

Research Article

Taxonomic and Ecological Notes on *Termes propinquus* Holmgren, 1914 Known from Sumatra (Blattodea: Termitoidea: Termitidae)

Samsul Muarrif ¹, Samadi Samadi ², Jauharlina Jauharlina ³,
Dalil Sutekad ^{1,4} and Syaokani Syaokani ⁴

¹Graduate School of Mathematics and Applied Sciences, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia

²Department of Animal Husbandry, Faculty of Agriculture, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia

³Department of Plant Protection, Faculty of Agriculture, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia

⁴Biology Department, Faculty of Mathematics and Natural Sciences, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia

Correspondence should be addressed to Syaokani Syaokani; syaokani@unsyiah.ac.id

Received 23 July 2021; Accepted 13 December 2021; Published 2 February 2022

Academic Editor: Mehrbakhsh Nilashi

Copyright © 2022 Samsul Muarrif et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

The genus *Termes* Linnaeus, 1758 consisting of a total of 24 valid named species known from the Old World, is a very heterogeneous group of termites and seems to involve many taxonomic obscurities and confusions. In the island of Sumatra, the sixth-largest island located in the Southeast Asian tropics, four species of *Termes* have been found, namely, *T. comis*, *T. laticornis*, *T. rostratus*, and *T. propinquus*. *Termes propinquus* is also known from Brunei, Indonesia (Kalimantan and Sumatra), Malaysia, and Thailand. However, previous authors have mentioned that *T. propinquus* has been poorly discriminated from the other congeners, especially *T. rostratus*. Therefore, the present study aimed at clarifying the discrimination of *Termes propinquus* from the morphologically similar congeners from Sumatra. A total of 14 nests were collected using a standardized sampling protocol and visual colony searching in Sumatra and its adjacent island. As a result of a careful morphological examination of the soldier caste, *T. propinquus* was discriminated from the three other congeners by a combination of the following characteristics: distinctly long frontal projection, larger head capsule, and 2nd antennal segment distinctly longer than the 3rd. The redescription of the soldier caste of *T. propinquus* and a key to *Termes* species known from Sundaland are provided. The nests of *T. propinquus* were attached to the bases of living trees, clinging to stumps or the bases of the dead tree, or were epigeal.

1. Introduction

Termites, from the epifamily Termitoidea (or the infraorder Isoptera), are dominant invertebrates in tropical and subtropical soil ecosystems [1–3] and perform indispensable functions as mechanical decomposers and ecological engineers, creating and preparing microhabitats for other organisms, including microbes that contribute to the decomposition process of organic matter [4–6].

Termitoidea is a monophyletic lineage consisting of more than 2 900 validly named species [7, 8], belonging to 281 genera and nine families. Six of these families, namely,

Kalotermitidae, Archotermopsidae, Hodotermitidae, Rhinotermitidae, Stylotermitidae, and Termitidae, are known from the Oriental region [9], and three families, namely, Kalotermitidae, Rhinotermitidae, and Termitidae, have been recorded in the Indo-Malayan subregion.

Termitidae constitutes the most species-rich and ecologically diversified family [10]. In Southeast Asia, this family is represented by four subfamilies, namely, Apicotermitinae, Termitinae, Macrotermitinae, and Nasutitermitinae [11, 12]. The genus *Termes* was classified by Holmgren [13] and consists of a total of 24 validly named species, of which most are known from the Ethiopian, Neotropical, and

Oriental regions, and a few from the Palearctic region [9]. The soldier caste of the genus has slightly asymmetrical [12] or asymmetrical snapping mandibles and a frontal projection [14]. The classification of the genera of the *Capritermes* complex has been in a confused state because some of the genera, including those involving *Termes*, seem to be composed of heterogeneous lineages [12, 15]. The nesting behavior of *Termes* is also diverse; various shapes of nests are found, and inquilism is also seen [16].

