

---

**Short Notes**

---

**Termite Fauna of Sungai Kangkawat, Imbak Canyon Conservation Area (ICCA), Sabah**

Nivaarani Arumugam<sup>1\*</sup>, Suganthi Appalasamy<sup>1,2</sup>, Alia Diyana Mohamed Hassim<sup>1</sup>, Homathevi Rahman<sup>3</sup>

<sup>1</sup>*Faculty of Earth Science, Universiti Malaysia Kelantan, Jeli Campus, 17600 Jeli, Kelantan, Malaysia*

<sup>2</sup>*Institute of Food Security and Sustainable Agriculture (IFSSA), Universiti Malaysia Kelantan, Jeli Campus, 17600 Jeli, Kelantan, Malaysia*

<sup>3</sup>*Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah, Jalan UMS, 88400 Kota Kinabalu, Sabah, Malaysia*

\*Corresponding author: niva035@gmail.com

**Abstract**

Termites are important inhabitants of the tropical rain forest, and they are commonly found in tropical soils. They have great importance in tropical terrestrial ecosystems especially in the decomposition process, mediate ecosystem processes and facilitate to improve the structure and quality of the soil. This study was conducted to identify the termite fauna of Sungai Kangkawat, Imbak Canyon Conservation Area (ICCA). Termites were collected using a standardized 100mx2m line transect at South Rim Trail and also through casual collection around the study site. A total of 31 termite species were recorded in this study. The termite assemblage comprises two families namely, Rhinotermitidae and Termitidae. Family Termitidae dominated the termite assemblage with 87.1% (27 species). The collected termite species in this study comprises 30% of recorded termite species of Sabah. Seven subfamilies that are commonly recorded in the tropical forest were identified in this study. Subfamily Termitinae and Nasutitermitinae from family Termitidae dominated the termite assemblage of Sungai Kangkawat with 12 species and ten species respectively. The previous study conducted at ICCA recorded 29 species which have 43.9% similarity with the current study. A total of 12 species were identified as new records for ICCA through this study. Hence, the total number of termite species of ICCA is 41. This study has provided the checklist of termite fauna in Sungai Kangkawat and updated the termite checklist of ICCA.

**Keywords:** Blattodea, Transect, Wood feeder, Termitidae, Imbak

## Introduction

Sabah is a state in Malaysia which has a total area of 7,487,564 ha (Sabah Forestry Department, 2010). This state is diverse with flora and fauna where, 48.17% of the total land has been gazetted under Permanent Reserve Forests (Sabah Forestry Department, 2010). Various studies have been conducted in these forests to identify the diversity of flora and fauna including termites. Eventhough economically termites can cause serious damage to wood and wood products (Kirton, 2005; Gibb & Oseto, 2006; Kuswanto et al., 2015), termites are important members of soil macrofauna in the tropical forest as they provide ecosystem services. They have a high contribution in improving structure and quality of soil, decomposition of organic matters and also recycling nutrients in an ecosystem (Jones et al., 1998; Bignell & Eggleton, 2000; Jones & Prasetyo, 2002; Elzinga, 2004; Inoue et al., 2006; Brune, 2014). Termites use physical and chemical defences to protect their colonies from enemies (Prestwich, 1984; Chuah, 2010; Alia diyana et al., 2019).

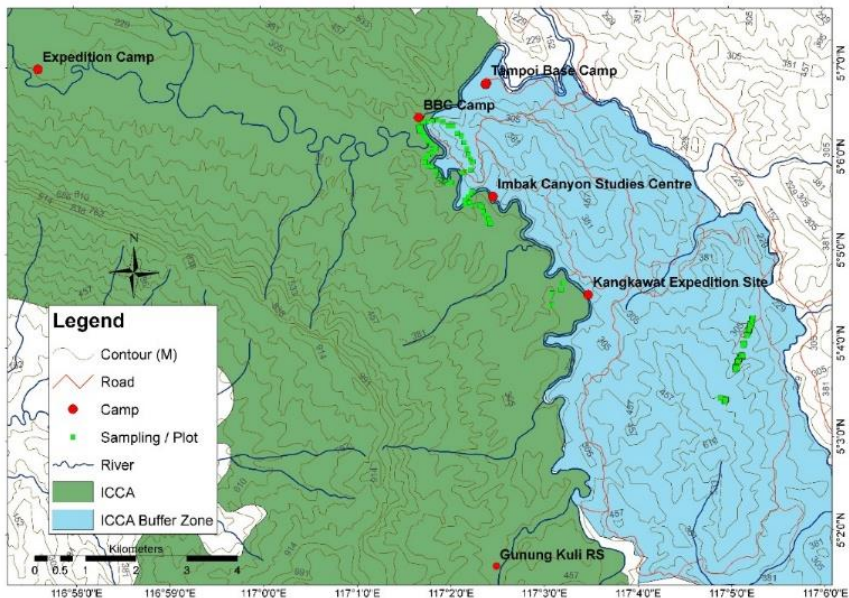
Imbak Canyon Conservation Area (ICCA) is one of the protected forests in Sabah managed by Kumpulan Yayasan Sabah. In 2010, a termite study was conducted at Riverine Trail and Ridge Trail of ICCA (Homathevi & Johar, 2011). The study recorded 29 termite species from 20 genera and two families (Rhinotermitidae and Termitidae). The current study was focused at Sungai Kangkawat basecamp of ICCA. This paper provides the checklist of termites at Sungai Kangkawat and updates the termite checklist of ICCA.

