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Atree, a remarkable new genus of the subfamily Brachistinae (Hymenoptera: Braconidae) and the first report of the tribe Diospilini from India

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Abstract

The braconid tribe Diospilini (subfamily Brachistinae) is reported for the first time from India with the description of a new genus, *Atree*, along with the description of a new species *A. rajathae* from south India. The newly described genus belongs to the *Aspigonus* genus group showing the presence of a wide, deep sculptured groove on the propleuron. Based on morphological affinities, two species reported from Taiwan which were earlier included in the genus *Diospilus* have been transferred to the new genus, as *A. improcerus* (Chou & Hsu, 1998) **comb. nov.** and *A. validus* (Chou & Hsu, 1998) **comb. nov.** A key to the Indomalayan and Palaearctic genera of Diospilini is provided along with the key to the species of *Atree* **gen. nov.**

Key words: Helconinae, new species, south India, taxonomic key, Indomalayan region

Introduction

The braconid subfamily Brachistinae Förster, 1863 is a cosmopolitan taxon with more than 750 species in 38 genera (Sharkey & van Achterberg 2021). The subfamily includes small helconoid species which develop as endoparasitoids in coleopteran larvae (Chen & van Achterberg 2019). Sharanowski *et al.* (2011) transferred three tribes (Brachistini, Brulleiini and Diospilini) included in the subfamily Helconinae, along with Blacini (hitherto treated as separate subfamily) to Brachistinae based on molecular data. Later Chen & van Achterberg (2019) added Tainitermini (subfamily Euphorinae) to this subgenus based on the molecular analyses by Stigenberg *et al.* (2015). Among five brachistine tribes, Brachistini and Diospilini are found to be more diverse (Yu *et al.* 2016; Chen & van Achterberg 2019). The subfamily is more speciose in the Palaearctic and only 76 species are known from the Indomalayan region but only one species, *Eubazus virhini* (Sathe, Inamdar & Dawale, 2003) belong to the tribe Brachistini, has been reported from India (Yu *et al.* 2016).

The tribe Diospilini consists of 13 genera and 125 species which are mostly distributed in the Palaearctic region (Yu *et al.* 2016). Although cosmopolitan, most of the diospilines are recorded from the Palaearctic and there are only six species reported from the Indomalayan region (Yu *et al.* 2016). Members of this tribe are endoparasitoids of relatively weakly concealed coleopteran larvae and are poorly studied in the tropics (Quicke 2015).

We report the tribe Diospilini for the first time from the Indian subcontinent along with the description of a new genus. A new species from South India is hereby described and illustrated. Two *Diospilus* species (*D. improcerus* and *D. validus*) are transferred to the newly described genus. A key to the Indomalayan and Palaearctic genera of Diospilini is provided along with a key to the species of the genus *Atree* **gen. nov.**

Materials and methods

The specimens were collected by Malaise traps placed in a primary forest understorey from Kalakad Mundanthurai Tiger Reserve (KMTR), Tamil Nadu, India. Collected specimens were preserved in ethyl alcohol and later card mounted. Images were taken by Keyence VHX-6000 digital microscope. Type specimens are deposited in the ATREE Insect Museum (AIMB), Bengaluru, India. The holotype will be eventually transferred to National Insect Museum, ICAR-National Bureau of Agricultural Insect Resources (ICAR-NBAIR). We have examined the type images of *A. improcerus* **comb. nov.** and *A. validus* **comb. nov.** provided on the website of Taiwan Agriculture Research Institute (TARI), Taiwan (https://digiins.tari.gov.tw/tarie/search_ResultE.php?id=Baeacis, Accessed on 26/12/2021).

Morphological terminology and wing venation follow van Achterberg (1993). Body sculpture follows Harris (1979).

Results

Taxonomy

Family Braconidae

Subfamily Brachistinae Förster, 1863

Tribe Diospilini Förster, 1863

Key to the Indomalayan and Palaearctic genera of Diospilini

- 1 Vein 1r-m of hind wing distinctly longer than vein 1-M (Fig. 5G); second labial palp segment short and distinctly wide (Figs 5I, 6E); second submarginal cell of fore wing narrower apically (Figs 6D, F, M); medial sulcus of propleuron coarsely crenulate and deep (Fig. 5K) **2**
- Vein 1r-m of hind wing subequal to vein 1-M (Fig. 5A) or shorter (Figs 3B, 6F, M), rarely longer in *Diospilus*; second labial palpomere comparatively long and slender (Fig. 5E); second submarginal cell of fore wing wider or parallel apically (Figs 3A, 5A, J); medial sulcus of propleuron variable **3**
- 2 Tarsal claws simple (Fig. 6C); clypeus at most slightly protruding medio-ventrally (Fig. 6B); pronope absent or obsolescent (Fig. 6A) *Aspicolpus* Wesmael, 1838
- Tarsal claws with wide lobe (Fig. 5C, M); clypeus distinctly protruding medio-ventrally (Fig. 5L); pronope large and deep (Fig. 5H) *Aspigonus* Wesmael, 1835
- 3 Second submarginal cell of fore wing more or less parallel-sided (thus vein 3-SR equal to vein 2-M (Figs 3A, 5A, J) or longer); first flagellomere 1.0–1.6 × as long as second flagellomere or longer (Figs 4C, D, 5B) **4**
- Second submarginal cell of fore wing distinctly narrowed anteriorly (vein 3-SR shorter than vein 2-M; Figs 6F, M); first flagellomere 0.9 × as long as second flagellomere (Figs 6G, L) **5**
- 4 Pronope small to medium-sized (Fig. 5F); medial sulcus of propleuron medium-sized, often largely smooth and median lamellae narrow (Fig. 5D); tarsal claws often with lobe (Fig. 5C) *Diospilus* Haliday, 1833 s.l.
- Pronope large (Fig. 2B); medial sulcus of propleuron widened, deep, coarsely crenulate and median lamellae comparatively wide (Figs 1F, 2F); tarsal claws slender and enlarged, without basal lobe (Fig. 4E) *Atree* **gen. nov.**
- 5 Dorsal carinae of first metasomal tergite curved and tergite robust (Fig. 6H); base of mandible slightly depressed basally (Fig. 6I); vein CU1b of fore wing absent (Fig. 6F) *Taphaeus* Wesmael, 1835
- Dorsal carinae of first metasomal tergite straight and tergite elongate (Fig. 6K); base of mandible distinctly depressed basally (Fig. 6J); vein CU1b of fore wing present (Fig. 6M) *Vadumasonium* Kammerer, 2006