On the island of Sumatra, the sixth-largest island located in the Southeast Asian tropics, four species of *Termes* are known, namely, *T. comis* [17], *T. laticornis* [17], *T. rostratus* [17], and *T. propinquus* [13]. *Termes propinquus* is known from Indonesia (Kalimantan and Sumatra), Malaysia, Brunei, and Thailand, and its type locality is Sumatra (Tandjong Slamet) [9, 13, 15]. However, Holmgren [13] and other authors [18, 19] have mentioned that *T. propinquus* has been poorly differentiated from the other congeners, especially *T. rostratus* [12].

The present article, therefore, aimed to give a redescription of the soldier caste of *T. propinquus* and to clarify the differentiation of *T. propinquus* from the other three Sumatran congeners based on the external morphology of the soldier caste. In addition, information on the nesting behavior of *T. propinquus* is provided.

2. Material and Methods

The specimens of *T. propinquus* examined in the present study were collected from various habitats and altitudinal zones of Sumatra between 1998 and 2017 (Table 1). As many as 10–20 individuals of the soldier caste were used for each colony. The syntypes in the collection of the Entomology Department, the Natural History Museum (UK), were examined (Table 2). The focus stacking images of the head, body, pronotum, and antenna of the soldier caste were created using Helicon Focus 6 software based on source images taken as multilayer montages using a Leica M205C stereomicroscope, controlled by Leica Application Suite version 3 software at the Fort Lauderdale Research and Education Center, University of Florida (USA). The images were taken by placing the specimen in a transparent Petri dish filled with ethanol gel (Purell hand sanitizer) in order to keep the specimen at an appropriate angle. A line drawing was also prepared based on the focus stacking images for *T. propinquus*, while *T. rostratus*, *T. comis*, and *T. laticornis* were redrawn with minor editorial modifications from Tho [12]. General morphological terminology and definitions of measuring characters followed Roonwal and Chhotani [20]. Head capsule length (HL) and maximum head width (HW) were measured by following Roonwal and Chhotani [20], Thapa [19], and Tho [12].

3. Result and Discussion

3.1. Redescription of *Termes propinquus* Holmgren, 1914 Based on the Soldier Caste. Head capsule brownish yellow; mandibles dark reddish-brown; antenna and pronotum of thorax pale brownish-yellow; and labrum, meso- and metanotum of

thorax, abdominal tergites, and legs pale ivory white (Figure 1). Head with several scattered hairs; frontal projection with long hair at the tip and on the dorsal side; postmentum with several hairs along the anterior and anterolateral margins; pronotum with long and short hair along the margins; and abdominal tergites with dense hairs. Head capsule in dorsal view elongate, almost 1.5 times longer than broad, rectangular or subrectangular; lateral margins straight and parallel. Frontal projection very long, in dorsal view cone-shaped; the apex in lateral view upcurved, acutely pointed; anterior margin in lateral view convex (Figures 1(a)–1(c)). Antenna 14-segmented; 2nd longer than 3rd; 4th shorter than 3rd; 5th–14th gradually increased in length toward the apex. Labrum elongate, longer than broad; lateral margin almost straight and parallel; anterior margin sinuate. Mandibles almost symmetrical; left mandible long, slender, gently incurved in the basal half, and acutely incurved at the tip. Postmentum in ventral view slightly swollen posteriorly. Pronotum saddle-shaped; anterior margin without a notch; posterior margin weakly concave at the middle. Legs short; apical tibial spurs 3:2:2.

3.2. Taxonomic Remarks. *Termes propinquus* can be discriminated from the three other congeners from Sumatra based on the external morphology of the soldier caste (Table 2). In the lateral view of the head, the frontal projection is less elongated in *T. laticornis* (Figure 2(c)) than in *T. propinquus* (Figure 2(d)). The head capsule is distinctly larger in *T. laticornis* (HL 1.82 mm, HW 1.13 mm) than in the other congeners from Southeast Asia [12, 19]. In the lateral view, the frontal projection is more elongated in *T. propinquus* (Figure 2(d)) than in *T. rostratus* (Figure 2(b)). The 2nd antennal segment is distinctly longer than the 3rd in *T. propinquus*, but only slightly longer than the 3rd in *T. comis*; the frontal projection in the lateral view is extremely elongate and has sparse hairs in the former (Figure 2(d)), but is moderately elongated and has dense hairs in the latter (Figure 2(a)). A key to the *Termes* species from the Sundaland of Southeast Asia, based on the soldier caste, is provided as below. For HL and HW, the range ($n = 10$) and mean are given.

