



A new species of *Theretra* Hübner (Lepidoptera: Sphingidae) from the southern Western Ghats, India

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Abstract

A new species of the genus *Theretra* Hübner [1819], *Theretra shendurneensis* sp. nov., is described from Shendurney Wildlife Sanctuary, southern Western Ghats, India, based on external and internal morphology, and genetic markers. The new species is compared in external and male genital morphology, genetic divergence and geographic range with three similar and closely related species: *T. boisduvalii* (Bugnion, 1839), *T. sumatrensis* (Joicey and Kaye, 1917) and *T. rhesus* (Boisduval, [1875]). Recent changes to the classification of *Theretra* are discussed and rejected.

Key words: Macroglossinae, taxonomy, new species descriptions, Kerala, Shendurney WLS

Introduction

Moths of the Old World hawkmoth genus *Theretra* Hübner, [1819] are small to medium sized, crepuscular or nocturnal hawkmoths belonging to subtribe Choerocampina, tribe Macroglossini, subfamily Macroglossinae (Kawahara *et al.* 2009), whose adults feed on nectar from flowers and which are frequently attracted to light (Bell & Scott 1937). Zolotuhin & Ryabov (2012) recently considered *Theretra* to be a “heterogeneous conglomerate” in which “at least 4 lineages are joined in this polyphyletic group”, which they then divided into four separate genera by the simple expedient of reinstating three of its junior synonyms (*Oreus* Hübner [1819], *Gnathostypsis* Wallengren, 1858 and *Florina* Tutt, 1903) and assigning some (but not all) of the current species of *Theretra* among them. While there are certainly issues regarding the current concept of *Theretra*, we consider the taxonomy proposed by Zolotuhin & Ryabov (2012) to be incomplete and methodologically inadequate (see arguments in Kitching, 2017), and so it is not adopted here.

Species of *Theretra* are found throughout India, with some species restricted to the Eastern and Western Himalaya. Sixteen of the 58 species (Kitching 2017) have been reported from the Indian sub-region: *alecto** (Linnaeus, 1758), *boisduvalii* (Bugnion, 1839), *castanea** (Moore, 1872), *clotho** (Drury, 1773), *gnoma** (Fabricius, 1775), *griseomarginata* (Hampson, 1989), *insignis* (Butler, 1882), *latreillii** (MacLeay, [1826]), *lycetus** (Cramer, 1775), *masoni* Clark, 1924, *nessus** (Drury, 1773), *oldenlandiae** (Fabricius, 1775), *pallicosta** (Walker, 1856), *silhetensis** (Walker, 1856), *suffusa* (Walker, 1856) and *sumatrensis* (Joicey and Kaye, 1917) (Kitching *et al.* 2014). Of these, 10 species (indicated above with an asterisk) have been previously reported from Kerala (Anonymous 2015; Ballesteros-Mejia *et al.* 2016; Bell and Scott 1937; Holloway 1987; Inoue *et al.* 1996; Kitching 2017; Mathew 1995; Mathew 2004; Patil *et al.* 2012; Shubhalaxmi 2012; Smetacek 1994). As part of a biodiversity assessment of moths in the southern Western Ghats, conducted by the first author between 2013 and 2016, four specimens of a *Theretra* species were recorded from Shendurney Wildlife Sanctuary that did not match the description of any known species of Indian *Theretra*. We therefore undertook a comparative study of the external morphology and male genitalia of these moths, supplemented by DNA sequence data from a single mitochondrial marker, to determine their identity and whether they matched any previously described species.

Materials and methods

As part of a survey of the Lepidoptera of Shendurney Wildlife Sanctuary, Kollam District, Kerala ($8^{\circ}49'39''\text{N}$ $77^{\circ}13'1''\text{E}$, elevation 1171 m, Fig. 1), the first author ran a moth trap consisting of a 160W mercury vapour lamp, powered by a portable generator (Honda™ EP 1000), placed in front of a 4×5 ft. white cotton screen, at the forest check post in Pandimotta (Fig. 2). The screen was illuminated from 7:30 pm until 12:30 am, except for 2 June, when it was run until 2:00 am (times constrained by the logistics of the project). Between 31 May and 2 June 2014, four specimens of a large, grey species of *Theretra* were observed and photographed with a Nikon™ D300 camera and a Nikon™ 105mm macro lens. No specimens were recorded arriving at the light after 10:00 pm, and so the relatively early close-down times are not considered likely to have precluded further captures. Tissues (three legs each) were collected from three of the specimens and stored in molecular grade (100%) ethanol and these tissue samples, together with two specimens (NCBS-QA070 and NCBS-QA587) collected, were deposited in the research collections of the National Centre for Biological Sciences (NCBS), Bengaluru (=Bangalore), Karnataka, India. Another male from which tissue was taken (NCBS-QA627) was released back in the field.

