

Taxonomy of the genus *Longipeditermes* Holmgren (Termitidae, Nasutitermitinae) from the Greater Sundas, Southeast Asia

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Abstract

More than 200 colonies of the genus *Longipeditermes* were collected in our field surveys across the Sundaland region of Southeast Asia from 1998 to 2014. Two species, *L. kistneri* Akhtar & Ahmad and *L. logipes* Holmgren, are recognized and redescribed with color photographs of the workers and major soldiers. We use variation in characters of soldier caste (head capsules, antennae, and pronotum) and worker caste (antennae and mandibles) to distinguish these two species. *Longipeditermes kistneri* seems to prefer high-altitude forests (above 1,000 m) and has so far been found exclusively in Java and Sumatra, while *L. logipes* seems to prefer lowland and swamp forests and is widespread in the Greater Sundas.

Key Words

Morphological characters, Nasutitermitinae, Open-air processional columns termites, species description

Introduction

A termite colony typically consists of a large number of workers and defensive soldiers together with a single king and a queen. This arrangement can, however, vary with seasonal cohorts of reproductive nymphs and dispersive alates (Watson and Gay 1991; Pearce 1997). The castes within termite societies are morphologically and behaviorally specialized to perform particular tasks (Lee and Wood 1971; Grimaldi and Engel 2005) to the point where workers and soldiers are so specialized for non-reproductive helping and defensive tasks that they are considered to be functionally sterile (Roisin 2000). The sexes, by contrast, are highly specialized for reproduction.

As the largest subfamily among the higher termites (Termitidae), Nasutitermitinae consists of more than 550 species (Emerson 1955), which belong to more than 63 genera (Collins 1989). This subfamily probably originated in the Neotropical region during the Cretaceous period (Emerson 1955) and is characterized by a highly specialized defensive caste (Collins 1989) that has a modified rostrum or “nasus” (Deligne et al. 1981; Prestwich 1984). This subfamily was erected by Hare (1937), who emphasized the conspicuous prolongation on the front of the head, which is often accompanied by degeneration of mandibles and the concomitant development of a frontal gland. The development of the nasus is continuously variable among species within the Na-

sutitermitinae from mild prolongation, as in *Syntermes*, to pronounced prolongation as in *Subulitermes*, *Convexitermes*, and *Nasutitermes*.

Longipeditermes, in the Nasutitermitinae, is a small genus with only two species so far recorded. These are *L. longipes* and *L. kistneri* from the Sundaland area (Gathorne: Hardy 2001; Hoare and Jones 1998). *Longipeditermes* is, however, well known for its remarkable foraging habit. Workers and soldiers form open-air processional columns on the ground, shrubs, and tree trunks typically inside forests (Gray and Dhanarajan 1974; Hoare and Jones 1998; Miura and Matsumoto 1998; Takematsu et al. 2013; Syaukani et al. 2016). The foraging activities of both species seem to be greatest during the day (Hoare and Jones 1998), as evidenced by workers carrying packed balls of organic matter between their mandibles and returning to the nest.

In the course of our long-term inventory and taxonomic research on termites in Southeast Asia, more than 200 colonies of *Longipeditermes* have been sampled from different habitats and altitudes across the Greater Sunda. In this paper, the two species of the genus are redescribed and illustrated using newly obtained nest series. Information on their life history is provided.

Materials and methods

We examined 216 colonies of *Longipeditermes* from various habitats and altitudes across the Greater Sunda (Table 1; Fig. 1). The specimens examined are deposited at the Museum Zoologicum Bogoriense (MZB), Cibinong, Indonesia; the Natural History Museum, London (UK);

and the Universitas Syiah Kuala (Biology Department), Darussalam, Banda Aceh (Indonesia).

The head, body (in profile), pronotum, and antenna of the soldier caste (preserved in 70% ethanol) were photographed using a digital microscope (KEYENCE HFVH-8000, Osaka). From these images, multifocused montages were produced using Helicon Focus v. 6.2.2 (Helicon Soft Ltd, Kharkov, Ukraine). Morphological terms and measurement characters follow those of Roonwal and Chhotani (1989), Sands (1998), Tho (1992), and Syaukani et al. (2011). We measured the characters (in millimeters): head capsule length including nasus (HLN), head capsule length excluding nasus (HL), nasus length (NL), nasus index = NL/HL, maximum head width at anterior part (HWA), maximum head width at posterior part (HWP), maximum height of head capsule excluding postmentum (HH), pronotum length (PL), and pronotum width (PW).

