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Studies on the subfamily Exothecinae (Hymenoptera: Braconidae) with the description of a new genus and a new species from India

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Abstract

A new genus of the subfamily Exothecinae, *Occipitotus* Singh & van Achterberg **gen. nov.** is proposed. The type species *Occipitotus langpramensis* Singh & van Achterberg **sp. nov.**, is described and illustrated, which is the second species of the subfamily known from India. A key to the extant genera of the subfamily Exothecinae is provided.

Key words: Exothecinae, new genus, new species, description, key, *Equisetum*, parasitoid, India

Introduction

The Exothecinae Foerster (1863) is a relatively small subfamily and contains ectoparasitoids of leaf-mining or gall-forming larvae of Lepidoptera, Diptera, Coleoptera and other Hymenoptera (van Achterberg, 1983; Belokobylskij, 1993; van Achterberg & Shaw, 2008). It is comprised of 103 described species and is mainly occurring in the Palaearctic and Oriental regions (Yu *et al*., 2012; Belokobylskij, 2019) divided over eight genera, *Colastes* Haliday, 1833; *Colastinus* Belokobylskij, 1984; *Orientocolastes* Belokobylskij, 1999; *Palaeocolastes* Belokobylskij & Zaldívar-Riverón, 2021 (fossil); *Pseudophanomeris* Belokobylskij, 1984; *Shawiana* van Achterberg, 1983; *Vietcolastes* Belokobylskij, 1994b and *Xenarcha* Foerster, 1863. Systematic studies of a few genera within the Exothecinae has remained complicated, as *Pseudophanomeris*, *Shawiana* and *Xenarcha* had been described or treated as subgenera of the genus *Colastes* s.l. by Belokobylskij and co-workers (Belokobylskij, 1984, 1993, 1994a, 1994b, 1996, 2000, 2019; Long & Belokobylskij, 2003; Belokobylskij *et al*., 2012). However, van Achterberg, 1983; Zaldivar-Riverón *et al*. 2004, 2006; van Achterberg & Shaw, 2008; Yu *et al.*, 2012; Broad *et al.*, 2016; van Achterberg *et al.*, 2017; and Quicke *et al*., 2021 elevated them to the status of genera. Since the studies by Papp (1975), van Achterberg (1983), Belokobylskij (1984, 1994b), Belokobylskij & Tobias (1986) and Whitfield & Wharton (1997) provide distinct morphological characters to consider them as separate genera.

Exothecinae in a broad sense has usually been inferred to have a number of small cyclostome tribes e.g., Cedriini, Clinocentrini, Hormiini, Lysitermini, Pambolini, Pentatermini and Rhysipolini (Belokobylskij, 1993, 1994a, 1994b, 1999, 2019; Antropov *et al*., 2014). Exothecinae (including the Hormiini) was considered as a tribe of Rogadinae in a broad sense with Rhyssalinae (van Achterberg, 1990) but separated as a subfamily by Quicke and van Achterberg (1990). Recent phylogenetic studies reveal that the Hormiini, Rhyssalini and Lysitermini are not closely related to the Exothecinae s. str. (Chen & van Achterberg, 2019); Lysitermini and Hormiini are now placed as the tribes of Hormiinae (Quicke *et al*., 2021; Jasso-Martínez *et al*., 2021); and Pambolinae and Rhysipolinae as separate subfamilies.

Members of exothecines are characterized by: occipital carina interrupted dorsally and ventrally absent before reaching base of mandible; if present, then remaining separated from hypostomal carina (but carina completely absent in male *Vietcolastes*); pronope present (but absent in *Colastes* and *Vietcolastes*); mesoscutum always largely smooth; prepectal carina absent (but present in front of precoxal sulcus in *Orientocolastes*); vein CU1b of fore

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wing present; vein cu-a strongly postfurcal (but interstitial in *Palaeocolastes*); vein M+CU of hind wing shorter than vein 1-M; vein m-cu of hind wing present; metasomal tergite I strongly sclerotized and sculptured; dorsope distinct (absent in undescribed genus from China); laterope absent; and ovipositor sheath shorter than the length of metasoma.

Cameron (1910) described a debatable exothecine *Colastes cilipennis* (Cameron, 1910) from Darjeeling, West Bengal, India based on a single female, originally described in the genus *Aclisis* Foerster, 1863 (Alysiinae). Papp (1967), after examining the type species (male, not female as mentioned in the original description) deposited in the Zoological Museum, Berlin (ZMB) transferred this species to the Exothecinae under the genus *Exothecus* Wesmael, 1838. Subsequently, Shenefelt (1975) transferred it to the genus *Colastes*. However, Belokobylskij (1994b) was uncertain about the type specimen and the generic status of the species. One of us (CvA) examined the holotype in ZMB 42 years ago and noted that it is close to the genus *Colastes* (no pronope) but it has no occipital carina. The present study includes the description of the new genus *Occipitotus* Singh & van Achterberg **gen. nov.** and of the type species *Occipitotus langpramensis* Singh & van Achterberg **sp. nov.** from India and provides an identification key to extant genera of the subfamily Exothecinae.

Materials and methods

The material was collected by net sweeping from horsetails, *Equisetum* sp. (Equisetaceae) at the vicinity of Ariangiuky stream, Langpram Village, Tamenglong Dist., Manipur, India. (Figs 1A, 1B, 1C). Source of map is from Google Earth images, Version 9.150.0.2 (https://earth.google.com). For the recognition of the subfamily Exothecinae: van Achterberg (1990, as tribe Exothecini of Rogadinae; 1993), for the terminology: van Achterberg (1988, 1993) and for microsculpture terminology: Harris (1979) were followed. Photographs were taken with Leica DMC4500 digital camera attached to a Leica M205A stereozoom microscope (with a Planopo 1.0x objective), using LAS (Leica Application Suite) version 4.12.0. For the descriptions and measurements, a Nikon SMZ18 stereomicroscope was used. The type materials are deposited with the National Zoological Collection, Zoological Survey of India, Kolkata, India (NZC).