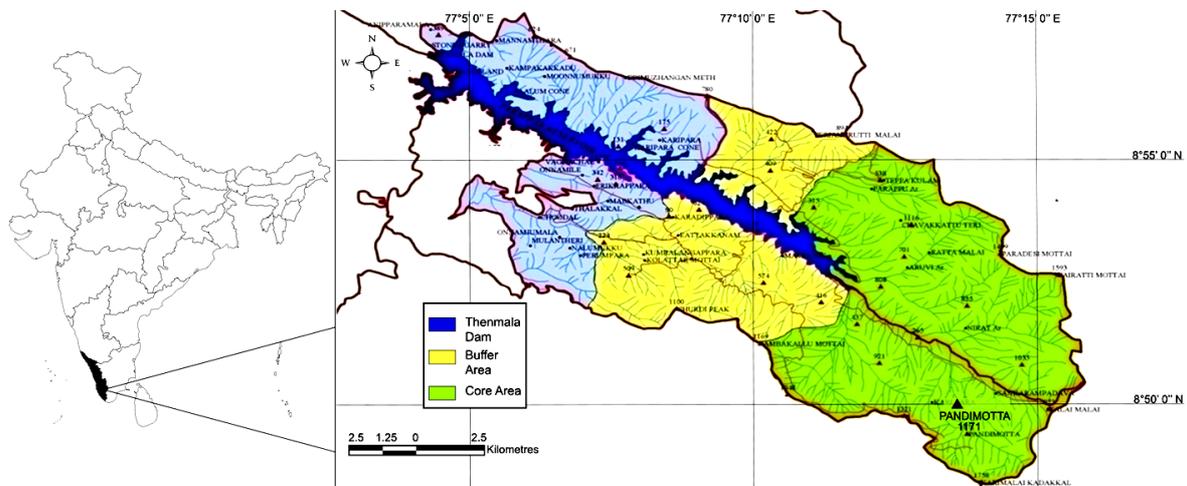


FIGURE 1. Map of Shendurney Wildlife Sanctuary in the southern Western Ghats of Kerala, India, indicating the location of Pandimotta, the type locality of *Theretra shendurneensis*, *sp. nov.* Map of the area is adapted from a map provided by the Kerala Forest Department.



FIGURE 2. Habitat at Pandimotta, Kerala, India ($8^{\circ}49'39''\text{N}$ $77^{\circ}13'1''\text{E}$; 1,171 m asl), the type locality of *Theretra shendurneensis*, *sp. nov.*

The genitalia of the male (NCBS–QA070) were dissected after soaking the last three abdominal segments for five minutes in a 10% aqueous KOH solution (w/v) at 95°C and photographed using a Leica™ MC120 HD camera attached to a Leica™ S8APO microscope. Morphological terminology follows Kitching & Cadiou (2000).

Total genomic DNA was extracted from the female (NCBS–QA587) with a Qiagen DNeasy Blood and Tissue Kit (Venlo, Netherlands) following the manufacturer's protocol. The DNA barcode region (648 bp of the cytochrome-oxidase gene, COI; Hebert *et al.* 2003) was amplified using K698-JANE primer pair (K698: 5' TACAATTTATCGCCTAAACTTCAGCC; JANE: 5' TAAAATTACTCCTGTTAATCCTCC; Brower *et al.* 2006). We used the following program for PCRs: an initial 2 min denaturation at 95°C, followed by 35 cycles of 30s at 94°C, 30s at 50°C and 1 min at 72°C, then a 7 min final extension at 72°C. PCR products were cleaned using ExoSap and sequenced using an ABI 310 Genetic Analyzer Version 3.1 (Applied Biosystems, Foster City, USA). Both DNA strands were sequenced, and cleaned using Geneious 7.1.7 (Drummond *et al.* 2012). Publicly available DNA barcode sequences of the phenotypically similar species, *Theretra rhesus*, *T. sumatrensis* and *T. boisduvalii*, together with those of several other species of *Theretra* and the more distantly related sphingid, *Agrius convolvuli*, to serve as an outgroup taxon, were downloaded from GenBank (<https://www.ncbi.nlm.nih.gov/genbank/>) and the Barcode of Life Database (BOLD; Ratnasingham & Hebert 2007; Table 1). This entire sequence dataset was aligned using ClustalW in Mega 6.06 (Tamura *et al.* 2013). Uncorrected p-distances were calculated using Mega 6.06 (Tamura *et al.* 2013) after removing ambiguous base-pairs (Table 2). The optimal partitioning and sequence evolution model was chosen using the greedy search algorithm of PartitionFinder (Lanfear *et al.* 2012). The phylogeny was reconstructed by the Maximum Likelihood (ML) method, implemented using raxmlGUI (Silvestro *et al.* 2012) under the GTR+G model, as identified by PartitionFinder, with a rapid bootstrap of 10,000 replicates. We restricted this basic phylogenetic analysis to a single barcode region because comparative sequence data are lacking for other genes in related hawkmoths, so a more comprehensive phylogenetic analysis is not possible at this time. This genus is also in need of a comprehensive revision, at which time a molecular and morphological phylogenetic analysis will be more appropriate.

Results

The phylogram from the limited dataset of the mitochondrial barcode region showed low bootstrap support (Fig. 3), but it indicated approximate species relationships of closely related species of *Theretra*. It also showed reasonably strong bootstrap support for species relationships within the monophyletic group containing the Shendurney moth: (*shendurneensis* (*sumatrensis*, *boisduvalii*)), and for most other close relatives in the clade. *Theretra rhesus* was the sister of these three species, but showed greater molecular divergence (Table 2) Molecular divergence between *shendurneensis*, *sumatrensis* and *boisduvalii* is low (approx. 0.6%), which is typical of inter-specific distances for this group of moths for the barcode region (Wilson *et al.* 2011). This indicated the phylogenetic placement of the Shendurney moth, although this may be improved with more rigorous phylogenetic analyses when more molecular data become available. Based on the available comparative sequence divergence within this moth group, the clear external and internal morphological differences to the three closely related species, and the markedly disjunct distributions of *sumatrensis* and the newly collected taxon, we consider the Shendurney moths to represent a hitherto undescribed species, which we describe below.