- (1) (i) Lateral view: frontal projection less elongated; HL 1.80–1.85 mm, 1.82 mm; HW 1.00–1.15 mm, 1.13 mm. *T. laticornis* [17]
- (ii) Lateral view: frontal projection moderately to extremely elongated 2
- (2) (i) Lateral view: frontal projection extremely elongated; HL 0.95–1.113 mm, 1.12 mm; HW 0.70–0.73 mm, 0.72. *T. propinquus* [13]
- (ii) Lateral view: frontal projection moderately elongated 3
- (3) (i) Dorsal view: frontal projection with dense hairs (especially on the anterior face); HL 1.40–1.45 mm, 1.44 mm; HW 0.90–1.10 mm, 0.94 mm. *T. comis* [17]

TABLE 1: Examined colonies of *Termes propinquus* collected from Sumatra and adjacent islands.

Colony ID	Sampling site		Altitude (m)	Forest type	Nest type
	Abb.	Coordinates			
KMR-SYK-1999-C015	NS-KM	03° 47' 50" N 97° 33' 02" E	1,100	Primary submontane	Attached to the bases of living trees
KMR-SYK-1999-C008	NS-KM	03° 47' 50" N 97° 33' 02" E	1,100	Primary submontane	Clung to the stumps or the bases of dead tree
KMR-SYK-2000-C106	NS-KM	03° 47' 50" N 97° 33' 02" E	1,100	Primary submontane	Clung to the stumps or the bases of dead tree
KMR-SYK-2014-C018	NS-KM	03° 47' 50" N 97° 33' 02" E	1,100	Primary submontane	Clung to stumps or the bases of dead tree
SE-FC-2016-C027	NS-SE	05° 26' 4" N 95° 41' 47" E	500	Secondary low land dipterocarp	Clung to the stumps or the bases of dead tree
KMR- SYK-2014-C022	NS-KM	03° 47' 50" N 97° 33' 02" E	1,100	Primary submontane	Epigeal
SUAQ- SYK-1999-C011	NS-SB	03° 02' 51" N 97° 25' 01" E	100	Primary low land dipterocarp	Epigeal
SUAQ-TT-2017-C012	NS-SB	03° 02' 51" N 97° 25' 01" E	100	Primary low land dipterocarp	Clung to the stumps or the bases of dead tree
SUAQ-TT-2017-C022	NS-SB	03° 02' 51" N 97° 25' 01" E	100	Primary low land dipterocarp	Epigeal
BL-SYK-2002-C061	NS-BL	03° 32' 18" N 98° 08' 50" E	350	Primary low land dipterocarp	Attached to the bases of living trees
BL SYK--2014-C034	NS-BL	03° 32' 18" N 98° 08' 50" E	350	Primary low land dipterocarp	Attached to the bases of living trees
KSNP SYK--2006-C-27	WS-KS	00° 41' 32" S 100° 26' 36" E	1,200	Primary submontane	Clung to the stumps or the bases of dead tree
SNP- SYK-2000-C014	MT-SB	01° 29' 22" S 98° 58' 09" E	50	Primary low land dipterocarp	Attached to the bases of living trees
SNP-SYK-2007-C098	MT-SB	01° 29' 22" S 98° 58' 09" E	50	Primary low land dipterocarp	Clung to the stumps or the bases of dead tree
SI-SYK-2007-006	MT-PS	02° 11' 57" S 99° 40' 02" E	50	Secondary low land dipterocarp	Clung to the stumps or the bases of dead tree

Abbreviations (Abb.) of sampling sites: NS-KM, Kemiri, North Sumatra; NS-SE, Seulawah Ecosystem, North Sumatra; NS-BL, Bukit Lawang, North Sumatra; NS-SB, Suaq Balimbing, North Sumatra; WS-KS, Kerinci Seblat, West Sumatra; MT-SB, Siberut, Mentawai; MT-PS, Pulau Sipora, Mentawai.

