SHORT COMMUNICATION

A Preliminary Survey of Species Composition of Termites (Insecta: Isoptera) in Samunsam Wildlife Sanctuary, Sarawak

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Abstract: A survey on termite species composition was conducted in Samunsam Wildlife Sanctuary, Sarawak in February 2015. Overall 19 species of termite belonging to 13 genera and 8 subfamilies was found in the sanctuary. It was recorded the subfamily of Termitinae had the highest number of species (6 species, equal to 31.58% of total species), followed by Nasutermitinae (3 species, 15.79%), Macrotermitinae, Amitermitinae, Rhinotermitinae, Coptotermitinae (2 species, 10.53% respectively), and Heterotermitinae, Termitogetoninae (1 species, 5.26% respectively). Since this rapid survey is the first termite assemblage representation in Samunsam Wildlife Sanctuary, the preliminary result may serve as the baseline data for termite composition in the area. Therefore, a whole coverage for the area within this sanctuary would definitely increase the number of termite species found in the sanctuary.

Keywords: Samunsam Wildlife Sanctuary, Termite, Composition, Termitinae

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Termites are one of the most popular insects that have been studied nowadays due to its capability to cause high economic damages (Bong et al. 2012). They are reported to destroy building and premises, become agricultural pests such as oil palm plantation, garden landscapes (Lee 2002) and bring damages to any cellulose materials such as books, papers, blanket, windows frame, furniture and man-made fabrics (Chao et al. 1989; Ibrahim & Adebote 2012). Although termites are known as destructive pests in building premises of urban areas (Van Quang et al. 2014) and have potential to affect economic growth, they are the most dominant inhabitants in tropical and subtropical regions, yet act as vital decomposer of cellulose materials in forest ecosystem (Pearce 2006; Vaessen et al. 2011).

Tho (1992) listed an estimated number of 175 species of termites from 42 genera and three families (Kalotermitidae, Rhinotermitidae and Termitidae) all across Peninsular Malaysia. A more recent review on termite taxonomy in the Sundaland region by Gathorne-Hardy (2004) listed about 132 species of termites in the Peninsula. There are about 104 species comprising 33 genera have been recorded in Sabah (Thapa 1981). Being responsive to habitat disturbance and environmental changes, the termite composition and assemblages in an area may be used as a model to evaluate the disturbance effects on an ecosystem (Davies 2002) and as potential indicator to investigate climatic change in a given area (Gathorne-Hardy et al. 2002). The study was conducted to investigate the composition of termites in the Samunsam Wildlife Sanctuary, the protected area in Sarawak. It is important to have faunal checklist of the area. The assessment will partially fill the gap of knowledge on the distribution of termites in Sarawak and serve as baseline data for future research.

Samunsam Wildlife Sanctuary is located at western tip of Sarawak (1° 55.00’ N 109° 36.00 E) (Fig. 1). Gazetted in 1979, Samunsam Wildlife Sanctuary is the first wildlife sanctuary to be established in Sarawak (Hazebroek & Abang Kashim 2000). The main access to the park is by a 60 min barge ride from Sematan jetty. Samunsam Wildlife Sanctuary was gazetted as a protected area mainly to protect the endemic proboscis monkey (Nasalis larvatus), Muller’s Bornean gibbons (Hylobates muelleri), silvered langurs (Presbytis cristata) and other wildlife species. The sanctuary which covers 6090 ha consists of mangrove, riverine, kerangas and mixed dipterocarp forests (Bennett & Sebastian 1988; Hazebroek & Abang Kashim 2000). The diverse vegetation exist in the sanctuary can supports such unique fauna by providing wide varieties of food sources and niches.

Survey was carried out along the natural trail (Fig. 1) and the sampling method is based on protocol established by Jones and Eggleton (2000). The 100 m belt transect consisted of 20 plots of 5 × 2 m² that were sampled sequentially. Each plot was sampled for 30 min by two workers and collection of samples were made in the following microsites: forest litter, dead wood, tree trunks and buttress roots, mounds, soil surface to 5 cm depth (10–15 points) and runways to 2 m height in the vegetation. The survey was conducted for seven consecutive days from 7 to 13 February 2015. Termites were surveyed twice daily in the morning from 0900 to 1200 and 1400 to 1700, focussing on the termite nests, forest floor
and dead woods. Approximately a total of 2 km of trail was covered representing different habitats including mangrove forest, swamp forest, mixed dipterocarp forest, riverine forest, and kerangas forest.