Results and description

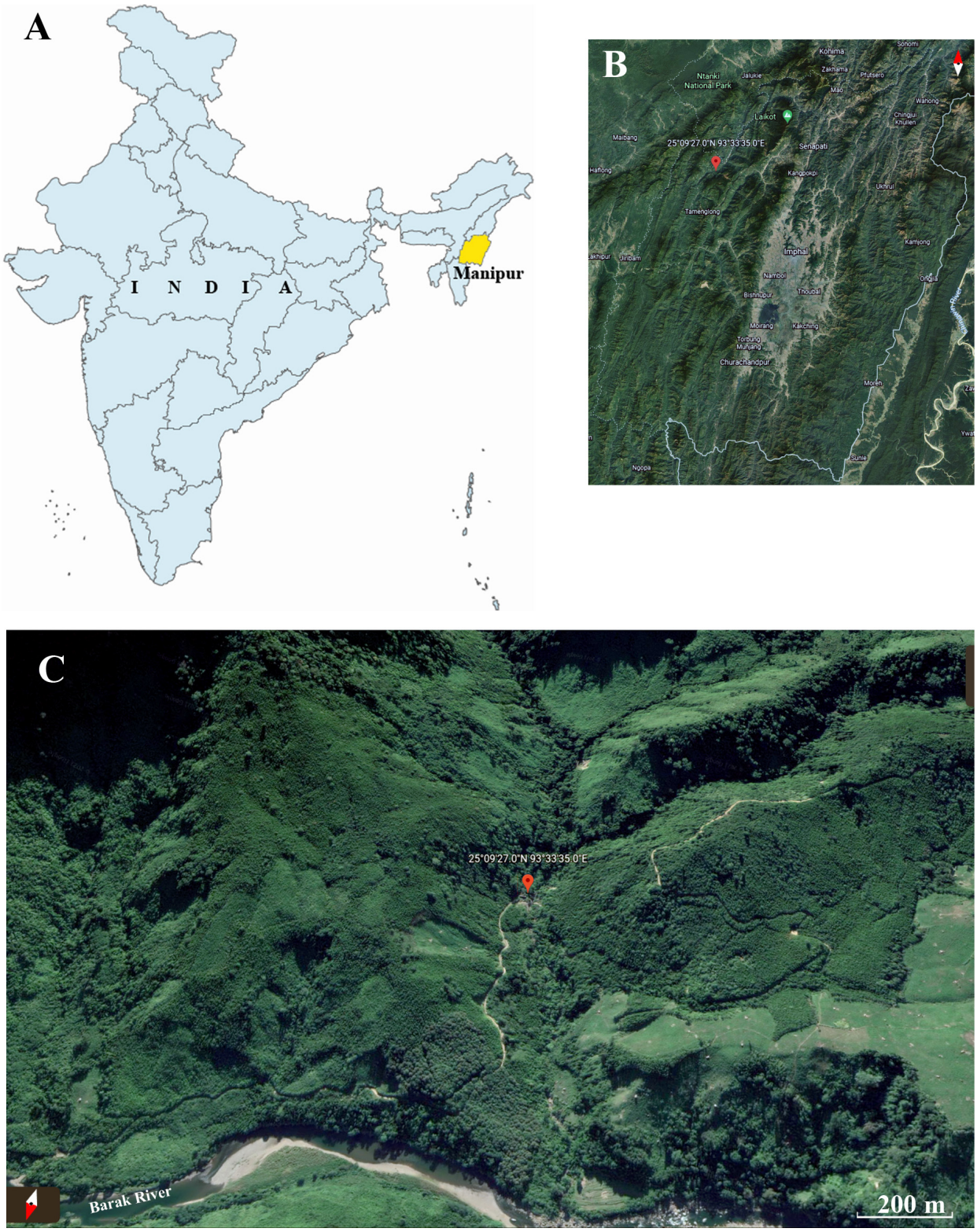
A. Key to the extant genera of the subfamily Exothecinae Haliday
(modified from Belokobylskij, 1984, 1994b, 2000; van Achterberg, 1983)

1. Prepectal carina present in front of precoxal sulcus; occipital carina complete dorsally and area in front of it rugulose; frons with crenulate median groove; precoxal sulcus very wide . . . . . *Orientocolastes* Belokobylskij, 1999
- Prepectal carina completely absent (Fig. 2F); occipital carina usually absent dorsally, **if** present then area in front of it smooth (Figs 3A, 4C); frons without crenulate median groove; precoxal sulcus absent or narrow (Fig. 2F); but distinctly developed in *Colastes* (*Discolastes* Belokobylskij, 2000) 2
2. Pronope absent or small, shallow and transverse, rarely medium-sized; clypeus convex 3
- Pronope present, large and deep (Fig. 3F); sometimes obsolescent in *Xenarcha*; clypeus flattened 4
3. Metasomal tergite V markedly enlarged, bent posteriorly and concealing subsequent tergites; tergites I–V entirely sculptured; male without occipital carina, but large temporal tubercles developed; malar suture distinct . . . . . *Vietcolastes* Belokobylskij, 1994
- Metasomal tergite V normal; tergites II–V either smooth or sculptured; in both sexes occipital carina developed and temporal tubercles absent; malar suture indistinct or obsolescent . . . . . *Colastes* Haliday, 1833
4. Tergites I–III forming a carapace-like metasoma, coarsely longitudinally striate, and their epipleura less sclerotised than their nota; remaining tergites covered by tergites I-III or largely so; tergite III on posterior margin with more or less distinct transparent border . . . . . *Colastinus* Belokobylskij, 1984
- Tergites I–III not forming a carapace-like metasoma, with their epipleura and nota equally sclerotised; remaining tergites distinctly exposed, tergite III along posterior margin without transparent border 5
5. Occipital carina complete, ventrally reaching up to base of mandible (Figs 3A, 4C, 6A–E); first subdiscal cell of fore wing elongate (Figs 5B, 5D); fore wing vein 1-M of male widened, as wide as or wider than the length of vein cu-a (Fig. 5D) . . . . . ***Occipitotus* gen. nov.**
- Occipital carina incomplete, dorsally interrupted; first subdiscal cell of fore wing broad; fore wing vein slender 6
6. Metasomal tergites I–V entirely sculptured; apical tergites not protruding (or only slightly) beyond tergite V; tergites IV and V with a lateral crease . . . . . *Pseudophanomeris* Belokobylskij, 1984

