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Source: *Revue suisse de Zoologie*, 129(1) : 51-57

Published By: Muséum d'histoire naturelle, Genève

URL: <https://doi.org/10.35929/RSZ.0061>

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First record of *Phallocaecilius* Lee & Thornton, 1967 (Psocodea: 'Psocoptera': Pseudocaeciliidae) from India, with the description of a new species from the Southern Western Ghats

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Abstract: *Phallocaecilius indicus* sp. nov., from the Southern Western Ghats of Tamil Nadu and Kerala, India, is here described and illustrated. This is the third known species in the genus, which is here reported from the Indian subcontinent for the first time.

Keywords: New species - barklice - taxonomy - Agasthiyamalai Biosphere Reserve - Meghamalai.

INTRODUCTION

Lee & Thornton (1967) erected the genus *Phallocaecilius*, with *P. hirsutus* (Thornton, 1961) from Hong Kong as the type species. The genus is characterized by the presence of sense-papillae in the anal area of the male forewing, a hypandrium with lateral sclerites, a long endophallus with thorn-like sclerites, a bilobed subgenital plate, small gonapophyses, and the ventral and dorsal valves unlobed and membranous (Lee & Thornton, 1967). Two species of this genus are known: *P. hirsutus* (Thornton, 1961) [Hong Kong] and *P. sentosus* Li, 1999 [China]. Their distribution is restricted to the Asia and Pacific regions (Hong Kong, China, Christmas Island, Indonesia, Japan); so far, the genus has not been recorded from the Indian subcontinent (Yoshizawa, 1996; Lienhard & Smithers, 2002; New & Lienhard, 2007). Here we describe a new species of *Phallocaecilius* from the Southern Western Ghats of Tamil Nadu and Kerala, India.

MATERIALS AND METHODS

The specimens were collected in an enamel tray by beating dead leaves and green vegetation near streams in different parts of Tamil Nadu and Kerala, India and stored in vials with 70% ethanol (Fig. 1). External morphology and color pattern of the specimens were studied by placing whole specimens under a stereo zoom

microscope (Leica M205A) and photographed using Leica Application Suite. The body parts (head, lacinia, legs, wings and genitalia) of fifteen specimens were dissected and mounted in Canada balsam. The remaining parts of the dissected specimens are preserved in 70% ethanol for further studies. The mounted body parts were observed, measured and photographed under a compound microscope (Leica DM3000). Illustrations were made using Clip Studio Paint Pro software and edited with Adobe Photoshop CS5. The terminology for body parts follows Yoshizawa (2005) and New & Lienhard (2007). The studied specimens are deposited in the following institutions: National Zoological Collections of the Southern Regional Centre, Zoological Survey of India, Chennai, Tamil Nadu, India (SRC/ZSI) and Western Ghats Regional Centre, Zoological Survey of India, Kozhikode, Kerala (WGRC/ZSI).

Abbreviations used in the descriptions and measurements are as follows: FWL, HWL: lengths of right fore- and hindwings; F, T, t1, t2: lengths of femur, tibia, and tarsomeres 1, and 2 of right hind leg; Mx4: length of the fourth segment of right maxillary palpus; ctt1: number of ctenidobothria on t1; fl...fn: lengths of flagellomeres 1...n of right antenna; IO, D, d: minimum distance between compound eyes, antero-posterior diameter, and transverse diameter of right compound eye, respectively, all in dorsal view of head; PO: d/D; measurements are in µm.