About 10 to 20 termite soldiers were collected from each colony found during survey. The termite specimens were collected and kept in small vials with 70%–80% ethanol. The termite species identification was made in the Parasitology Laboratory, Universiti Malaysia Sarawak following Tho (1992), Thapa (1981), Gathorne-Hardy (2004), Syaukani and Thompson (2011) and other relevant publications.

The photographs of the soldiers were taken using a Motic SMZ-16B Series stereomicroscope attached to a Moticam 2000 camera and then the image sequences were combined with Helicon Focus 6 software. Calibrated measurements were taken by using Motic Image Plus 2.0 software. The soldier identification features include (1) shape and characteristics of the head and mandibles, (2) antennae, (3) post-mentum, (4) pro-, meso- and meta-notum, (5) size and colouration of termites, and (6) other individual characteristics.

A total of 17 species identified were belong to two families, eight subfamilies and twelve genera (Table 1). Termites found were assigned into one of five feeding groups based on classification given in Collins (1984) and Eggleton et al. (1997) whether (i) wood feeders (termites feeding on living or dead wood), (ii) wood-litter feeders (foraging termites feeding on leaf litter or woody litter), (iii) soil feeders
(termites feeding on humus and mineral soil), (iv) soil-wood interface feeders (termites feeding on highly decayed, friable and soil-like wood), or (v) epiphyte feeders (termites feeding on lichens, epiphytes and other free living non-vascular plants).

From a total of 17 species collected (Table 1), 11 species were assigned as wood feeding (W) species and by far the most common in all transects, represented by genera of *Nasutitermes*, *Havilanditermes*, *Prohamitermes*, *Microcerotermes*, *Schedorhinotermes*, *Coptotermes*, *Heterotermes* and *Termitogen*. Four species of soil humus feeders (S/H) dominated by *Discuspiditermes*, *Procapritermes* and *Pericapritermes*. Wood-litter feeders (WL) was found to be the least feeding group in the area represented by *Odontotermes mathuri* and *O. dentriculatus* (Table 1). Only the soil wood and epiphyte feeder were not encountered in the present study. Figure 2 represented the comparison between percentage of termite species and feeding group. *S. brevialatus* dominated wood feeders (n = 19) by 21.1% followed by *C. sepangensis* (15.8%), *C. curvignathus*, *N. matangensisformis* and *S. javanicus* with 10.5% respectively. For both wood-litter feeders (WL) and soil/humus feeders (S/H), they are equally represented, 50% by *O. mathuri* and *O. dentriculatus* respectively for WL group and 25% by *D. nemorosus*, *D. paramkhamensis*, *P. latignathus* and *P. neosetiger* respectively for S/H group. Data observed were further analysed for Chi Square test by using statistical computation program SPSS 18.0. The comparison between (i) the number of species and feeding group and (ii) the number of species and subfamily were computed to their significance.

![Figure 2: Comparison between percentage of termite species and feeding group.](image-url)
Table 1: Relative abundance of termite species collected in Samunsam Wildlife Sanctuary, based on number of 'hits' of each species in a transect (the presence of species in one section represents one hit). Feeding group: W= wood feeders; WL = wood-litters feeders; S/H = soil/humus feeders.