Results

Taxonomic accounts

Genus *Longipeditermes* Holmgren, 1913

Soldier. Bimodal in its size distribution. Head capsule pale brown to blackish; antenna much paler than head capsule in coloration, with the basal segments (first and second) generally darker than the remaining segments; pronotum paler than or as pale as head capsule; abdominal tergites pale brown to dark sepia brown; coxae yellow.



Figure 1. Distribution of *Longipeditermes longipes* (yellow dot) and *L. kistneri* (red dot) on the Greater Sundas, Southeast Asia.

lowish to pale brown; femora yellow to brown; tibiae pale yellow to yellow. In dorsal view head capsule excluding rostrum pear-shaped to somewhat triangular, weakly constricted behind antennal sockets; its posterior margin weakly to strongly convex; dorsal outline in profile weakly to strongly concave; rostrum excluding the apex somewhat cylindrical rather than conical. Antenna long, with 14 segments; 3rd segment at least twice as long as 4th. Mandible relatively long, with sharp apical processes. Legs very long.

Worker. Monomorphic but showing size variation. Pale brown to blackish. Antenna with 15 segments, with the basal segments darker than the following ones. Left mandible with 3rd marginal tooth weakly to moderately protruding from cutting edge, and 4th partially hidden behind molar prominence.

Remarks. In *Longipeditermes*, the soldier caste is dimorphic. The caste is subdivided into major and minor soldiers that differ markedly in size (Thapa 1981; Tho 1992; Gathorne-Hardy 2001; Miura and Matsumoto 1998) and slightly in coloration; the former being darker than the latter. The major soldier has more characters useful for species recognition and identification. Two varied

species, *L. longipes* and *L. kistneri*, were recognized in our collection (Table 1), while no additional species were found by our morphology-based examination. The two species are relatively easily distinguished from each other by a combination of characters given in Table 2. These characters are re-described below in detail.

***Longipeditermes longipes* (Haviland, 1898)**

Termes longipes Haviland 1898: 439–440. Type locality: Perak, Malay Peninsula. Syntypes examined.

Eutermes longipes Wasmann 1902: 131.

Eutermes (Longipeditermes) longipes: Holmgren 1902: 215–217; John 1925: 406.

Longipeditermes longipes: Snyder 1949: 317; Ahmad 1958: 126; Tho 1992: 180–181; Miura and Matsumoto 1998: 179–189 (ecology); Hoare and Jones 1998: 1357–1366.

Longipeditermes mandibulatus Thapa 1981: 349–352. Sabah, Borneo. Synonymized by Hoare and Jones 1998: 1357–1366.

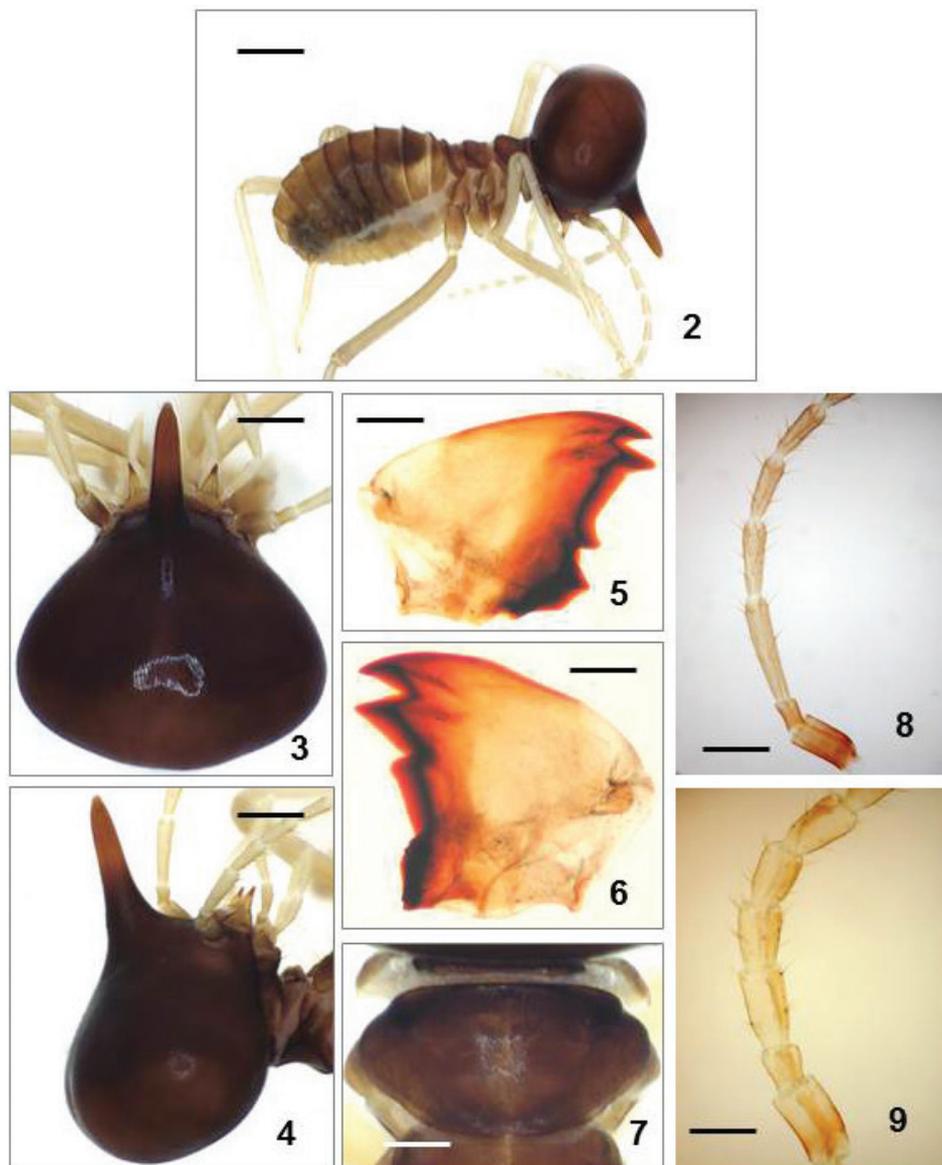
Materials examined. Sumatra. SYK1998 & 1999-L-1115, 1117, 1120, 1121, 1124, 1130, 1133, 1136, 1138, 1139, 1141, 1143, 1147, 3025: soldiers and workers from