Theretra shendurneensis sp. nov.

(Figs. 4–6, Table 1)

ZooBank LSID urn:lsid:zoobank.org:act: 369A10C8-1E5F-41E5-B555-8DA213315372

Holotype (Fig. 4a, b, 5a, b): ♂, India, Kerala, Kollam District, Shendurney Wildlife Sanctuary, Pandimotta forest camp, 8°49'39"N 77°13'1"E, 1,171 m, 31.v.2014, Yash Sondhi leg. Preserved dry, pinned, deposited in the Research Collections at the National Centre for Biological Sciences, Bengaluru (= Bangalore), India. Voucher code NCBS-QA070.

Paratype: 1♀ (Fig. 4c, d, 5c), data as holotype. Preserved dry, pinned, deposited in the Research Collections at the National Centre for Biological Sciences, Bengaluru, India. Voucher code NCBS–QA587. **Additional material (non-type)**: ♂ (Fig. 5d, e), data as holotype but date 1.vi.2014. Only DNA extracted from legs retained from this

specimen, deposited in the Research Collections at the National Centre for Biological Sciences, Bengaluru, India. Voucher code NCBS-QA627. ♂ (Fig. 5f), data as holotype but date 2.vi.2014 (not collected).

TABLE 1. Sequences used to generate the ML phylogram (Fig. 3).

Species Name	Locality	Accession Number	Source	Sequence Length
<i>Agrius convolvuli</i>	Australia: Queensland, Kuranda (Top of the Range)	KJ168817.1	GenBank	658
<i>Theretra rhesus</i>	Philippines: Panay Isl., Mt Madja-As	JN678629.1	GenBank	658
<i>Theretra margarita</i>	Australia: Western Australia, Mistake Creek, c. 12 km n. Turkey Creek on Great Northern Hwy	KJ169404.1	GenBank	646
<i>Theretra sumatrensis</i>	Indonesia: Jawa Timur, Mt. Gumitir	JN678600.1	GenBank	658
<i>Theretra oldenlandiae lewini</i>	Australia: N. Queensland, Chillagoe Mungana NP, Almaden	KJ169249.1	GenBank	658
<i>Theretra latreillii latreillii</i>	Australia: North Queensland, near Tully, Tully Gorge NP	KJ168913.1	GenBank	657
<i>Theretra nessus</i>	Australia: North Queensland, Daintree NP, Cape Tribulation	KJ168794.1	GenBank	658
<i>Theretra celata babarensis</i>	Indonesia: Maluku	SOWC829-06	BOLD	649
<i>Theretra boisduvalii</i>	Indonesia: Nusa Tenggara Barat	SOWC832-06	BOLD	658
<i>Theretra celata</i>	Australia: Queensland, 14km ENE Heathlands	KJ169401.1	GenBank	598
<i>Theretra shendurneensis</i>	India: Pandimotta, Shendurney WLS, Kerala	KY688373	GenBank	585