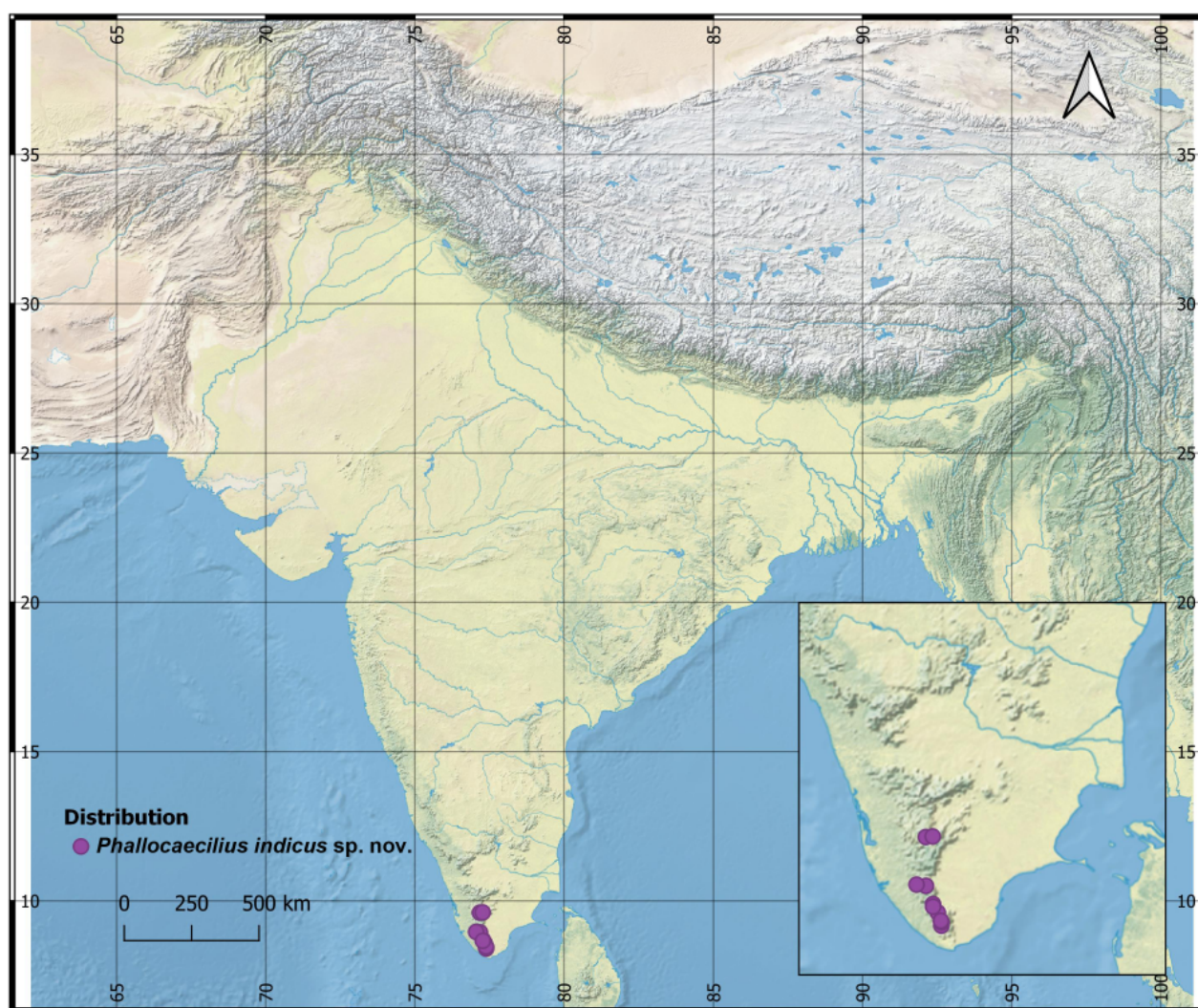


Fig. 1. Distribution records of *Phallocaecilius indicus* sp. nov. in the Southern Western Ghats.

TAXONOMIC PART

Phallocaecilius indicus sp. nov.

Figs 2-17

Material examined

Holotype: SRC-ZSI/I/PSO/78; male (Slide mounted); India, Tamil Nadu, Tirunelveli District, Agasthiyamalai Biosphere Reserve, Kalakkad-Mundanthurai Tiger Reserve (KMTR), Ambasamudram Range, Kuthiraivetti, 8.58790° N, 077.34141° E, 1231 m; 22.08.2019; leg. R. Babu.

