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First report of the termite *Glyptotermes ceylonicus* (Blattodea: Isoptera: Kalotermitidae) from India: an example of discontinuous distribution

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**Abstract:** We report *Glyptotermes ceylonicus* (Holmgren, 1911), an endemic Sri Lankan termite, for the first time from India. *Glyptotermes* show a high degree of endemism throughout the world. Record of this species from the current location indicates a wide distribution of this species in southern India, in the past, before the complete separation of Sri Lanka from India. The current distribution of *Glyptotermes ceylonicus* is also an example of discontinuous distribution. Pictorial illustrations of the morphologically important parts and revised key for the Indian species are provided.

**Keywords:** Dichotomous key, diversity, endemism, southern India.

*Glyptotermes ceylonicus* is a species of damp wood termite endemic to the high elevations of Sri Lanka. Holmgren (1911) described *G. ceylonicus* from Peradeniya, Ceylon. *Glyptotermes* is a highly endemic genus of the family Kalotermitidae. Krishna et al. (2013), reported 456 species from this family, including 127 species of *Glyptotermes*. Two more species were introduced into the genus recently, making a total of 129 *Glyptotermes* species worldwide. In India, eight of the 13 species of *Glyptotermes* species reported are endemic (Thakur et al. 2010; Amina & Rajmohana 2016; Sengupta et al. 2019). Three species of *Glyptotermes*—*ceylonicus* Holmgren (1911), *dilatatus* (Bugnion & Popoff 1910), and *minutes* Kemner 1932—reported from Sri Lanka are endemic to the area (Sri Lanka). None of the Indian species of *Glyptotermes* were reported from Sri Lanka. Likewise, none of the Sri Lankan species of *Glyptotermes* were reported from India. The total termite species reported from Kerala is 67, which belongs to three families and 30 genera (Mathew & Ipe 2018).

**MATERIALS AND METHODS**

Termites were collected from Pinnakkanadu, Kottayam district of Kerala State, located in southern India. The study area is situated between 9.64°N and 76.76°E at an altitude of 97.536 m. The collection was made from the core of a rotten wood of *Hevea brasiliensis* Müll.Arg, 1857, with high moisture content. The periphery of the wood was severely infected with *Heterotermes indicola* (Wasmann, 1902). The specimens were collected using an aspirator and preserved in 80% alcohol. Voucher specimens were deposited in the Zoological Survey of India (ZSI) Western Ghats Regional Centre Specimen Repository with register number ZSI/WGRC/I.R.-INV.17975. Measurements were...
made in 80% alcohol under a stereo zoom microscope, Labomed Luxeo 4D binocular microscope with attached camera and pixel pro software at magnification of 8–35X. Morphological terminology, measurements and indices for describing soldiers, workers and imago follow Roonwal & Chhotani (1989) and Sands (1998). Mandibles, antennae, and labrum of the imago, soldier and worker caste were mounted on a glass slide for examining diagnostic characters. Photographs were taken using Labomed Luxeo 4D binocular microscope with an attached camera.

**Systematics**

- **Family Kalotermitidae Froggatt, 1897**
- **Genus Glyptotermes Froggatt, 1897**
- **Glyptotermes ceylonicus** (Holmgren, 1911)

**Materials examined**


**Diagnosis**

**Soldier:** (Image 1, Table 1). Head-capulse brownish yellow, frons reddish-brown with an inclination angle of about 70°. Labrum and antennae pale yellow. Mandibles black, body and legs straw yellow. Head sparsely and body moderately hairy. Mandibles with short hairs at basal humps. Head-capulse sub-rectangular, length a little less than twice width. Antennae with 12 segments, segment three shortest. Mandibles thick, stout, and short, broadly narrowed at tips. Left mandible with two large and broad marginal teeth. First marginal situated at about one-fourth from the distal tip or closer to tip, second marginal broader and situated medially or just below first postmentum long, club-shaped, widest anteriorly at one fourth, waist long and narrow, minimum width of waist less than half to about half of maximum width.