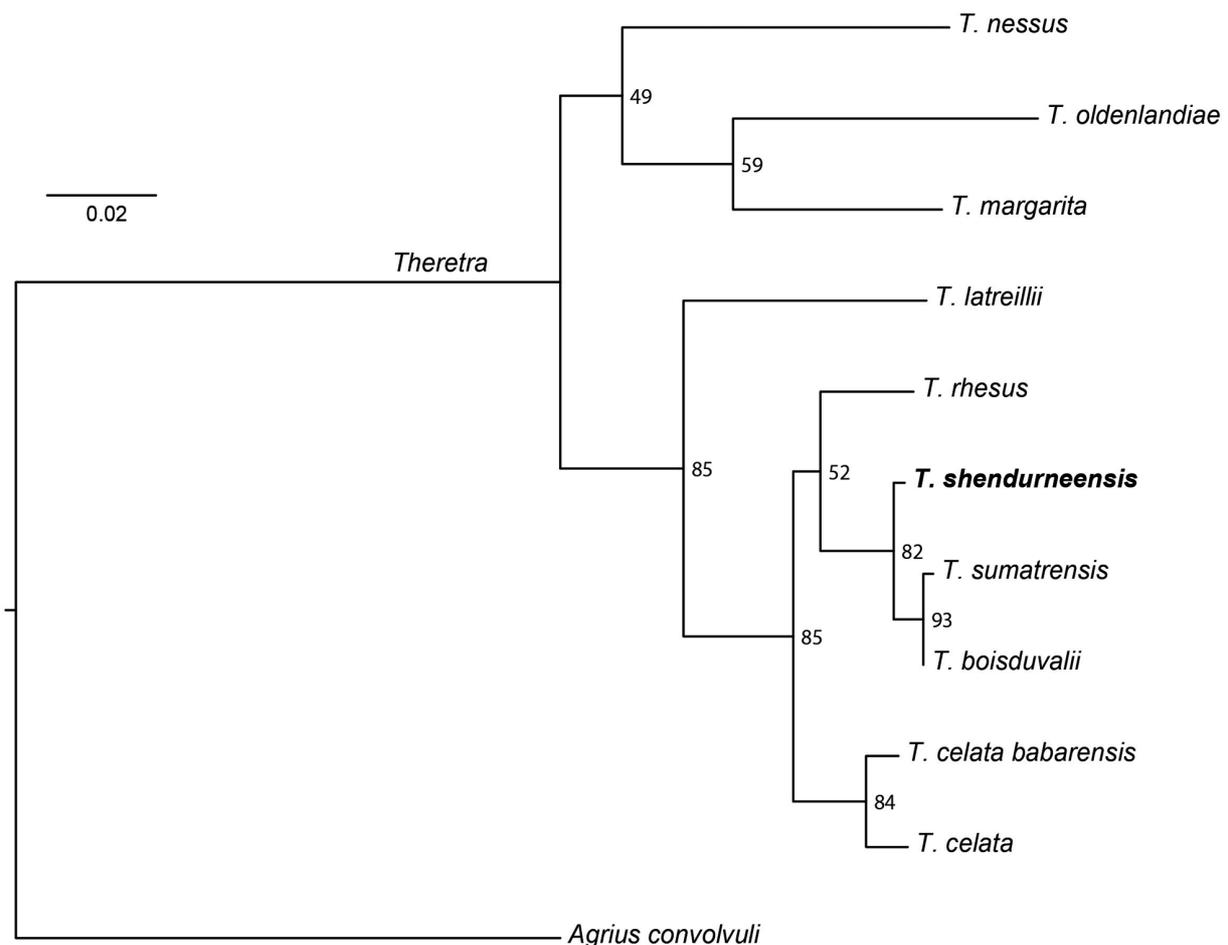


FIGURE 3. Maximum Likelihood phylogram of selected species of the genus *Theretra* based on the mitochondrial barcode marker. Bootstrap scores of approx. 50% and greater are indicated at the nodes.

Description. Male (holotype; NCBS-QA070): Forewing length: 43.5 mm. **Upperside:** Head, thorax and abdomen dull greenish-brown dorsally; antennae fasciculate, apically hooked, white scaled above; eyes ringed with brown; frons green; gena and labial palps white; proboscis dark to pale brown; tegulae edged in off-white; abdomen with a pair of basal, lateral black patches and a blackish dorsal stripe flanked by two more diffuse longitudinal lines. *Forewing:* ground colour dull greenish-brown; discal spot distinct, small, black; antemedial lines two, faint; medial lines three, basal line stronger, almost twice width of middle line, distalmost line very faint; postmedial lines also two, basal line strong, broader and darker than basal antemedial line, narrowing towards apex, distal line weaker, area between them darker than ground colour; submarginal line well-developed, running parallel to termen. *Hindwing:* ground colour black; a small yellow patch near anal angle with a distinct V-shaped marking; a narrow yellow band running along inner margin, not extending to base; a broad yellow patch extending from base to middle of costa, where it narrows sharply, vein Sc+R highlighted with black within this patch; a small, scaleless region present in the centre of the costal yellow patch in the male only.

Underside. Head, thorax, legs and abdomen pale fawn. Ground colour of both wings pale yellow, faintly irrorated with minute black dots throughout. *Forewing:* basal half black; costa with a prominent subapical black spot; postmedial line black, concave, slightly sinuous, running from apex to inner margin, sharply angled outwards toward termen at vein Rs3, and irregular from vein Rs3 to inner margin; area distal to postmedial line paler; a pale yellow area along basal half of inner margin. *Hindwing:* antemedial line faint, formed from a series of oblique v-shaped marks; postmedial line even less distinct, curved, running from apex and ending before inner margin.

Female (paratype). Similar to male but larger (forewing length = 51 mm); antennae thinner, simple; abdomen bulkier, dorsal stripe fainter; wing pattern more prominent; forewing broader and more rounded in outline.

Male genitalia. Similar to other taxa of the *Theretra boisduvalii* species-group (Fig. 6): uncus and gnathos forming the typical macroglossine “bird-beak” structure; saccus broad and anteriorly rounded; valve sole-shaped, inner surface covered with strong, basally-directed setae; harpe a low, broadly triangular lobe with indistinct teeth along the distal edge; phallus slightly curved.

DNA barcode. The 648 bp barcode region of COI of the paratype female is deposited in NCBI GenBank (accession number KY688373).

Etymology. The moth is named after the type locality, Shendurney Wildlife Sanctuary.

