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Four new species of the genus *Diolcogaster* Ashmead, 1900 (Hymenoptera: Braconidae: Microgastrinae) from South East Asia with a key to the Indian species

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Abstract Four new species of the genus *Diolcogaster* Ashmead, 1900 (Hymenoptera: Braconidae: Microgastrinae) are described and illustrated: *Diolcogaster andamanensis* n. sp. from the Andaman Islands, and *D. duocolor* n. sp., *D. longistria* n. sp. and *D. solitarium* n. sp. from mainland India. The solitary larval parasitoid *D. solitarium* was reared from *Gatesclarkeana* sp. (Lepidoptera: Tortricidae). A new combination, *Diolcogaster tomentosae* (Wilkinson, 1930) n. comb., is proposed for the Indian species *Protomicroplitis tomentosae* (Wilkinson, 1930) along with its redescription and documentation of the gregarious cocoons associated with the pyralid (Epipaschiinae) host feeding on *Terminalia cattappa* L.

Introduction

The genus *Diolcogaster* Ashmead, 1900 (Hymenoptera: Braconidae: Microgastrinae) was proposed by

Ashmead (1900) based on the type-species *Microgaster melligaster* Provancher, 1886. Zeng et al. (2011) recently revised this genus based on material from China and compiled the list of lepidopteran families with species that are hosts of *Diolcogaster* spp.: Geometridae Leach, Lasiocampidae Harris, Limacodidae Duponchel, Noctuidae Latreille, Notodontidae Stephens, Plutellidae Guenee, Pyralidae Latreille, and also the earlier named families Arctiidae Leach and Lymantriidae Hampson [presently in Erebididae as Arctiinae and Lymantriinae; see Zahiri et al. (2012) and Regier et al. (2013)] and Thaumetopoeidae Aurivillius [presently Thaumetopoeinae, a subfamily of the Notodontidae; see Zahiri et al. (2011)]. Additionally the earlier hosts compiled by Saeed et al. (1999) included Anthelidae Turner, Choreutidae Stainton, Nymphalidae Rafinesque and Tortricidae Latreille. Zeng et al. (2011) also recorded species of the sawfly family Tenthredinidae Latreille (Hymenoptera) in association with *Diolcogaster*; however, this is just a repetition of a relatively old reference (Telenga, 1955) which cited a sawfly host without further details. In the historical literature there are a few records of non-lepidopteran hosts for Microgastrinae (see Yu et al. 2012 for a complete list); most, if not all of these records are unconfirmed and not likely to be accurate.

A recent key to the Indian species of *Diolcogaster* was provided by Reema & Sheeba (2004), including three species: *D. indicus* Rao & Chalikwar, 1970, *D. narendrani* Reema & Sheeba, 2004, and *D. punctata* Rao & Chalikwar, 1976. Later *Diolcogaster malabarensis*

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Narendran & Sheeba, 2005 was described from Kerala, India (Narendran & Sheeba, 2005).

In this paper the first species from the Andaman Islands, *Diolcogaster andamanensis* n. sp., is described and illustrated, along with three other species from mainland India, *D. duocolor* n. sp., *D. longistria* n. sp. and *D. solitarium* n. sp. An updated illustrated key to the Indian species of *Diolcogaster* is also provided. *Diolcogaster duocolor* n. sp. is unique in having bi-coloured antenna with distinct intermediary white flagellomeres. The solitary parasitoid *Diolcogaster solitarium* n. sp. was reared from *Gatesclarkeana* sp. (Lepidoptera: Tortricidae). Gregarious cocoons of *D. tomentosae* (Wilkinson, 1930) n. comb. are recorded for the first time from a pyralid (Epipaschiinae) host caterpillar feeding on *Terminalia cattappa* L.