## Methodology

Termite sampling was conducted at two main trails at Sungai Kangkawat, Imbak Canyon Conservation Area (ICCA) from 29 September to 2 October 2018 during the Borneo Geographic Expedition 2018. South Rim Trail and Pelajau Trail were the two trails focused on in this study.

Termites were collected at South Rim Trail (N05°04.499' E117°03.448') using a standardized line transect (100 mx2 m) method (Eggleton et al., 1997; Eggleton et al., 1999; Nivaarani & Homathevi, 2015). The transect was divided into 20 contiguous sections and each section was searched by two people for 30 minutes. All possible microhabitats of the termites were explored such as carton runways on tree trunks, leaf litter, soil, dead wood and nests (Arumugam et al., 2019). Termites were also searched casually at South Rim Trail and Pelajau Trail.

All collected termites were preserved in 80% ethanol for further identification (Kori & Arumugam, 2017). The identification was done at the Natural Resources Laboratory, Faculty of Earth Science, Universiti Malaysia Kelantan, Jeli Campus with the aid of Thapa (1981); Collins (1984) and Tho (1992). Feeding groups were allocated according to Collins (1984), Eggleton et al. (1997), Jones & Brendell (1998) and Donovan et al. (2001). Identified termites deposited at BORNEENSIS, Universiti Malaysia Sabah. A duplicate specimen was deposited at Natural Resources Museum, Universiti Malaysia Kelantan, Jeli Campus.



**Figure 1.** Map of Imbak Canyon Conservation Area indicating the Sungai Kangkawat expedition site (Source: the map was provided by the expedition organizer during Borneo Geographic Expedition 2018).

## Results and Discussion

This study recorded a total of 31 termite species at Sungai Kangkawat, Imbak Canyon Conservation Area (ICCA). The species comprised 21 genera, seven subfamilies and two families (Table 1). The collected termite species in this study consists of 30% of recorded termite species of Sabah by Thapa (1981).

**Table 1.** Termite species collected from Sg.Kangkawat, Imbak Canyon Conservation Area using a standardised transect and casual collection: Feeding groups, l = litter feeders, e = micro-epiphyte feeders, s = soil feeders, s/w = soil/wood interface feeders, w = wood feeders, (f) = fungus growers. \* = new record.

Scientific Name	Feeding Group
<b>Family: Rhinotermitidae</b>	
<b>Sub-family: Heterotermitinae</b>	
<i>Heterotermes tenuior</i> (Haviland)	w
<b>Sub-family: Coptotermitinae</b>	
* <i>Coptotermes borneensis</i> Krishna	w
<b>Sub-family: Rhinotermitinae</b>	
<i>Schedorhinotermes sarawakensis</i> (Holmgren)	w
* <i>Schedorhinotermes tarakanensis</i> (Oshima)	w
<b>Family: Termitidae</b>	
<b>Sub-family: Amitermitinae</b>	
* <i>Prohamitermes mirabilis</i> (Haviland)	s/w
<b>Sub-family: Termitinae</b>	
<i>Dicuspitermes nemorosus</i> (Haviland)	s
<i>Homallotermes eleanorae</i> Emerson	s/w
* <i>Kemneritermes</i> sp.1	s
* <i>Malaysiocapritermes prosetiger</i>	s
<i>Microcerotermes dubius</i> (Haviland)	w
<i>Pericapritermes latignathus</i> (Holmgren)	s
<i>Pericapritermes nitobei</i> (Shiraki)	s
* <i>Pericapritermes paraspeciosus</i> Thapa	s
<i>Pseudocapritermes</i> sp.1	s
<i>Pseudocapritermes</i> sp.2	s
<i>Syncapritermes</i> sp.1	s
<i>Termes propinquus</i> (Holmgren)	s/w
<b>Sub-family: Macrotermitinae</b>	
* <i>Macrotermes gilvus</i> (Hagen)	w/l(f)
<i>Macrotermes malaccensis</i> (Haviland)	w/l(f)
<i>Odontotermes grandiceps</i> Holmgren	w(f)
* <i>Odontotermes oblongatus</i> Holmgren	w(f)