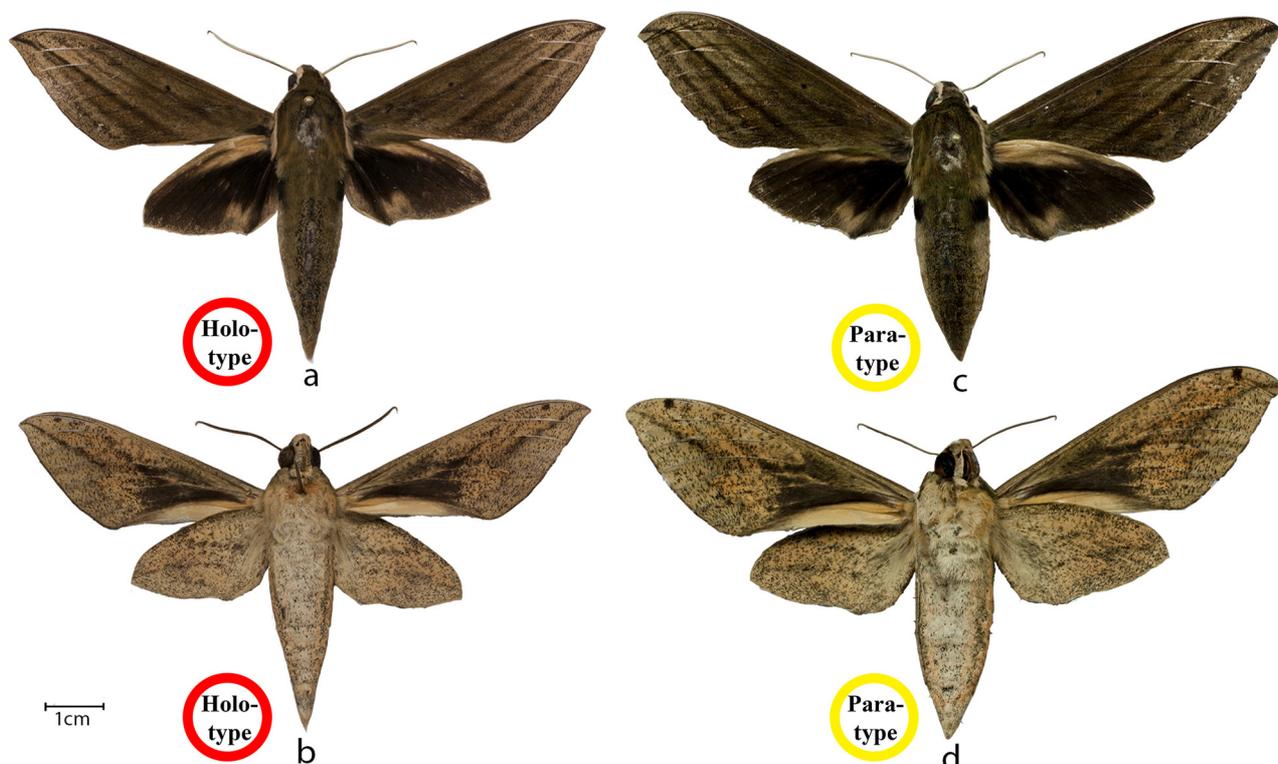


FIGURE 4. *Theretra shendurneensis* sp. nov. a–b: holotype ♂ (NCBS-QA070), upperside and underside. c–d: paratype ♀ (NCBS-QA587), upperside and underside.

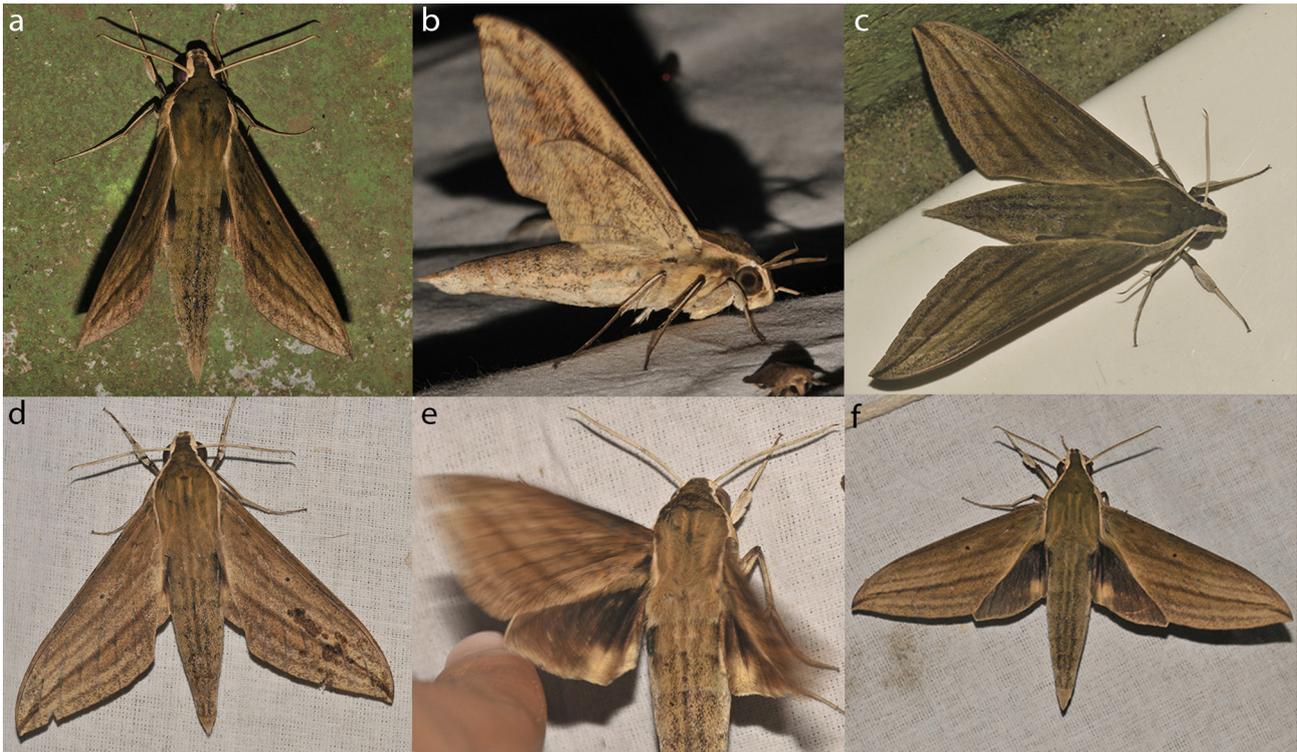


FIGURE 5. *Theretra shendurneensis* sp. nov. habitus. a,b: holotype ♂ (NCBS-QA070); c: paratype ♀ (NCBS-QA587); d,e: ♂, tissue taken for sequencing, specimen not collected (NCBS-QA627); f: ♂, tissue not taken and specimen not collected.

