

‘The *adikeshavus*-group’: A new species group of *Idris* Förster (Hymenoptera, Platygasteridae) from India, with descriptions of five new species

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Abstract

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Key Words

‘the *adikeshavus* group’

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Ceratobaeus

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Scelioninae

spiders

Idris Förster is a megagenus in the tribe Baeini comprising species that exclusively parasitize the eggs of spiders dwelling in vegetation and leaf litter. This is the only tribe in Platygasteridae capable of using spider eggs for their development. Constructing species groups will facilitate studies of highly speciose genera like *Idris*. So far only one species group ‘the *melleus*-group’ has been proposed in this genus. A new species group ‘the *adikeshavus*-group’ from India is proposed. Five new species in this genus – *I. adikeshavus*, *I. deergakombus*, *I. brevicornis*, *I. lopamudra* and *I. teestai* – are described from India. All five species are imaged and a key to them is provided.

Introduction

Platygasteroidea, the third largest superfamily of Parasitic Hymenoptera, are ubiquitous. They parasitize the eggs of most orders of insects and are host group specific. For instance, Gryonini use heteropteran eggs, Teleasinae and Xenomerini use carabid eggs, Embidobiini use embiid eggs, and so on (Masner 1976; Austin et al. 2005, Austin and Field 1997). The tribe Baeini under subfamily Scelioninae (one of the five subfamilies in Platygasteridae) is worldwide in distribution. All species in Baeini are known to be specialist parasitoids on the eggs of spiders (Austin 1985, Austin and Field 1997). This high level of host specificity is the result of their having speciated along with spiders over an extended period of time (Iqbal and Austin 2000a, Stevens and Austin 2007). They also exhibit high levels of sexual dimorphism that varies be-

tween genera. Clava with four compact fused clavomeres, A1 not extending beyond level of anterior ocellus and a tridentate mandible with convex outer surface serve to distinguish this from all other tribes in the subfamily (Austin and Field 1997).

In spite of their ubiquity and species richness, the taxonomy of the Baeini remains in its infancy with the fauna in most regions remaining to be worked. Australia, however, is the exception since intensive studies have been carried out on this tribe (Austin 1986, 1988, Iqbal and Austin 2000b). Nevertheless, it has been estimated that 80% of the species remain to be discovered and described even in Australia (Stevens and Austin 2007). Additionally, Iqbal and Austin (1997) feel that Baeini exhibit high levels of endemism and are confined to small geographic localities. Areas that have not yet been surveyed are therefore likely to yield many new species.

The genus *Idris* (Tribe: Baeini) was erected by Förster in 1856 with *I. flavicornis* as the type species (Förster 1856). Masner and Denis (1996) state that very small or very large eggs of spiders are not parasitized by this genus, as a result of which all species are generally of uniform size varying from 1–2 mm. So far 154 species of *Idris* have been described worldwide (Johnson 2015), of which 24 are from India (Mani 1939, 1973, 1975; Mani and Mukerjee 1976, Mani and Sharma 1982, Mukerjee 1978, 1981, 1994).

Idris and *Ceratobaeus* were considered two distinct genera by Masner (1976). Later Huggert (1979) treated *Ceratobaeus* as a subgenus of *Idris*. Austin (1984, 1995) and Galloway and Austin (1984) retained them as two separate genera. In 1996 Masner and Denis in their work on the 'melleus-group' of *Idris* treated *Ceratobaeus* as a junior synonym of *Idris*. Iqbal and Austin (2000a) state that both *Ceratobaeus* and *Idris* are polyphyletic and were of the opinion that they be treated as distinct till the Baeini as a whole are studied to resolve the confusion. This was later resolved by molecular studies conducted by Carey et al. (2006) and Murphy et al. (2007) based on combined analysis of the nuclear 28S rRNA and mitochondrial CO1 genes both of which indicated that Baeini is not monophyletic. Three definitive clades were found viz. clade A consisting of *Idris* + *Ceratobaeus* Ashmead + *Hickmanella* Austin + *Odontacolus* Kieffer; clade B with *Baeus* and clade C with *Mirobaeoides* Dodd + *Neobaesus* Austin. *Mirobaeoides* and *Neobaesus* were more closely related to other platygastriids that do not parasitize spider eggs. Analysis of highly species rich genera like *Idris* and *Ceratobaeus* indicated that they were not monophyletic and that the horn on T1 housing the long ovipositor (when not in use) has evolved many times within the tribe. The reduction in wings was inferred to be an adaptation to enhance the efficiency of locating spider eggs in leaf litter and for penetrating the silk walls of the egg sacs of spiders. It was also concluded that macroptery is most likely an ancestral condition in Scelionidae, with no evidence that this character state had been regained as functional wings post wing reduction. The results of these molecular phylogenetic studies were at odds with the phylogenies constructed using morphological characters alone (Carey et al. 2006, Murphy et al. 2007).

As *Idris* is highly speciose with the possibility of over a thousand species being present (Valerio et al. 2013), the clustering of species into groups will aid in the study of this genus. Only one species group, the 'melleus-group', has so far been proposed by Masner and Denis (1996) for Nearctic species of *Idris*. India being a subtropical country will without doubt harbour a large fauna of Baeini. This initial study of Indian species of *Idris* reveals a closely knit group of five species for which a new species group, 'the *adikeshavus*-group' has been proposed. The females of the species in this group possess a horn on T1 which is absent in males and the propodeum present as lateral lamellae anterior to the horn. Other diagnostic characters of this species group have been mentioned under results.

Materials and methods

Morphological terminology is after Masner (1976, 1980) and Mikó et al. (2007, 2010). Specimens were mounted on point-card tips. The descriptions and imaging were carried out employing Leica M205A stereomicroscope, with 1× objective and Leica DFC-450 digital camera.

The holotypes and paratypes of all the five new species are deposited in the ICAR-National Bureau of Agricultural Insect Resources, Bangalore, India.

We have used the following abbreviations in the description of the taxa. All the measurements taken are as per Miko (2010). HL – Head Length; HW – Head width; HH – Head height; FCI (Frontal cephalic index) = HW/HH; LCI (Lateral cephalic index) = HH/HL; A1–A12 – Antennomeres 1–12 (A1 = Scape, A2 = pedicel); L – Length; W – Width; H – Height; OOL – Ocellar-ocular length; POL – Posterior ocellar length; IOS – Interorbital space; T1–T7 – Metasomal tergites 1 to 7. Width of all metasomal tergites taken anteriorly.

All the specimens were collected by using sweep nets (SN), yellow pan traps (YPT) and pitfall traps (PFT). In addition to these, spider egg sacs were collected for obtaining adults of Baeini. The 151 parasitized spider egg sacs collected over a period of time were attacked by *Idris s.l.* (74.83%), *Baeus* (1.98%), *Ceratobaeus s.l.* (3.97%), *Odontacolus* (1.32%), Eupelmidae (0.66%), Eulophidae viz., ?*Pediobius* sp. (9.27%), Ichneumonidae (0.66%), Mantispidae (5.29%) and Diptera (1.98%). In 49% of the cases *Idris s.l.* occurred as the sole parasitoid in the egg sacs while *Ceratobaeus s.l.* and other non-platygastriid parasitoids were the only ones that emerged from 3% and 11% of the parasitized egg sacs respectively. Spiderlings emerged along with the parasitoids from 37 % of the parasitized egg sacs. The number of adult *Idris* emerging from an individual spider egg sac varied from 5–677. However no species in 'the *adikeshavus* species-group' dealt in this paper were reared from spider eggs.

Results

'The *adikeshavus* species-group'

Diagnosis. This species group is very unique as compared to all other *Idris* spp. in the following combination of character states:

1. T2 is either 1.7–2.0× longer than T3 or equal to T3
2. Both fore wing and hind wing with extremely long marginal cilia; hind wing curved inwards beyond submarginalis
3. Both wing shape and density of microtrichia on wings vary between males and females
4. Presence of propodeum as lateral lamellae anterior to horn
5. T7 and S6 very large and elongate
6. Densely setose vertex
7. Male antenna twelve segmented, constriction between A11 and A12 distinct

Description. Body convex; head transverse, wider than mesosoma in dorsal view; eyes small, densely setose; lateral ocelli adjacent to eyes; temples not visible when viewed laterally; head wider than high, higher than long; IOS larger than eye height; vertex with dense setae; facial striae present, striae reaching lower orbit of eye; lower frons smooth, upper frons setigerous punctate; central keel well developed, not reaching anterior ocellus; occipital carina sharp; radicle elongate, $> 1/4^{\text{th}}$ length of A1; female clava broad; length of clava 1.0–1.4× length of A2–A6; male antenna with clear constriction between A11–A12.

Mesosoma: Notauli well developed posteriorly, ranging in length from 0.27–0.32× length of mesoscutum; mesoscutum and mesoscutellum densely setose; mesoscutellum semicircular; metascutellum narrow in females and well defined in males; propodeum present as lateral triangular lamellae; lateral pronotal area rugose or with weak transverse ridges; mesopleuron with or without several transverse ridges beneath tegula; mesopleural depression distinct; metapleuron almost smooth; in females fore wing spatulate and with extremely long marginal cilia 1.7–2.2× width of wing; hind wing with a typical inward curve at the end of submarginal vein; hind wing marginal cilia 2.18–2.9× width of wing; in males the wings are narrow, densely covered with microtrichia, and hind wing less curved beyond the submarginal vein.