Note. Traditionally, *Taphaeus* Wesmael is included in the tribe Diospilini and, therefore, included in the key. However, more likely this genus belongs to the tribe Blacini because of the presence of curved dorsal carinae on the first tergite and absence of vein CU1b of the fore wing.

Atree Ranjith, van Achterberg & Priyadarsanan **gen. nov.**

(Figures 1–4)

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Type species. *Atree rajathae* Ranjith, van Achterberg & Priyadarsanan **sp. nov.**

Description. Female

Head. Head wider than long (Figs 1B–D). Eyes sparsely setose (Figs 1B–F, 2A). Transverse diameter of eye slightly longer than temple in lateral view. Malar suture shallow (Figs 1B, E–F). Face smooth, distinctly punctate, slightly diverging posteriorly, setose (Fig. 1B). Tentorial pit deep (Fig. 1B). Clypeus with distinct acute lobe medio-ventrally (Figs 1B, D). Clypeal suture indistinct (Fig. 1B). Mandible curved with two teeth, upper tooth slightly longer than lower tooth (Figs 1B, D, F). Basal transverse groove of mandible less impressed (Figs 1E–F, 2A). Maxillary palp with five segments, labial palp with four segments (Fig. 1F). Frons smooth with distinct midlongitudinal carina (absent in *A. improcerus*) (Figs 1C–D). Ocelli arranged in equilateral triangle (Fig. 1C). Vertex and occiput smooth (Fig. 1C). Temple rounded in dorsal view (Fig. 1C). Occipital carina complete (Fig. 1C), joining with hypostomal carina above mandibular base (Figs 1F, 2A). Antenna with 31–44 antennomeres (Fig. 4C). Scapus longer than wide (Figs 4C–D). Pedicel slightly longer than wide (Figs 4C–D). First flagellomere with glandular opening, longer than second (Figs 4C–D). Medial flagellomeres slightly transverse (Fig. 4C). Terminal flagellomere pointed apically (Fig. 4C).

Mesosoma. Mesosoma longer than high (Figs 1A, 2D). Pronotum with deep pronope, crenulated groove postero-medially and extending laterally to posterior margin; without subpronope (Fig. 2B). Propleuron with ‘V’ shaped wide groove medially (Fig. 2E). Mesoscutum rounded in lateral view (Figs 1A, 2D). Notauli deeply crenulated, joining in a deeply punctate area above scutellar sulcus (Fig. 2C). Middle lobe of mesoscutum punctate anteriorly, lateral lobes smooth, sparsely setose with distinct lateral carina (Fig. 2C). Scutellar sulcus wide, crenulated (Fig. 2C). Scutellum smooth, setose (Fig. 2C). Mesopleuron with precoxal sulcus deeply impressed, setose (Fig. 2D). Prepectal carina present (Fig. 2D). Metapleuron mostly rugose with smooth median area with distinct lobe posteriorly (Fig. 2D). Metanotum with crenulated groove antero-medially, posteriorly widely crenulated with a smooth area medio-posteriorly, blunt (Fig. 2F). Propodeum rugose without longitudinal or transverse carina (Fig. 2F). Propodeal spiracle rounded (Fig. 2F).

Wings. Fore wing (Fig. 3A): Fore wing hyaline (Fig. 3A). Vein 1-SR absent (Fig. 3A). Pterostigma wide (Fig. 3A). Vein r originating from apical 1/3rd. Marginal cell long (Fig. 3A). Vein cu-a postfurcal (Fig. 3A). Second submarginal cell parallel sided anteriorly (Fig. 3A). Vein r-m as long as 2-SR. Veins 1A and 2A present. Second subdiscal cell closed (Fig. 3A). Vein m-cu antefurcal (Fig. 3A). Vein 3-M distinct. Hind wing (Fig. 3B): Hind wing with three hamuli. Marginal cell subparallel apically (Fig. 3B). Vein M+CU 2.0 × longer than 1-M. Vein 2-SC+R longitudinal (Fig. 3B). Vein cu-a slightly curved (Fig. 3B).