| Family          | Subfamily       | Species                        | Feeding group | Relative abundance of species |
|-----------------|-----------------|--------------------------------|---------------|------------------------------|
| Termitidae      | Macrotermitinae | Odontotermes mathuri           | WL            | 1                            |
|                 |                 | Odontotermes denticulatus      | WL            | 1                            |
| Termitinae      | Discuspiditermes| paramkhamensis                 | S/H           | 1                            |
|                 |                 | Discuspiditermes nemorosus     | S/H           | 1                            |
|                 |                 | Procapritermes neosetiger      | S/H           | 1                            |
|                 |                 | Pericapritermes latignathus    | S/H           | 1                            |
| Nasutitermitinae| Nasutitermes    | matangensisiformis             | W             | 2                            |
|                 |                 | longinasoides                 | W             | 1                            |
|                 |                 | Havilanditermes atripennis     | W             | 1                            |
| Amitermitinae   | Prohamitermes   | hosei minor                    | W             | 1                            |
|                 |                 | Microcerotermes serrula        | W             | 1                            |
| Rhinotermiidae  | Rhinotermes     | Schedorhinotermes brevialatus  | W             | 4                            |
|                 |                 | Schedorhinotermes javanicus    | W             | 2                            |
| Coptotermitinae | Coptotermes     | curvignathus                   | W             | 2                            |
|                 |                 | sepangensis                   | W             | 3                            |
| Heterotermitinae| Heterotermes    | tenuior                        | W             | 1                            |
| Termitogetoninae| Termitogen      | planus                         | W             | 1                            |

Total number of species 17
Relative abundance (total hits) 25

Table 2 shows the percentage of species number encountered in Samunsam Wildlife Sanctuary. The subfamily Termitinae had the highest number of species (4 species, equal to 23.53% of total species), followed by Nasutitermitinae (3 species, 17.65%), Macrotermitinae, Amitermitinae, Rhinotermiidae, Coptotermitinae, (2 species, 11.76% respectively), and Heterotermitinae, Termitogetoninae (1 species, 5.88% respectively). Two species of genus Coptotermes were found in this study, C. curvignathus (Fig. 3) and C. sepangensis (Fig. 4). The Coptotermes is an important genus of subterranean termites as structural pests in Malaysia with five species; C. curvignathus (Holmgren), C. travians (Haviland), C. kalshoveni (Kemner), C. sepangensis (Krishna) and C. havilandi (Holmgren) (Lee 2002).

A study by Hanis et al. (2014) and Vaessen et al. (2011) had recorded the family of Termitidae as the dominant family found and the largest subfamily
was Nasutitermitinae. In the present study, family of Termitidae was found the dominant family as well, yet the largest subfamily was Termitinae. Two genus of *Nasutitermes* (Fig. 5) and *Havilanditermes* (Fig. 6) under Nasutitermitinae family was only encountered, which is poorly represented in this area compared to Hanis et al. (2014) and Vaessen et al. (2011) data. The *Schedorhinotermes* spp. (Fig. 7) of Rhinotermitinae subfamily was recorded to have the most total number of hits in Rhinotermitidae family (Table 1).

**Table 2: The genera composition of termites in Samunsam Wildlife Sanctuary.**

| No. | Scientific name                  | Species number | Percentage (%) |
|-----|----------------------------------|----------------|----------------|
|     | **RHINOTERMITIDAE**              |                |                |
|     | Rhinotermitinae Froggatt        | 2              | 11.76          |
| 1   | *Schedorhinotermes* Silvestri   | 2              | 11.76          |
|     | Coptotermitinae Holmgren        | 2              | 11.76          |
| 2   | *Coptotermes* Wasmann           | 2              | 5.88           |
|     | Heterotermitinae Froggatt      | 1              | 5.88           |
| 3   | *Heterotermes* Froggatt        | 1              | 5.88           |
|     | Termitogenetinae Holmgren      | 1              |                |
| 4   | *Termitogen* Desneux           | 1              |                |
|     | **TERMITIDAE**                  |                |                |
|     | Macrotermitinae Kemner         | 2              | 11.76          |
| 5   | *Odontotermes* Holmgren        | 2              | 23.53          |
|     | Termitinae Sjostedt            | 4              |                |
| 6   | *Discupiditermes* Krishna      | 2              |                |
| 7   | *Procapritermes* Holmgren      | 1              |                |
| 8   | *Pericapritermes* Silvestri    | 1              | 17.65          |
|     | Nasutitermitinae Hare          | 3              |                |
| 9   | *Nasutitermes* Dudley          | 2              |                |
| 10  | *Havilanditermes* Light        | 1              |                |
|     | Amitermitinae Kemner           | 2              | 11.76          |
| 11  | *Prohamitermes* Holmgren       | 1              |                |
| 12  | *Microcerotermes* Silvestri    | 1              |                |
|     | Relative Abundance             | 17             | 100            |
Further statistical analysis of Chi-square showed that the $p$-values of each data observed is smaller than $\alpha = 0.05$ (Table 3). This indicated both termite feeding groups and subfamilies are significantly different with the termite species as shown in Table 3.