Materials and methods

Specimens were collected with Malaise trap, sweep net and hand picking of caterpillars. Field-collected caterpillars were reared at the National Bureau of Agriculturally Important Insects (NBAIL), Bangalore. Wasp specimens were identified consulting Wilkinson (1930), Rao & Chalikwar (1970, 1976), Saeed et al. (1999), Narendran & Sheeba (2005), Luo & You (2003, 2005), Zeng et al. (2011) and Rousse & Gupta (2013). Morphological terms and measurements used in the species descriptions largely follow Austin & Dangerfield (1992). All measurements are in millimetres and are taken from the holotype (unless specified otherwise). Typically measurements for length $\times$ width are provided and the others are specified in the text. Photographs of the wasps were taken using Leica M 205 A stereozoom microscope with Leica DC 420 inbuilt camera using automontage software (version 3.8). Types are deposited in the collection of the National Bureau of Agriculturally Important Insects (NBAIL), Bangalore, India. Images of *Diolcogaster narendrani* (type repository: Zoological Survey of India, Kolkata) and *Diolcogaster malabarensis* (type repository: Zoological Survey of India, Kozhikode) are also included (Supplementary File 1). The terminology and abbreviations used are as follows: ocular-ocellar line (OOL); post-ocellar line (POL); funicular segments 1–16 (F1–F16); tergites 1–6 (T1–T6); fore wing veins [costa (C+SC+R);

radius (r); metacarpus (1-R1); medius (M+CU1); first intercubitus (2-SR); discoideus (1-CU1, 2-CU1); cubitus (2-M, 1-SR-M, 2-SR-M); recurrent vein (m+cu)]; hind wing veins [mediella (1-M, M+CU); basella (1 r-m); nervellus (cu-a); submediella (1-1A)].

Diolcogaster andamanensis n. sp.

Type-host: Not known.

Type-locality: Andaman Islands (11.3656°N, 92.40°E), Sippighat, India.

Type-material: Holotype, one female on card, 08.iii.2012, malaise trap (Fig. 1A), leg. Ankita Gupta (NBAIL/Bra/Mic/Diol/80312-A). Paratypes, three males on card, with same data as for the holotype (NBAIL/Bra/Mic/Diol/80312-B).

Etymology: The name refers to the collection locality of the species, the Andaman Islands.

Description (Figs. 1A–F, 2A–F)

Female [Measurements based on the holotype; see also Table 1.] Body length 1.97 (Fig. 1A). *Colour* (Figs. 1A–F). Body black except first 2 metasomal tergites; labial and maxillary palps white; eyes grey; ocelli yellow testaceous; region below clypeus yellow; mandibles yellow with apical margins black. Antenna with scape and pedicel yellow; flagellomeres yellowish-brown in lateral view, more yellowish ventrally and brownish dorsally; tegula yellowish-brown. Fore and mid leg light yellow brown (except fore coxa medially black with extreme base and apical region yellow, trochantellus yellow testaceous); hind leg with coxa black, trochantellus yellow testaceous; hind femur distinctly bi-coloured, with distinct diagonal demarcation between the 2 coloured regions, almost one third apical half of hind femur dark brown, basal 2 thirds yellowish-brown; hind tibia with sub-basal ring, extreme base and apical half dark brown, remaining yellow; hind tibial spurs yellow testaceous; fore wing infuscated with brown apical patch, pterostigma dark brown; first and second metasomal tergite yellow testaceous except for black spot at medio-posterior margin of second tergite adjoining third tergite, remaining black. *Head* (Fig. 1D). Head 0.82 $\times$ as long as wide, coarsely rugose punctate, with median longitudinal carina in dorsal half; eyes densely setose; face with sparse pilosity; setae much denser around