Paratypes: SRC-ZSI/I/PSO/79 to SRC-ZSI/I/PSO/92 and ZSI/WGRC/I.R.- INV.18308 (slide-mounted, or in 70% ethanol); 19 males, 24 females, same data as the holotype. 1 male, 10 females; Tamil Nadu, Tirunelveli District, Kalakkad-Mundanthurai Tiger Reserve, Mundanthurai Range, Karaiyar Beat, Gouthalaiaru, 8.66766° N, 077.27757° E, 289 m; 18.08.2019; leg. R. Babu. 3 males, 15 females; Tamil Nadu, Tirunelveli District, Kalakkad-Mundanthurai Tiger Reserve,

Mundanthurai Range, Servalar, Kodamadi, 8.70349° N, 077.27581° E, 440.6 m; 19.08.2019; leg. R. Babu. 1 male, 18 females; Tamil Nadu, Kanyakumari District, Kanyakumari Wildlife Sanctuary, Kalikesam, 8.410000° N, 77.389367° E, 124 m; 04.12.2018; leg. J. Thilak. 2 males, 13 females; Tamil Nadu, Kanyakumari Wildlife Sanctuary, Alagiyapandiapuram Range, Balamore, 8.455683° N, 77.391417° E, 450 m; 04.12.2018; leg. J. Thilak. 5 females; Tamil Nadu, Kanyakumari Wildlife Sanctuary, on the way to Muthukulivayal, 2nd bend, 08.47609° N, 077.38336° E, 994 m; 16.02.2020; leg. Varadaraju. 1 male, 12 females; Tamil Nadu, Theni District, Meghamalai Wildlife Sanctuary, Gudalur Range, Vannathiparai, 9.61901° N, 77.27161° E, 504 m; 28.02.2019; leg. R. Babu. 9 males, 11 females; Tamil Nadu, Theni District, Meghamalai Wildlife Sanctuary, Gudalur Range, Amaravathi Beat, Bublimesh Stream, 9.61103° N, 77.17855° E, 891 m; 01.03.2019; leg. R. Babu. 6 males, 3 females; Kerala, Agasthiyamalai Biosphere Reserve, Shendurney Wildlife Sanctuary,

Kollam District, Rosemala, 8.949933° N, 77.180500° E, 555 m; 22.01.2019; leg. G. Ramesh. 5 males; Kerala, Agasthiyamalai Biosphere Reserve, Shendurney Wildlife Sanctuary, Kollam District, Deer Park, Thenmala, 8.966522° N, 77.052261° E, 91 m; 23.01.2019; leg. G. Ramesh.

Diagnosis: *Phallocaecilius indicus* sp. nov., differs from the other known species, *P. hirsutus* and *P. sentosus* by the male phallosome endophallus having stout, spine like (like hard stout spines) thorn sclerites; in females, the subgenital plate apical lobes bear one seta apically and another one on the mesial border, gonapophyses ventral valves narrow, pointed apically; dorsal valves with broad lobe, bearing a bristled stylet; external valves rounded, apically thin, bearing four long setae. In the other two species, the phallosome endophallus bears less robust thorns. In the female of *P. hirsutus*, the apical lobe of the subgenital plate bears five to six setae, external valves triangular, dorsal valves bulged and ventral valves fleshy or membranous.

Etymology: The species epithet refers to the country name India.