**Imago:** (Image 2, Table 2). Head brown, paler in front. Pronotum paler than head. Abdomen brownish above paler below. Wings iridescent, with brownish anterior veins. Head thick, almost quadrately oval. Eyes and ocelli are small, ocelli separated from the eyes by their diameter or a little more. Clypeus short. Antenna 13 segmented, distinctly thickened distally. Segment two is almost as long as three.

**Pseudoworker:** (Image 3, Table 3). Head-capulse pale yellow, antennae, labrum, legs and body paler. Head and body moderately hairy. Head-capulse subcircular, a little broader than its length to base of mandibles. Eyes translucent and round. Ocelli absent. Antennae with 13 segments, segment three shortest. Labrum broadly tongue-shaped, hairy near anterior margin and on body. Mandibles typically *Glyptotermes*-type.

**Biology**

*Glyptotermes ceylonicus* is a rare species in Sri Lanka and India. It is reported from dead, decaying logs and branches of *Hevea, Acacia*, and *Artocarpus integrifolia* Linn.f. 1782. In Sri Lanka, it is found at an altitude between 460–610 m. In India, it is reported at 97.536 m. The nest is in the form of longitudinal galleries. The galleries and chambers contain a small round heap of faecal matter.

**Distribution**

- India: Kottayam (new record)
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Discussion

Kalotermitidae is a monophyletic lineage (Inward et al. 2007); it contains lower termites that evolved during the Cretaceous period. Three species of Kalotermitidae are preserved in Miocene amber from the Dominican Republic, which belong to the living genera Cryptotermes, Glyptotermes, and Incisitermes (Rohr et al. 1986). The higher distribution and abundance of Glyptotermes in the Neotropical (34.2%) and Indo-Malayan (31.5%) regions suggest, the genus had its origin in either of these regions. They got dispersed in the late Jurassic or early Cretaceous to the Australian and Papuan regions and dispersed through the Bering land bridge (Emerson 1952, 1955) or they originated in southern landmass when they were contiguous and dispersed before landmass drifted apart according to Warner’s hypothesis (Chhotani 1970). Either of the two theories gives an insight into the reason behind the peculiar distribution.

Studies show that East Gondwana, including India, split from West Gondwana between 165 and 150 million years ago (Krutzhc 1989; McLoughlin 2001; Briggs 2003). The collision of the Deccan plate (comprising India, Sri Lanka, and Seychelles) with Laurasia during the Eocene between 55 and 40 million years ago led to the rise of the Himalayan chain (Partridge 1997; Willis & McElwain 2002). The tropical climate of this region supports the development of the tropical biome in southeastern Asia. Sri Lanka was probably connected to India until 6,000 years ago, with a continuous stretch of tropical rain forest, which permitted the exchange of fauna of these regions. Later, Sri Lanka separated from the Indian mainland due to rise in sea levels (McLoughlin 2001).

Roonwal & Chottani (1989) conducted extensive studies on the termite fauna of the Indian subcontinent and reported 12 species of Glyptotermes. Thakur et al. (2010), introduced a new species, Glyptotermes roonwali, from northern India. Amina & Rajmohana (2016), introduced a new species, Glyptotermes chiraraharitae,
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from southern India in 2016, and the presence of two Glyptotermes species were revalidated by Rituparna et al. (2019) in 2019. Currently, a total of 17 Glyptotermes species are reported from the Indian region. Earlier it was thought that Glyptotermes ceylonicus was restricted to Sri Lanka. This is not a very common species and was earlier reported from Chilaw, Hewaheta, Elpitiya, Kurunegala, Pasara, and Peradeniya at an elevation of 460–610 m (Hemachandra et al. 2012). This species prefers to feed on dead, decaying logs and branches of Hevea, Acacia, and Artocarpus integrifolia with high water content (Roonwal & Chhotani 1989). Through the present study, we report Glyptotermes ceylonicus for the first time in India. The population is found in the western part of Western Ghats, 500 km (aerial distance) away from the currently known location, at an elevation of 97.536 m. The species may have been widely distributed in southern India before the separation of Sri Lanka from India. Invasion through traded goods is thin because artificial transport of this rare species is difficult (Chhotani 1970). These family of termites are obscure in nature, except Paraneotermes simplicicornis, which exclusively dwells in woody structures (Thakur et al. 2010), resulting in under-exploration. Another reason for the absence of this species from the area between Sri Lanka and current location might be due to the extinction in the intermediate areas due to the influence of anthropogenic factors (Basu et al. 1996). Amina et al. (2013) reported Sri Lankan termite Hospitalitermes monoceros (Konig, 1779) from Chinnar Wildlife Sanctuary, Western Ghats, Kerala. This also supports our view that many termites are distributed in southern India and Sri Lanka and later dwindled to narrow geographical areas. The present documentation of Glyptotermes ceylonicus is an example of discontinuous distribution.