Metasoma: T1 with a short or long horn, horn with or without costae; T1 costate; T2 either subequal (as in *I. adikeshavus*) or 1.7–2.0× longer than T3; T7 and S6 very

large and elongate, ovipositor extruded; laterotergites wide and well incised into sternites.

Discussion. The character states, ocelli adjacent to eye; female with seven antennomeres and an unsegmented clava; male antenna with 12 antennomeres; skaphion absent; hind wing with complete submarginal vein reaching frenal hooks and presence of horn on T1 (though not found in many species of *Idris*) (Masner, personal communication) place this group under *Idris*.

The members of ‘the *adikeshavus*-group’ however can be distinguished from other species of *Idris* by the combined occurrence of seven character states as mentioned under diagnosis. However the presence of three key character states, viz. T2 either 1.7–2.0× longer or equal to T3; T7 and S6 very large and elongate; fore wing and hind wing with extremely long marginal cilia with hind wing curved inwards beyond submarginalis readily distinguishes this species group from other species of *Idris*. As of now ‘the *adikeshavus*-group’ is restricted to India with five species. Since all species in the Baeni are parasitoids of spider eggs, members of ‘the *adikeshavus*-group’ too in all likelihood parasitize the eggs of spiders. The members of this group are rare as only 52 specimens were collected during six years of intensive collecting.

The males and females are sexually dimorphic, varying in the presence and absence of horn on T1, shape of wings and density of microtrichia on wings. The presence of a horn (of variable length between species) indicates the presence of a long ovipositor housed within it when not in use as is the case in *Odontacolus* and *Ceratobaeus s.l.*

Key to the *adikeshavus* species-group of *Idris* (based on females)

- 1 Horn on T1 smooth (Figs 3 & 4) or with weak striae (Fig. 41); microtrichia on fore wings long (Figs 7, 36) 2
- Horn on T1 costate (Figs 30, 32); fore wing almost smooth and shiny (Fig. 33) 4
- 2 Mesoscutum fully reticulate (Fig. 40) *I. teestai* sp. n.
- Mesoscutum sculptured otherwise (Fig. 2) 3
- 3 T2 equal to T3 (Fig. 6); T3 weakly striate antero-medially (Fig. 7); forewing marginal cilia 1.7× width of wing (Fig. 7) *I. adikeshavus* sp. n.
- T2 1.7–2.0 longer than T3 (Fig. 23); T3 smooth (Fig. 23); forewing marginal cilia 2.1× width of wing (Fig. 27) *I. deergakombus* sp. n.
- 4 Propodeum medially produced as a rectangular costate plate (Figs 11 & 14); horn short, weakly transversely costate laterally and almost smooth posteriorly (Figs 12 & 17); posterior margin of horn round *I. brevicornis* sp. n.
- Propodeum not produced medially (Fig. 31); horn long, strongly transversely costate laterally and posteriorly (Fig. 30); posterior margin of horn almost wedge shaped (Fig. 31) *I. lopamudra* sp. n.

Idris adikeshavus Veenakumari, sp. n.

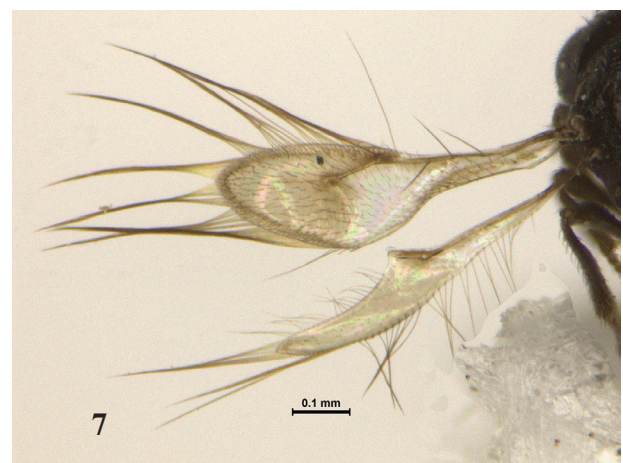
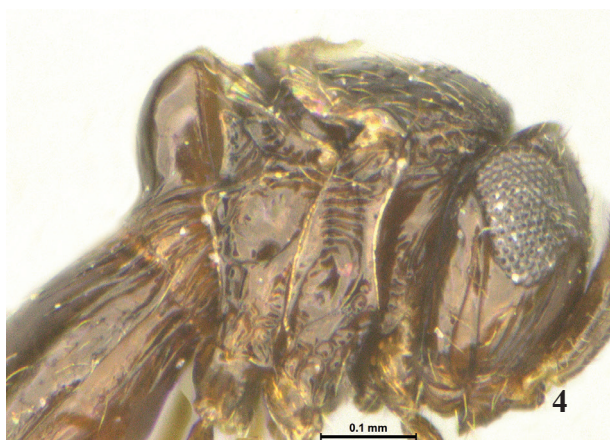
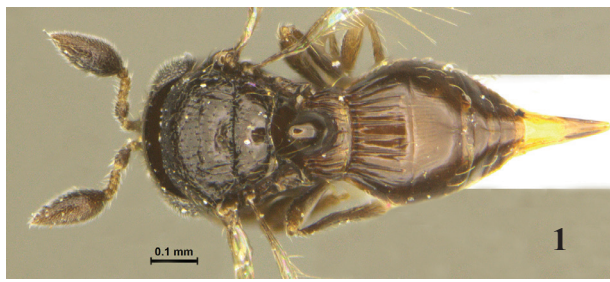
<http://zoobank.org/57DE4BAC-CC39-4C2F-8A50-F33AF8CA6FEC>
Figures 1–7

Holotype (Female). (ICAR/NBAIR/P371) INDIA: Sikkim, Gangtok, Hanuman Tok, SN, 15.x.2008. **Paratypes:** (ICAR/NBAIR/372), 1 female same data as holotype; (ICAR/NBAIR/P373), 1 female Sikkim, Gangtok, Ranipul, 04.vi.2008, SN; (ICAR/NBAIR/P374), 1 female Sikkim: Pakyong, MT, 02.11.2014; (ICAR/NBAIR/P375), 1 male Sikkim, Tadong, ICAR complex for North Eastern Hill Region, YPT, 29.x. 2014.

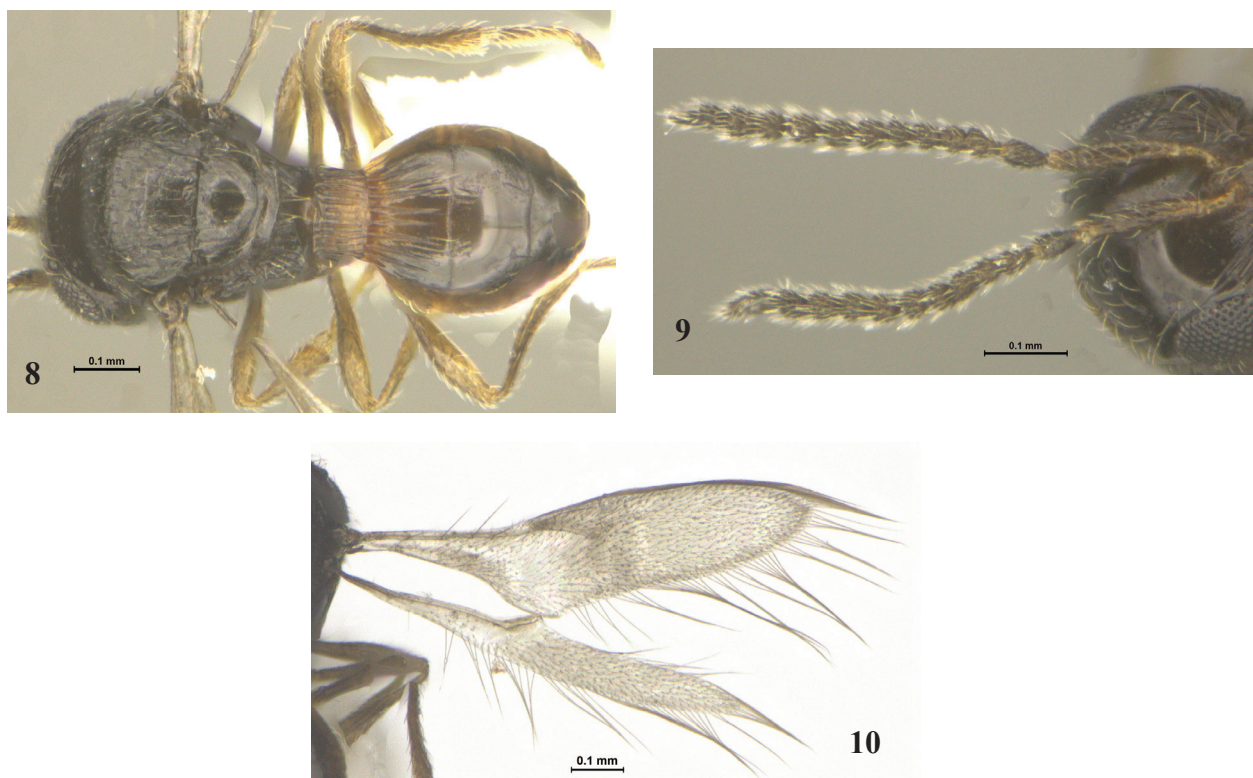
Type locality. INDIA: Sikkim

Description of female. Color and size (Figs 1, 3). Head and mesosoma blackish brown, metasoma brown, shining; T7 anteriorly yellow and posteriorly brownish yellow; legs including coxae brown; radicle light brown; A1 brownish black with extremities light brown; A2 dark brown with apex light brown; A3–A6 light brown; clava brownish black. Body length=1.194 mm.

