al. 2006) adapted to oil palm environment. For over a decade (October 2001 – October 2011) we made several sampling campaigns across the estate to include the transect method, wood-stakes baiting using *Hevea brasiliensis* (e.g. Sajap 1999), stand scouting, census and other casual encounters (refer Faszly & Idris 2008; Faszly 2008 for methodologies). At any instances, we collect as many individuals of the colonies encountered to include

all the castes occurring in the colony. Specimens were wet stored in either 70% or 95% ethanol and kept in the cold room at the Centre for Insect Systematics, Biological Sciences Building, Faculty of Science and Technology, Universiti Kebangsaan Malaysia. Specimens in 95% ethanol were intended for further molecular work on the specimens.

Identification and classification

Termites collected using the various sampling methods were identified to species level. References to Thapa (1981) and Tho (1992) were made to updated revisions (Homathevi 1999; Kirton & Brown 2003; Scheffrahn & Su 2005) and descriptions accounts (Jones & Brendell 1998; Jones & Prasetyo 2002; Jones et al. 2003; Eggleton et al. 2007;).We used soldier external morphology with stable characters erected by authors to assign our materials to named species. We classify the termites based on the new phylogenetic classification of termites under the Order Blattodea, epifamily Termitoidae (Inward et al. 2007; Eggleton et al. 2007). Ecological classification of termites into feeding and nesting groups, andfunctional taxonomic group, were also made to illuminate the ecology of each species (e.g. Donovan et al. 2001; Gathorne-Hardy et al. 2002, 2003).

RESULTS & DISCUSSION

Our ten years of sampling for termites retrieved a total of 35 species altogether. Although the number seemed small, the collection represented one of the most comprehensive checklist of termites from a single oil palm plantation on peat soil site in Malaysia. To date, there had never been any published record making up to the number of termite assemblages in oil palm agroecosystems.

The species checklist (Table 1) was represented by three families, with 12 genera. Five functional taxonomic groups (FTG) namely the Kalotermitidae, Rhinotermitidae, *Amitermes* group II, *Capritermes* group III, and *Nasutitermes* group II were present. Feeding habits of the species include wood feeders (83%), soil-

intermediate feeders (3%) and organic soil feeders (14%). The assemblage consisted of termites that nest in wood (54%), epigeal (9%), hypogeal (14%), and arboreal nester (17%) as well as inquiline nester (6%).The composition indicates almost all of the known termite assemblages occurring in forests of Peninsular Malaysia. The various feeding and nesting habits of the termite assemblage reflected that through time the oil palm agro-ecosystem were able to provide niches for various species of termites to establish or recolonize.

Table 1. Checklist of termite species collected over a decade in oil palm agroecosystem on peat soil of Ladang Endau Rompin from October 2001 to October 2011.

Species	Feeding group†	Nesting group‡	FG¤
KALOTERMITIDAE			
Kalotermitinae			
Glyptotermes brevicaudatus (Haviland) 1898 *NR*	*w*	w	I
RHINOTERMITIDAE			
Coptotermitinae			
Coptotermes curvignathus (Holmgren) 1913	*w*	w	I
Coptotermes gestroi (Holmgren) 1913	*w*	w	I
Coptotermes kalshoveni Kemner 1934	*w*	w	I
Coptotermes sepangensis Krishna 1956	*w*	w	I
Coptotermes travians (Haviland) 1898	*w*	w	I
Rhinotermitinae			
Parrhinotermes aequalis (Haviland) 1898	*w*	w	I
Parrhinotermes inaequalis (Haviland) 1898	*w*	w	I
Schedorhinotermes brevialatus (Haviland) 1898 *NR*	*w*	w	I
Schedorhinotermes malaccensis	*w*	w	I

Table 1 continue...

Table 1 continued...

Species	Feeding group†	Nesting group‡	FG¤
(Holmgren) 1913			
Schedorhinotermes medioobscurus (Holmgren) 1914	*w*	w	I
Schedorhinotermes javanicus Kemner 1934	*w*	w	I
Schedorhinotermes sarawakensis (Holmgren) 1913	*w*	w	I
Schedorhinotermes tarakanensis (Oshima) 1914	*w*	w	I
Schedorhinotermes sp.	*w*	w	
Termitinae			
***Amitermes* group II**			
Amitermes dentatus (Haviland) 1898	*w*	e	II
Amitermes minor (Holmgren) 1914	*w*	e	II
Amitermes sp.	*w*	e	II
Globitermes globosus (Haviland) 1898	*w*	i	II
Microcerotermes havilandi Holmgren 1913	*w*	a	II
***Capritermes* group III**			
Termes rostratus Haviland 1898	*i*	i	III
Pericapritermes dolichocephalus (John) 1925	*o*	h	III
Pericapritermes latignathus (Holmgren) 1914 *NR*	*o*	h	III
Pericapritermes mohri (Kemner) 1934	*o*	h	III
Pericapritermes nitobei (Shiraki) 1909 *NR*	*o*	h	III
Pericapritermes semarangi (Holmgren) 1913	*o*	h	III
Nasutitermitinae			
***Nasutitermes* group II**			
Havilanditermes atripennis (Haviland) 1898	*w*	w	II
Hospitalitermes hospitalis (Haviland) 1898	*e*	w	II(e)
Hospitalitermes umbrinus	*e*	w	II(e)