The wood feeding species dominated in the area by relative abundance of 19 total species hits (Table 1) explained the characteristics of the Samunsam Wildlife Sanctuary which full of tree trunks with humid soil conditions. Most of wood feeder termites only feed on dead trunks and have less contact with soil while certain are infesting on a living tree. The wood feeding group hold the ability to hollow out wood from within, without penetrating the surface. The least disturbance
caused by human activity often resulting in increasing termite species richness, abundance and function by providing more structural and physical complexity which provides microhabitats for termites (Jones et al. 2003).

Figure 5: Soldier and worker *Nasutitermes*

Figure 6: Soldier of *Havilanditermes*

Figure 7: Soldier head of *Scheidorhinotermes* spp.
Table 3: Statistical analysis of Chi-square obtained for $H_1$: Species vs Feeding groups and $H_2$: Species vs Subfamilies

| Hypothesis testing                  | Significance value |
|-------------------------------------|--------------------|
| $H_1$: Species vs Feeding groups    | $p = 0.022 < \alpha = 0.05^*$ |
| $H_2$: Species vs Subfamilies       | $p = 0.000 < \alpha = 0.05^*$ |

Chi-square test $\alpha = 0.05$; $^*$ = significantly different

The lower percentage of soil humus feeding termite may be due to the location of the study sites which were in close proximity of water bodies (river, streams and lake). Soil feeders are said to account for more than 60% of the known termite species (Eggleton 2000). However, only three genera of *Discupiditermes*, *Procapritermes*, and *Pericapritermes* (Fig. 8) with four species encountered in this study (*D. paramkhamensis*, *D. nemorosus*, *P. neosetiger* and *P. latignathus*).

The sampling period was done after high annual rainfall, and certain parts of the study areas may be flooded or inundated during the time. The occasional soil inundations may affect termite’s habitat and create unfavourable condition to soil termites especially the soil feeder which probably explain their low composition in this study. As reported by Collins (1979), high annual rainfall and seasonal flooding create difficulties in termites nesting and foraging. Dibog *et al.* (2000) also observed a significant effect of seasonal rainfall on termite diversity and abundance that decline with increasing rainfall.

Wood leaf feeding species is the termite that forages for leaf litter and small woody items litter in various stages of decay. This group includes some subterranean and other mound-building Macrotermitinae (with fungal association) (Eggleton *et al.* 1996). In this study, only two mounds of Macrotermitinae species
were found along transect in the study location. According to Wood and Johnson (1986), *Odontotermes* are known to build huge mounds of selected clay-rich subsoil. Commonly, the mound builder species are more prevalent in post clearing land-spaces such as in oil palm plantation area or along the side road. The least species composition of mound builder species such as *Odontotermes* may due to the area covered in the study area. This supported by Axelson and Anderson (2012) who suggested that the mounds predominantly occurred in sites with denser canopies. Canopy cover can protect the mounds from sun exposure, soil erosion due to heavy rainfall, provide microclimate conditions and ground moisture. It can be suggested that if the sampling period was prolonged and more are were covered, the chances of more termite mound builder can be found in the study location as the location are very suitable for mound builder species of termites with dense canopies and have high moisture.

The overall species found in Samunsam Wildlife Sanctuary was relatively low compared to the number of species found in other forests areas and peat areas reported from several studies conducted in Borneo (e.g., Eggleton et al. 1997, Jones & Prasetyo 2002, Vaessen et al. 2011). A study of termite assemblages along a land use gradient on peat areas in Sarawak (Vaessen et al. 2011) had recorded the overall 20 species from four different sites which relatively higher than Samunsam Wildlife Sanctuary. However, the total number of species found in near natural peat swamp forest in their study was relatively lower than our present study with recorded to have 11 species found and relative abundance of 16 termite hit species. As our present study was not designed to determine the effect of different gradient of land use, no conclusion can be drawn from our result.