Head (Figs 2, 5). FCI = 1.37; LCI = 1.7; IOS 0.56× width of head; POL > LOL in ratio of 19.7:10.2; lateral ocelli contiguous with eye; compound eyes small (L:W = 14.7:12.7) densely setose; orbital carina sharp, well developed; temples



Figures 1–7. *Idris adikeshavus* sp. n. (female) **1.** Habitus (dorsal); **2.** Head and mesosoma; **3.** Habitus (lateral); **4.** Pleuron; **5.** Head (frontal view) and antennae; **6.** Metasoma; **7.** Wings.



Figures 8–10. *Idris adikeshavus* sp. n. (male). 8. Habitus; 9. Antennae; 10. Wings.

not visible in lateral view; lower frons smooth and shining with strong facial striae; upper frons and vertex setigerous punctate; gena smooth; central keel $0.37 \times$ head height; length and width of antennomeres A1–A7 in ratio of 15.1:3.3, 5.1:2.8, 2.0:2.1, 1.9:1.8, 1.8:2.0, 1.9:2.3, 17.2:7.7, respectively; radicle $0.27 \times$ length of A1.

Mesosoma (Figs 2, 4). Mesoscutum (L:W = 18.5:27.6) setose, anteriorly reticulate, posteriorly punctate; notauli (L:W = 6.0:1.5) present; internotular distance $0.45 \times$ width of mesoscutum; mesoscutellum (L:W = 7.6:22.7) sparsely setigerous punctate; scutoscuteellar sulcus laterally foveate and medially non-foveate; metascutellum smooth, narrow medially, increasing in size laterally; metanotal trough foveate; lateral pronotal area smooth, foveate on posterior margin; mesopleuron with 8 transverse ridges beneath tegula; mesopleural carina, femoral depression and mesopleural pit distinct; metapleuron smooth, metapleuron pit distinct; paracoxal sulcus foveate basally; propodeum present as two carinate lamellae anterior to horn.

Fore wing (Fig. 7) (L:W = 63.1:18.0) spatulate, apically stipulate; apical half of fore wing with extremely long marginal cilia, $1.7 \times$ width of wing; five long, thick bristles present on submarginalis; entire wing covered with long thin microtrichia; length of submarginalis : marginalis : stigmalis in ratio of 28.2:3.5:10.4; hind wing (L:W = 62.7:10.7) deeply curved inwards beyond submarginal vein; long marginal cilia, $2.65 \times$ width of wing present apically; marginal cilia on the incurved anterior margin of wing, $0.26 \times$ width of wing, while those on posterior margin of wing $0.81 \times$ width of wing; microtrichia on hind wing small and sparse.

Metasoma (Fig. 6). (L:W = 69.1:31.4); T1 finely costate with a long smooth horn; length of horn $1.28 \times$ length of T1; posterior margin of T1 beyond horn smooth with a single costa in between; T2 costate, costae broad, tapering posteriorly, almost reaching posterior margin of T2; length of T2 equal to T3; T3 weakly costate antero-medially; costae reaching $0.63 \times$ length of T3; rest of T3 smooth; T4–T7 smooth; T7 acuminate; long setae present on lateral margin of T2, sublateral and lateral margin T3–T6; ovipositor extruded $0.35 \times$ length of T7; length and width of tergites T1–T7 in ratio of 11.2:18.1, 13.8:19.1, 13.8:30.9, 6.0:26.1, 3.2:20.1, 2.1:14.6, 19.2:10.6, respectively.

Variability (n=4). Female body length: 1.158–1.198 mm (m=1.176, SD=0.03); FCI=1.30–1.38 (m=1.34; SD=0.04); LCI=1.68–1.8 (m=1.69; SD=0.01); mesoscutum length=0.183–0.205 mm (m=0.188; SD=0.07); mesoscutum width=0.25–0.282 mm (m=0.269; SD=0.09); mesoscutellum length=0.074–0.080 mm (m=0.075; SD=0.08); mesoscutellum width=0.188–0.229 mm (m=0.206; SD=0.01); fore wing length=0.621–0.653 mm (m=0.643; SD=0.03); fore wing width=0.170–0.185 mm (m=0.183; SD=0.09); length of fore wing marginal cilia=0.396–0.426 mm (m=0.406; SD=0.08); hind wing length=0.62–0.638 mm (m=0.632; SD=0.03); hind wing width=0.084–0.11 mm (m=0.092; SD=0.04); length of hind wing marginal cilia=0.283–0.302 mm (m=0.286; SD=0.08); length of T1=0.104–0.112 mm (m=0.109; SD=0.07); length of T2=0.136–0.139 mm (m=0.137; SD=0.07); length of T3=0.134–0.138 mm (m=0.135; SD=0.03).

Description of male (Figs 8, 9, 10). Body length = 1.14 mm. Similar to female except for the following character states.

1. Absence of horn on T1
2. Metascutellum broad and distinct when viewed dorsally
3. Male antenna twelve segmented, constriction between A11 and A12 distinct; length and width of antennomeres A1–A12 in ratio of 15.0:4.3, 5.5:3.5, 4.5:3.8, 3.5:3.3, 3.3:3.8, 3.5:3.8, 3.5:3.8, 4.3:3.8, 4.1:3.8, 4.1:4.3, 3.8:4.3, 8.0:4.3
4. Shape of wings different. Fore wing (L:W=87.1:20.0) narrow, elongate and densely setose; hind wing (L:W = 79.1:10.3) less curved, densely setose; fore wing marginal cilia 1.34× width of wing; hind wing marginal cilia 1.73× width of wing; wings 1.39× longer than in female

Etymology. The species is named '*adikeshavus*' meaning first one to have long hairs in Sanskrit, alluding to the long marginal setae on both pairs of wings in this species as well as the species group.

Diagnosis. *I. adikeshavus* differs from *I. brevicornis*, *I. deergakombus* and *I. lopamudra* by having T2 equal to T3 while in all others T2 > 1.7× length of T3; T3 faintly costate in *I. adikeshavus* while T3 smooth in other three species; *I. adikeshavus* differs from *I. brevicornis* and *I. lopamudra* in having longer and denser microtrichia on fore wings, while it is almost smooth in the latter two. In *I. adikeshavus*, A4 and A5 subequal to A3 while in others A4 and A5 0.6–0.7× length of A3. *I. teestai* differs from *I. adikeshavus* in having a fully reticulate mesoscutum and mesoscutellum.

Idris brevicornis Veenakumari, sp. n.

<http://zoobank.org/551EA7B3-358D-4012-90FD-7191CCD0832C>

Figures 11–17

Holotype (Female). (ICAR/NBAIR/P381) INDIA: Karnataka: Bengaluru, Attur, PFT, 24.xii.2012. **Paratypes**: (ICAR/NBAIR/P382), 1 male, same data as holotype, YPT, 08.viii.2013; (ICAR/NBAIR/P383), 1 female, Karnataka: Chikkaballapur, Nandi Hills, SN, 16.xi.2009; (ICAR/NBAIR/P384, P385, P386), 3 females, Karnataka: Bengaluru, Jarakabande Kaval, MT, 22.xi.2013; (ICAR/NBAIR/P387), 1 female, same data as P386, 31.xii.2013; (ICAR/NBAIR/P388), 1 female, same data as P386, 18.x.2013; (ICAR/NBAIR/P389), 1 female, same data as P386, 09.xii.2013; (ICAR/NBAIR/P390), 1 male, Tamil Nadu: Hosur, Uddanapalli, YPT, 31.i.2015; (ICAR/NBAIR/P408, P409), 2 females, Karnataka: Bengaluru, Gandhi Krishi Vigyana Kendra, YPT, 22.xii.2014; (ICAR/NBAIR/P410), 1 female, same data as P390; (ICAR/NBAIR/P411), 1 female, same data as P384, 30.xii.2014.

Type locality. INDIA: Karnataka, Tamil Nadu

Description of female. Color and size (Figs 11, 12). Entire body dark brownish black except yellow T7; legs brown. Body length = 0.716 mm.

Head (Figs 13, 14, 16). FCI=1.37; LCI=1.70; IOS 0.62× width of head; POL > LOL in ratio of 16.5:10.4; length and width of compound eye in ratio of 11.1:8.0; lower frons smooth with facial striae; upper frons and vertex with setigerous punctae; length and width of antennomeres A1–A7 in ratio of 11.6:2.8, 4.5:2.5, 1.8:1.5, 1.3:1.5, 1.3:1.5, 1.8:2.0, 11.5:6.5 respectively; radicle 0.26× length of A1.