- Metasomal tergites less sculptured, at most tergite III completely and base of tergite IV sculptured; apical tergites distinctly protruding beyond tergite V; tergites IV and V without a lateral crease 7

7. Posterior half of notauli absent or obsolescent; vein r of fore wing usually departing between basal third and base of pterostigma; if departing near basal 0.4 of pterostigma, then vein m-cu of fore wing distinctly converging to vein 1-M posteriorly . . . . . *Shawiana* van Achterberg, 1983

- Posterior half of notauli distinctly impressed, (nearly) complete; vein r of fore wing departing from basal 0.4–0.6 of pterostigma and vein m-cu of fore wing less converging posteriorly . . . . . *Xenarcha* Foerster, 1863



FIGURES 1(A–C). Map of India showing the location of Manipur; (B–C) map-pin markers indicate the location of collection site Langpram Village, Tamenglong Dist., Manipur.

B. Description

Occipitotus Singh & van Achterberg gen. nov.
(Figures 2–6)

Type species: *Occipitotus langpramensis* Singh & van Achterberg sp. nov.

Etymology. The generic name *Occipitotus* is masculine and refers to the complete occipital carina on the head; "occipit" stands for occipital carina and "totus" (Latin for "complete").

Diagnosis. Antenna with 22–30 flagellomeres (25–30 in female; 22–28 in male), longer than fore wing (Figs 2B, 4B), scapus small, subglobose, shorter ventrally than dorsally; occipital carina complete (Figs 3A, 4C), ventrally straight or slightly curved reaching base of mandible (rarely reduced near base of mandible) and raised into a flange; remaining widely separated from hypostomal carina (Figs 6A–E); hypoclypeal depression deep and small (Fig. 2E); clypeus slightly convex or flat, not protruding beyond the level of the face (Fig. 2A); malar suture obsolescent; pronope large and deep (Figs 3F, 4C); mesoscutum glabrous and shiny; notauli finely crenulate, terminating into rugose area posteriorly (Figs 3B, 4D); vein r of fore wing distinctly oblique and arising from basal 0.4–0.5 of pterostigma; first subdiscal cell of fore wing elongate (Figs 5B, 5D); fore wing vein 1-M of male widened, as wide as or slightly wider than length of cu-a (Fig. 5D); propodeum coarsely rugose-reticulate, with weak median carina anteriorly (Fig. 4D) or entire; dorsal carinae of metasomal tergite I not united medially and tergite coarsely rugose-reticulate with (feeble) (Fig. 3C) or without (Fig. 3G) median carina; metasomal tergite II longitudinally striate (nearly) complete (Figs 3C, 4A) or anterior half striate (Fig. 5A); tergite II slightly longer than tergite III, feebly striate antero-laterally (Fig. 4A) or smooth and shiny (Fig. 5A); tergites IV–VI smooth and sparsely setose (Figs 3C, 4A); length of ovipositor sheath 0.5–0.7 times as long as first tergite (Figs 2B, 4A).

Biology. Host unknown, but collected from horsetails, *Equisetum* sp. (Equisetaceae; Fig. 7B) along with an unidentified species of Coleoptera (Chrysomelidae; Fig. 7A); considering the biology of other species of the members of this subfamily Exothecinae, it is likely to be an ectoparasitoid of coleopterous larvae on *Equisetum* sp.