Table 1. Summary of collection sites.

Site	Vegetation type	Altitude (m)
The Leuser Ecosystem, Sumatra	Lowland & subalpine forests Protected & unprotected	50–1400
Aceh Province (outside the Leuser Ecosystem), Sumatra	Lowland forest	20–600
Batang Gadis National Park, Sumatra	Lowland forest	800–1200
North Sumatra Province (except the Leuser Ecosystem)	Lowland & subalpine forests	20–1100
Kerinci Seblat National Park, Sumatra	Lowland & subalpine forests	300–1350
West Sumatra Province (outside Kerinci Seblat N. P.), Sumatra	Lowland forest	50–400
Jambi Province (outside Kerinci Seblat N.P.), Sumatra	Lowland forest	50–600
Bukit Barisan Selatan National Park, Sumatra	Lowland forest	50–600
Bengkulu Province (outside Bukit Barisan Selatan National Park), Sumatra	Lowland forest	100–700
Lampung Province (outside Bukit Barisan Selatan National Park), Sumatra	Lowland forest	10–300
Endau Ronpin National Park, Malay Peninsula	Lowland forest	150–600
Teluk Bahang National Park, Malay Peninsula	Lowland forest	5–200
Bukit Tangkiling Nature Preserve, Borneo	Lowland forest	25–170
Pararawen Nature Preserve, Borneo	Lowland forest	50–350
Barito Ulu, Borneo	Lowland & subalpine forests	900–1200
Gunung Palung National Park, Borneo	Lowland forest	50–300
Betung Kerihun National Park, Borneo	Lowland forest	400–850
West Kalimantan Province (outside Betung Kerihun NP) Borneo	Lowland forest	50–650
East Kalimantan Province (outside Gunung Palung NP) Borneo	Lowland forest	150–500
Bukit Suharto, Borneo	Lowland forest	40–300
North Kalimantan Province (outside Kayan Mentarang NP), Borneo	Lowland & subalpine forests	500–1200
Gunung Halimun National Park, West Java	Lowland & subalpine forest	800–1350
Pangandaran Natural Reserve, West Java	Lowland	10–40
Bukit Lengkong, West Java	Lowland & subalpine forest	800–1250

Table 2. Summary of morphological characters for the *Longipeditermes* based on major soldiers and workers.