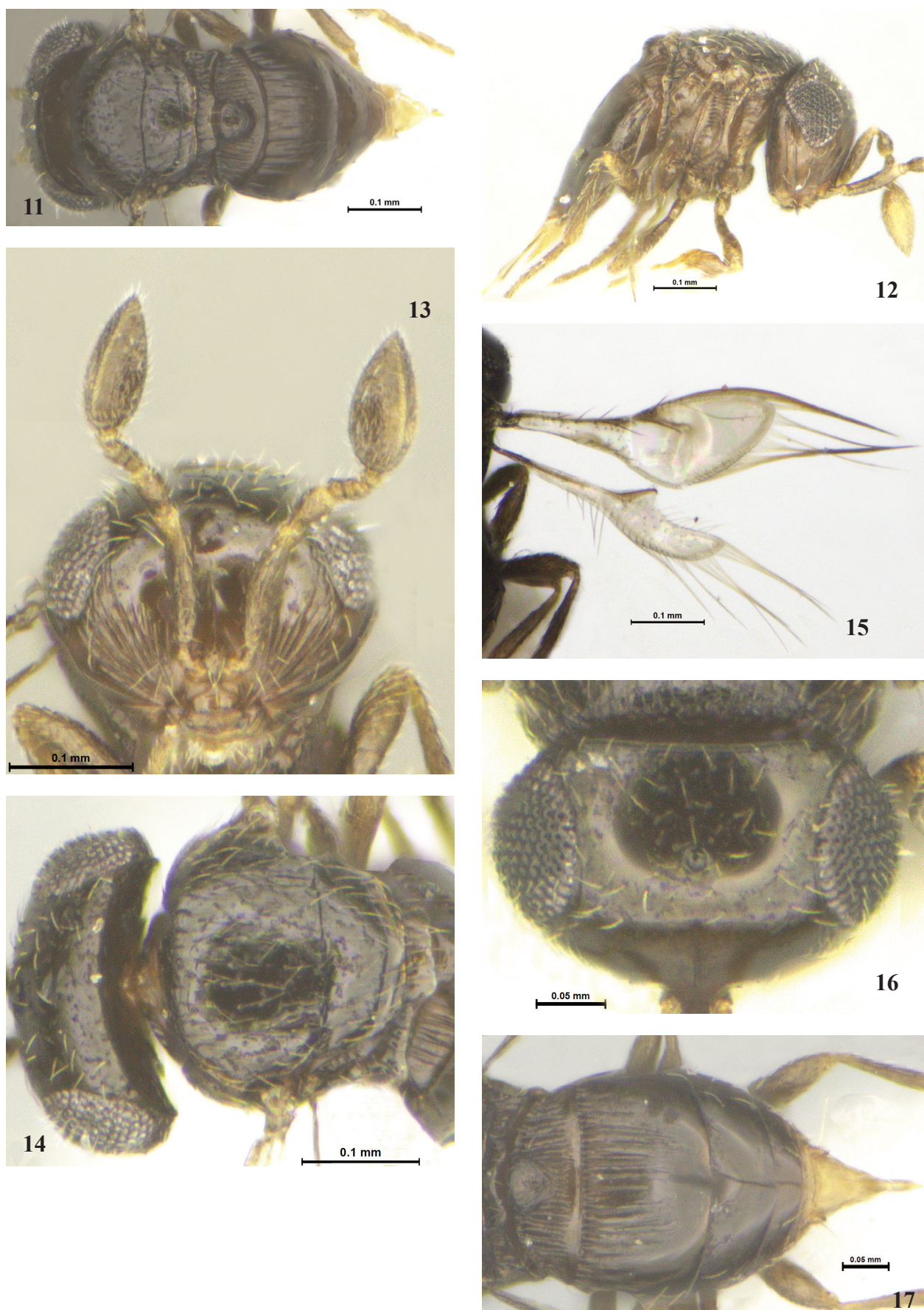
Mesosoma (Fig. 14). Mesoscutum (L:W = 14.3:22.5) anteriorly weakly reticulate, rest smooth, sparsely setose; mesoscutellum (L:W = 5.6:16.9) smooth, sparsely covered with setigerous punctae; notauli short (L:W = 3.9:0.8); internal notular distance 0.54× width of mesoscutum; lateral pronotal area smooth with few foveae ventrally; mesopleuron with six transverse carinae beneath tegula and two short transverse carinae beneath these elongate carinae; femoral depression distinct with foveae posteriorly; mesepimeral sulcus distinct; metapleuron smooth with few foveae ventrally; metapleural pit distinct; scutoscutellar sulcus not foveate except for a single fovea laterally; metascutellum narrow, rectangular; metanotal trough anteriorly smooth and posteriorly with longitudinal foveae; propodeum medially produced as a rectangular costate plate; lateral propodeal area weakly costate.

Fore wing (Fig. 15) (L:W = 34.9:12.7) totally devoid of microtrichia in apical half; a few short microtrichia found basally; hind wing (L:W = 34.3:7.9) with a few short microtrichia; fore wing marginal cilia 2× width of wing while hind wing marginal cilia 2.14× width of wing; submarginalis: marginalis: stigmalis in ratio of 16.1:3.1:5.3.

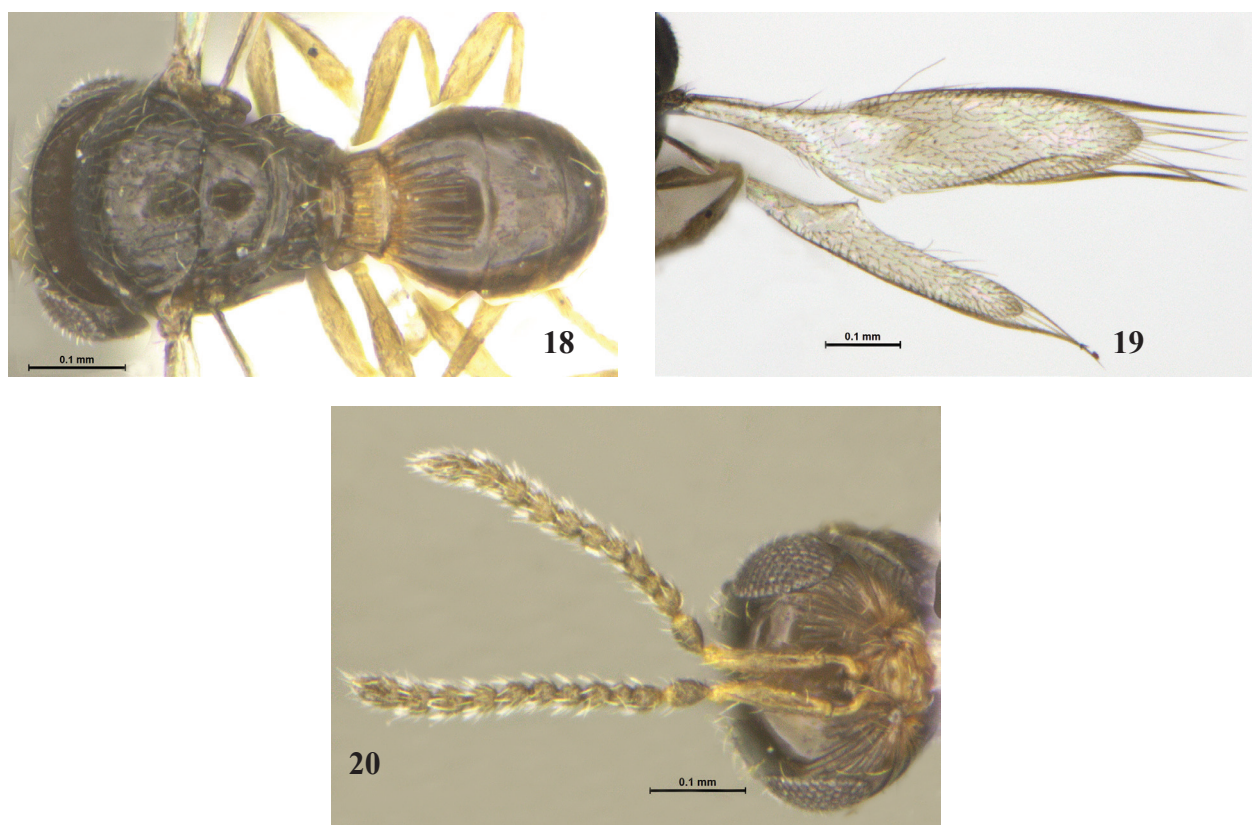
Metasoma (Fig. 17). (L:W = 41.3:25.1); T1 finely costate, with a short round medial horn; horn with a few weak transverse costae laterally and almost smooth posteriorly; height of horn 0.39× length of T1; T2 with basal foveae; T2 costate, costae not reaching posterior margin; rest of tergites smooth; T2, 1.95× longer than T3; sparse long setae found laterally and sublaterally on T2–T4; length and width of tergites T1–T7 in ratio of 7.7:17.5, 13.7:19.4, 7.0:23.8, 2.6:19.5, 1.5:14.2, 1.5:11.8, 6.7:8.3, respectively; ovipositor 0.65× length of T1.