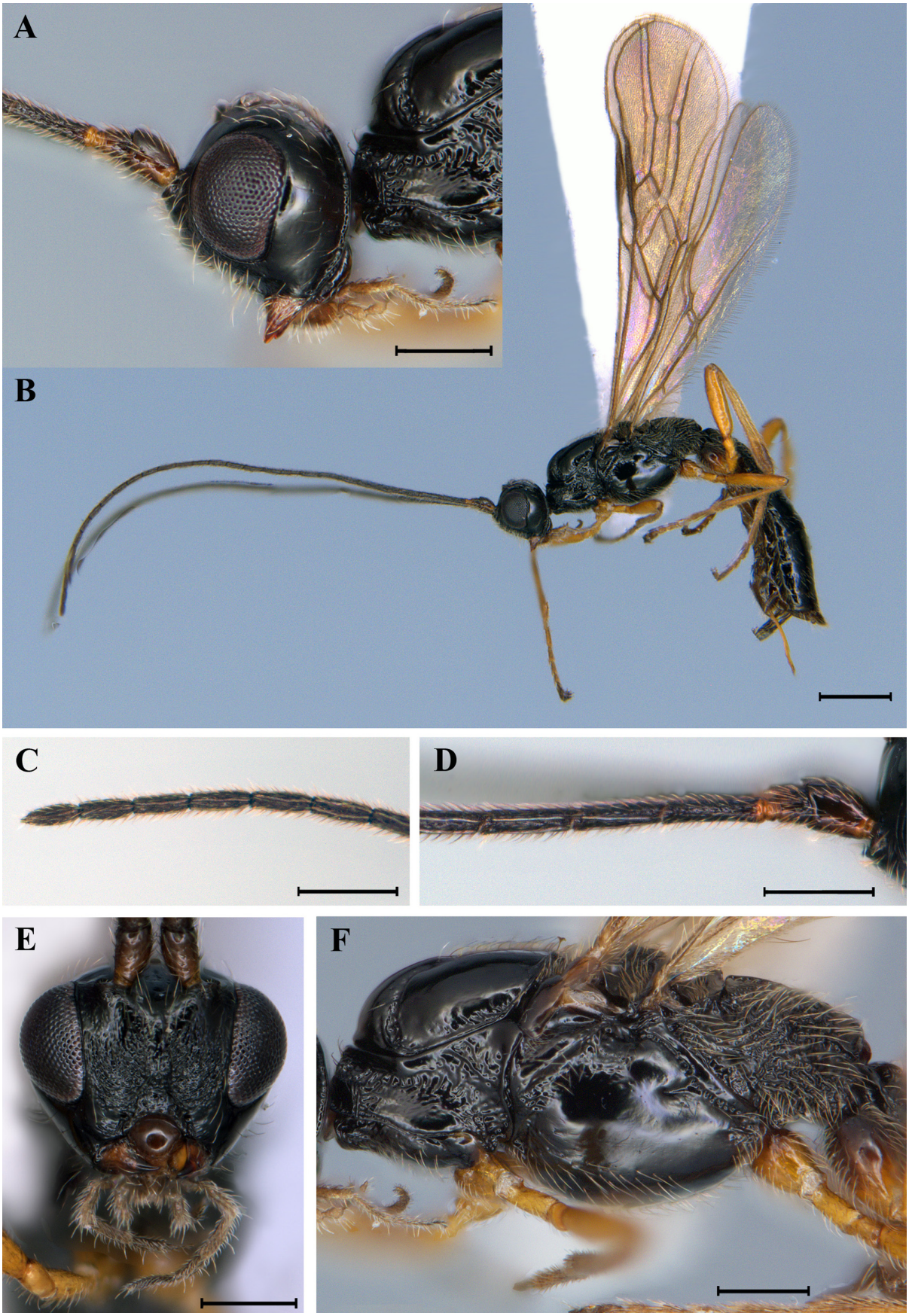
Distribution. Oriental.

Occipitotus langpramensis Singh & van Achterberg sp. nov.
(Figures 2–6)

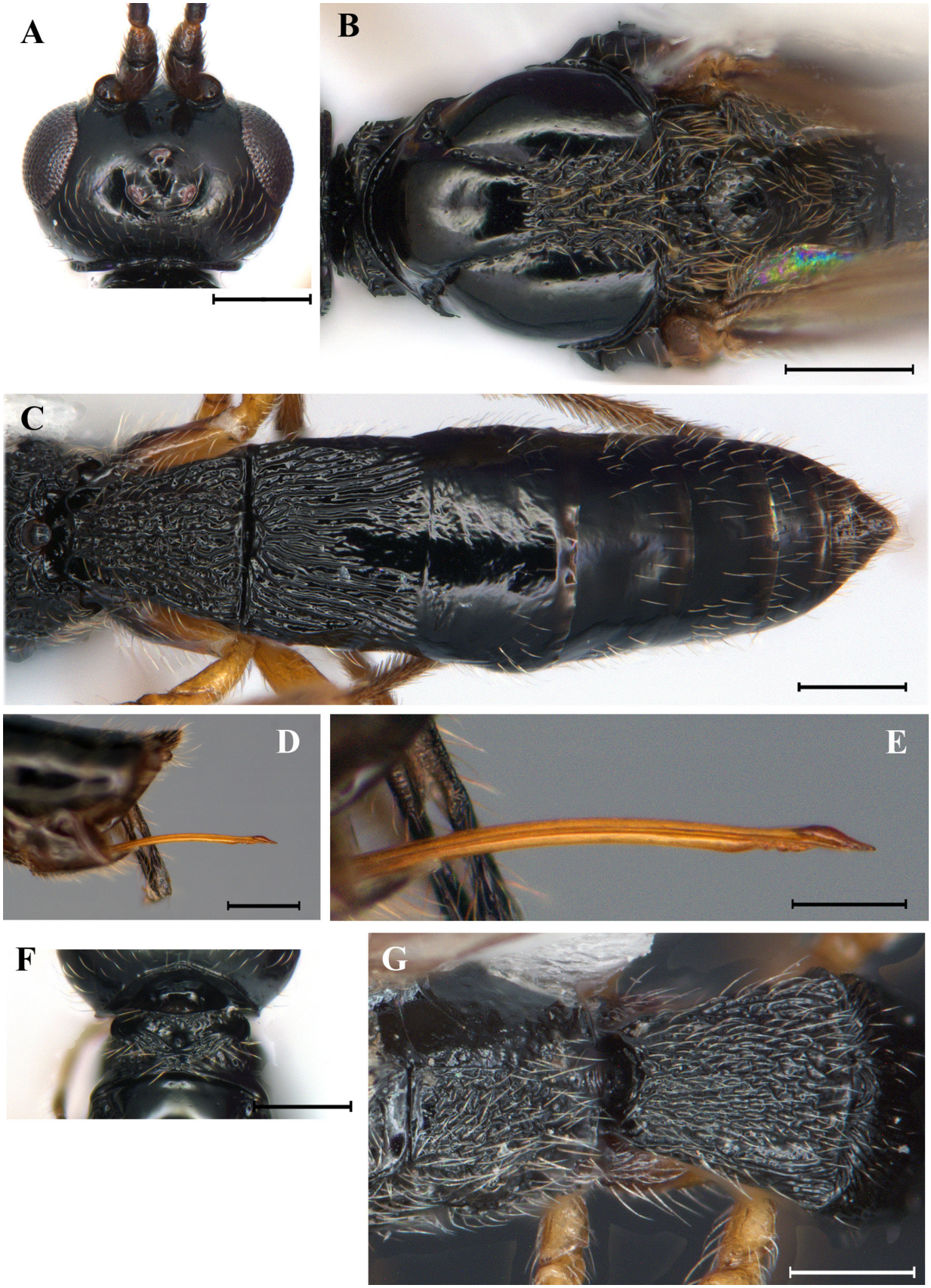
Holotype, female, length of body 3.1 mm and of fore wing 2.9 mm and hind wing 2.5 mm.