It was expected that more termite species from Samusam Wildlife Sanctuary would found because the area is protected from any logging activities since the establishment in 1979. Back then during 1969, logging activities had been done extensively and intensively may disturb the composition of the termite especially with soil feeder termite being the most at risk to the loss of primary forest. Contrary to soil feeder termite, wood feeder termite can survive in disturb area and in some cases have better survivorship in disturb area that provide greater organic output. This shown that different feeding group of termites would give different effects to habitat disturbances as explained by previous studies (Eggleton et al. 1997, Eggleton & Tayasu, 2001).

Conclusively from this preliminary study, Samunsam Wildlife Sanctuary harbours a minimum of 17 species of termites. This study is the first termite assemblage survey at Samunsam Wildlife Sanctuary and the results can be used as the baseline data for future survey. More extensive explorations and inventories are suggested in order to get a better representation of the entire termite composition of this area which will further relate to the species response to landscape changes in Western Sarawak.
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REFERENCES

Abe T, Bignell, D E and Higashi M. (eds.). (2000). *Termites: Evolution, sociality, symbioses, ecology*. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Axelson E P and Anderson J. (2012). A case study of termite mound occurrence in relation to forest edges and canopy cover within the Baradabhar forest corridor in Nepal. *International Journal of Biodiversity and Conservation* 41(15): 633–641.

Bennett E L and Sebastian A C. (1988). Social organization and ecology of proboscis monkeys (*Nasalis larvatus*) in mixed coastal forest in Sarawak. *International Journal of Primatology* 9(3): 233-255. https://doi.org/10.1007/BF02737402

Bong J C F, King P J H, Ong K H and Mahadi N M. (2012). Termite assemblages in oil palm plantation in Sarawak, Malaysia. *Journal of Entomology*, 9(2): 68–78.

Chao G -D, Wu H -J and Chow Y -S. (1989). *Investigation and ecological analysis of pests on historical buildings*. Council for Cultural Affairs, Taipei, Taiwan.

Collins N M. (1979). Observations on the foraging activity of *Hospitalitermes umbrinus* (Haviland) (Isoptera: Termitidae) in the Gunung Mulu National Park, Sarawak. *Ecological Entomology* 4: 231–238. https://doi.org/10.1111/j.1365-2311.1979.tb00580.x

Collins N M. (1984). The termites (Isoptera) of the Gunung Mulu National Park, with a key to the genera known from Sarawak. *Sarawak Museum Journal* 30: 65–87.

Davies R G. (2002). Feeding group responses of Neotropical termite assemblage to rain forest fragmentation. *Oecologia* 133: 233–242. https://doi.org/10.1007/s00442-002-1011-8

Dibog L, Eggleton P and Forzi F. (2000). Seasonality of soil termites in a humid tropical forest, Mbalmayo southern Cameroon. *Journal of Tropical Ecology* 14: 841–850. https://doi.org/10.1017/S0266467498000601

Eggleton P. (2000). Global patterns of termite diversity. In: *Termites: Evolution, sociality, symbioses, ecology*. Netherland: Springer.

Eggleton P and Tayasu I. (2000). Feeding groups, lifetypes and the global ecology of termites. *Ecological Research* 16(5): 941–960.

Eggleton P, Bignell D E, Sands W A, Mawdsley N S, Lawton J H, Wood T G and Bignell N C. (1996). The diversity, abundance and biomass of termites under differing levels of disturbance in the Mbalmayo Forest Reserve, Southern Cameroon. *Philosophical Transactions of the Royal Society of London B* 351: 51–68. https://doi.org/10.1098/rstb.1996.0004
Eggleton P, Homathevi R, Jeeva D, Jones D T, Davies R G and Maryati M. (1997). The species richness and composition of termites (Isoptera) in primary and regenerating lowland dipterocarp forest in Sabah, East Malaysia. Ecotropica 3: 119–128.