Variability (n=12). Female body length: 0.677–0.782 mm (m=0.72; SD=0.04). FCI=1.31–1.41 (m=1.38; SD=0.02); LCI=1.65–1.71 (m=1.68; SD=0.01); mesoscutum length=0.122–0.149 mm (m=0.138; SD=0.07); mesoscutum width=0.213–0.239 mm (m=0.227; SD=0.01); mesoscutellum length=0.046–0.065 mm (m=0.054; SD=0.06); mesoscutellum width=0.16–0.192 mm (m=0.183; SD=0.01); fore wing length=0.297–0.398 mm (m=0.352; SD=0.03); fore wing width=0.113–0.135 mm (m=0.12; SD=0.01); length of fore wing marginal cilia=0.212–0.239 mm (m=0.221; SD=0.01); hind wing length=0.288–0.346 mm (m=0.331; SD=0.03); hind wing width=0.075–0.089 mm (m=0.08; SD=0.04); length of hind wing marginal cilia=0.148–0.189 mm (m=0.172; SD=0.01); length of T1=0.071–0.079 mm (m=0.076; SD=0.04); length of T2=0.123–0.139 mm (m=0.131; SD=0.06); length of T3=0.051–0.071 mm (m=0.062; SD=0.08).

Description of male (Figs 18, 19, 20). Similar to female; Body length=0.758 mm; length and width of antenno-



Figures 11–17. *Idris brevicornis* sp. n. (female). **11.** Habitus (dorsal); **12.** Habitus (lateral) and pleuron; **13.** Head (frontal view) and antennae; **14.** Head and mesosoma; **15.** Wings; **16.** Head showing ocelli; **17.** Metasoma.



Figures 18–20. *Idris brevicornis* sp. n. (male) **18.** Habitus; **19.** Wings; **20.** Antennae.

meres A1–A12 in ratio of 11.8:3.3, 5.3:3.3, 3.5:3.3, 2.3:2.8, 2.5:3.3, 2.3:2.8, 2.8:3.0, 3.0:3.3, 3.0:3.5, 3.0:3.5, 3.5:3.5, 5.8:3.5 respectively; fore wing (L:W = 60.7:14.2) and hind wing (L:W = 52.7:7.3) densely covered with long microtrichia; fore wing marginal cilia equal to width of wing; hind wing marginal cilia $1.81\times$ width of wing.

Etymology. The species is named '*brevicornis*' referring to the short horn on T1.

Diagnosis. *I. brevicornis* differs from *I. lopamudra* in having a short horn, with the latter having a longer horn which is distinctly costate laterally and posteriorly; T2 in *I. brevicornis* is $1.95\times$ longer than T3 while in *I. lopamudra* T2 $1.7\times$ longer than T3; propodeum is extended as median costate plate in *I. brevicornis* which is not so in other species of *Idris* described here.

***Idris deergakombus* Veenakumari, sp. n.**

<http://zoobank.org/C4EDBF3E-E01C-4342-A665-D9F6FD7FE428>
Figures 21–27

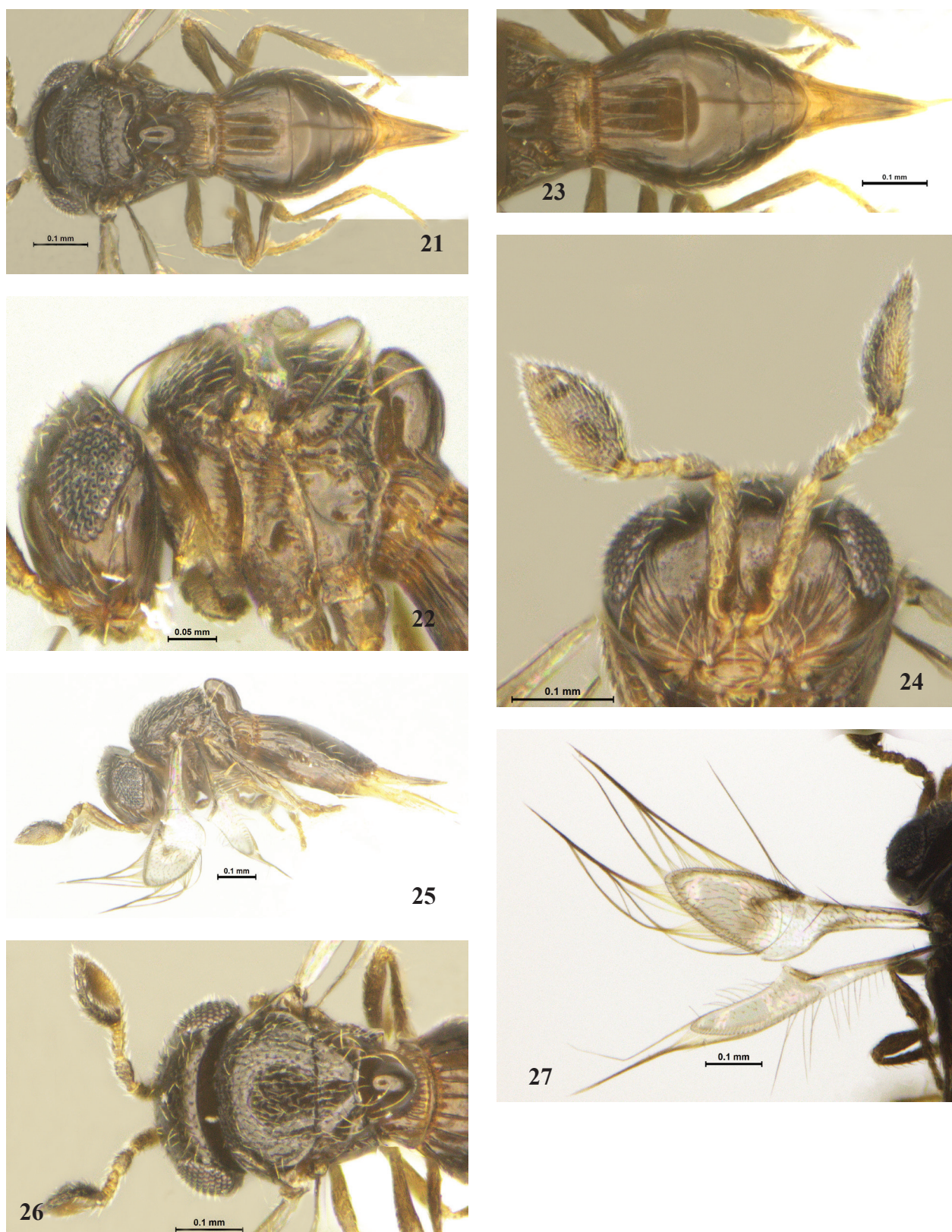
Holotype (Female) (ICAR/NBAIR/P376) INDIA: Arunachal Pradesh, Pasighat, College of Horticulture and Forestry, YPT, 05.v.2014. **Paratypes:** (ICAR/NBAIR/P377, P378), 2 females, same data as that of holotype; (ICAR/NBAIR/P379), same data as holotype, SN, 03.v.2014; (ICAR/NBAIR/P380), same data as holotype, YPT, 03.v.2014.

Type locality. INDIA: Arunachal Pradesh, Pasighat.

Description of female. Color and size (Figs 21, 25). Head, mesosoma, horn on T1 dark brown; metasomal tergites T1–T6 paler than mesosoma; T7 yellowish brown; legs same color as metasoma except paler tarsi; antennae brown except dark brown T2 and clava. Body length=0.989 mm.

Head (Figs 24, 26). FCI=1.25; LCI=1.60; IOS $0.6\times$ width of head; lower frons smooth, upper frons setigerous punctate; facial striae present reaching lower orbit; gena smooth; POL>OOL in ratio of 17.9:9.9; eyes (L:W = 12.7:9.8) densely setose; length and width of antennomeres A1–A7 in ratio of 12.6:2.7, 4.6:3.0, 1.8:1.8, 1.1:1.7, 1.1:1.8, 1.9:2.5, 13.6:7.8, respectively; radicle $0.27\times$ length of A1.

Mesosoma (Figs 22, 25). Mesoscutum (L:W = 15.4:23.7) anteriorly reticulate, posteriorly setigerous punctate; mesoscutellum (L:W = 6.0:15.0) with similar sculpture as that of mesoscutum anteriorly, posteriorly almost smooth; notauli (L:W = 4.0:1.2) present; internotular distance $0.43\times$ width of mesoscutum; lateral pronotal area almost smooth with weak transverse ridges; mesopleuron with eight transverse ridges beneath tegula, femoral depression, mesopleural carina distinct; posterior margin of femoral depression crenulate; metapleuron smooth, with distinct metapleurul sulcus and metapleurul pit; scutoscuteellar sulcus weakly foveate; metascutellum medially narrow and laterally broad; propodeum present as lateral lamellae anterior to horn.



Figures 21–27. *Idris deergakombus* sp. n. (female) 21. Habitus (dorsal); 22. Pleuron; 23. Metasoma 24. Head (frontal view) and antennae; 25. Habitus (lateral); 26. Head and mesosoma; 27. Wings.

Fore wing (Figs 26, 27) (L:W = 46.3:13.9) transparent with long microtrichia; hind wing (L:W = 45.7:8.4) with sparse short microtrichia; submarginalis : marginalis: stigmalis of fore wing in ratio of 20.7:3.0:6.4 respectively; fore wing marginal cilia $2.1\times$ width of wing while hind wing marginal cilia $2.94\times$ width of wing.