Table 1 continue...

Table 1 continued...

Species	Feeding group†	Nesting group‡	FG¤
(Haviland) 1898			
Nasutitermes havilandi (Desneux) 1904	*w*	a	II
Nasutitermes johoricus (John) 1925	*w*	a	II
Nasutitermes longinasus (Holmgren) 1913	*w*	w	II
Nasutitermes matangensis (Haviland) 1898	*w*	a	II
Bulbitermes germanus (Haviland) 1898	*w*	a	II
Bulbitermes singaporiensis (Haviland) 1898	*w*	a	II

† Feeding groups: wood-feeder (*w*); soil-wood or intermediate-feeder (*i*); organic soil-feeder (*o*); microepiphyte-feeder (*e*).

‡ Nesting groups: wood or trees-nester (w); hypogeal-nester (h) i.e. nests below ground surfaces; epigeal-nester (e) i.e. nests with some parts protruding above the ground; arboreal-nester (a) i.e. nests totally above ground; inquiline-nester (i) i.e. sharing the nests built by another species of termite.

¤ FG (functional groups): I = group I (wood-feeder); II = group II (partially decayed wood feeder); II(e) = group II (microepiphyte feeder) and III = group III (soil-interface and humus feeder)

[NR]newly recorded speciesfor Peninsular Malaysia

TAXONOMIC REVISION TO THE INITIAL CHECKLIST

In the initial checklist, a total of 20 species of termites was listed. This include five undesignated species and 15 species designated to the established named species following Thapa (1981) and Tho (1992). However, the revisions to the specimens are needed as more materials had been collected to confirm the taxonomic status and amended for misidentification if any. Our reassignment and finalization of the species from the initial list are discussed below.

FAMILY RHINOTERMITIDAE

Subfamily Coptotermitinae
Genus *Coptotermes* Wasmann

***Coptotermes havilandi* (Holmgren)**
This species is revised and reassigned as *Coptotermes gestroi* based on revisions by Kirton and Brown (2003). The authors revised the misidentification of the species and that *C. havilandi* was junior synonym of *C. gestroi*. Therefore, we follow the up-to-date nomenclature of the species.

***Coptotermes* sp. 1**
This species was noted by Faszly et al. (2003b) as having the soldier head capsule length to the base of mandible lesser that *C. curvignathus*. We reassign this species to *C. gestroi* based on the the redescription by Kirton and Brown (2003).

***Coptotermes* sp. 2**
This species exhibit length and width of head much lesser than *C. havilandi*. We reassign thespecimens to *C. travians* based on description by Tho (1992) and Kirton and Brown (2003).

The reassignments in this latest checklist resolved the taxonomic statusfor the genus *Coptotermes*that was incorrectly identified earlier (Faszly et al. 2003b) to only two species i.e. *C. gestroi* and *C. travians*. Therefore, the total number of species for *Coptotermes*known from the site is currently five species, including *C. kalshoveni* that was not recorded in the initial list (Table 1).

Subfamily Rhinotermitinae
Genus *Schedorhinotermes* Silvestri

***Schedorhinotermes* sp. 1**
This species were noted in the initial list.It exhibits the length and width of head much lesser than *Schedorhinotermes medioobscurus*. Upon examining more materials, we found that

the species was *S. javanicus* based on the number of antennal segments where many of our materials (from several populations)can be separated to both *S. medioobscurus* (16 antennal segments) and *S. javanicus* (less than 16 antennal segments) (Tho 1992). Therefore we assign *S.* sp. 1 to *S. javanicus*.

With the above assignment, the total number of species under the genus *Schedorhinotermes* collected from this site isseven altogether. The current list included three additional specieswhere interestingly, two of the species have not been recorded in Peninsular Malaysia (see below). We reserve *S. malaccensis* and *S. sarawakensis* based on the consistencies of our materials to exhibit distinct differences in character for the labrum shape (refer Tho 1992). The latter exhibit labrum of major soldier with notch at the median apical process, whereas the former has a flat termination of their apical process.