TABLE 2: Morphological comparison among four *Termes* species known from Sumatra and adjacent islands.

Species	Measurement range (<i>n</i> = 10) and mean		Frontal projection	
	HL	HW	Lateral view	Dorsal view
<i>Termes comis</i> [17] Syntype no.305	1.40–1.45, 1.44	0.90–1.10, 0.94	Moderately prominent, with dense hairs especial on the anterior face	Medium size, cone-shaped
<i>T. laticornis</i> [17] Syntype no. 231	1.80–1.85, 1.82	1.00–1.15, 1.13	Weakly prominent, with sparse hairs	Small size, cone-shaped
<i>T. rostratus</i> [17] Syntype no. 477	1.00–1.20, 1.13	0.60–0.72, 0.68	Moderately prominent, with sparse hairs	Small size, dome-shaped
<i>T. propinquus</i> [13]	0.95–1.13, 1.12	0.70–0.73, 0.72	Strongly prominent, with sparse hairs	Extremely large size, cone-shaped

HL, head capsule length; HW, maximum head width.

(ii) Dorsal view: frontal projection with sparse hairs; HL 1.00–1.20 mm, 1.13 mm; HW 0.60–0.72 mm, 0.68 mm.

T. rostratus [17]

Four nests (28%) were attached to the bases of living trees, and seven nests (50%) were attached to stumps or the bases of dead trees (Figure 3). The advantages of this type of nest might be (1) to increase the physical robustness of the nests (resistance to disturbances by ground-dwelling mammals or heavy rain), (2) to economize the total amount of building material for building nests, (3) to reduce dehydration by reducing the surface area of the nests, and (4) to gather food

3.3. Nesting Behavior. A total of 14 nests of *T. propinquus* [13] were found in this study (Table 1 for colonies and nests).

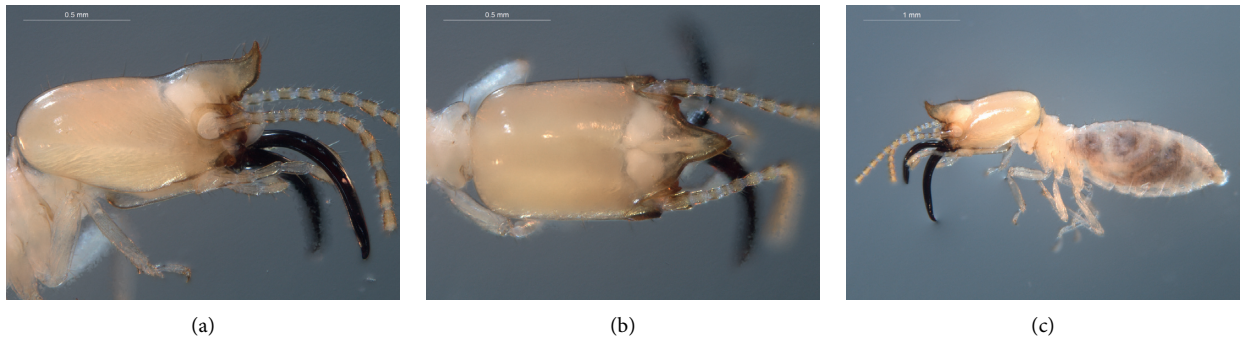


FIGURE 1: (a) *Termes propinquus* in lateral view. (b) *Termes propinquus* in dorsal view. (c) *Termes propinquus* body in lateral view.