REFERENCES


Table 1. Measurements of soldier cast of Glyptotermes ceylonicus.

<table>
<thead>
<tr>
<th>Characters</th>
<th>Present study</th>
<th>Roonwal &amp; Chhotani (1989)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Mean</td>
</tr>
<tr>
<td>Total body Length</td>
<td>7.00–7.11</td>
<td>7.15</td>
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<tr>
<td>Head Length to the base of mandible</td>
<td>2.11–2.19</td>
<td>2.15</td>
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<tr>
<td>Head Width</td>
<td>1.37–1.4</td>
<td>1.38</td>
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<tr>
<td>Mandible Length</td>
<td>0.97–1.00</td>
<td>0.98</td>
</tr>
<tr>
<td>Labrum Length</td>
<td>0.35–0.38</td>
<td>0.36</td>
</tr>
<tr>
<td>Labrum Width</td>
<td>0.34–0.35</td>
<td>0.345</td>
</tr>
<tr>
<td>Pronotum Length</td>
<td>1.72–1.75</td>
<td>1.73</td>
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<tr>
<td>Pronotum Width</td>
<td>1.32–1.38</td>
<td>1.35</td>
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<tr>
<td>Postmentum Length</td>
<td>1.92–1.95</td>
<td>1.93</td>
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<tr>
<td>Postmentum Width Maximum</td>
<td>0.49–0.58</td>
<td>0.53</td>
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<tr>
<td>Postmentum Width Minimum</td>
<td>0.2–0.23</td>
<td>0.21</td>
</tr>
<tr>
<td>Antenna segments</td>
<td>12</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 2. Measurements of imago cast of Glyptotermes ceylonicus.

<table>
<thead>
<tr>
<th>Characters</th>
<th>Present study</th>
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<tr>
<td></td>
<td>Range</td>
<td>Mean</td>
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<tr>
<td>Total Length with wings</td>
<td>8.5–9.63</td>
<td>9.06</td>
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<tr>
<td>Total Length without wings</td>
<td>4.8–5.77</td>
<td>5.28</td>
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<tr>
<td>Head Length</td>
<td>1.47–1.49</td>
<td>1.48</td>
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<tr>
<td>Head Width</td>
<td>1.24–1.29</td>
<td>1.26</td>
</tr>
<tr>
<td>Labrum Length</td>
<td>0.31–0.33</td>
<td>0.32</td>
</tr>
<tr>
<td>Labrum Width</td>
<td>0.29–0.31</td>
<td>0.30</td>
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<tr>
<td>Pronotum Length</td>
<td>0.61–0.66</td>
<td>0.63</td>
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<tr>
<td>Pronotum Width</td>
<td>1.06–1.09</td>
<td>1.07</td>
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<tr>
<td>Diameter of the eye</td>
<td>0.27–0.30</td>
<td>0.28</td>
</tr>
<tr>
<td>Diameter of Ocellus</td>
<td>0.09–0.11</td>
<td>0.10</td>
</tr>
<tr>
<td>Antenna segments</td>
<td>13</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 3. Measurements of pseudo-worker cast of Glyptotermes ceylonicus.