Metasoma (Fig. 23) (L:W = 60.3:25.0); anterior margin of T1 crenulate; T1 strongly costate; horn on T1 long, smooth except for few weak costae posteriorly; length of horn $1.41\times$ length of T1; T1 with two lateral setae; T2 anteriorly smooth beneath which a row of basal foveae present; T2 costate beneath basal foveae, costae not reaching posterior margin; T2, $2\times$ length of T3; T2 with dense short lateral setae; T3–T7 smooth; T3 with long sublateral setae; T4 and T5 with single sublateral seta; ovipositor extruded $0.25\times$ length of T7; T7 acuminate; length and width of tergites in ratio of 7.4:17.3, 16.7:15.7, 8.0:24.5, 5.0:23.0, 3.3:17.4, 2.0:13.9, 17.8:10.9, respectively.

Variability (n=5). Female body length=0.929–1.128 mm (m=1.07; SD=0.07); FCI=1.21–1.36 (m=1.3; SD=0.02); LCI=1.58–1.69 (m=1.63; SD=0.03); mesoscutum length=0.141–0.159 mm (m=0.15; SD=0.07); mesoscutum width=0.22–0.239 mm (m=0.227; SD=0.07); mesoscutellum length=0.056–0.073 (m=0.066; SD=0.07); mesoscutellum width=0.135–0.161 mm (m=0.157; SD=0.015); fore wing length=0.407–0.468 mm (m=0.426; SD=0.03); fore wing width=0.124–0.150 mm (m=0.133; SD=0.01); length of fore wing marginal cilia=0.284–0.385 mm (m=0.332; SD=0.03); hind wing length=0.432–0.483 mm (m=0.445; SD=0.04); hind wing width=0.071–0.087 mm (m=0.077; SD=0.04); length of hind wing marginal cilia=0.221–0.251 (m=0.232; SD=0.04); length of T1=0.068–0.084 mm (m=0.073; S. D.=0.09); length of T2=0.148–0.174 mm (m=0.16; SD=0.09); length of T3=0.078–0.092 mm (m=0.085; SD=0.05).

Male. Unknown

Etymology. The species is named '*deergakombus*' which means 'long horn' in Sanskrit.

Diagnosis. *I. deergakombus* differs from *I. brevicornis* and *I. lopamudra* in having long and denser microtrichia on fore wing while in the latter two the wings are almost smooth; horn on T1 is longer and smooth in *I. deergakombus* while it is costate in *I. brevicornis* and *I. lopamudra*. *I. deergakombus* has a long horn while it is short in *I. brevicornis*; In *I. deergakombus* T2 $2\times$ length of T3 while in *I. lopamudra* T2 $1.7\times$ length of T3.

Idris lopamudra Veenakumari, sp. n.

<http://zoobank.org/359E61DA-8A59-4501-8A28-4CBF3758191A>
Figures 28–34

Holotype (Female). (ICAR/NBAIR/P391) INDIA: Karnataka: Bengaluru, Hebbal, YPT, 12.iv.2010. **Paratypes**: (ICAR/NBAIR/P392), 1 female, same data as holotype, PFT, 18.i.2010; (ICAR/NBAIR/P393), 1 female, same data as P392, 11.i.2010; (ICAR/NBAIR/P394), 1 female, same

data as P392, 04.i.2010; (ICAR/NBAIR/P395), 1 female, same data as P392, YPT, 03.iii.2010; (ICAR/NBAIR/P396), 1 female, same data as P392, PFT, 20.ii.2010; (ICAR/NBAIR/P397, P398), 2 females, Bengaluru, Malleshwaram, Aranyabhavan, PFT, 17.ii.2010; (ICAR/NBAIR/P399), 1 female, Bengaluru, Attur, YPT, 27.vii.2013; (ICAR/NBAIR/P400), 1 female, Karnataka: Tumkur, Ranganathswamy Betta, SN, 20.ix.2011; (ICAR/NBAIR/P401), 1 female, Karnataka: Bengaluru, Jarakabande Kaval, MT, 23.i.2015; (ICAR/NBAIR/P402), 1 female, same data as P401, YPT, 13.i.2014; (ICAR/NBAIR/P403), 1 female, same data as P401, MT, 29.i.2014; (ICAR/NBAIR/P404), 1 female, same data as P401, MT, 31.xii.2013; (ICAR/NBAIR/P405), 1 female, Tamil Nadu: Hosur, Uddanapalli, MT, 31.i.2015; (ICAR/NBAIR/P406), 1 female, same data as P405, YPT, 31.i.2015; (ICAR/NBAIR/P407), 1 female, same data as P405, YPT, 02.xii.2014.

Type locality. INDIA, Karnataka, Tamil Nadu

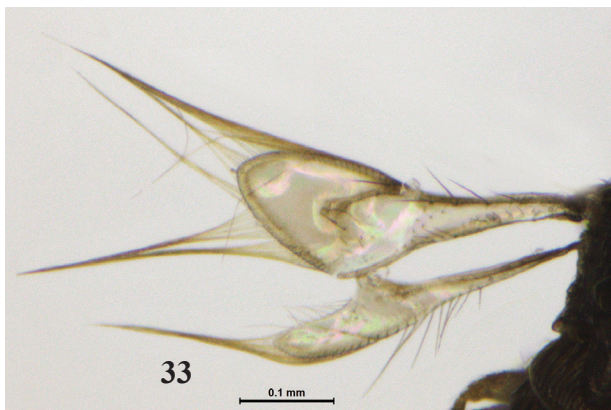
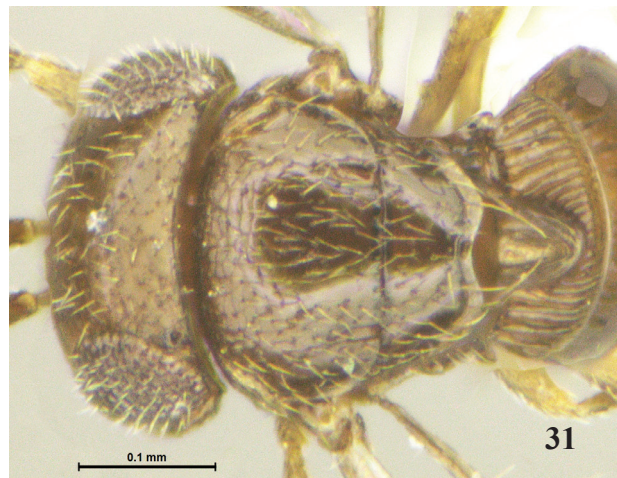
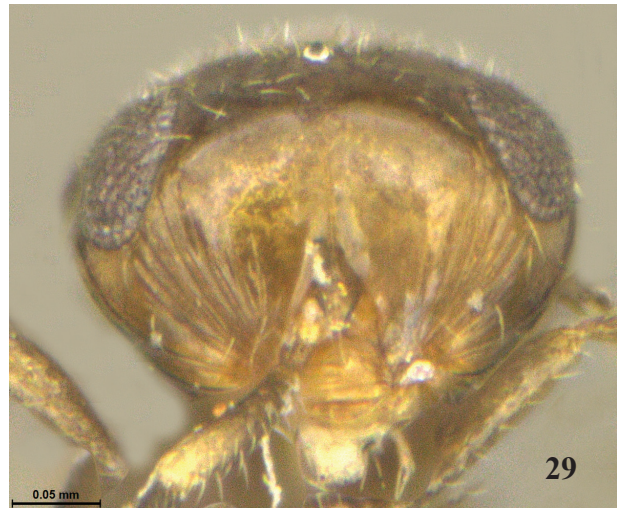
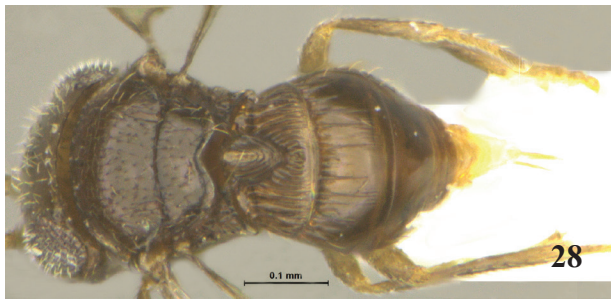
Description of female. Color and size (Fig. 28). Head, mesosoma brown, metasoma paler than mesosoma; posterior tergites yellowish brown; legs same color as metasoma; antennae brown to dark brown with patches of yellow on apical A1, anterior and posterior margin of A2 and lateral clava. Body length=0.725 mm.

Head (Figs 29, 31, 34). FCI=1.24; LCI=1.65; IOS $0.57\times$ width of head; lower frons smooth, upper frons and vertex with setigerous punctae; eyes (L:W = 11.1:10.1) densely setose; strong facial striae present; central keel present; gena smooth. POL>LOL in ratio of 15.4:8.5; length and width of antennomeres A1–A7 in ratio of 11.2:3.8, 5.0:3.3, 1.8:2.3, 1.1:2.0, 1.2:2.3, 1.7:2.3, 11.5:7.5, respectively; radicle $0.24\times$ length of A1.