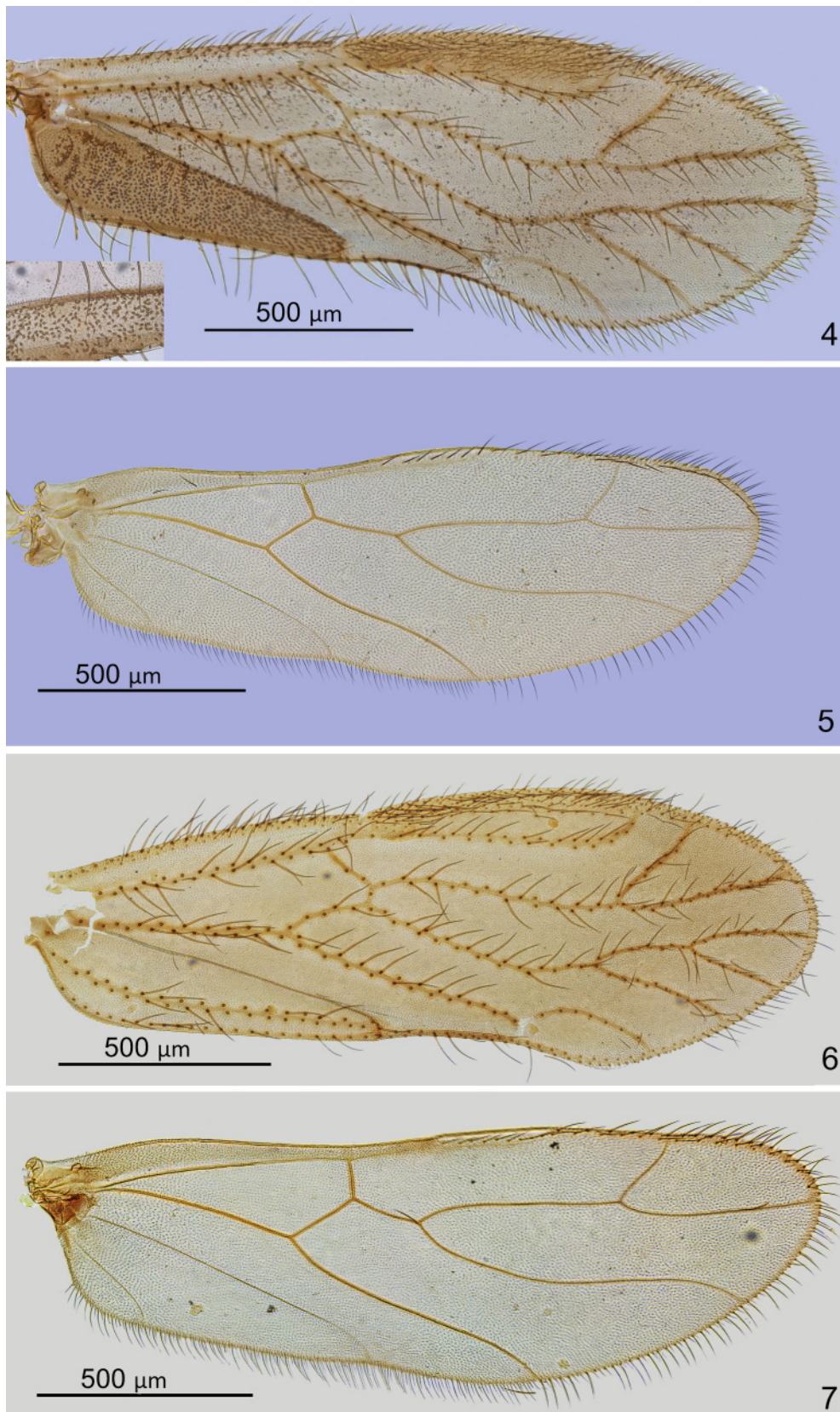
Description of the male holotype

Color: Vertex and frons yellowish-brown, ocelli hyaline, with conspicuous reddish-brown centripetal crescents, genae pale yellowish, eyes brownish-black, third and fourth maxillary palpomeres slightly brown, clypeus yellowish-brown, antenna buff, scape and pedicel light brown. Prothorax pale yellowish, meso- and metathorax light brown. Forewings brown, veins brown except for M+Cu1, R2+3, R4+5, M1 and M2 light brown. Hindwings hyaline, veins pale yellow except M+Cu1, Rs and proximal Cu1 light brown. Legs: femora, tibiae and tarsi light brown, claws brown. Abdomen yellowish brown (Fig. 2).