**Sub-family: Nasutitermitinae**

<i>Bulbitermes constrictiformis</i> (Holmgren)	w
<i>Bulbitermes constrictus</i> (Haviland)	w
<i>Bulbitermes flavicans</i> (Holmgren)	w
* <i>Hirtitermes spinocephalus</i> (Oshima)	w
<i>Hospitalitermes umbrinus</i> (Holmgren)	e
* <i>Leucopitermes leucops</i> (Holmgren)	s
<i>Longipeditermes longipes</i> (Haviland)	w
* <i>Nasutitermes havilandi</i> (Desneux)	w
<i>Nasutitermes longinasus</i> (Holmgren)	w
* <i>Nasutitermes neoparvus</i> Thapa	w
<b>Number of Species</b>	<b>31</b>

The common termite families in Malaysia, Rhinotermitidae (lower termite) and Termitidae (higher termite) were collected in this study. Family Termitidae dominated the termite assemblage with 87.1% (27 species). Subfamily Termitinae and Nasutitermitinae from family Termitidae dominated the termite assemblage of Sungai Kangkawat with 12 species and ten species respectively. These subfamilies also dominated the assemblage in the previous study at ICCA (Homathevi & Johar, 2011).

Family Rhinotermitidae only recorded four species from three genera. The recorded genera are similar as in the previous study at ICCA namely, *Heterotermes*, *Coptotermes* and *Schedorhinotermes* (Homathevi & Johar, 2011). These genera are ecologically important genera where they are categorised as wood feeders. The genus *Coptotermes* are identified as pest species that can attack living trees (Kuswanto et al., 2015).

Termites have different feeding habits. Five types of feeding groups were identified in this study. However, wood feeders dominated the assemblage with 48.4%, followed by soil feeders (32.2%), soil-wood interface feeders (9.7%), wood-litter feeders (6.5%) and epiphyte feeder (3.2%). Most of the primary forest of Sabah is dominated by soil feeders. However, wood feeders dominated the termite assemblage at Sungai Kangkawat compared to other feeders. A similar situation has also been observed in the Maliau Basin Conservation Area and Belum-Temenggor Forest Complex (Jones et al., 1998; Aiman Hanis et al. 2014).

A previous study conducted at ICCA recorded 29 termite species (Homathevi & Johar, 2011) while the present study recorded 31 termite species. Both studies have 43.9% species similarity. A total of 12 species were identified as new

records for ICCA through this study (Table 1). This includes five new genera that were never recorded in ICCA. The genera are *Prohamitermes*, *Kemneritermes*, *Malaysiocapritermes*, *Hirtitermes* and *Leucopitermes*.

## Conclusion

The present study has provided a checklist of termites at Sungai Kangkawat, ICCA and includes an update on the total number of termite species in ICCA (41 termite species). Twelve termite species and five genera are identified as a new record for ICCA through this study.

## Acknowledgement

We would like to thank Universiti Malaysia Sabah for financial support (Grant No. SDK0043-2018), Sabah Biodiversity Council for the access license Ref. JKM/MBS.1000-2/1JLD.3 (246), Imbak Canyon Management Committee for research permission. Thank you for the facilities given to us throughout our stay at Sungai Kangkawat, Imbak Canyon Conservation Area (ICCA) during the Borneo Geographic Expedition 2018. The authors are also thankful to Mr. Steve from the Institute for Tropical Biology and Conservation (IBTP) and forest ranger of ICCA for guidance and help provided during sampling. We are also grateful to the Faculty of Earth Science, Universiti Malaysia Kelantan, Jeli Campus for providing needed facilities.