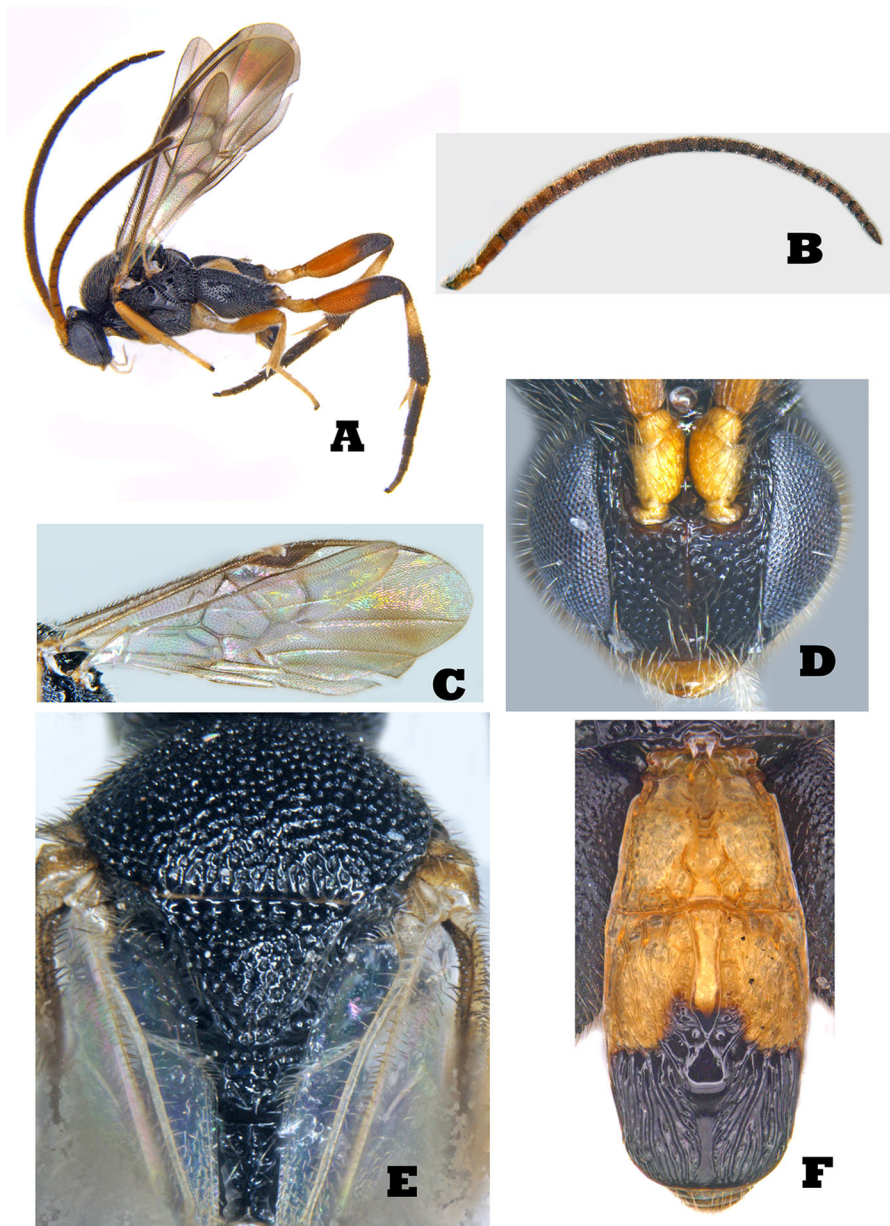


Fig. 1 *Diolcogaster andamanensis* n. sp. (female). A, Profile view; B, Antenna; C, Wings; D, Head, frontal view; E, Mesosoma; F, Metasoma

torular region and clypeal region; antenna $1.70\times$ as long as body in profile view. Ocellar region smooth, shiny, with prominent setae. Antenna length 3.35; head median length 0.55, width 0.67; OOL: POL 0.07: 0.14; compound eye (height $\times$ width) 0.38×0.18 ; inter-toruli distance 0.11; inter-tentorial pit distance 0.13; clypeus (height $\times$ width) 0.08×0.21 ; width of face at dorsal clypeal edge 0.35. Measurements: scape

0.17×0.11 ; pedicel 0.06×0.08 ; F1 0.21×0.09 ; F2 0.21×0.09 . *Mesosoma* (Fig. 1E). Mesosoma coarsely punctate and sparsely setose; punctations clear, well separated; scutellar sulcus with 10 costulae; scutellum coarsely punctate; mesopleuron rugose and punctate except for smooth glabrous antero-median patch; metapleuron mostly punctate except for anteriormost region. Dorsal scutellum $0.76\times$ as long as