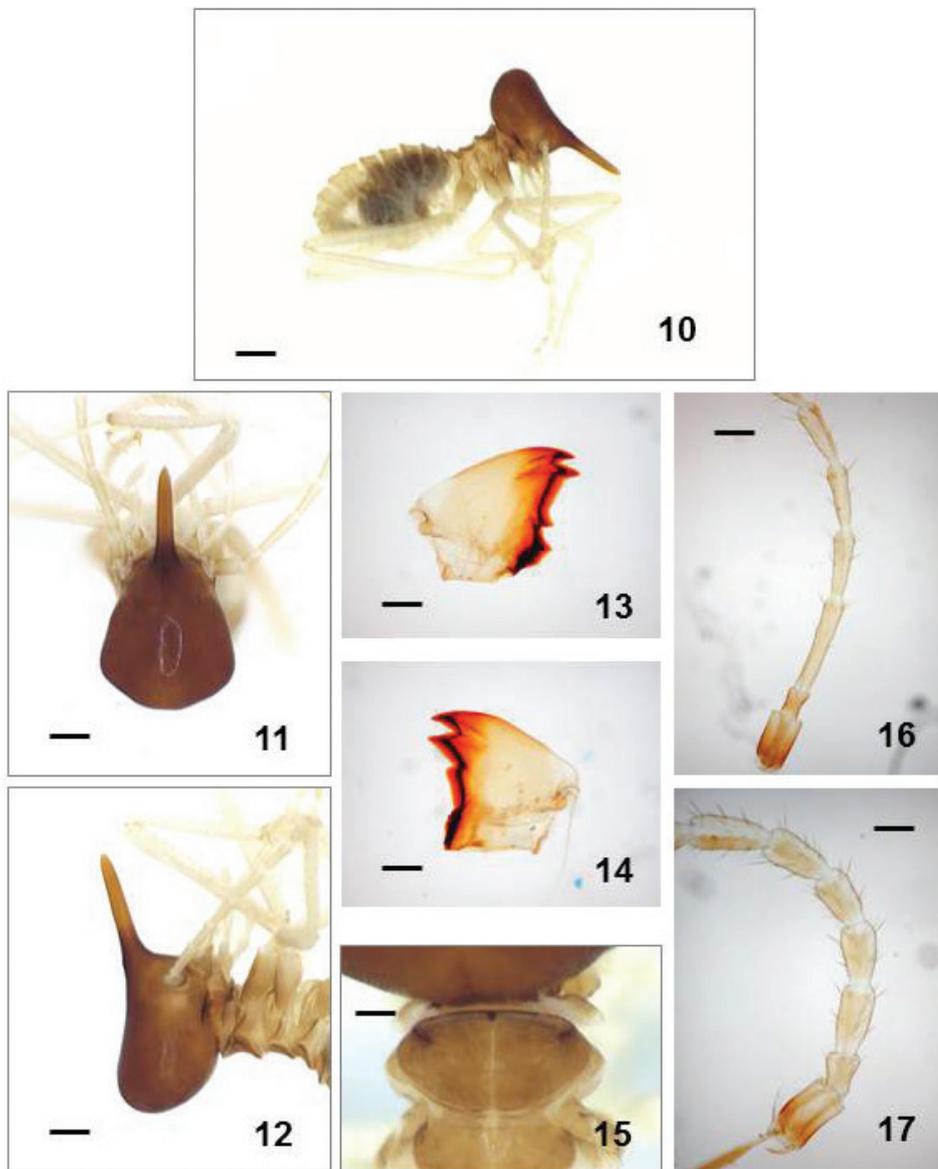
Species	Soldier			Worker	
	Coloration of head capsule	Rostrum	Anterior margin of pronotum	Antennae	Left mandible
<i>L. longipes</i>	Sepia brown to blackish	Apical 2/3 lighter & basal 1/3 darker	Nearly straight	4 th segment longer than 5 th	3 rd marginal tooth moderately protruding from cutting edge
<i>L. kistneri</i>	Pale brown to dark brown	Apical 2/3 darker and basal 1/3 lighter	Strongly indented in the middle	4 th to 6 th segments almost equal in length	3 rd marginal tooth weakly protruding from cutting edge



Figures 2–9. (SYK2006-KSNP-0011). *Longipeditermes longipes* (major soldier & major worker). Soldier (2–4, 7, 8) and worker (5, 6, 9). Habitus in profile (2), head in dorsal view (3), head in profile (4), left (5) and right (6) mandibles, pronotum (7), antennae (8, 9). Scale bars: 0.6 mm (2), 0.3 mm (3, 4), 0.1 mm (5–9), 1.7 mm (6).

undisturbed forest, 300–500 m altitude, Ketambe, Southeast Aceh. SYK1998-L-3005, 3010: soldiers and workers from disturbed forest, 450 m altitude, Lokop, East Aceh, Aceh. SYK-L-1148, 3006: soldiers and workers from disturbed forest, 80 m altitude, Soraya, Singkil, Aceh. SYK1998 & 2000-L-1126, 1127, 1131, 1199, 1145, 3007, 3008: soldiers and workers from undisturbed forest, 150–350 m altitude, Bukit Lawang, Langkat, North Sumatra. SYK1998-L-3009, 3022, 3024: soldiers and workers from disturbed forest, 200 m altitude, MRT Logging Concession, South Aceh. SYK1999 & 2001-L-1116, 1123, 1125, 1128, 1134, 1135, 1137, 1144, 1146: soldiers and workers from disturbed forest, 50 m altitude, Sekundur, Langkat, North Sumatra. SYK1999-L-1112, 1118, 1129, 1132, 1140, 1142: soldiers and workers from undisturbed forest, 200–400 m