Legs. Hind coxa smooth, setose (Fig. 1A). Tarsal claw slender, enlarged without basal lobe (Fig. 4E).

Metasoma. First tergite sculptured, except smooth and depressed basal area, and without converging dorsal carinae basally (Fig. 3E). Remaining tergites smooth and polished, mostly glabrous (Figs 4A–B). Ovipositor sheath setose (Fig. 1A), 0.45–1.7 × longer than fore wing. Ovipositor with distinct notch subapically (Fig. 4F).

Etymology. We dedicate the genus to the Ashoka Trust for Research in Ecology and the Environment (ATREE), a global environmental think tank and leading research institution commemorating their 25 years of active contributions in the fields of biodiversity conservation and sustainable development.

Distribution. Indomalayan region (India and Taiwan).

Comparative diagnosis. The new genus, *Atree* share a more or less plesiomorphic character, presence of wide, crenulate groove on propleuron with other diospilinae genera. But *Atree* **gen. nov.** can be differentiated from the rest of genera in having a combination of characters viz., presence of deep pronope, second submarginal cell of fore wing parallel sided anteriorly and tarsal claw without basal lobe. The parallel-sided second submarginal cell of fore wing can be useful to separate the new genus from the diospilinae genera, *Aspicolpus* and *Vadumasonium*. Additionally, the absence of curved longitudinal carina of first metasomal tergite clearly separate the new genus from *Vadumasonium*. Based on this character the new genus comes close to the nearest genus, *Diospilus*, but the former can be separated by a combination of characters like, presence of deep pronope, medial sulcus of propleuron widened anteriorly and tarsal claw without basal lobe. The new genus is also similar to the Australian genus, *Depelbus* in having clypeus with distinct protrusion medio-ventrally. This character is likely a homoplastic character within the tribe Diospilini, and it can be used as an intergeneric character only in combination with other characters.

So far, antennal glands have been reported only in braconid subgenera Aphidiinae (*Aphidius*) and Ichneutiinae (*Paroligoneurus*) (Quicke 2015). Till now, this character is completely unknown from Brachistinae (Donald Quicke, personal communication). For the first time a glandular opening in the first flagellomere (Figs 4C, D) is reported from the Brachistinae genus *Atree* **gen. nov.** Detailed examination of the two Taiwanese species described

in the genus *Baeacis* (junior synonym of *Diospilus*) falls in line with the character boundaries of the newly described genus. So, we hereby transfer these species to *Atree* **gen. nov.** as, *A. improcerus* **comb. nov.** and *A. validus* **comb. nov.** However, *A. improcerus* **comb. nov.** does not have the medio-longitudinal carina at the frons. The new genus, *Atree* belongs to the diospiline genus group (*Aspigonus* group) having distinct, anteriorly widened medial groove on propleuron and deep pronope.