## References

- Aiman Hanis J, Abu Hassan A, Nurita AT, Che Salmah MR. 2014. Community structure of termites in a hill dipterocarp forest of Belum and Temenggor Forest Complex, Malaysia: emergence of pest species. *Raffles Bulletin of Zoology*. 62: 3-11.
- Alia Diyana MH, Appalasamy S, Arumugam N, Boon JG. 2019. A study of a termite chemical defense fluid compound of *Macrotermes carbonarius*. In *IOP Conference Series: Earth and Environment Science* Vol. 269.
- Arumugam N, Appalasamy S, Rak AE. 2019. A note on termite fauna of Pulau Pangkor, Perak, Peninsular Malaysia. *The Malaysian Forester* 82(1): 275-280.
- Bignell DE, Eggleton P. 2000. Termites in Ecosystems. In: Abe T, Bignell DE, Higashi M. (Eds). *Termites: Evolution, Sociality, Symbioses, Ecology*, pp.363-387. London: Kluwer Academic Publishers.
- Brune A. 2014. Symbiotic Digestion of Lignocellulose in Termite Guts. *Nature Reviews Microbiology* 12: 168-180.

- Chuah CH. 2010.** Chemical Weapons and Defense Mechanism of Malaysian Termites. In *Chemistry in Malaysia*. Kuala Lumpur: Institut Kimia Malaysia, pp. 4-11.
- Collins NM. 1984.** The Termites (Isoptera) of the Gunung Mulu National Park, with the key to the genera known from Sarawak. *Sarawak Museum* **30**: 65-87.
- Donovan SE, Eggleton P, Bignell DE. 2001.** Gut content analysis and a new feeding group classification of termites. *Ecological Entomology* **26**: 356-366.
- Eggleton P, Homathevi R, Jeeva D, Jones DT, Davies RG, 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.
- Eggleton P, Homathevi R, Jones DT, MacDonald JA, Jeeva D, Bignell DE, Davies RG, Maryati M. 1999.** Termite assemblages, forest disturbance and greenhouse gas fluxes in Sabah, East Malaysia. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences* **354(1391)**: 1791-1802.
- Elzinga RJ. 2004.** Fundamentals of Entomology. (6th edition). New Jersey: Pearson Education, Inc.
- Gibb TJ, Oseto CY. 2006.** Arthropod Collection and Identification: Laboratory and Field Techniques. London: Elsevier Academic Press Publication.
- Homathevi R, Johar M. 2011.** Termite (order: Isoptera) fauna of Imbak Canyon Conservation Area. In *Imbak Canyon Conservation Area, Sabah: Geology, biodiversity and socio-economic environment*, ed. Latiff, A and Sinun, W. Akademi Sains Malaysia, pp. 215-220.
- 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.
- Jones DT, Brendell MJD. 1998.** The termite (Insecta: Isoptera) fauna of Pasoh Forest Reserve, Malaysia. *The Raffles Bulletin of Zoology* **46**: 79-91.
- Jones DT, Jeffrey T, Bakhtiar EY. 1998.** The termites (Insecta: Isoptera) of the Maliau Basin, Sabah. In *Maliau Basin Scientific Expedition*, ed. Maryati, M., Waidi, S., Ann, A., Mohamed, N.D. and Abdul, H. A. Kota Kinabalu: Universiti Malaysia Sabah, pp. 95-112.
- Jones DT, Prasetyo AH. 2002.** A Survey of the Termites (Insecta: Isoptera) of Tab along District, South Kalimantan, Indonesia. *National University of Singapore* **50(1)**: 117-128.
- Kirton LG. 2005.** The Importance of Accurate Termite Taxonomy in the Broader Perspective of Termite Management. Proceedings of the Fifth International Conference on Urban Pests. 1-7, 10-13 July 2005.
- Kori NSM, Arumugam N. 2017.** Termites of Agropark, Universiti Malaysia Kelantan, Jeli Campus: Diversity and Pest Composition. *Journal of Tropical Resources and Sustainable Science* **5**: 104-108.

- Kuswanto E, Ahmad I, Dungani R. 2015.** Threat of subterranean termites attack in the Asian countries and their control: A review. *Asian Journal of Applied Sciences*, 8(4), 227-239.
- Nivaarani A, Homathevi R. 2015.** Termite Fauna (Blattodea:Termitoidae) of Mahua, Crocker Range Park, Sabah, Malaysia. *Malayan Nature Journal* 67(4): 403-411.
- Prestwich GD. 1984.** Defense mechanisms of termites. *Annual Review of Entomology* 29(1): 201-232.
- Sabah Forestry Department. 2010.** Fact Sheets of Forest Reserves in Sabah, 24pp. Sandakan: Sabah Forestry Department.
- Thapa RS. 1981.** Termites of Sabah. Sabah Forest Record 12: 1-374.
- Tho YP. 1992.** Termites of Peninsular Malaysia. Malayan Forest Record No. 36. Forest Research Institute Malaysia, Ampang.