TABLE 2. P-distances of the COI barcode region of the species compared in this study.

	1	2	3	4	5	6	7	8	9	10	11
1. <i>T. boisduvalii</i>	-										
2. <i>T. celata</i>	0.036	-									
3. <i>T. celata babarensis</i>	0.034	0.012	-								
4. <i>T. latreillii</i>	0.052	0.06	0.062	-							
5. <i>T. margarita</i>	0.079	0.067	0.072	0.069	-						
6. <i>T. nessus</i>	0.076	0.072	0.077	0.082	0.07	-					
7. <i>T. oldenlandiae</i>	0.081	0.079	0.081	0.079	0.065	0.088	-				
8. <i>T. rhesus</i>	0.029	0.034	0.029	0.058	0.069	0.074	0.077	-			
9. <i>T. sumatrensis</i>	0.002	0.038	0.036	0.053	0.081	0.077	0.082	0.031	-		
10. <i>T. shendurneensis</i>	0.005	0.034	0.033	0.053	0.077	0.077	0.082	0.027	0.007	-	
11. <i>Agrius convolvuli</i>	0.115	0.112	0.112	0.113	0.112	0.115	0.112	0.112	0.117	0.113	-

Differential diagnosis. The preliminary DNA barcode analysis undertaken in the present study showed that two other Indian species of *Theretra*, *T. boisduvalii* and *T. sumatrensis*, are closely related to the new species (Fig. 3), although neither has yet been found in the Western Ghats. A third species, *T. rhesus*, is genetically more distantly related to *T. shendurneensis* sp. nov. but has a similar habitus; it has not yet been reported from India.

Habitus (Fig. 7): In body and wing pattern *T. shendurneensis* sp. nov. most closely resembles *T. rhesus*. However, the two species can be separated by the pattern of oblique lines on the forewing. In *T. shendurneensis* sp. nov., the distalmost of the three medial lines is barely visible and easily overlooked, whereas in *T. rhesus* the middle and distal lines are of approximately the same intensity. *T. rhesus* is also slightly smaller than *T. shendurneensis* sp. nov. In comparison to these two species, *T. boisduvalii* and *T. sumatrensis* are much plainer moths. In both these species, all the oblique lines are much weaker; in particular, the basalmost postmedial line is

very faint, only being strongly marked on the veins as a series of dark dots or short dashes. When fresh, *T. boisduvalii* is a rather greenish moth with a rather uniform suffusion of darker scales, whereas *T. sumatrensis* is paler and more brownish, with a cleaner pattern, and most specimens have a distinct diffuse darker cloud across the middle of the forewing.

Male genitalia (Fig. 8): The structures of the male genitalia of the four related species are very similar overall. Although the shapes of the uncus, gnathos and saccus show small differences in shape, the harpes are distinctive. The harpe of *T. rhesus* is distinctly higher than wide, where those of the other three species are at least as wide as high and usually wider. The harpe of *T. boisduvalii* and *T. sumatrensis* is convex, rather rounded and broad in the former and more angular and toothed in the latter. In contrast, the distal margin of the harpe in *T. shendurneensis* is almost straight with minute teeth.



FIGURE 6. *Theretra shendurneensis* sp. nov., holotype (NCBS-QA070), ♂ genitalia, top to bottom: genital capsule (with left valve removed, lateral view; left valve, external view; phallus; genital capsule, dorsal view.

Geographic Distribution. *Theretra shendurneensis* sp. nov. has so far been reported only from the type locality. There are no historical records (Bell & Scott 1937) or specimens in the collections of the Natural History Museum, London, that might correspond to this species (I. Kitching, pers. obs.). There are no other known records

from Indian museums or from other hawkmoth researchers in India (P.R. Shashank, IRAI, pers. comm.; also personal correspondence and museum visits of Yash Sondhi). A report on the Sphingidae of Karnataka state undertaken by the staff of the Sphingidae Museum, Příbram, Czech Republic (Melichar, 2012) did not list any records of a species resembling *T. shendurneensis* **sp. nov.** Such a narrow distribution is unusual for *Theretra*, since most other related species appear to be more widespread. The geographical ranges of *T. boisduvalii*, *T. sumatrensis* and *T. rhesus* were modelled as part of a larger macroecological study on Old World Sphingidae by Ballesteros-Mejia *et al.* (2016) and maps can be found on the Map of Life at https://mol.org/species/Theretra_boisduvalii, https://mol.org/species/Theretra_sumatrensis and https://mol.org/species/Theretra_rhesus respectively. Despite being closest in wing pattern, *T. rhesus* is restricted to Southeast Asia, from southern Thailand (whence it is predicted to occur in neighbouring parts of Myanmar, Cambodia and Vietnam), Peninsular Malaysia, Sumatra and Java, the Western Lesser Sunda Islands, Borneo, Sulawesi, the Philippines, and Lanyu Island (Taiwan). It has not been recorded in India, nor is it currently predicted to. *Theretra sumatrensis* occurs from SW China (Yunnan and Xizang) to central Myanmar, northern Thailand, Laos, Vietnam, Peninsular Malaysia, Java, Sumatra, the Western Lesser Sundas, and Borneo, but it does not reach Sulawesi, the Philippines or Taiwan. It was previously not reported from India, but we here extend its range into NE India based on a specimen from Mawkisyiem, East Khasi Hills District, Meghalaya (NCBS–PW607, male, Fig. 7c) and two specimens photographed at Langka, Pakke Tiger Reserve, East Kameng District, and the Sessa Orchid Sanctuary, West Kameng District, Arunachal Pradesh (Moths of India image codes bh543 and bk466, respectively; Sondhi *et al.* 2017). In the Natural History Museum, London, there are five specimens labelled simply “Sikkim”, three labelled “Darjeeling”/“Darjiling”, three from “Khasia Hills” and three from “Lakhimpur, Assam”, all of which were probably collected in the last two decades of the nineteenth century. *Theretra boisduvalii* has a similar range to *T. sumatrensis* but extends further east through southern China to Taiwan, and further west through the southern Himalaya to NW India (Himachal Pradesh). *Theretra boisduvalii* was described from a specimen purportedly from Crete but this is most likely an error. Ballesteros-Mejia *et al.* (2016) also predicted *T. boisduvalii* to occur in the north-eastern part of peninsular India, which may be correct but has yet to be confirmed, and crucially in the Western Ghats and Sri Lanka. There were then, and still are, no specimen records to back up this purported range extension, which was based solely on the macroecological models they used. In retrospect, however, it would seem reasonable to infer that this part of the modelled distribution of *T. boisduvalii* actually represents the predicted distribution of *T. shendurneensis* **sp. nov.** Thus, *T. shendurneensis* **sp. nov.** may be expected to be more widely distributed in the Western Ghats and possibly also in Sri Lanka and/or other parts of peninsular India such as the Eastern Ghats.