altitude, Bengkung, Southeast Aceh. SYK2006-AL-0104: Soldiers and workers from disturbed forest, 50 m altitude, Maestong, Batang Hari, Jambi. SYK2006-KSNP-0011, 0019, 0080, 0091, 0093, 0095, 0096, 0097, 0104, 0206: soldiers and workers from the undisturbed forest, 300 m in altitude, Sungai Manau, Merangin, Jambi. SYK2006-AL-0100, 0101, 0102, 0103: soldiers and workers from disturbed forest, 50 m altitude, Maestong, Batang Hari, Jambi. SYK2007-LP-0019: soldiers and workers from undisturbed forest, 1350 m altitude, Sumber Jaya, Kota Bumi, Lampung. **Java.** SYK2001-HL-067, 072: soldiers and workers from protected forest, 1,450 m altitude, Halimun NP, West Java. SYK2006-PD-0011, 048: soldiers and workers from protected forest, 10 m altitude, Pangandaran Nature Reserve. West Java. **Malay Peninsula.**



Figures 10–17. (SYK2006-KSNP-0011). *L. longipes* (minor soldier & minor worker). Soldier (10–12, 15) and worker (13, 14, 17). Habitus in profile (10), head in dorsal view (11), head in profile (12), left (13) and right (14) mandibles, pronotum (15), antennae (16, 17). Scale bars: 0.6 mm (10), 0.3 mm (11, 12), 0.1 mm (13– 17), 1,7 mm (15).

SYK2009-ER-084, 085, 086, 087, 088: soldiers and workers from protected forest, 50 m altitude, Endau Rompin NP. SYK2011-TB-011, 012, 013, 014: soldiers and workers from protected forest, 10 m altitude, Teluk Bahang NP. **Borneo.** SYK2014-BT-0054: soldiers and workers from protected secondary forest, 35 m altitude, Palangkaraya, Central Kalimantan. SYK-2014-P-0012: soldiers and workers from undisturbed forest, 220 m altitude, North Barito, Central Kalimantan. SYK-2014-P-0024: soldiers and workers from undisturbed forest, 270 m altitude, North Barito, Central Kalimantan.

Soldier (Figs 2–4, 7, 8, 10–12, 15, 16). Bimodal continuum in size. **Major soldier** (Figs 2–4, 7, 8). Head capsule sepia brown to blackish, in dorsal view somewhat triangular, very weakly constricted behind antennal sock-

ets, with posterior margin roundly convex; dorsal outline (including nasus) in lateral view moderately concave; rostrum feebly bicolored, with apical 2/3 lighter and basal 1/3 darker. Mandible with short to long apical processes in dorsal view. Antenna with 14 segments, much paler than head capsule; 1st antennal segment darker than the following segments, which are uniformly colored; 3rd segment approximately 1.5 times as long as 4th; 5th slightly shorter than 4th; 6th–14th gradually shortening toward the apex. Pronotum in dorsal view paler than head capsule; anterior margin nearly straight; posterior margin weakly indented in the middle. Coxae pale brown to brown; femora pale brown to yellow; tibiae pale yellow. Abdominal tergites pale brown to dark sepia brown. Measurements and index (20 major soldiers from 10 colonies): HLN 2.30–2.71 mm;

HL 1.57–1.62 mm; NL 0.72–0.77 mm; NL/HL 0.47–0.51; HWA 0.81–0.98 mm; HWP 1.87–1.92 mm; HH 1.22–1.32 mm; PL 0.37–0.40 mm; PW 0.75–0.78 mm.

Worker (Figs 5, 6, 9, 13, 14, 17). Monomorphic but showing size variation. **Worker (large-sized)** (Figs 5, 6, 9). Blackish brown to blackish. Left mandible with apical tooth shorter than 1st marginal tooth; 3rd marginal moderately protruding from cutting edge; 4th completely hidden, scarcely visible behind molar prominence. Right mandible with posterior edge of 2nd marginal tooth nearly straight or weakly concave; the inner layer of molar plate very moderately convex; notch moderately developed. Antenna with 15 segments, whitish yellow; 1st and 2nd segments darker than the following segments; 3rd clearly