FAMILY TERMITIDAE

Subfamily Termitinae
Amitermes group II
Genus *Microcerotermes* Silvestri

***Microcerotermes serrula* (Desneux)**

This species was revised from the initial list. Upon revising the whole batch of *Microcerotermes* in our collection, we identified that all of the specimens fit to the description of *M. havilandi* with a much slender mandibles as compared to *M. serrula*. *M. havilandi* comes close to *M. dubius* in mandible shape except for that it is smaller.

Capritermes group III
Genus *Pericapritermes* Silvestri

We revised more materials of *Pericapritermes* from our collections and came to a concensus thatthere were five species altogether (Table 1). The genus was initially assigned based on a poor number of materials (very rare presence of soldier castes) from the transect collections. The initial list was all reassigned with

more specimens that were collected throughout the sampling period. Accept for *P. semarangi* three other species from the initial list i.e. *P. buitenzorgi*, *P.* sp. C (Tho) and *P.* sp. D (Tho) was revised and reassigned as follows:

***Pericapritermes buitenzorgi* (Kemner)**
With more samples at in hand, we found that the range of head capsule length and width of this species somewhat similar to the range of *P. mohri*. There had never been any recent publications of checklist bearing the name *P. buitenzorgi* from Sundaland that the name, in our opinion should be erected. Therefore, we reserve all the specimens to *P. mohri*.

***Pericapritermes* sp. C**
Tho (1992) described this species to have and apical hook on the left mandible. However, consistencies of *Pericapritermes* in the recent accounts (e.g. Homathevi 1999) had separated *Pericapritermes* from other *Capritermes* group to having mandibles without an apical hook and terminate in a flat apical process. Therefore, as noted by Tho (1992) the species *P.* sp. C might not be a valid species or at least a species not assigned to the *Pericapritermes* complex (*Procapritermes* et al.). We therefore, reassign the specimens (both species showed head capsule of similar range) to two of the named species – the smaller (head capsule length less than 2.00 mm) being *P. mohri* and the larger (head capsule length more than 2.00 mm) to *P. dolichocephalus*.

***Pericapritermes* sp. D**
Tho (1992) had also noted that this species might not be a valid species. The closest valid species was *P. mohri*. Therefore, all our materials are revised and reassigned to *P. mohri*.

Subfamily Nasutitermitinae
***Nasutitermes* group II**
Genus *Havilanditermes* Light

***Havilanditermes atripennis* (Haviland)**
This species was considered invalid by some authors and that it was considered to be the higher range of *Nasutitermes matangensis*. Syaukani (no date) listed this species under the genus *Nasutitermes* but his key was contradictorily labelled between *N. atripennis* and *N. proatripennis*. We reconsider our materials to stand as *H. atripennis*as several recent authors erected the species as a valid named species but it was recorded from Borneo (*sensu* Jones et al. 2010; Vaessen et al. 2011). Furthermore, we found a few unrelated colonies to exhibit larger ranges of head capsule and length of nasus compared to other *Nasutitermes* materials that we have collected throughout the ten years. We hold to the distinction that this species possessed longer, well extended nasus than the *Nasutitermes* which often exhibit shorter nasus.

Additional records and new findings from the collection

With all the revisions above, the total number of species retained from the initial list was 14 which include *Glyptotermes brevicaudatus, C. curvignathus, C. sepangensis, Parrhinotermes aequalis, S. malaccensis, S. medioobscurus, S. sarawakensis, Globitermes globosus, Pericapritermes dolichocephalus, P. mohri, P. semarangi, H. atripennis, N. havilandi,* and *N. johoricus*. The revisions added another five species, *C. gestroi, C. travians, S. javanicus, M. havilandi* and *P. latignathus* making a total of 19 species to be recognized from the initial list. The other 16 species in the checklist (Table 1) were additional species which consolidated to the initial list making the total of 35 termite species altogether to be recognized from oil palm agroecosystem on peat in Endau Rompin.

It was interesting to note also that our collection consisted of four newly recorded species for Peninsular Malaysia and possibly two new species.

The four species, *G. brevicaudatus*, *S. brevialatus*, *Pericapritermes nitobei* and *P. latignathus* had only been recorded previously by Thapa (1981) in Sabah and had never been documented by Tho (1992) or by other authors making checklist of termites from Peninsular Malaysia thereafter. The latest record for *S. brevialatus* was only published very recently by Vaessen et al. (2011) to be abundant in the oil palm plantation on peat soil in Sarawak. Therefore, we suggest establishing the four species as new record for Peninsular Malaysia.