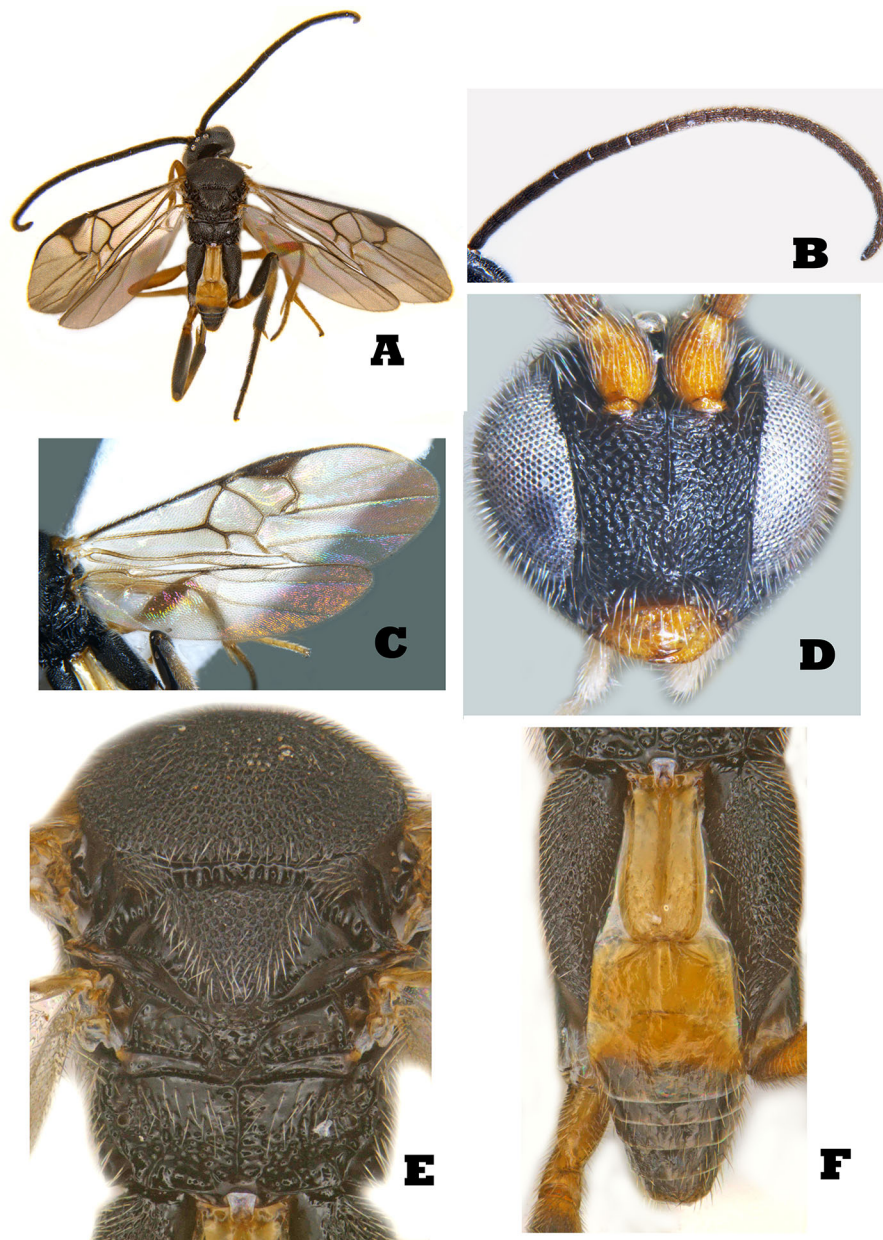


Fig. 2 *Diolcogaster andamanensis* n. sp. (male). A, Dorsal view; B, Antenna; C, Wings; D, Head, frontal view; E, Mesosoma; F, Metasoma

wide. Propodeum $2.46\times$ as wide as long, with strong medial longitudinal carina; coarsely punctate except for shining patch on either side of median longitudinal carina in anterior half; punctations denser in basal half; spiracle oval, surrounded by punctations. Measurements: mesosoma in dorsal view $1.2\times$ as long as wide, 0.11×0.09 ; scutellum 0.11×0.09 ; propodeum