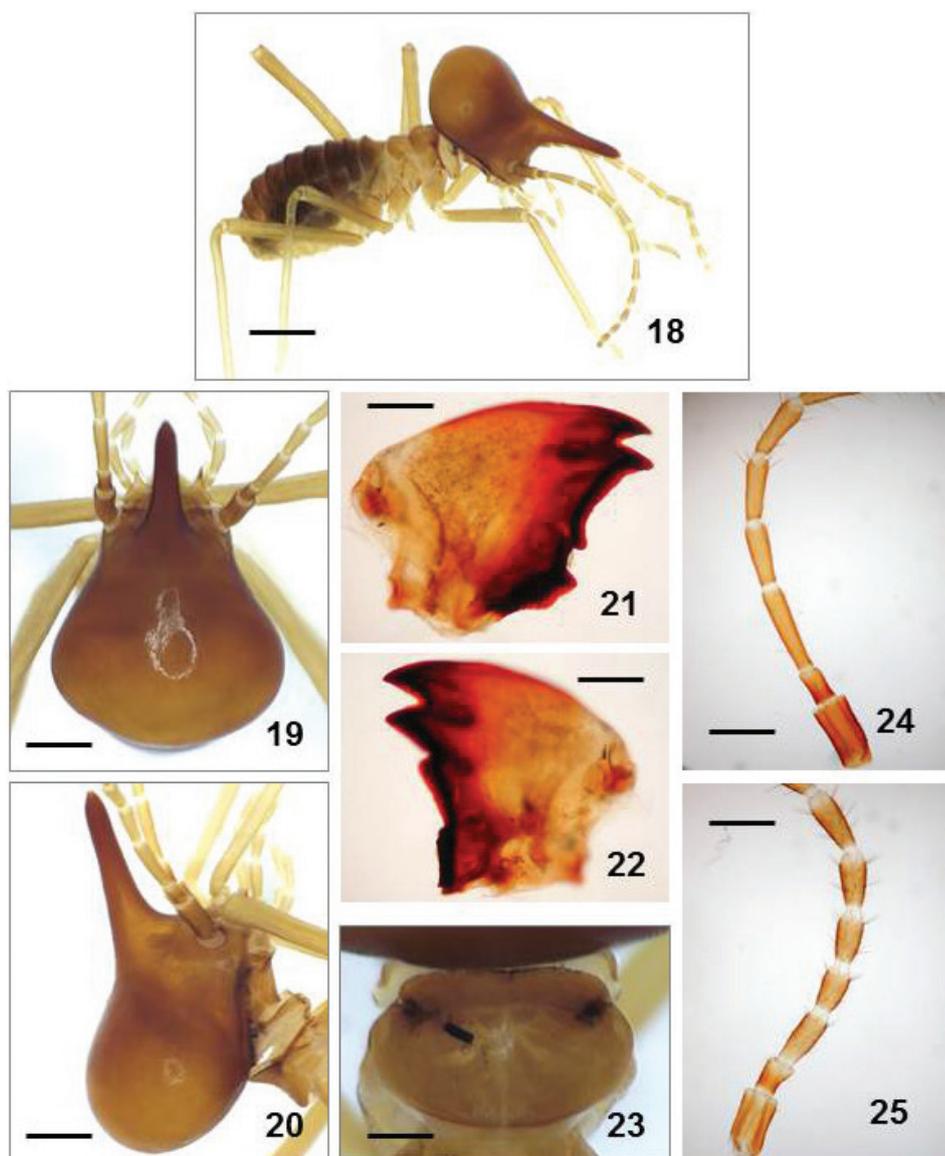
longer than 4th; 4th longer than 5th, 6th–15th gradually shortening toward the apex.

Distribution. Sumatra, Peninsular Malaysia, Java (**new record**), and Borneo.