Head. Antennae with 27–28 flagellomeres (left 28 and right 27), first flagellomere 1.1 times second flagellomere, length of first, second, third and penultimate flagellomeres 5.0, 4.4, 4.0 and 3.5 times their width, respectively (Figs 2C, 2D); terminal flagellomere acuminate; head in dorsal view slightly transverse, 1.4 times as broad as long (Fig. 3A) and 1.15 times wider than the width of mesoscutum; length of eye 1.9 times length of temple in dorsal aspect; OOL (ocular ocellar line): diameter of ocellus: POL (posterior ocellar line) = 9.5:3:4.5; vertex, temple smooth and conspicuously setose; frons smooth; face finely granulate, medially obscurely scabriculous (Fig. 2E); width of face: width of head: height of eye = 3.9: 7.3: 3.7; occipital carina complete (Fig. 3A) and reaching base of mandible, occipital flange rather wide (Fig. 6A); hypostomal carina raised into an elevated flange (Fig. 6A), its height almost equal to length of third segment of labial palp; clypeus slightly convex, dorsally smooth and ventral rim of clypeus finely foveate; hypoclypeal depression small, less than half as wide as face (Fig. 2E); malar space as wide as basal width of mandible and 0.4 times as long as the maximum width across mandibles; malar space smooth, anteriorly granulate; first tooth of mandible distinctly longer than second, both teeth of mandible acute, striate on outer side; length of maxillary palp 1.3 times height of head.

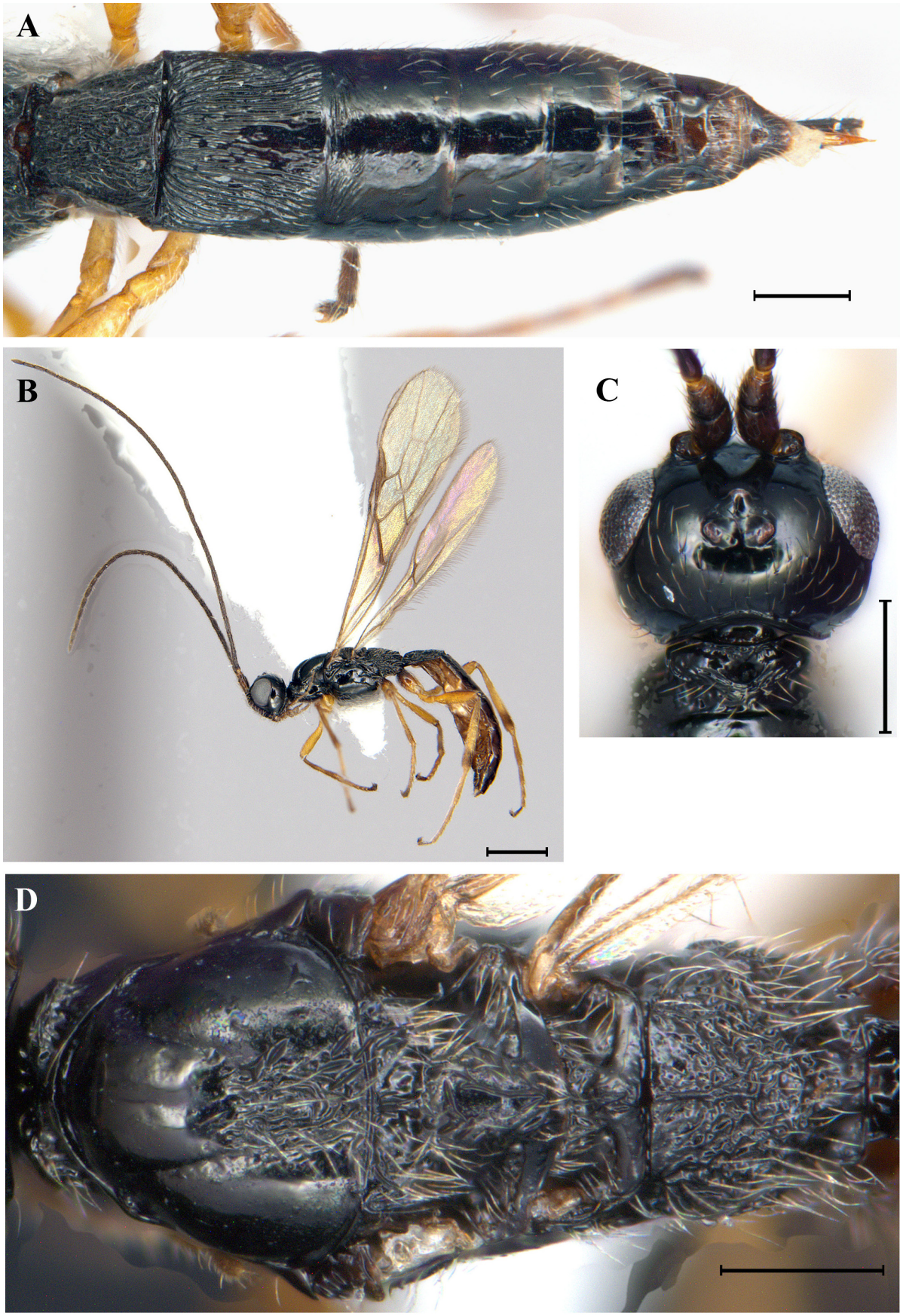
Mesosoma. Length of mesosoma 2.0 times its height; pronope deep and large; a narrow anterior marginal pronotal sulcus crenulate; side of pronotum smooth to finely rugulose, with crenulate transverse depression (Fig. 2F); propleuron smooth, shiny and striate-rugose anteriorly; mesoscutum glabrous, shiny and anterior margin with a well-developed sulcus; notauli finely crenulate, posteriorly not strongly converging and ending in broad rugose, slightly depressed setose area (Fig. 3B); scutellar sulcus wide, deep, 0.3 times length of scutellum and rugose with a mid-longitudinally carina; scutellum weakly convex, setose and rugulose but medio-dorsally