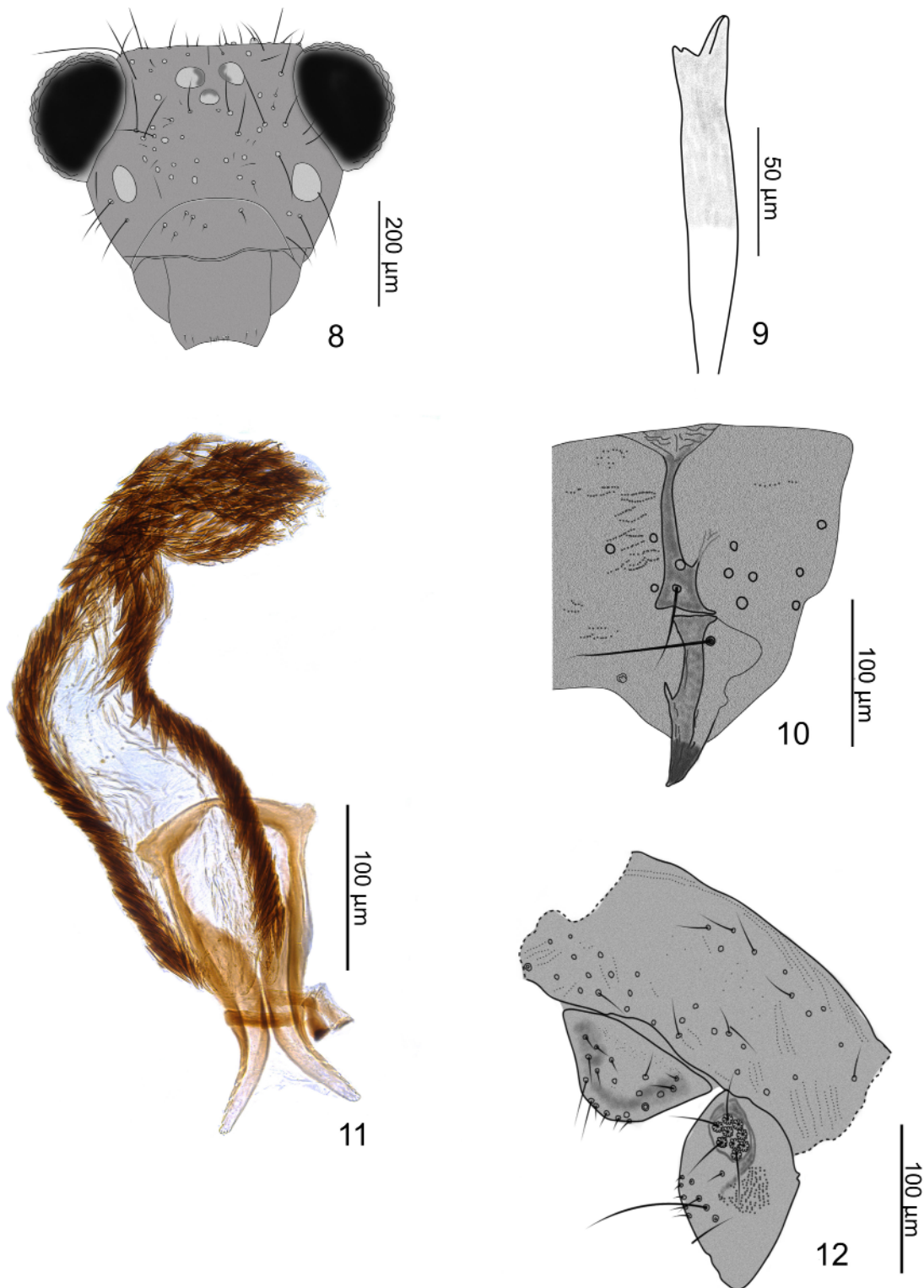
General morphology: Body length 1.8-2.1 mm. Frons and vertex bearing stout black setae, compound eyes small, three ocelli, in triangular arrangement (Fig. 8), fourth maxillary palpomere apically rounded, setose.