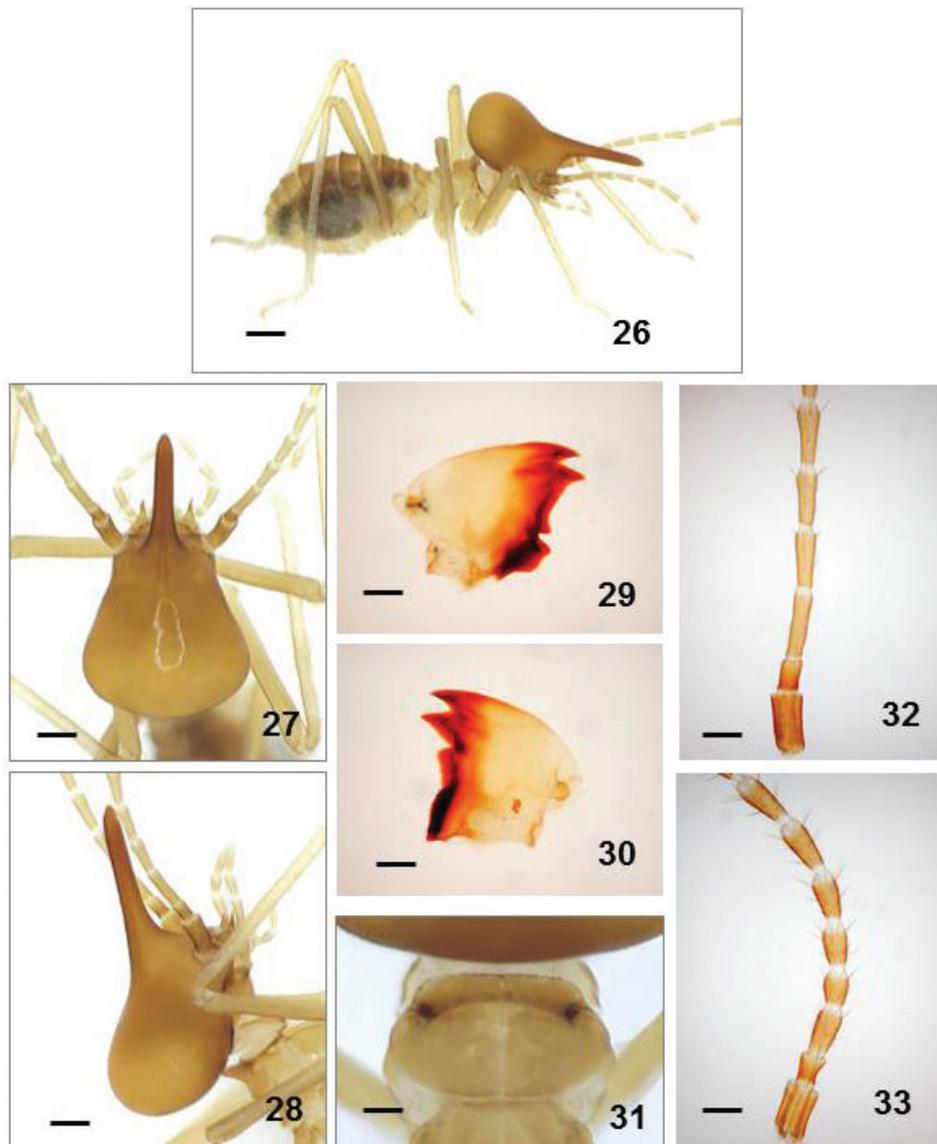
Longipeditermes kistneri Akhtar & Ahmad, 1985

Longipeditermes kistneri Akhtar and Ahmad 1985: 215–217. Bogor, West Java.

Material examined. SYK1998 & 1999-L-1098, 2001, 3011: soldiers and workers from the undisturbed forest, 1100–1400 m altitude, Kemiri Mountain, Southeast Aceh, Aceh, Sumatra.



Figures 18–25. (SYK1999-L-3011). *L. kistneri* (major soldier and major worker). Soldier (18–20, 23, 25) and worker (21, 22, 25). Habitus in profile (18), head in dorsal view (19), head in profile (20), left (21) and right (22) mandibles, pronotum (23), antennae (24, 25). Scale bars: 0.6 mm (18), 0.3 mm (19, 20), 0.1 mm (21, 22, 24, 25), 1.7 mm (23).



Figures 26–33. (SYK1999-L-3011). *L. kistneri* (minor soldier and minor worker). Soldier (26–28, 32) and worker (29, 30, 33). Habitus in profile (26), head in dorsal view (27), head in profile (28), left (29) and right (30) mandibles, pronotum (31), antennae (32, 33). Scale bars: 0.6 mm (26), 0.3 mm (27, 28), 0.1 mm (29, 30, 32, 33), 1.7 mm (31).

Soldier (Figs 18–20, 23, 24, 26–28, 31, 32). Bimodal continuum in size. **Major soldier** (Figs 18–20, 23, 24). Head capsule pale to dark brown, in dorsal view somewhat triangular, very weakly constricted behind antennal sockets, with posterior margin roundly convex; dorsal outline (including nasus) in profile moderately concave; rostrum feebly bicolored, with apical 2/3 darker and basal 1/3 paler. Mandible with short to long apical processes. Antenna with 14 segments, much paler than head capsule; 1st and 2nd antennal segments darker than the following segments, which are uniformly colored; 3rd approximately 1.5 times as long as 4th; 5th slightly shorter than 4th; 6th–14th gradually shortening toward the apex. Pronotum in dorsal view as pale as or paler than head capsule; anterior margin indented in the middle; posterior margin weakly indented

in the middle. Coxae and femora yellowish to pale brown; tibiae pale yellow to yellow. Abdominal tergites brown to dark sepia brown. Measurements and index (20 major soldiers from 10 colonies): HLN 2.22–2.43 mm; HL 1.62–1.68 mm; NL 1.02–1.12 mm; NL/HL 0.66–0.73; HWA 0.86–0.90 mm; HWP 1.63–1.71 mm; HH 0.98–1.04 mm; PL 0.40–0.44 mm; PW 0.77–0.82 mm.