FIGURES 2(A–F). *Occipitotus langpramensis* **sp. nov.**, holotype, female. (A) Head, lateral view; (B) habitus, lateral view; (C) apex of antenna; (D) base of antenna; (E) head, frontal view; (F) mesosoma, lateral view. Scale bars = 0.2 mm (A, C, D, E, F); 0.5 mm (B).



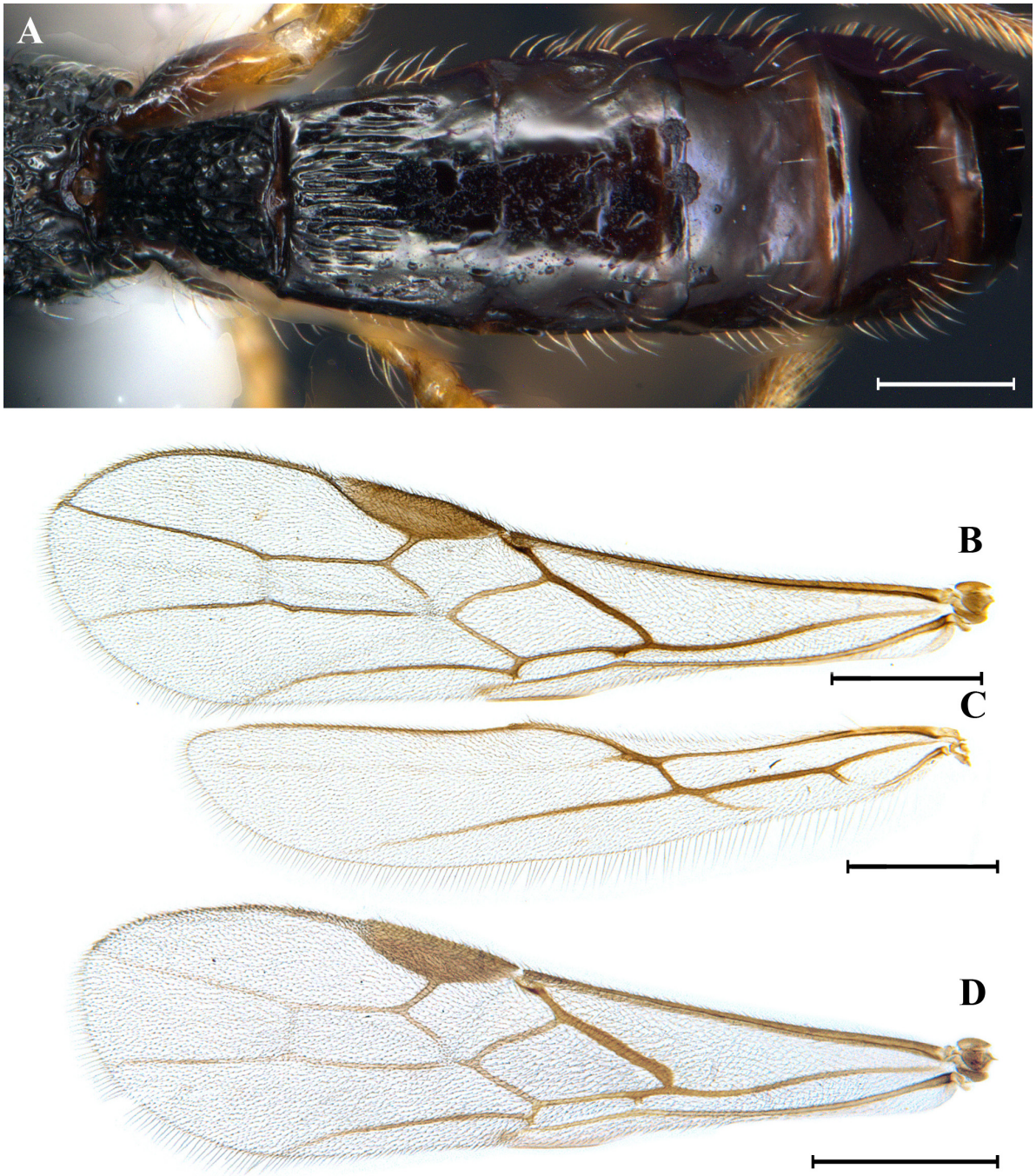
FIGURES 3(A–G). (A–E) *Occipitotus langpramensis* **sp. nov.**, holotype, female. (A) Head, dorsal view; (B) mesosoma, dorsal view; (C) metasoma, dorsal view; (D) apex of metasoma, showing ovipositor sheath and ovipositor; (E) ovipositor; (F–G) paratype, female. (F) Pronotum, dorsal view, showing pronope; (G) propodeum + metasomal tergite I, dorsal view. Scale bars = 0.2 mm (A, B, C, D, F, G); 0.1 mm (E).