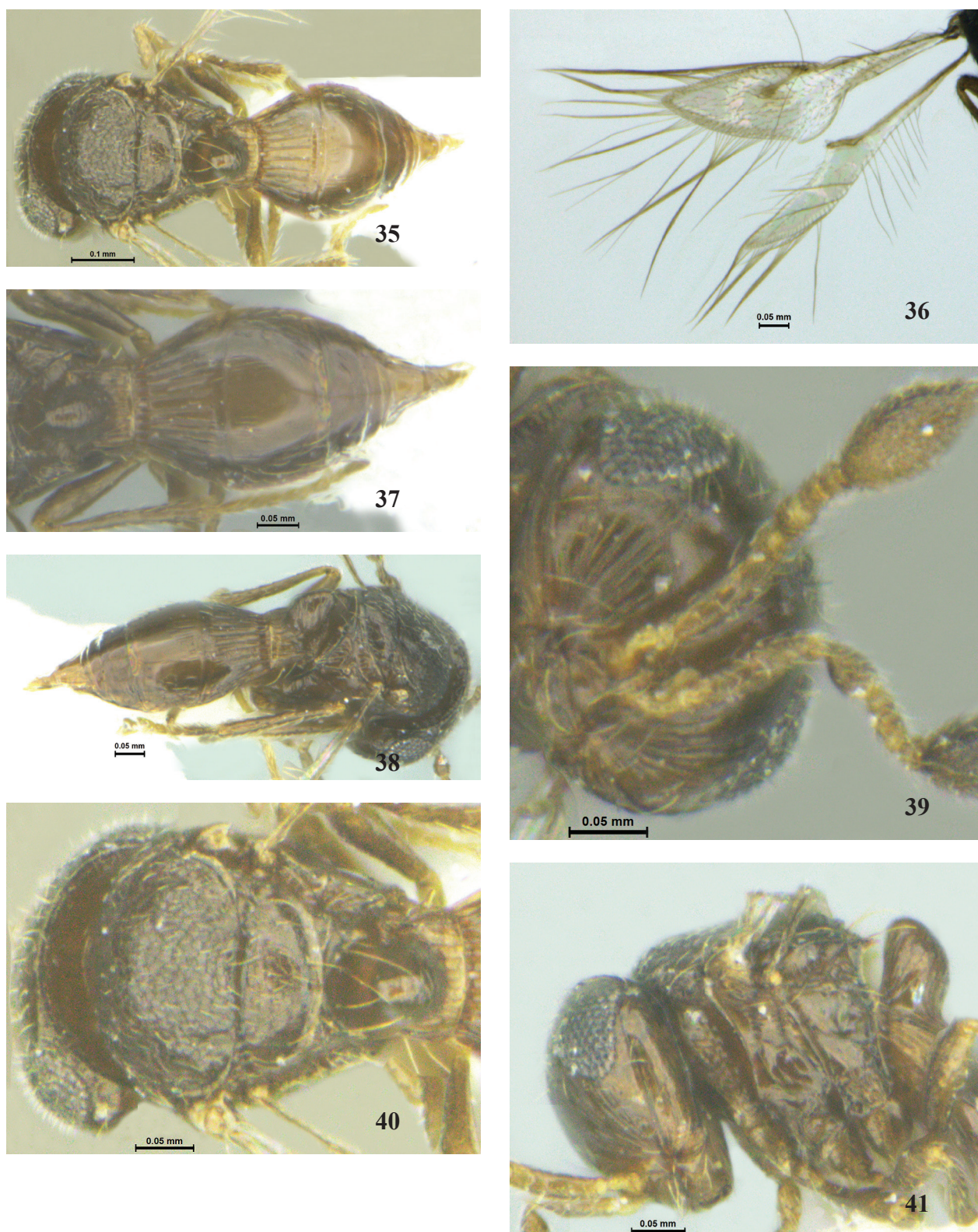
Mesosoma (Figs 30, 31). Mesoscutum (L:W = 13.6:22.9) anteriorly reticulate and posteriorly setigerous punctate; notauli (L:W = 4.1:1.4) present; internotular distance $0.44\times$ width of mesoscutum; mesoscutellum (L:W = 5.2:18.8) with setigerous punctae; metascutellum smooth, narrow and medially indented; metanotal trough weakly foveate; scutoscuteellar sulcus not foveate medially, foveate laterally; lateral pronotal area almost smooth except for a few faint transverse carinae anteriorly; mesopleuron with eight transverse carinae beneath tegula; femoral depression and mesopleural carina distinct; metapleuron almost smooth except for some uneven sculpture dorsally; propodeum present as lateral lamellae anterior to horn.

Fore wing (Fig. 33) (L:W = 34.8:12.6) transparent with very sparse microtrichia in basal half; hind wing (L:W = 32.3:7.6) less curved, with sparse microtrichia; fore wing marginal cilia $2.12\times$ width of wing; hind wing marginal cilia $2.46\times$ width of wing; submarginalis: marginalis: stigmalis in ratio of 16.7:2.6:6.6 respectively.

Metasoma (Fig. 32). (L:W = 40.5:24.8); T1 strongly costate, costae extending up to posterior margin; T1 with median horn, horn transversely costate laterally and posteriorly; horn almost wedge shaped posteriorly; T2 basally foveate, costate, costae wide apart; T2 $1.7\times$ longer than T3; T3–T7 smooth; sparse long setae present sublaterally on T2 and T3; length and width of tergites T1–T7 in



Figures 28–34. *Idris lopamudra* sp. n. (female) **28.** Habitus; **29.** Head (frontal view); **30.** Pleuron; **31.** Head and mesosoma; **32.** Metasoma; **33.** Wings; **34.** Head and antennae.



Figures 35–41. *Idris teestai* sp. n. (female) 35 Habitus (dorsal); 36 Wings; 37 Metasoma (dorsal); 38 Metasoma (lateral); 39 Head and antennae; 40 Mesoscutum and mesoscutellum showing reticulations; 41 Pleuron.

ratio of 8.6:18.5, 11.4:20.1, 6.7:24.3, 2.0:16.9, 1.8:13.6, 0.9:9.2, 8.6:8.0, respectively.

Variability (n=15). Female body length=0.745–0.837 mm (m=0.8; SD=0.03); FCI=1.15–1.30 (m=1.25; SD=0.06);

LCI=1.63–1.72 (m=1.68; SD=0.09); mesoscutum length=0.123–0.149 mm (m=0.136; SD=0.09); mesoscutum width=0.192–0.239 mm (m=0.219; SD=0.04); mesoscutellum length=0.05–0.065 mm (m=0.058; SD=0.09);

mesoscutellum width=0.18–0.193 mm (m=0.189; SD=0.01); fore wing length=0.341–0.391 mm (m=0.353; SD=0.09); fore wing width=0.121–0.141 mm (m=0.132; SD=0.05); length of fore wing marginal cilia=0.273–0.318 mm (m=0.291; SD=0.01); hind wing length=0.315–0.342 mm (m=0.329; SD=0.03); hind wing width=0.07–0.081 mm (m=0.079; SD=0.09); length of hind wing marginal cilia=0.17–0.205 (m=0.186; SD=0.01); length of T1=0.08–0.092 mm (m=0.087; SD=0.01); length of T2=0.113–0.121 mm (m=0.117; SD=0.05); length of T3=0.057–0.071 mm (m=0.067; SD=0.07).

Male. Not known.

Etymology. The species is named ‘*lopamudra*’ after the wife of the Vedic sage Agastya, who was one of the few women philosophers of ancient India; used here as a noun in apposition.

Diagnosis. The distinguishing characters for this species are mentioned under other species of *Idris*.

Idris teestai Veenakumari, sp. n.

<http://zoobank.org/8CAB4371-84C2-4F2B-A733-5100F8106172>

Figures 35–41

Holotype (Female). (ICAR/NBAIR/P856) INDIA: Sikkim, Gangtok, Hanuman Tok, SN, 12.x.2008.

Type locality. INDIA: Sikkim.

Description of female. Color and size (Fig. 35). Head, mesosoma dark brown with lateral margin of mesoscutum and metanotum greyish-brown; metasoma brown except T7 which is a shade paler, horn dark brown, legs dark brown; radicle yellowish brown, rest of antennomeres brown except dark brown clava. Body length = 0.834 mm. (n=1).

Head (Figs 39, 41). FCI=1.23; LCI=1.68; IOS 0.61× width of head; lower frons smooth; upper frons and vertex setigerous punctate; eyes (L:W = 10.6:8.5) densely setose; facial striae strong; central keel long, 0.5× height of head; POL>LOL in ratio of 15.8:8.6; interantennal process projecting; length and width of antennomeres A1–A7 in ratio of 10.8:2.6, 3.9:2.9, 1.8:1.8, 1.2:1.9, 1.3:1.5, 1.8:2.2, 11.0:5.3, respectively; radicle long 0.37× length of A1.

Mesosoma (Figs 40, 41). Mesoscutum (L:W = 14.4:22.2) fully reticulate, sparsely setose, setae short; notauli short (L:W = 3.2:1.1); internotular distance 0.67× width of mesoscutum; mesoscutellum (L:W = 6.4:14.6), with same sculpture as that of mesoscutum; metascutellum smooth, narrow, uniformly rounded posteriorly; metanotal trough with weak foveae; scutoscuteellar sulcus not foveate medially, weakly foveate laterally; lateral pronotal area weakly rugose; mesopleuron with weak transverse striae beneath tegula; mesopleural pit with deep foveae ventrally; metapleuron almost smooth with uneven sculpture ventrally; metapleuron pit present; propodeum present as lateral lamellae anterior to horn; anterior and posterior margin of propodeum projecting as a small spine.