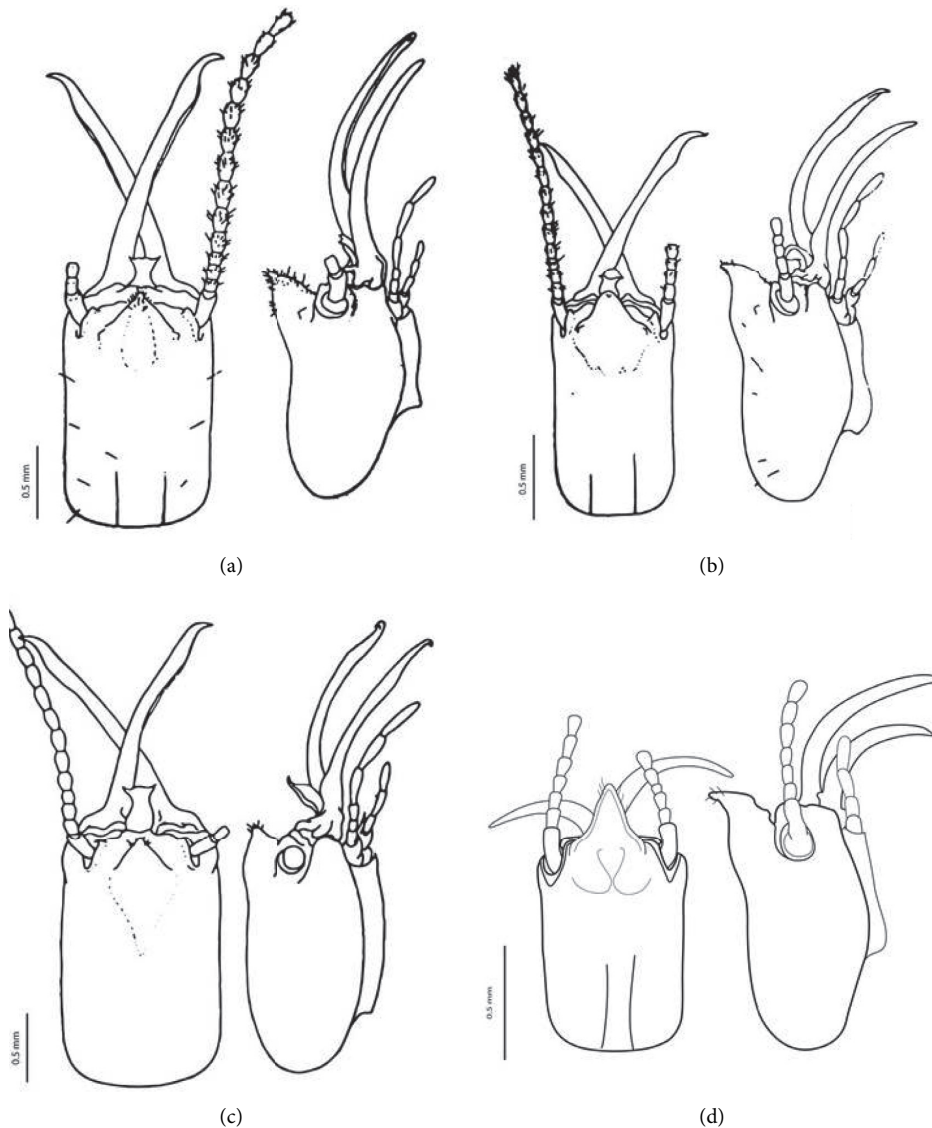


FIGURE 2: Dorsal and lateral views of head of the soldier caste. (a) *Termes comis*, (b) *T. rostratus*, (c) *T. laticornis*, and (d) *T. propinquus*. (a-c) Redrawn with minor editorial modification from Tho (1992), (d) drawn from the specimen (SUAQ-TT-2017-C012).

and building materials, such as rotten wood and humus, which accumulate around the tree base and stumps.

Three nests (22%) were epigeal (standing on the ground); however, epigeal nests might be destroyed by ground-

dwelling mammals (Figure 4). Mammals are probably ranked as the second most important predators for termites; the first position is likely occupied by ants [21–23]. We also found as many as four of the 14 epigeal nests showed signs of having



FIGURE 3: A nest of *Termes propinquus* attached to a stump, in a dipterocarp forest of Suaq Balimbing, North Sumatra (Suaq Balimbing Field Station; colony (SUAQ-TT-2017-C012).