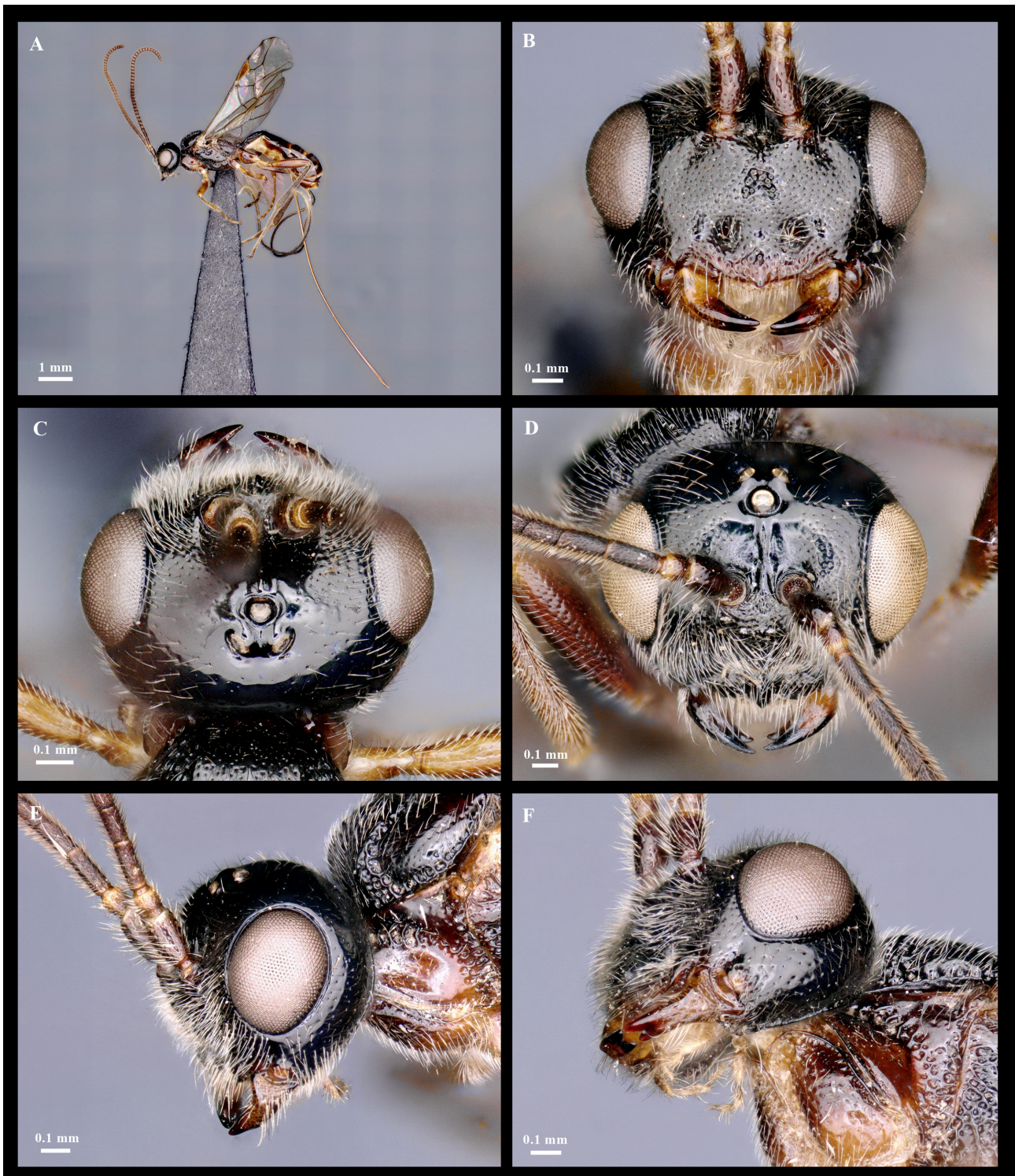


FIGURE 1. *Atree rajathae* **gen. et sp. nov.** holotype, female A) habitus, lateral view; B) head, anterior view; C) head, dorsal view; D) head, antero-dorsal view; E) head, lateral view; F) head, ventro-lateral view.



FIGURE 2. *Atree rajathae* gen. et sp. nov. holotype, female A) pronotum, lateral view; B) pronotum, dorsal view; C) mesosoma, dorsal view; D) mesosoma, lateral view; E) mesosoma, ventral view; F) propodeum, dorsal view.

Included species.

Baeacis improcerus Chou & Hsu, 1998 from China (Taiwan) => *Atree improcerus* (Chou & Hsu, 1998) **comb. nov.**

Atree rajathae Ranjith, van Achterberg & Priyadarsanan **sp. nov.** (India).

Baeacis validus Chou & Hsu, 1998 from China (Taiwan) => *Atree validus* (Chou & Hsu, 1998) **comb. nov.**