Elizabeth L B. (1986). Wetland forest conservation in Sarawak. Kuala Lumpur: WWF Malaysia.

Gathorne-Hardy F J. (2001). A review of the South East Asian Nasutitermitinae (Isoptera:Termitidae) with descriptions of one new genus and a new species and including key to the genera. Journal of Natural History 35: 1486–1506. https://doi.org/10.1080/002229301317067647

Gathorne-Hardy F J. (2004) The termites of Sundaland: a taxonomic review. Sarawak Museum Journal 60(81): 89–133.

Gathorne-Hardy F J, Syaukani, Davies R G, Eggleton P and Jones D T. (2002). Quartenary rainforest refugia in South-East Asia: using termites (Isoptera) as indicators. Biological Journal of the Linnean Society 75: 453–466. https://doi.org/10.1046/j.1095-8312.2002.00031.x

Hanis A, Abu Hassan A, Nurita A T and Che Salmah M R. (2014). Community structure of termites in a hill dipterocarp forest of Belum–Temengor Forest Complex, Malaysia: emergence of pest species. Raffles Bulletin of Zoology, 62: 3–11.

Hazebroek H P and Abang Kashim A M. (2000). National Park of Sarawak. Kota Kinabalu: Natural History Publications (Borneo).

Ibrahim B U and Adebote D A. (2012). Appraisal of the economic activities of termites: A review. Bayero Journal of Pure andApplied Sciences, 5(1): 84–89. https://doi.org/10.4314/bajopas.v5i1.16

Jones D T and Eggleton P. (2000). Sampling termite assemblages in tropical forest: testing a rapid biodiversity assessment protocol. Journal of Applied Ecology 37: 191–203. https://doi.org/10.1046/j.1365-2664.2000.00464.x

Jones D T and Prasetyo A H. (2002). A Survey of the Termites (Insecta: Isoptera) of Tab Along District, South Kalimantan, Indonesia. The Raffles Bulletin of Zoology, 50(1): 117–128.

Jones D T, Susilo F X, Bignell D E, Hardiwinoto S, Gillison A N and Eggleton P. (2003). Termite assemblage collapse along a land use intensification gradient in lowland central Sumatra, Indonesia. Journal of Applied Ecology 40: 380–391. https://doi.org/10.1046/j.1365-2664.2003.00794.x

Lee C Y. (2002). Subterranean termite pests and their control in the urban environment in Malaysia. Sociobiology 40: 3–9.

Lee K E and Wood T G. (1971). Termites and soils. London, UK: Academic Press.

Pearce M J. (2006). Termites: Biology and pest management. Wallingford, England: CAB International.

Syaukani and Thompson G J. (2011). Taxonomic notes on Nasutitermes and Bulbitermes (Termitidae, Nasutitermitinae) from the Sunda region of Southeast Asia based on morphological and molecular characters. ZooKeys 148: 135–160. https://doi.org/10.3897/zookeys.148.2055

Swift M J, Heal O W and Anderson J M. (1979). Decomposition in terrestrial ecosystem (Vol. 5). Berkeley: University of California Press.

Thapa R S. (1981). Termites of Sabah. Sabah Forest Record 12: 1–374.

Tho Y P. (1992). Termites of Peninsular Malaysia. In: Kirton LG (ed.) Malayan Forest Records 36. Kepong: Forest Research Institute of Malaysia.

Vaessen T, Verwer C, Demies M, Kaliang H. and Van Der Meer P J. (2011). Comparison of termite assemblages along a landuse gradient on peat areas in Sarawak, Malaysia. Journal of Tropical Forest Science 23(2): 196–203.
Van Quang N, Hai Huyen N, Mai Duyen T T and Van Hoan N. (2014). Data on species composition and distribution of termites (Insecta: Isoptera) in different habitats of Xuan Mai area, Hanoi. In Proceeding of the 10th Pacific-Termites Research Group Conference, Kuala Lumpur.

Wood T G and Johnson R A. (1986). The biology, physiology and ecology of termites. In S B Vinson (ed.). *The economic impact and control of social insects*. New York: Praeger Publishers, 1–68.