FIGURE 4: A rebuilt nest of *Termes propinquus* after being destroyed probably by a mammal, in a dipterocarp forest of Suaq Balimbing, North Sumatra (Suaq Balimbing Field Station; colony (SUAQ-TT-2017-C022).

been attacked by ants, such as *Camponotus gigas* (two nests), *Pheidole* sp. (one nest), and *Oecophylla smaragdina* (one nest). Ants prey on termites and also often destroy their nests. The irregular-shaped nests clinging to the forest floor (Figure 4) are likely to be rebuilt from destroyed epigeal nests. Therefore, multiple physical and biotic factors on the forest floor might influence the diversity of the nest architecture of *T. propinquus*.

4. Conclusion

As many as four species of the genus *Termes* have so far been recorded from Sumatra, including *Termes propinquus* that can be separated from other congeners based on the condition of frontal projection, the head capsule structure, and the antennal segmentation in the soldier caste. Measurements of the head capsule are useful for species identification to the Sumatran genus. *Termes propinquus* prefers to construct their nests attached to bases of living or dead trees, epigeal, and stumps. Both ants and mammals were the most important predators of *T. propinquus* on Sumatra.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

The authors thank the Termite Research Group (Universitas Syiah Kuala, Indonesia), Sugesti, M. Rapi, Tarmizi, M. Isa, Usman, and Mat Plin (Leuser Development Program, Indonesia), and Manager and Field Staff at Suaq Balimbing Field Station for assistance in the field and laboratory. The authors are grateful to Katsuyuki Eguchi (Tokyo Metropolitan University, Japan), Seiki Yamane (Kagoshima University Museum, Japan) for various supports, Paul Eggleton, and David Jones (Natural History Museum, UK), and staff at the Museum Zoologicum Bogoriense (MZB, Indonesia) for allowing the corresponding author to examine the type material. Also they thank the staff in the Forestry Department in Indonesia for their help and assistance during field surveys and Rudolf Scheffrahn (Florida University, USA) for facilitating Syauckani in taking specimen photos. This research was partly funded by the PMDSU Doctoral Program, the Ministry of Research, Technology and Higher Education, Indonesia (MRTHE) (Leader Syauckani: FY2016-18), Fundamental Grant, MRTHEI (Leader Syauckani FY2018-19), Professor Grant USK (Leader Syauckani: FY2021), and WCP Grant, the Ministry of National Education and Culture (Leader Syauckani: FY2021).

References

- [1] N. Arumugan, A. D. M. Hassim, and S. Appalasamy, "Termite fauna of gunung telapak buruk, berembun forest reserve, negeri sembilan, Malaysia," *Borneo Journal of Resource Science and Technology*, vol. 10, no. 2, pp. 166–171, 2020.
- [2] D. E. Bignell, "Termite ecology in the first two decades of the 21st century," *A Review of Reviews: Insects*, vol. 10, no. 3, pp. 1–10, 2019.
- [3] J. Korb, B. D. Kasseney, Y. T. Cakpo et al., "Termite taxonomy, challenges and prospects: west Africa, a case example," *Insects*, vol. 10, no. 1, pp. 1–18, 2019.
- [4] D. E. Bignell and P. Eggleton, "Termites in ecosystems," in *Termites: Evolution, Sociality, Symbiosis, Ecology*, T. Abe, D. E. Bignell, and M. Higashi, Eds., Kluwer Academic Publishers, Dordrecht, Netherlands, pp. 363–387, 2000.
- [5] M. J. Pearce, *Termites Biology and Pest Management*, CAB International, Willingford, UK, 1997.
- [6] F. Hasan, D. T. Jones, S. Syauckani, and P. Eggleton, "Termite transects from Buton Island, Sulawesi, have a low diversity compared with Sundaland sites," *Journal of Tropical Ecology*, vol. 37, no. 4, pp. 161–164, 2021.
- [7] M. S. Engel, D. A. Grimaldi, and K. Krishna, "Termites (isoptera): their phylogeny, classification, and rise to ecological dominance," *American Museum Novitates*, vol. 3650, pp. 1–7, 2009.
- [8] S. Syauckani, G. J. Thompson, T. Yamasaki et al., "Taxonomy of the genus longipeditermes holmgren (termitidae, nasutitermitina) from the greater Sundas, southeast Asia," *Zoosystematics and Evolution*, vol. 95, no. 2, pp. 309–318, 2019.
- [9] K. Krishna, D. A. Grimaldi, V. Krishna, and M. S. Engel, "Treatise on the isoptera of the world," *Bulletin of the American Museum of Natural History*, vol. 377, no. 7, pp. 1–200, 2013.