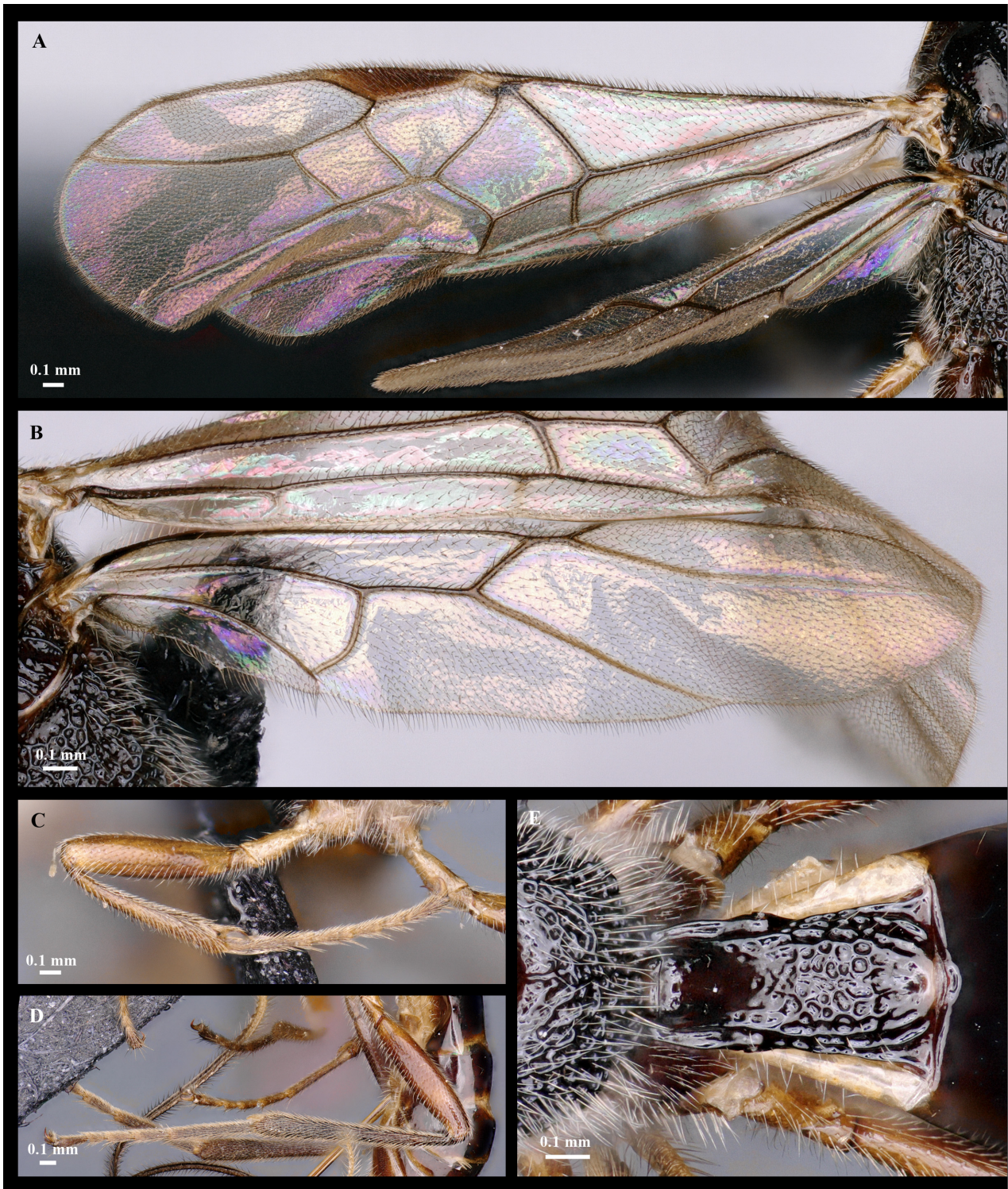


FIGURE 3. *Atree rajathae* gen. et sp. nov. holotype, female A) fore wing; B) hind wing; C) fore leg; D) hind leg; E) first metasomal tergite, dorsal view.

Key to species of *Atree* gen. nov.

1. Ovipositor sheath $0.4\text{--}0.5 \times$ as long as fore wing; frons without medio-longitudinal carina; antenna with ca. 31 antennomeres; length of eye $1.1 \times$ as long as temple; ovipositor sheath completely blackish brown; pterostigma $2.5 \times$ as long as wide; first metasomal tergite $1.3 \times$ as long as wide posteriorly (Taiwan) *Atree improcerus* (Chou & Hsu)
- Ovipositor sheath $1.6\text{--}1.7 \times$ as long as fore wing; frons with medio-longitudinal carina (Fig. 1D); antenna with 40–44 antennomeres; length of eye $1.4\text{--}1.8 \times$ as long as temple; ovipositor sheath yellowish apically (Fig. 1A); pterostigma $3.0\text{--}4.0 \times$ as

- long as wide; first metasomal tergite $1.6 \times$ as long as wide posteriorly 2
2. Pterostigma $3.0 \times$ as long as wide; middle lobe of mesoscutum reticulate apically; first flagellomere $1.1 \times$ as long as second; hind wing vein cu-a slightly curved; OOL $6.0 \times$ as long as POL; hind basitarsus $9.6 \times$ as long as wide (Taiwan) *Atree validus* (Chou & Hsu)
- Pterostigma $4.0 \times$ as long as wide; middle lobe of mesoscutum punctate apically (Fig. 2C); first flagellomere $1.3 \times$ as long as second (Figs 4C–D); hind wing vein cu-a distinctly curved (Fig. 3B); OOL $3.4 \times$ as long as POL; hind basitarsus $6.7 \times$ as long as wide (India) *Atree rajathae* sp. nov.