Forewing (Fig. 36.) (L:W = 47.9:14.6) with long marginal cilia 2.1× width of wing; entire wing with long microtrichia; length of submarginalis: marginalis: stigmalis

in ratio of 23.7:4.6:8.6 respectively; hind wing (L:W = 47.3:7.9) with short, sparse microtrichia; hind wing marginal cilia 2.18× width of wing.

Metasoma (Figs 37, 38). (L:W = 49.8:21.8); T1 strongly costate the entire length; horn (L:W = 8.6:6.3) on T1 smooth with weak striae; striae longitudinal laterally and transverse posteriorly; T2 basally foveate, strong costae arising from these foveae; costae on T2 not reaching posterior margin; T2 posteriorly smooth; anterior margin of T3 convex as a result of which length of T2 is longer laterally; T2 subequal to T3; T3 weakly striate in anterior half, setose sublaterally; T4–T7 smooth; length and width of tergites T1–T7 in ratio of 7.5:10.1, 12.8:11.0, 12.6:21.6, 4.5:18.2, 1.7:14.2, 1.2:10.1, 9.7:8.1, respectively.

Male. Not known.

Etymology. The species is named ‘*teestai*’ after the river Teesta in the state of Sikkim, from where the type specimen was collected.

Diagnosis. This species can be easily distinguished from the other four species described here by reticulate sculpture on mesoscutum and mesoscutellum.

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The first and second authors are grateful to the Director ICAR-NBAIR, Bengaluru for providing facilities and encouragement. We thank Lubomir Masner for discussions and for confirming the taxonomic identity; we also thank N.F. Johnson and A.D. Austin for their critical review of the paper – all of which helped considerably improve the paper. We thank Christoph Germann for Latinizing the names. We are indebted to the Museum für Naturkunde, Berlin for the waiver of page charges. We also thank B.L. Lakshmi, V. Shashikala and B. Nagaraja for their support both in the field and the laboratory. Thanks are also due to the Platygastroidea Planetary Biodiversity Inventory, under National Science Foundation grant No. DEB-0614764, for literature support.

References

- Austin AD (1984) The fecundity, development and host relationship of *Ceratobaeus* spp. (Hymenoptera: Scelionidae), parasites of spider eggs. *Ecological Entomology* 9: 125–138. doi: 10.1111/j.1365-2311.1984.tb00707.x
- Austin AD (1985) The function of spider egg sacs in relation to parasitoids and predators, with special reference to the Australian fauna. *Journal of Natural History* 19: 359–376. doi: 10.1080/00222938500770261
- Austin AD (1986) A taxonomic revision of the genus *Mirobaeoides* Dodd (Hymenoptera: Scelionidae). *Australian Journal of Zoology* 34: 315–337. doi: 10.1071/ZO9860315
- Austin AD (1988) A new genus of baeine wasp (Hymenoptera: Scelionidae) from New Zealand associated with moss. *New Zealand Journal of Zoology* 15: 173–183. doi: 10.1080/03014223.1988.10422612
- Austin AD (1995) New species of baeine parasitoids of spider eggs (Hymenoptera: Scelionidae) from Western Australia. *Records of the Western Australian Museum, Supplement No. 52*: 253–263.

- Austin AD, Field SA (1997) The ovipositor system of scelionid and platygastroid wasps (Hymenoptera: Platygastroidea): comparative morphology and phylogenetic implications. *Invertebrate Taxonomy* 11: 1–87. doi: 10.1071/IT95048
- Austin AD, Johnson NF, Dowton M (2005) Systematics, evolution and biology of scelionid and platygastroid wasps. *Annual Review of Entomology* 50: 552–583. doi: 10.1146/annurev.ento.50.071803.130500
- Carey D, Murphy NP, Austin AD (2006) Molecular phylogenetics and the evolution of wing reduction in a tribe of parasitoid wasps (Hymenoptera: Scelionidae: Baeni). *Invertebrate Systematics* 20: 489–501. doi: 10.1071/IS06011
- Förster A (1856) *Hymenopterologische Studien*. II. Heft. Chalcidae und Proctotrupii. Ernst ter Meer, Aachen, 152 pp.
- Galloway ID, Austin AD (1984) Revision of the Scelioninae (Hymenoptera: Scelionidae) in Australia. *Australian Journal of Zoology, Supplementary Series* 99: 1–138.
- Huggert L (1979) Revision of the west Palaearctic species of the genus *Idris* Foerster *s.l.* (Hymenoptera, Proctotrupoidea, Scelionidae). *Entomologica Scandinavia Suppl.* No. 12, 60 pp.
- Iqbal M, Austin AD (1997) Species richness and endemism of baeline wasps (Hymenoptera: Scelionidae) in Australia. *Memoirs of Museum Victoria* 56: 455–459.
- Iqbal M, Austin AD (2000a) Systematics of the wasp genus *Cerato-baeus* Ashmead (Hymenoptera: Scelionidae) from Australasia: parasitoids of spider eggs. *Records of the South Australian Museum, Monograph Series* 6: 1–164.
- Iqbal M, Austin AD (2000b) A preliminary phylogeny for the Baeni (Hymenoptera: Scelionidae): Endoparasitoids of spiders eggs. In: Austin AD, Dowton M (Eds) *The Hymenoptera; Evolution, Biodiversity and Biological control*. CSIRO Publishing, Melbourne, 178–191.
- Johnson NF (2015) Platygastroidea. http://osuc.biosci.ohio-state.edu/hymDB/eol_scelionidae.home [accessed on 14.6.2014]
- Mani MS (1939) Descriptions of new and records of some known chalcidoid and other hymenopterous parasites from India. *Indian Journal of Entomology* 1: 69–99.
- Mani MS (1973) On a new scelionid parasite (Hymenoptera: Serphoidea). *Oriental Insects* 7: 353–354. doi: 10.1080/00305316.1973.10434097
- Mani MS (1975) On a collection of Scelionidae and Platygasteridae (Hymenoptera: Proctotrupoidea) from India. *Memoirs of the School of Entomology, St. John's College* 4: 63–80.
- Mani MS, Mukerjee MK (1976) On some Baeninae (Proctotrupoidea: Scelionidae) from India. *Oriental Insects* 10: 497–526. doi: 10.1080/00305316.1976.10434520
- Mani MS, Sharma SK (1982) Proctotrupoidea (Hymenoptera) from India. A review. *Oriental Insects* 16: 135–258. doi: 10.1080/00305316.1982.10434314
- Masner L (1976) Revisionary notes and keys to world genera of Scelionidae (Hymenoptera: Proctotrupoidea). *Memoirs of the Entomological Society of Canada* 108: 1–87. doi: 10.4039/entm10897fv
- Masner L (1980) Key to genera of Scelionidae of the Holarctic region, with descriptions of new genera and species (Hymenoptera: Proctotrupoidea). *Memoirs of the Entomological Society of Canada* 112: 1–54. doi: 10.4039/entm112113fv
- Masner L, Denis J (1996) The Nearctic species of *Idris* Foerster. Part I: the *melleus*-group (Hymenoptera: Scelionidae). *The Canadian Entomologist* 128: 85–114. doi: 10.4039/Ent12885-1
- Mikó I, Masner L, Deans AR (2010) World revision of *Xenomorus* Walker (Hymenoptera: Platygastroidea, Platygasteridae). *Zootaxa* 2708: 1–73.
- Mikó I, Vilhelmsen L, Johnson NF, Masner L, Péntzes Z (2007) Skeleto-musculature of Scelionidae (Hymenoptera: Platygastroidea) head and mesosoma. *Zootaxa* 1571: 1–78.
- Mukerjee MK (1978) Descriptions of some Baeninae-complex (Hymenoptera: Proctotrupoidea: Scelionidae) from India. *Memoirs of the School of Entomology, St. John's College* 5: 47–66.
- Mukerjee MK (1981) On a collection of Scelionidae and Platygasteridae (Hymenoptera: Proctotrupoidea) from India. *Records of the Zoological Survey of India, Miscellaneous Publication, Occasional Papers*. No. 2, 78 pp.
- Mukerjee MK (1994) Descriptions of some new and records of some known Proctotrupoidea (Hymenoptera) from Garhwal Himalayas, India. *Records of the Zoological Survey of India, Occasional Papers* 163: 1–73.
- Murphy NP, Carey D, Castro LR, Dowton M, Austin AD (2007) Phylogeny of the platygastroid wasps (Hymenoptera) based on sequences from the 18srRNA, 28S rRNA and cytochrome oxidase *I* genes: implications for the evolution of the ovipositor system and host relationships. *Biological Journal of the Linnean Society* 91: 653–669. doi: 10.1111/j.1095-8312.2007.00825.x
- Stevens NB, Austin AD (2007) Systematics, distribution and biology of the Australian 'micro-flea' wasps, *Baeus* spp. (Hymenoptera: Scelionidae): parasitoids of spider eggs. *Zootaxa* 1499: 1–45.
- Valerio AA, Austin AD, Masner L, Johnson NF (2013) Systematics of Old World *Odontacolus* Kieffer *s.l.* (Hymenoptera, Platygasteridae *s.l.*): parasitoids of spider eggs. *ZooKeys* 314: 1–151. doi: 10.3897/zookeys.314.3475