- [10] S. Hellemans, T. Bourguignon, P. Kyjaková, R. Hanus, and Y. Roisin, "Mitochondrial and chemical profiles reveal a new genus and species of neotropical termite with snapping soldiers, palmitermes impostor (termitidae: termitinae)," *Invertebrate Systematics*, vol. 31, no. 4, pp. 394–405, 2017.
- [11] F. J. Gathorne-Hardy, "A review of the south-east Asian nasutitermitinae (isoptera: termitidae), with descriptions of one new genus and a new species and including a key to the genera," *Journal of Natural History*, vol. 35, pp. 1486–1506, 2001.
- [12] Y. P. Tho, *Termites of Peninsular Malaysia*, vol. 36, Forest Records. Forest Research Institute Malaysia, Kepong, Malaysia, 1992.
- [13] N. Holmgren, "wissenschaftliche ergebnisse einer forschungsreise nach ostindien, ausgeführt im auftrage der kgl. preuss. akademie der wissenschaften zu berlin von h.v. buttel-reepen. iii. termiten aus sumatra, java, malacca und 140 ceylon. gesammelt von herrn prof. Dr. V. Buttel-Reepen in den Jahren 1911-1912," *Zoologische Jahrbücher—Biodiversity Heritage Library*, vol. 36, pp. 229–290, 1914.
- [14] T. Bourguignon, M. Leponce, and Y. Roisin, "Revision of the termitinae with snapping soldiers (isoptera: termitidae) from new Guinea," *Zootaxa*, vol. 1769, no. 1, pp. 1–34, 2008.
- [15] F. J. Gathorne-Hardy, "The termites of Sundaland: a taxonomic review," *Sarawak Museum Journal*, vol. 60, pp. 89–133, 2004.
- [16] M. Cosarinsky, "Nest micromorphology of the neotropical termite *Termes saltans* (isoptera: termitidae)," *Sociobiology*, vol. 43, no. 3, pp. 1–11, 2004.
- [17] G. D. Haviland, "Observations on termites; with descriptions of new species," *Journal of the Linnean Society of London, Zoology*, vol. 26, no. 169, pp. 358–442, 1898.
- [18] O. John, "Termiten von ceylon, der malayaischen halbinsel, Sumatra, Java und den Aru-Inseln," *Treubia*, vol. 6, pp. 360–419, 1925.
- [19] R. S. Thapa, "Termites of sabah," *Sabah Forest Record*, vol. 12, pp. 1–374, 1981.
- [20] M. L. Roonwal and O. B. Chhotani, *The Fauna of India and the Adjacent Countries*, vol. 1, Zoological Survey of India, Kolkata, India, 1989.
- [21] J. Deligne, A. Quennedey, and M. S. Blum, "The enemies and defense mechanisms of termites," in *Social Insect*, H. R. Hermann, Ed., vol. 2, pp. 1–76, Academic Press, New York, NY, USA, 1981.
- [22] E. O. Wilson, *The Insects Societies*, Harvard University Press, Cambridge, MA, USA, 1971.
- [23] K. H. Redford, "Ants and termites as food," in *Current Mammalogy*, H. H. Genoways, Ed., vol. 1, pp. 349–399, Springer Science Business Media, New York, NY, USA, 1987.