0.31×0.79 ; hind femur 0.86×0.22 ; hind tibia 0.85×0.18 . *Wings* (Fig. 1C). Fore wing dusky, with dark apical patch, $2.94\times$ as long as wide; areolet small, triangular, slit-like. Hind wing vannal lobe slightly concave. Fore wing 2.71×0.96 ; pterostigma (length $\times$ height) 0.53×0.18 . Fore wing vein length measurements: $C+SC+R$ 1.16; r 0.19; $1-R1$ 0.63;

Table 1 Comparative data for the newly-described and redescribed species based on females: *Diolcogaster andamanensis* n. sp., *D. duocolor* n. sp., *D. longistria* n. sp., *D. solitarium* n. sp. and *D. tomentosae* n. comb.

Character*/Species	<i>D. andamanensis</i>	<i>D. duocolor</i>	<i>D. longistria</i>	<i>D. solitarium</i>	<i>D. tomentosae</i> n. comb.
Antenna/ body length ratio	1.70	1.20	1.19	0.72	0.70
Areolet shape	triangular, slit-like	more open, not slit-like	triangular, slit-like	large, more open and quadrangular	more open
Ratio POL: OOL	2.00	0.72	1.44	0.86	0.69
Inner tibial spur/ hind basitarsus length ratio	0.77	0.63	0.76	0.84	0.87
Length ratio of fore wing veins (1-CU1/ 2-CU1)	0.69	0.39	0.72	subequal	0.67
Median field	present in T1, T2 and T3	absent	present in T1, T2 and T3	present in T2	present in T2
Pronotum	rugose	rugose	rugose, punctate	shiny, finely- punctate	rugose
Length ratio of hind wing veins (1-M/ M-CU)	1.24	1.12	0.85	1.03	1.09
Fore wing with apical patch	present	absent	present	absent	absent
T1, T2 and T3 forming carapace	present	no carapace	present	no carapace	no carapace
Antennae with white segments	absent	present	absent	absent	absent
Hind coxal length/ T1 median length ratio	1.95	1.78	1.72	1.77	1.97
Ratio of T2/ T3 median length	1.03	0.76	0.51	0.66	0.72

* Measurements taken from the holotypes. *Abbreviations*: POL, post-ocellar line; OOL, ocular-ocellar line ; T1, first tergite of metasoma; T2, second tergite of metasoma; T3, third tergite of metasoma; 1-CU1 and 2-CU1, discoideus veins; 1-M and M-CU, mediella veins

M+CU1 0.87; 1-SR 0.04; 2-SR 0.15; 2-M 0.08; 1-CU1: 2-CU1 0.16: 0.23; 1-SR-M 0.44; 2-SR-M 0.11; m+cu 0.12. Hind wing vein length measurements: 1-M 0.42; M+CU 0.34; 1 r-m 0.07; cu-a 0.15; 1-1A 0.28. *Metasoma* (Fig. 1F). *Metasoma* 1.16 × 0.51; T1 0.41 × 0.49, T2 0.36 × 0.52; T3 0.35 × 0.23. Hind coxa 0.90 × 0.42, 2.14× as long as wide, 2.14× as long as T1, distinctly punctate with sparse pilosity. Inner hind tibial spur length: outer spur length 0.40: 0.28, inner tibial spur 0.77× as long as hind basitarsus (0.52). Hind coxa reaching anterior half of T3. T1-T3 forming carapace; T1 0.84× as long as wide, widening posteriorly, anterior half slightly depressed, smooth, with median longitudinal groove merging with median groove in T2, posterior half with median groove expanding into circular region, later merging into narrow median field towards apical margin, laterally coarsely rugose in posterior half; T2 median length 0.36, 0.82× as long as T1, subequal to T3 median length (0.36), slightly

widening posteriorly, anterior margin straight on sides with dent in middle; T2 with median groove broad at base, narrow in middle, closing into 'V' shape impression at the apical margin, noticeable black infuscation in V-shaped region of median groove located at apical margin and also surrounding its lateral sides giving appearance of black round median spot; lateral fields of T2 coarsely rugose with longitudinal striations. T3 completely black, with smooth, shining median field; triangular impression in median field joining V-shaped region of T2; median field broader at base, narrower at apex; lateral sides with strong longitudinal striations. T4-T6 brown, setose; visible at extreme apex in dorsal view. Suture between T1 and T2 more distinct as compared to suture between T2 and T3; ovipositor sheaths yellow brown, visible in lateral view.