The two possibly new species from this sampling campaign were *Schedorhinotermes* sp. and *Amitermes* sp. (Table 1). The latter is a species that had been collected also by Syaukani (pers. comm.)from Kalimantan. According to Syaukani, there is a need to detail out the taxonomic description of the species to confirm the status. Generally, the *A.* sp. is much smaller than *A. dentatus* and *A. minor*. We had collected the material several times separately within ten years which made it possible that the species was neither the smaller form of *A. dentatus* nor *A. minor*. Therefore we reserve this species as new until detailed description is made. The *Schedorhinotermes* sp. somewhat fits to the description of *S.* sp. A by Tho (1992).

Few other authors considered *S.* sp. A is the larger form of *S. sarawakensis*. The materials that Tho held were collected from montane forest whereas our materials were from peat soil or peat swamp forest ecosystem which should vary distinctively in microclimate and topography. Therefore, we reserve this species to a possibly new species subject to revision and description. Notes on the newly recorded species and the newly discovered species will be published later.

Some rather rare species collected in the plantation were *Schedorhinotermes tarakanensis*, and two *Hospitalitermes* species that were only encountered from occasional samplings during the earlier years of our campaign. *S. tarakanensis* were only retrieved a few times from *Hevea* baiting stakes and was not collected again in the later years. Similarly, we managed to collect neither *H. hospitalis* nor *H. umbrinus* in the later years when the oil palm reaches its mature years (approx. 10 yr.). It is interesting to identify further the fate of the termite species when oil palm development progresses as we have suggested below.

Comparison with other studies in oil palm agroecosystem

The fact that most of the studies were intended to identify the origin of pest species distribution and habitats, made the encounters of other species to be occasional, at less priority or by chance. Studies on termite assemblages in oil palm often used labor intensive method to sample termites of excavating large logs, uprooting stumps and dissecting oil palm stands previously (e.g. Cheng 2002) and recently (e.g. Lau et al. 2011). Without appropriate sampling methods and design, adding to the unknown distribution pattern of termites in the field, the overall assemblages of termite can never be achieved (*sensu* Jones et al. 2006). There were only few species from collection of others that were different from our checklist. The variation might only be real due to the factors pertaining to biogeography. For examples, Vaessen et al. (2011) recorded only six species from oil palm in Sarawak. Besides their small sample size, they have listed among others all *Schedorhinotermes* that we have collected. Only three species were different namely the *Prohamitermes mirabilis, Bulbitermes borneensis* and *B. constrictus*.

Above all, there is no comprehensive records of termite assemblages from a peat swamp forest site from Malaysia. There were only few preliminary records available providing list of termites from a peat swamp forest. For example we published a preliminary checklist from the Sungai Bebar Peat Swamp Forest scientific expedition (Faszly et al. 2005) to provide comparisons of the species existing in natural peat swamp forest. The list identified several species that were not retrieved from our sampling campaign. This shed light to the possibility that some species might be excluded from the community when a peat swamp forest was converted to oil palm, while some might be able to succeed and recolonize the available niches. Although attempts had been made compare termite assemblages composition between near natural peat swamp forest and oil palm (e.g. Vaessen et al. 2011), the species composition were depauperately represented due to small sample sizes. Therefore, further studies to quantify the compositional variations of termite assemblages in oil palm agro-ecosystem of varying land use history (Eggleton et al. 1997)

as well as natural forested habitat especially peat swamp forest are urgently needed. Such studies will help in understanding the rate of species turnover and fate of the species of termite assemblage when a natural forest is converted to oil palm. The information is important to enable quantitative assessment on the ability of termite to recolonize the oil palm agro-ecosystem be made because termites are important soil communities in the recycling of nutrient and other free ecosystem services (Lavelle et al. 2006). The rate at which the communities regenerate will enable management to clearly identify which of the oil palm fields are in need of further attention in terms of additional input of fertilization. Besides that, management could be informed on the emergence of pest infestation especially in areas where the community composition is imbalance.

CONCLUSION

Our collection effort for a decade, using various sampling techniques which thoroughly covered oil palm microhabitats had illuminated the most comprehensive and representative of the termite assemblage from a single oil palm agroecosystem site on peat soil in Peninsular Malaysia. Our checklist indicated a rather high number of species of termite than earlier expectation and comparably highest amongst previous reports with 35 species from diverse ecological habits. However, we suggest that a comparative study be made in natural forest and followed through to oil palm years for better understanding of the effect on termite assemblages when forest is converted to oil palm plantation

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