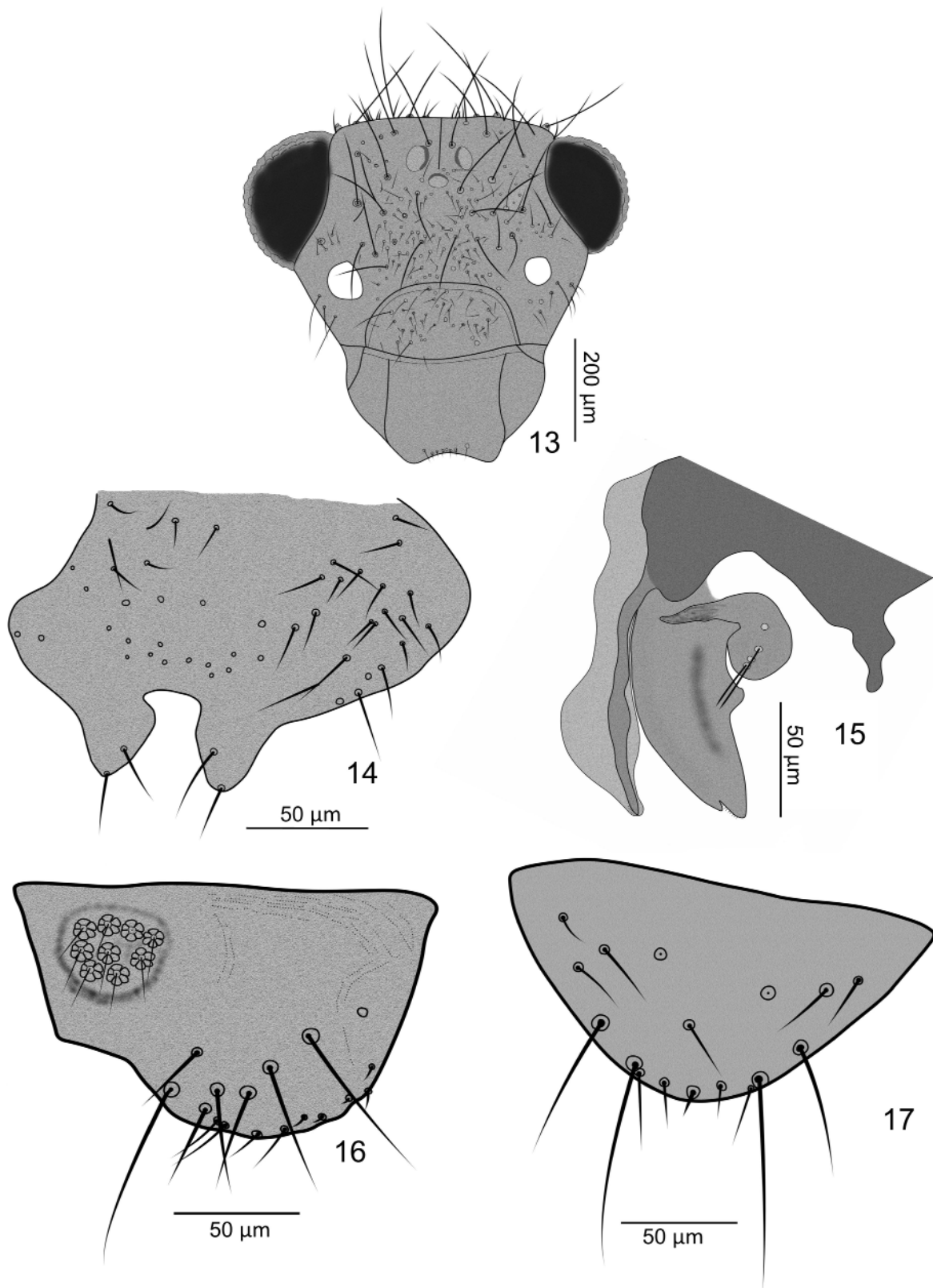
Figs 2-3. *Phallocaecilius indicus* sp. nov. (2) Male habitus. (3) Female habitus.



Figs 4-7. *Phallocaecilius indicus* sp. nov. (4-5) Male forewing and hindwing. (6-7) Female forewing and hindwing.



Figs 8-12. *Phallocaecilius indicus* sp. nov. Male. (8) Front view of head. (9) Right lacinia. (10) Hypandrium. (11) Phallosome. (12) Clunium, epiproct and paraproct.



Figs 13-17. *Phallocaecilius indicus* sp. nov. Female. (13) Front view of head. (14) Subgenital plate. (15) Gonapophyses. (16) Right paraproct. (17) Epiproct.

Lacinia as in Fig. 9. Forewings: veins and wing margin setose, Rs and M joined by a cross vein, pterostigma long and narrow, cells of 1a and cu2 covered with sensory papillae, areola postica flattened (Fig. 4). Hindwing membrane and veins smooth, outer margin with dense setose except for $\frac{3}{4}$ of basal coastal margin glabrous (Fig. 5). Claws without preapical teeth, apically slightly curved, ribbon-like pulvillus.