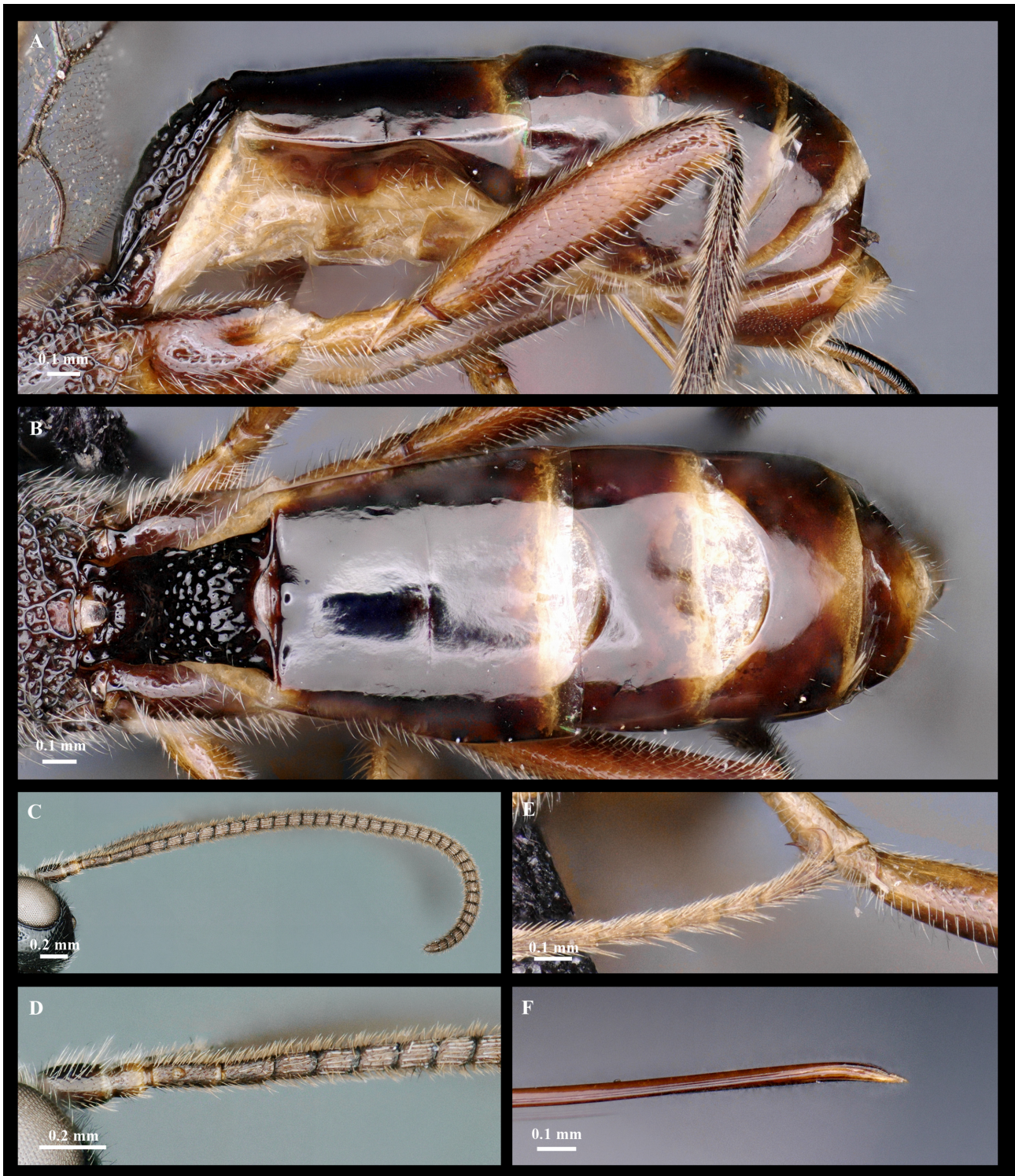


FIGURE 4. *Atree rajathae* gen. et sp. nov. holotype, female A) metasoma, lateral view; B) metasoma, dorsal view; C) antenna; D) basal antennomeres; E) tarsal claw; F) apex of ovipositor.

Atree rajathae Ranjith, van Achterberg & Priyadarsanan sp. nov.

(Figures 1–4)

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Material examined. Holotype, female, INDIA: Tamil Nadu, Kalakad Mundanthurai Tiger Reserve (KMTR), primary forest, understorey, Malaise trap, 5.x.2008, coll. Priyadarsanan, D.R. Paratype: one female, same data as holotype.

Description. Holotype, female. Body length 6.0 mm, fore wing 4.3 mm, ovipositor 6.9 mm.