<table>
<thead>
<tr>
<th>Characters</th>
<th>Present study</th>
<th>Roonwal &amp; Chhotani (1989)</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Range</td>
<td>Mean</td>
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<tr>
<td>Total body Length</td>
<td>7.94–8.6</td>
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<tr>
<td>Head Length to the base of mandible</td>
<td>1.30–1.42</td>
<td>1.36</td>
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<tr>
<td>Head Width</td>
<td>1.45–1.5</td>
<td>1.47</td>
</tr>
<tr>
<td>Labrum Length</td>
<td>0.46–0.48</td>
<td>0.47</td>
</tr>
<tr>
<td>Labrum Width</td>
<td>0.39–0.42</td>
<td>0.40</td>
</tr>
<tr>
<td>Pronotum Length</td>
<td>0.57–0.62</td>
<td>0.59</td>
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<tr>
<td>Pronotum Width</td>
<td>1.09–1.14</td>
<td>1.11</td>
</tr>
<tr>
<td>Antenna segments</td>
<td>13</td>
<td>-</td>
</tr>
</tbody>
</table>
1. Large species; frons sharply inclined in front at an angle of more than 65°. ................................................................. 2
   — Small species; frons gradually inclined in front at an angle of 45–50°. ................................................................. 5
2. Head much longer (1.7–1.85 times) than wide, left mandible with four marginal teeth ........................................... 3
   — Head not much longer (a little more than 1.5 times) than wide left mandible with three marginal teeth ................. 4
3. Head length to base of mandible 3.20–3.50 mm, head width 1.90–2.05 mm. Antennae 14–15 segmented; mandibles long (1.48–1.58 mm) ................................................................. 6. Glyptotermes tkaderi Chhotani & Bose, 1985
   — Head length to base of mandibles 2.67–3.00 mm, headwidth 1.50–1.67 mm; antennae 12-segmented; mandibles shorter (0.90–1.00 mm) ................................................................. G. ceylonicus (Holmgren, 1911)
4. Antennae 14 segmented; labrum subsquare, broader than long; postmentum long (1.78 mm), waist much narrower, postmentum contraction index 0.42; small species ................................................................. 2. G. taruni Bose, 1999
   — Antennae 12 segmented; labrum tongue shaped, longer than wide; postmentum not much long (1.48–1.70 mm), waist comparatively wider, postmentum contraction index 0.47–0.52; large species ................ 6. G. chiraharitae Amina & Rajmohana, 2016
5. Head capsule large and wide (head length to base of mandibles 1.93–2.27 mm, head width 1.25–1.40 mm); antennae 12–14 segmented ................................................................. 12. G. tekafensis Akhtar, 1975
   — Head capsule small and narrow (head length to base of mandibles 1.18–1.73 mm, head width 0.88–1.20 mm); antennae 8–12 segmented ................................................................. 10. G. roonwali Thakur et al. 2010
6. Head width less than 1.00 mm ........................................................................................................................................... 7
   — Head width more than 1.00 mm ........................................................................................................................................... 9
7. Ocelli absent; antennae 10–11 segmented ......................................................................................................................... 8
   — Ocelli present; antennae 8–12 segmented ......................................................................................................................... 11
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   — Epicranial suture distinct; antennae 8–12 segmented .......................................................................................... 9
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   — Mandibles with a weak basal bump; antennae 11–12 segmented ................................................................. 11. G. roonwali Thakur et al. 2010
10. Antero-lateral corners of head sharply pointed in font ............................................................................................................. 11
    — Antero-lateral corners of head rounded and not pointed in font ............................................................................................................. 13
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    — Mandibles with weaker basal humps; antennae 11–12 segmented .................................................................................. 12
12. Margin between 2nd and 3rd marginal teeth of left mandible not sharp and roundly incurved; postmentum narrow at waist (width at waist 0.16–0.20 mm) ................................................................. 13. G. sensarmal Mait, 1976
    — Margin between 2nd and 3rd marginal teeth of left mandible, not continuous, but with angular cutting edges; postmentum comparatively wider at waist (0.19–0.29 mm) ................................................................. G. brevicaudatus Haviland, 1898
13. Head comparatively wide (head width index 0.67–0.77); epicranial suture incomplete; postmentum wide (maximum width of postmentum 0.40–0.43 mm) ............................................................................................................. G. almoresens Gardiner, 1945
    — Head comparatively narrow (head index 0.59–0.66); epicranial suture complete; postmentum narrow (maximum width of postmentum 0.30–0.37 mm) ............................................................................................................. G. nicobarensis Maiti & Chakraborty, 1981


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– Chelmala Srinivasulu & Gandla Chethana Kumar, Pp. 21266–21281