Genitalic characters: Hypandrium: simple, setose, with lateral sclerites and sclerotized in apical lateral sclerites (Fig. 10). Phallosome: lateral projection at a basal angle of phallobase, parameres strongly arched, aedeagus strongly sclerotized, endophallus expanded with many thorn-like (like hard stout spines) sclerites (Fig. 11). Epiproct and paraprocts as illustrated (Fig. 12).

Description of the female allotype

Color: Same as in the male (Fig. 3).

General morphology: Body length 1.9-2.2 mm. Similar to the male, but sensory papillae absent in the cells 1a and cu2 in forewing (Fig. 6). Hindwing similar to that in the male (Fig. 7).

Genitalic characters: Subgenital plate: with apically deep indentation, apical lobe well developed, bilobed, each lobe bearing an apical seta and another on mesial border. The rest of the plate setose (Fig. 14). Gonapophyses: ventral valves narrow, apically pointed; dorsal valves with broad lobe, bearing a bristled stylet; external valves rounded, apically thin, bearing four long setae (Fig. 15). Paraprocts with fields of 9-10 trichobothria, bearing a row of apical and subapical setae (Fig. 16). Epiproct triangular, with two long setae latero-apically and five small setae distally (Fig. 17).

Dimensions (in μm): *Male holotype:* FWL: 2001, HWL: 1665, F: 441, T: 774, t1: 257, t2: 60, ctt1: 14, Mx4: 116, f1: 410, f2: 249, f3: 182, f4: 153, f5: 96, f6: 108, f7: 95, f8: 92, f9: 101, f10: 80, IO: 372, D: 243, d: 182, IO/D: 1.53, PO: 0.74. *Female allotype:* FWL: 2423, HWL: 1926, F: 537, T: 890, t1: 298, t2: 70, ctt1: 16, Mx4: 113, f1: 421, f2: 268, f3: 197, f4: 154, f5: 108, f6: 102, f7: 89, f8: 92, f9: 54, f10: 50, f11: 37, f12: 37, IO: 440, D: 218, d: 134, IO/d: 2.01, PO: 0.61.

Distribution: Southern Western Ghats of Tamil Nadu and Kerala, India between 8.41°N to 9.61°N and 94 m to 994 m. The specimens were collected from green and dry leaves in evergreen forest understorey adjacent to streams.

Type locality: India, Tamil Nadu, Tirunelveli District, Agasthiyamalai Biosphere Reserve, Kalakkad-Mundanthurai Tiger Reserve (KMTR), Ambasamudram Range, Kuthiraivetti.

Remarks: The genus *Phallocaecilius* is recorded for the first time in India. The described new species is widely distributed in the Southern Western Ghats of Tamil Nadu and Kerala. This species is distinguished

from the other two species in the genus by the structure of the endophallus and female genitalia. Vaughan *et al.* (1989) discussed the geographic variation of *P. hirsutus*. In *P. indicus* no such variations were found in male or female samples from the different populations studied in the Southern Western Ghats.

ACKNOWLEDGMENTS

We are grateful to Dr Dhriti Banerjee, Director, Zoological Survey of India, Kolkata for providing necessary facilities and encouragement. We are also grateful to Dr Kazunori Yoshizawa (Hokkaido University, Sapporo, Japan) for valuable taxonomic inputs and critical comments on the manuscript. We extend thanks to Dr P. M. Sureshan, Officer-in-Charge, Western Ghat Regional Centre, Zoological Survey of India, Calicut and Dr Jayasree Thilak and Dr Varadaraju, Southern Regional Centre, Zoological Survey of India, Chennai for providing logistic support for collecting the specimens. We also thank the Principal Chief Conservator of Forests and Chief Wildlife Warden, Tamil Nadu, Chief Conservator of Forests and Field Director, KMTR, Tirunelveli, Wildlife Wardens of Meghamalai Wildlife Sanctuary, Kanyakumari Wildlife Sanctuary, Tamil Nadu and Neyyar Wildlife Sanctuary, Peppara Wildlife Sanctuary and Shendureny Wildlife Sanctuary, Kerala for providing necessary permissions to conduct the study. We also thank Dr Alfonso Neri García Aldrete, Departamento de Zoología, Instituto de Biología, Universidad Nacional Autónoma de México, México and John Hollier, Muséum d'histoire naturelle, Genève, Switzerland for critical comments.

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