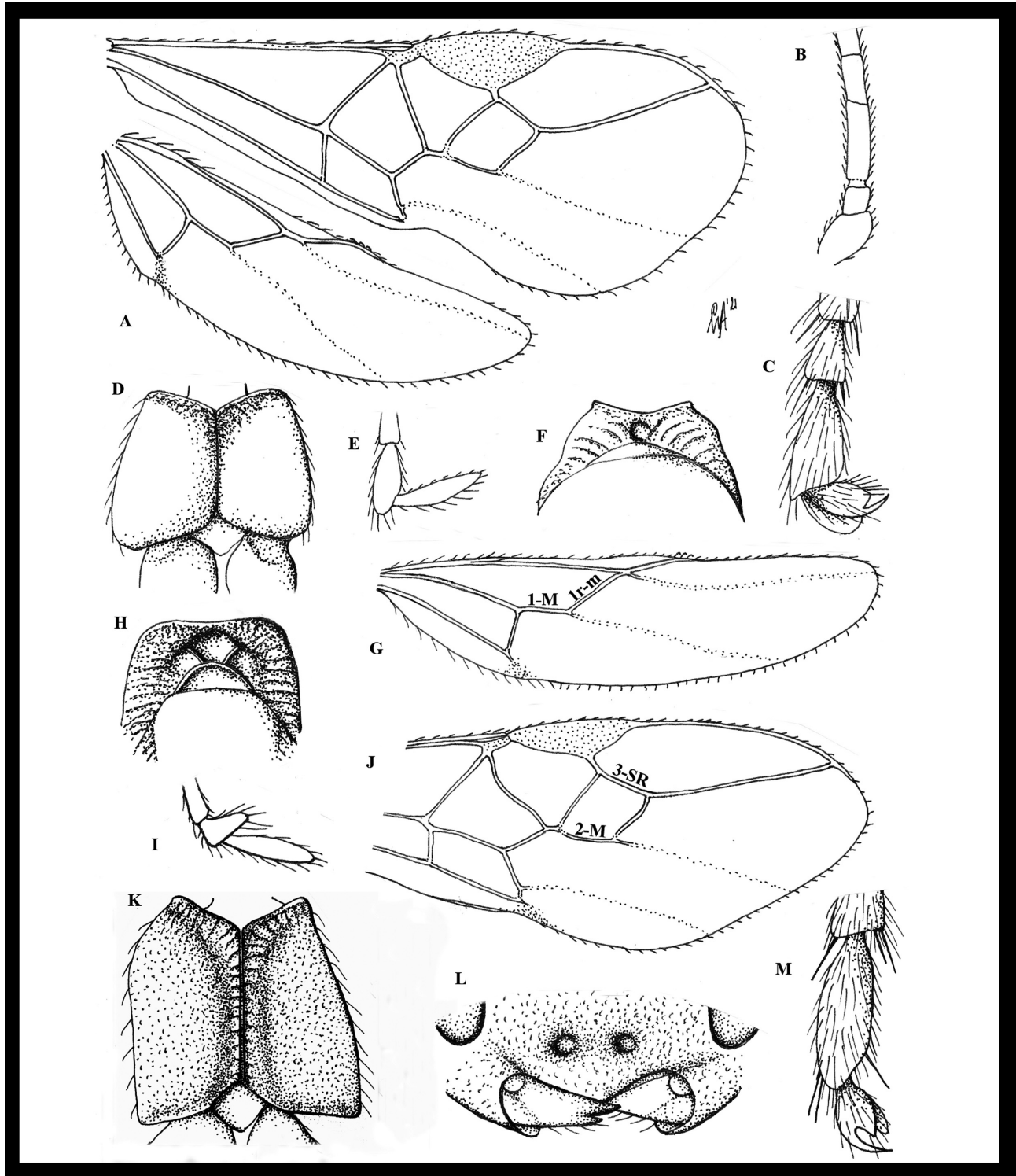


FIGURE 5. A–F. *Diospilus affinis* (Wesmael), female; G–M. *Aspigonus diversicornis* Wesmael, female A) wings; B) first and second flagellomeres; C, M) hind tarsal claw; D, K) propleuron, ventral view; E, I) labial palp; F, H) pronotum, dorsal view; G) hind wing; J) apical part of fore wing; L) clypeus, anterior view.

Head. Head $1.5 \times$ as wide as long in anterior and dorsal view. Face $2.5 \times$ as wide as long. Ratio of height of clypeus: inter-tentorial distance: tentorio-ocular distance = 1.2: 1.0: 1.4. Malar space $1.1 \times$ as long as basal width of mandible. Length of eye $1.8 \times$ as long as temple in dorsal view. Ratio of POL: transverse diameter of ocellus: OOL = 1.0: 1.1: 3.4. Antenna 40 segmented, $0.7 \times$ as long as body. Scape $1.7 \times$ as long as wide. Pedicel as long as wide. First flagellomere $1.3 \times$ as long as second. First and second flagellomeres 2.8 and $2.3 \times$ as long as wide, respectively. Terminal flagellomere $1.8 \times$ as long as wide.