Worker (Figs 21, 22, 25, 29, 30, 33). Monomorphic but showing size variation. **Worker (large-sized)** (Figs 21, 22, 25). Body pale brown to brown. Left mandible with apical tooth shorter than 1st marginal tooth; 3rd marginal weakly protruding from cutting edge; 4th not completely hidden behind molar prominence. Right mandible with posterior edge of 2nd marginal tooth nearly straight; the inner layer of the molar plate very weakly concave; notch moderately

to strongly developed. Antenna with 15 segments, with 1st and 2nd segments slightly darker than the following segments; 3rd clearly longer than 4th; 4th–6th nearly equal in length; 7th–15th gradually shortening toward the apex.

Distribution. Sumatra and Java.

Discussion

Longipeditermes species are distinguished from those of the other groups of Southeast Asian nasutitermitine termites by forming open-air processional foraging columns (e.g., *Hospitalitermes* and *Lacessititermes*) and by having major and minor soldiers that both have long legs and a long rostrum. No information is available for the ratio of the largest and smallest soldiers in typical colonies, but minor soldiers appear to be more numerous (Figs 34, 35). The soldier does not exhibit a clear dimorphism, but a bimodal continuum in size.

Longipeditermes kistneri was only collected from Sumatra during our intensive surveys in the Greater Sundas, although the type locality is Java. Nine colonies were found in protected forests above 1,000 m in altitude. Four nests were located among buttresses and roots of big trees (under the ground covered with decayed leaf litter and small decayed branches). This nesting habit makes it difficult to estimate the sizes of their colonies. Both soldiers and workers forage on the surface of the ground. The size of foraging columns is smaller in *L. kistneri* than in *L. longipes*. Their pale- to dark-brown body color and smaller columns make it difficult to find colonies of *L. kistneri*.

Longipeditermes longipes seems to prefer lowland and swamp forests and is widespread in the Greater Sundas. Nests of *L. longipes* are usually constructed among buttresses of trees (Fig. 36) and in dead or decayed stumps, with decayed wood debris and leaves (Fig. 37). Several subterranean nests of this species were found in Lambir Hills National Park (Sarawak, Borneo) by Miura and Mat-



Figures 34, 35. Foraging column of *Longipeditermes longipes* on the forest floor in Southeast Asia. Workers collecting and transporting food source from a decayed branch (34) and leaf litter (35), soldiers protecting the worker from predators such as *Componotus gigas* (Latreille).



Figure 36. Nest entrances (red arrows) of subterranean nest of *Longipeditermes longipes* found in SE Asia tropical forests.

sumoto (1998). Underground nests are sometimes made from consisting of soil and litter. This species forages on the ground during the day. However, Hoare and Jones (1998) reported foraging activity at night, during which no food balls were being carried. We also found foraging columns at night; the columns consisted of limited numbers of workers carrying food balls to the nests. In typical processional foraging columns, numerous soldiers guard workers. Foraging ecology and diet of *L. longipes* have been poorly studied, but we know that this species feeds on leaf litter (Miura and Matsumoto 1998) and in the Pasoh Forest Reserve on the Malay Peninsula it prefers to consume older leaf litter rather than newly fallen leaves (Matsumoto and Abe 1979). We observed foraging columns consuming a mixture of bark, twigs, and decayed wood in forests of Sumatra and the Malay Peninsula.



Figure 37. Above-ground nest of *L. longipes* constructed in and around a dead tree stump (*Shorea* sp.). The cavity was fulfilled with a mixture of soil, debris and litter.

Conclusion

In general, from the current study, we conclude that only two species of *Longipeditermes* (*L. longipes* Holmgren and *L. kistneri* Akhtar & Ahmad) have so far been collected in the Greater Sundas. Long legs and size dimorphism of soldier caste can help to separate this genus from other nasute termites in Southeast Asia. The condition of rostrum, head capsule, pronotum, and antennae determine the soldier caste, while the condition of antennae and left mandibles of worker caste serve to distinguish these two species. *Longipeditermes kistneri* seems to prefer high-altitude forests and has been found exclusively from Java and Sumatra, while *L. longipes* seems to prefer lowland and swamp forests and is widespread in the Greater Sundas.

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