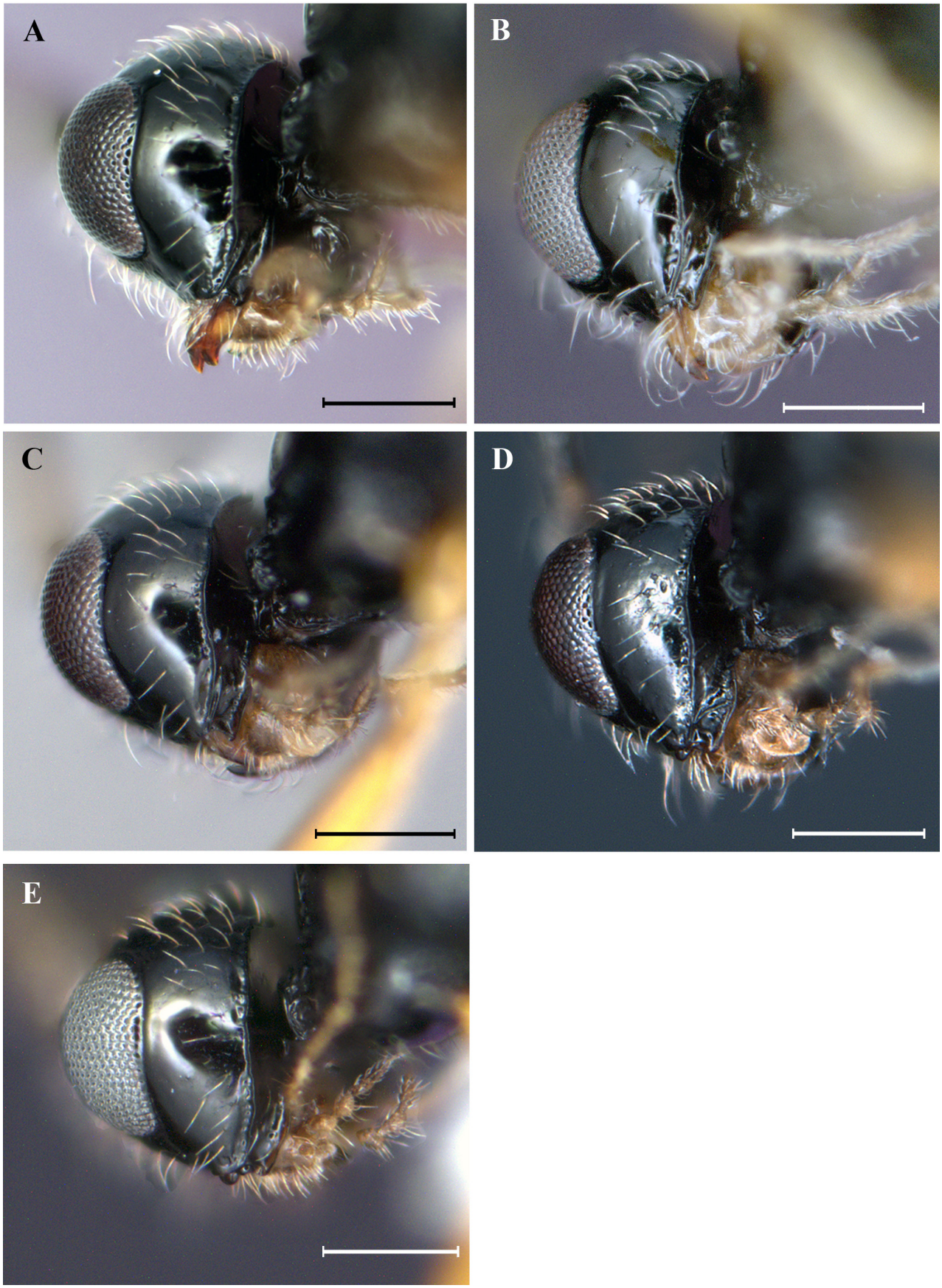
FIGURES 4(A–D). (A) *Occipitotus langpramensis* **sp. nov.**, paratype, female, metasoma, dorsal view; (B–D), paratype, male; (B) habitus, lateral view; (C) head + pronotum, dorsal view, showing pronope; (D) mesosoma, dorsal view. Scale bars = 0.2 mm (A, C, D); 0.5 mm (B).

smooth; subalar depression smooth; mesopleuron largely smooth but rugose antero-dorsally and conspicuously setose ventrally (Fig. 2F); mesosternum with a foveate mid-longitudinal sulcus (mesosternal sulcus) and setose; mesopleural (epicoxal) sulcus extends dorsally and crenulate; metanotum largely smooth with a short fine streak antero-medially and posteriorly with a strongly raised median area and rugulose; propodeum and metapleuron coarsely rugose-reticulate; propodeum with a weak irregular median carina anteriorly.

Wings. Fore wing (Fig. 5B): Length 3.65 times its maximum width; angle between veins 1-SR and C+SC+R ≈ 35°; marginal cell long, vein SR1 almost reaching the wing margin, 0.95 times of distance between apex of pterostigma and wing tip; length of veins r: 3-SR: SR1 = 1.3: 4.0: 6.9; 1-SR+M evenly curved posteriorly, 0.8 times as long as 1-M; second submarginal cell narrow, length of veins 2-SR: 3-SR: r-m = 2.5: 4.0: 1.5; vein cu-a postfurcal and first subdiscal cell elongate; length of veins 1-CU1: 2-CU1: cu-a = 2.2: 7.0: 0.7; 3-CU1: CU1b = 2.2: 1.5. Hind wing (Fig. 5C): Length 5.7 times its maximum width; length of veins SC+R1: 2-SC+R: 1r-m = 4.0: 0.9: 1.1; m-cu present, antefurcal; M+CU: 1-M: 1r-m = 1.2: 1.4: 0.35; 1r-m straight.



FIGURES 5(A–D). (A, D) *Occipitotus langpramensis* **sp. nov.**, paratype, male. (A) Metasoma, dorsal view; (D) fore wing; (B–C) paratype, female. (B) fore wing; (C) hind wing. Scale bars = 0.2 mm (A); 0.5 mm (B, C, D).