Flight Period. The first author conducted 40 days of field surveys between 2013 and 2016 in the southern Western Ghats during most months (February, April, May, June, August, September, October and November) of the year. The new species was only recorded on 31 May 2014 and 1–2 June 2014, on consecutive days at the same locality (no surveys were undertaken there in 2013 or 2015 and no specimens were recorded in 2016). Hence, as far as known, *T. shendurneensis* **sp. nov.** is possibly univoltine, and that adults fly during the summer and pre-monsoon months.

Status, habitat, and habits. *T. shendurneensis* **sp. nov.** appears to be rare, at least at light; however further sampling is necessary to confirm this. Despite extensive collecting and rearing, Bell & Scott (1937) did not find the species, nor did a more recent survey of the hawkmoths of Karnataka (Melichar, 2012). Even during the surveys of the first author, when *T. shendurneensis* **sp. nov.** was seen on three consecutive nights, only four individuals were recorded. The type locality of Pandimotta (8°49'39" N 77°13'1" E, elevation 1171 m, Figs 1-2), is part of the Shendurney Wildlife Sanctuary (8°48'–8°58' N, 77°4'–77°7' E), which itself is located in the Agasthyamalai Biosphere Reserve in the Thenmala Forest Division of Kollam District of Kerala. The Shendurney Wildlife Sanctuary lies on either side of the Shendurney River and is a biodiverse area from where numerous rare and endemic species of flora and fauna have been recorded (Sasidharan & Anto 1997; Mathew *et al.* 2004; Abraham *et al.* 2013; Joshi *et al.* 2016). The habitat at Pandimotta comprises mid-elevation evergreen forests and grasslands. Common woody plant genera in this area include *Mesua*, *Hopea*, *Calophyllum*, *Cullenia*, *Syzygium*, *Cinnamomum*, *Calamus* and *Strobilanthus* (Birdlife International, 2017). The vegetation immediately surrounding the Pandimotta forest rest house, where the specimens of this species were collected and photographed, is mid-elevation evergreen forests mixed with reed (*Ochlandra*, Poaceae) patches. A list of all the Sphingidae species collected at the type locality is included in Table 3. The habits of *T. shendurneensis* **sp. nov.** are unknown, apart from the fact that it comes to blacklight at night.



FIGURE 7. *Theretra* species similar *T. shendurneensis* **sp. nov.** a: *Theretra rhesus*, male, BMNH(E)#274965. North Korintji Valley, Sumatra, Indonesia. b: *Theretra boisduvalii*, female, BMNH(E)#274961. Bukit Larut, (formerly Maxwell's [Hill], Lt. Cottage), Taiping, Perak, Malaysia. c: *Theretra sumatrensis*, male, NCBS-PW607. Mawkisyiem, East Khasi, Meghalaya, India. d: *Theretra shendurneensis* **sp. nov.**, holotype male, NCBS-QA070, Pandimotta, Kollam, Kerala, India. Upperside (left) and underside (right) of each specimen are illustrated.