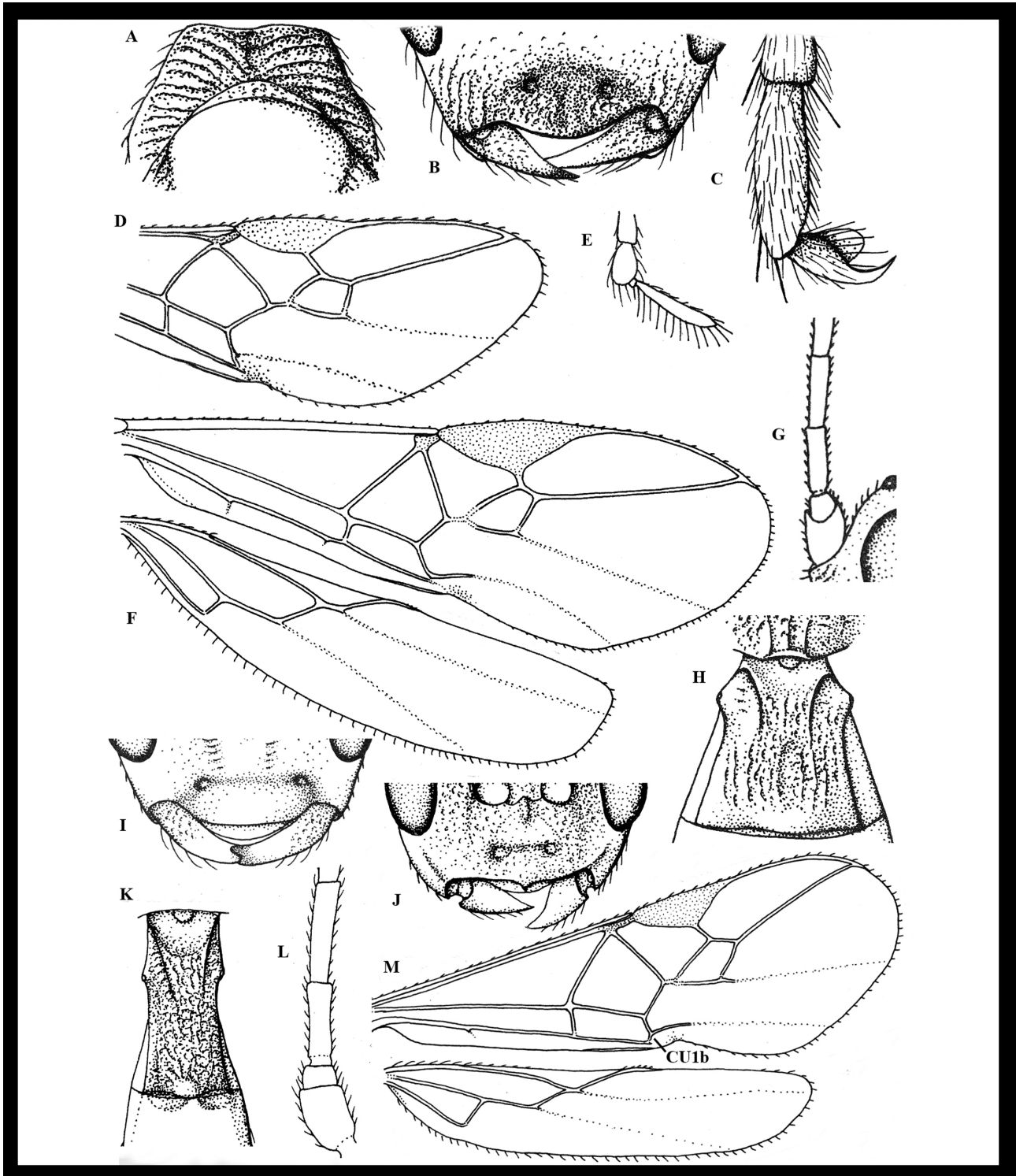


FIGURE 6. A–E. *Aspicolpus carinator* (Nees), female; F–I. *Taphaeus hiator* (Thunberg), female; J–M. *Vadumasonium var-dyorum* van Achterberg & Broad, female A) pronotum, dorsal view; B, I, J) clypeus and mandibles, anterior view; C) hind tarsal claw; D) apical part of fore wing; E) labial palp; F, M) wings; G, L) first and second flagellomeres; H, K) first metasomal tergite, dorsal view.

Mesosoma. Mesosoma $1.4 \times$ as long as high. Scutellar sulcus divided by three carinae (Fig. 2C).

Wings. Fore wing: Pterostigma $4.0 \times$ as long wide. Ratio of length of veins r: 3-SR: SR1 = 1.0: 3.2: 8.7. Ratio of length of veins 2-SR: 3-SR: SR1 = 1.0: 1.0: 2.7. Hind wing: Vein M+CU $2.6 \times$ as long as 1-M. Vein 1r-m $1.5 \times$ as long as 2-SC+R.

Legs. Ratio of length of fore femur: tibia: tarsus = 1.0: 1.1: 1.2 (Fig. 3C). Fore femur $4.0 \times$ as long as wide. Ratio of length of hind femur: tibia: basitarsus = 1.6: 2.2: 1.0 (Fig. 3D). Hind femur, tibia and basitarsus 4.2 , 8.4 , $6.7 \times$ as long as wide respectively.

Metasoma. Metasoma $1.3 \times$ as long as head and mesosoma combined. First metasomal tergite $1.6 \times$ as long as wide. Second metasomal tergite $1.1 \times$ as long as third, $0.8 \times$ as long as wide. Third metasomal tergite $0.5 \times$ as long as wide. Setose part of ovipositor sheath $1.6 \times$ as long as fore wing.

Colour. Body mostly brownish black except antenna, mandible basally, pronotum posteriorly, fore and mid legs, hind legs except tibia and tarsus, tegula and pterostigma yellowish brown, ocelli, sternites, metasomal tergites 3–6 posteriorly and apex of ovipositor sheath yellow.

Etymology. The species is named commemorating ATREE's Rajatha Jubilee (25th anniversary) which is being celebrated in 2021–22. Gender: feminine.

Male. Unknown.

Biology. Unknown.

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References

- Chen, X.-X. & van Achterberg, C. (2019) Systematics, phylogeny, and evolution of braconid wasps: 30 years of progress. *Annual Review of Entomology*, 64 (1), 335–358.
<https://doi.org/10.1146/annurev-ento-011118-111856>
- Harris, R.A. (1979) A glossary of surface sculpturing. *California Department of Food and Agriculture, Bureau of Entomology, Occasional Paper*, 28, 1–31.
- Quicke, D.L.J. (2015) *Biology, systematics, evolution and ecology of braconid and ichneumonid parasitoid wasps*. Wiley Blackwell, Chichester, 688 pp.
<https://doi.org/10.1002/9781118907085>
- Sharanowski, B.J., Dowling, A.P.G. & Sharkey, M.J. (2011) Molecular phylogenetics of Braconidae (Hymenoptera: Ichneumonoidea), based on multiple nuclear genes, and implications for classification. *Systematic Entomology*, 36, 549–572.
<https://doi.org/10.1111/j.1365-3113.2011.00580.x>
- Sharkey, M.J. & van Achterberg, C. (2021) Subfamily Brachistinae. Available from: <https://www.sharkeylab.org/sharkeylab/docs/posts/web/Brachistinae.pdf> (accessed 18 December 2021)
- Stigenberg, J., Boring, C.A. & Ronquist, F. (2015) Phylogeny of the parasitic wasp subfamily Euphorinae (Braconidae) and evolution of its host preferences. *Systematic Entomology*, 40, 570–591.
<https://doi.org/10.1111/syen.12122>
- van Achterberg, C. (1993) Illustrated key to the subfamilies of the Braconidae (Hymenoptera: Ichneumonoidea). *Zoologische Verhandelingen Leiden*, 283, 1–189.
- Yu D.S., van Achterberg K. & Horstmann K. (2016) World Ichneumonoidea 2015. Taxonomy, Biology, Morphology and Distribution. Taxapad interactive Catalogue Database. Nepean, Ottawa. [on flash-drive]