FIGURES 6(A–E). *Occipitotus langpramensis* **sp. nov.**, head, latero-posterior view. (A) Holotype, female; (B–E) paratypes. (B–D) females; (E) male. Scale bars = 0.2 mm.

Legs. Legs slender and relatively long; length of femur, tibia and tarsus of foreleg = 5.4: 7.0: 7.6; length of femur, tibia and basitarsus of hind leg = 6.5: 10.6: 4.4, 4.3, 9.6 and 6.1 times longer than their maximum width, respectively; tibia as long as tarsus; hind coxa medium-sized, without a basoventral tooth, 1.8 times longer than wide, 0.55 times as long as hind femur; length of inner and outer spurs of hind tibia 0.22 and 0.18 times as long as hind basitarsus, respectively; tarsal claws simple.

Metasoma. Length of tergite I 1.2 times its apical width, its dorsal surface coarsely rugose-reticulate; its dorsal carinae not joined with weak mid-longitudinal carina (Fig. 3C); dorsope distinct, with continuous crenulate depression posteriorly; laterope absent; tergite II longitudinally striate (nearly complete); second metasomal suture weak, smooth; tergite III basally with weak oblique short striate; remaining tergites entirely smooth, sparsely setose; length of setose part of ovipositor sheath 0.7 times as long as tergite I; ovipositor with dorsal nodus, ventral valves with 3 ventral serrations (Figs 3D, 3E).

Colour. Black; antenna dark brown except scapus (ventrally) and annellus yellowish-brown; mandible pale brownish, apical teeth darker; palpi, tegulae, wing veins, metasomal tergites VII and VIII yellowish-brown; pterostigma, parastigma and vein 1-M slightly darker; wing membrane subhyaline; legs yellowish, but apical third of hind tibia and tarsus infuscate; telotarsus darker and hind coxa basally dark brown to yellowish; ovipositor pale yellowish, but apically yellowish-brown.

Variations. Length of body 2.6–3.2 mm (female) or 2.0–2.8 mm (male), and of fore wing 2.2–2.9 mm (female) or 1.8–2.5 mm (male); antenna of female with 25 (1), 27 (3), 28 (2), 29 (2) or 30 (1) flagellomeres, and of male with 23 (1), 24 (3), 25 (4), 26 (6), 27 (6) or 28 (5) flagellomeres; occipital carina complete and continues up to base of the mandible (8 females; 24 males) (Figs 6B–E) or interrupted ventrally above base of mandible (1 female, holotype; 2 males) (Fig. 6A); area between occipital and hypostomal carinae smooth (Figs 6A, 6B, 6E); a short carina running close to occipital carina (Fig. 6C), or with oblique or transverse carinae and weakly crenulate (Fig. 6D); face largely smooth or finely granulate; side of pronotum largely smooth in males, with crenulate transverse depression; propodeum coarsely rugose-reticulate, with weak median carina anteriorly (Fig. 4D) or entire; vein 3-SR of fore wing 1.6–1.9 times as long as vein 2-SR in females and that of males 1.6–1.7 times; fore wing vein 1-M of male widened, as wide as or wider than the length of vein cu-a (Fig. 5D); metasomal tergite I with (feeble) or without median carina; tergite II longitudinally striate (nearly) completely (in female) (Figs 3C, 4A) or anterior half striate (mostly in males) (Fig. 5A); second metasomal suture weak (Figs 3C, 4A) or obsolescent (Fig. 5A); length of ovipositor sheath 0.5–0.7 times as long as tergite I; metasomal tergites largely black and sclerotized, but in some males, tergites III and remaining comparatively less sclerotized and dark brown in colour.

Distribution. India.

Type material. Holotype female: **INDIA**: Manipur, Tamenglong Dist., Langpram Village, Ariangiuky stream, 25°09’27.0”N 93°33’35.0”E; appx. 363 mt. a.s.l., 3.iv.2019, sweep net on *Equisetum* sp. (Equisetaceae), col. L.R.K. Singh (NZC, ZSI, Kolkata; Registration No. 26520/H3); paratypes: 9 females (NZC, ZSI, Kolkata; Registration Nos. 26521-26529/H3), 26 males (NZC, ZSI, Kolkata; Registration Nos. 26530-26555/H3), data same as the holotype.

Etymology. The species is name after its type locality, Langpram Village, Tamenglong Dist., Manipur.

Discussion

The new genus runs in the key by van Achterberg (1990, 1993) to the subfamily Exothecinae (Exothecini). *Occipitotus langpramensis* **gen. et. sp. nov.** can be well differentiated from other genera and species of the subfamily in having a complete occipital carina (Figs 3A, 4C, rarely narrowly reduced ventrally), ventrally straight or slightly curved and raised into a flange (Figs 6A–E); pronope large and deep (Figs 3F, 4C); first subdiscal cell of fore wing elongate (Figs 5B, 5D); and fore wing vein 1-M of male widened, as wide as or slightly wider than the length of vein cu-a (Fig. 5D).

Occipitotus **gen. nov.** resembles genus *Xenosternum* Muesebeck, 1935 (now in Hormiinae, it was long regarded as a member of Exothecinae (van Achterberg, 1983) in having complete occipital carina and absent prepectal carina. But it differs in the following characters: first subdiscal cell elongate and closed (vs broad and opened in *Xenosternum*); fore wing vein cu-a strongly postfurcal (Figs 5B, 5D) (vs slightly postfurcal or interstitial); vein M+CU of hind wing shorter than vein 1-M (Fig. 5C) (vs subequal); and dorsope distinct (Figs 3C, 3G) (vs obsolescent).

FIGURES 7(A–B). (A) Unidentified species of Coleoptera (Chrysomelidae); (B) horsetails, *Equisetum* sp. (Equisetaceae).

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