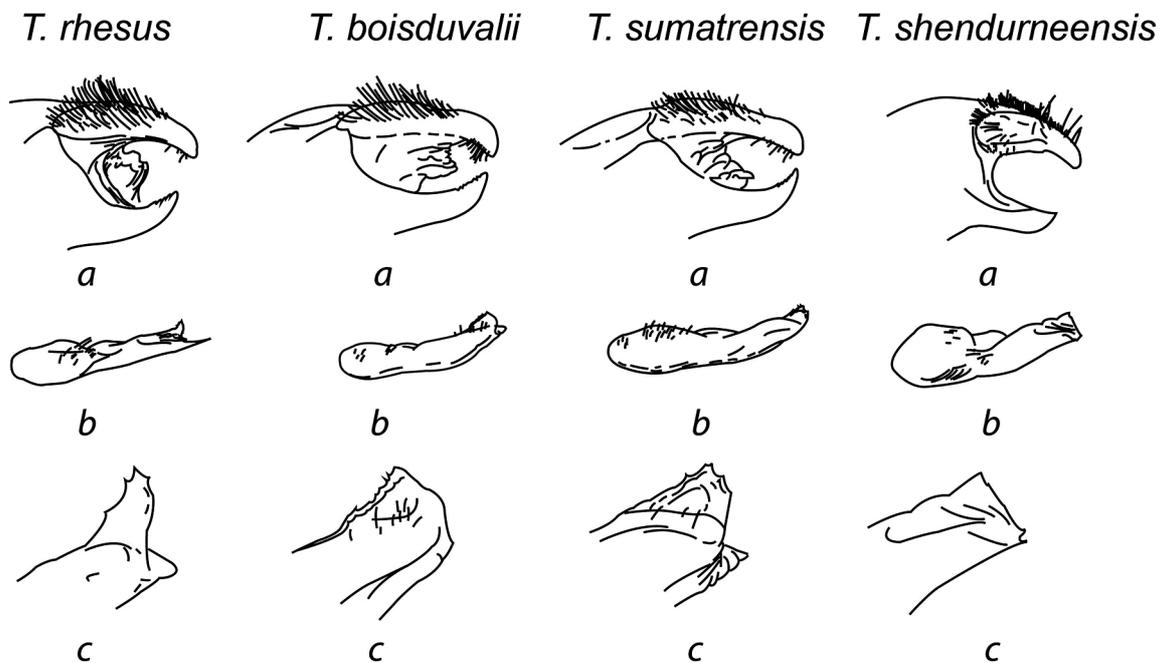


FIGURE 8. Comparative diagrams of the male genitalia of *Theretra shendurneensis* **sp. nov.** and related species: a: uncus and gnathos, lateral view; b: right sacculus and harpe; c: right harpe (not to scale). *Theretra rhesus*, *T. boisduvalii* and *T. sumatrensis* were redrawn from Vaglia *et al.* (2010).

Life History. Unknown, but likely to be similar to related *Theretra* species, which are themselves poorly recorded. The immature stages of *T. rhesus* are still unknown, and while Dupont & Roepke (1941), and Roessler & Küppers (1977) and Diehl ([1982]), referred to the life history of “*Theretra boisduvalii*”, in Java and Sumatra respectively, these data may refer to *T. sumatrensis* instead as these two species have been confused in the past. Larvae of the *Theretra clotho* species group are known to feed mostly on species of plants from the following families: Vitaceae, Araceae, Dilleniaceae and more rarely Malvaceae, Onagraceae and Begoniaceae. The larvae of *T. shendurneensis* **sp. nov.** should be searched for, and will probably be found, on such plant families.

TABLE 3. List of the Sphingidae recorded at Pandimotta.

Subfamily	Species
Macroglossinae	<i>Acosmeryx akanshi</i> Melichar, Řezáč, Manjunatha & Horecký, 2014
Macroglossinae	<i>Acosmeryx anceus</i> (Stoll, 1781)
Macroglossinae	<i>Hippotion velox</i> (Fabricius, 1793)
Macroglossinae	<i>Hippotion rosetta</i> (Swinhoe, 1892)
Macroglossinae	<i>Hippotion celerio</i> (Linnaeus, 1758)
Macroglossinae	<i>Rhagastis castor</i> (Walker, 1856)
Macroglossinae	<i>Theretra clotho</i> (Drury, 1773)
Macroglossinae	<i>Theretra nessus</i> (Drury, 1773)
Macroglossinae	<i>Theretra gnoma</i> (Fabricius, 1775)
Macroglossinae	<i>Theretra castanea</i> (Moore, 1872)
Macroglossinae	<i>Theretra shendurneensis</i> sp. nov.
Macroglossinae	<i>Theretra pallicosta</i> (Walker, 1856)
Smerinthinae	<i>Ambulyx substrigilis</i> Westwood, 1847
Smerinthinae	<i>Ambulyx moorei</i> Moore, 1858
Smerinthinae	<i>Ambulyx belli</i> (Jordan, 1923)
Smerinthinae	<i>Amplipterus panopus</i> (Cramer, 1779)
Smerinthinae	<i>Marumba nympa</i> Rothschild & Jordan, 1903
Sphinginae	<i>Acherontia lachesis</i> (Fabricius, 1798)
Sphinginae	<i>Agrius convolvuli</i> (Linnaeus, 1758)
Sphinginae	<i>Megacorma obliqua</i> (Walker, 1856)
Sphinginae	<i>Meganoton nyctiphanes</i> (Walker, 1856)
Sphinginae	<i>Psilogramma vates</i> (Butler, 1875)
Sphinginae	<i>Dolbina manjunatha</i> Haxaire and Melichar 2013

Discussion

The discovery of this new species is perhaps not surprising given that several Western Ghats Sphingidae populations have recently been shown to be distinct, endemic species separate from populations elsewhere in South-East Asia; e.g., *Dolbina manjunatha* Haxaire & Melichar, 2013 was separated from *Dolbina inexacta* (Walker, 1856), and *Acosmeryx akanshi* Melichar, Řezáč, Manjunatha & Horecký, 2014 was separated from *Acosmeryx shervillii* (Boisduval, [1875]). The evolutionary origins of *Theretra shendurneensis* remain unknown. A better understanding of its distribution, together with a comprehensive phylogenetic and phylogeographic study of the entire genus, will be critical in understanding the systematics, biogeography and speciation in this clade.

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