Male [Measurements based on the paratype.] Body length 2.14. Sexually dimorphic; hind femur dark

brown except yellowish-brown extreme base; antenna dark brown; T1, T2 and anterior half of T3 yellow. **Head** (Fig. 2D). Head coarsely rugose punctate, with median longitudinal carina in middle of face; eyes densely setose; face with sparse pilosity; setae much denser around torular and clypeal region; head $0.87\times$ as long as wide; antenna $1.28\times$ as long as body in dorsal view. Ocellar region rough without prominent setae. Antenna length 2.74; head median length 0.54; head width 0.62; OOL: POL 0.08: 0.12; compound eye (height $\times$ width) 0.36×0.15 ; inter-toruli distance 0.11; inter-tentorial pit distance 0.17; clypeus (height $\times$ width) 0.05×0.18 ; width of face at dorsal clypeal edge 0.32. Measurements: Scape 0.13×0.11 ; pedicel 0.04×0.07 ; F1 0.19×0.08 ; F2 0.21×0.08 . **Mesosoma** (Fig. 2E). Mesosoma coarsely punctate, sparsely setose; punctations clear, well separated; scutellar sulcus with 12 costulae; scutellum coarsely punctate. Dorsal scutellum $0.79\times$ as long as wide. Propodeum $2.12\times$ as wide as long; with strong median longitudinal carina, coarsely rugose except for shining patch on either side of median longitudinal carina in anterior half; spiracle oval, surrounded by rugosity. Measurements: mesosoma in dorsal view $1.12\times$ as long as wide (0.93×0.83); scutellum 0.27×0.34 ; propodeum 0.25×0.53 ; hind femur 0.75×0.15 ; hind tibia 0.88×0.13 . **Wings** (Fig. 2C). Fore wing infumated; $2.82\times$ as long as wide; areolet small, triangular, slit-like. Hind wing vannal lobe slightly concave at one third basal margin. Fore wing 2.48×0.88 ; pterostigma (length $\times$ height) 0.47×0.18 . Vein length measurements: C+SC+R 1.04; 1-R1 0.63; M+CU1 0.76; 1-SR 0.04; r 0.14; 3-SR 0.06; r-m 0.05; 2-SR 0.15; 2-M 0.09; 1-CU1 0.12; 2-CU1 0.18; 1-SR-M 0.32; 2-SR-M 0.08; m+cu 0.13. Hind wing vein length measurements: 1-M 0.32; M+CU 0.26; 1 r-m 0.17; cu-a 0.13; 1-1A 0.21. **Metasoma** (Fig. 2F) measurements 0.97×0.34 ; T1 (length $\times$ maximum width) 0.41×0.19 , T2 0.16×0.35 ; T3 0.21×0.31 . Hind coxa 0.73×0.21 ; $3.48\times$ as long as wide; $1.78\times$ as long as T1; rugose and setose. Inner hind tibial spur length: outer spur length 0.33: 0.19, inner tibial spur $0.63\times$ as long as hind basitarsus (0.52). Hind coxa surpassing posterior half of T3. T1-T3 occupying more than half of metasoma; T1 $2.16\times$ as long as wide (maximum width). T1 $3.68\times$ as long as its apical width; with uniform median longitudinal groove all over its length except at apex, T1 little bulged pre-apically and curved at apex; setose in apical half. T2 smooth, with oblique straight lateral sulci in anterior one

third; T3 light yellowish-brown in anterior half, posterior half setose, dark brown. T3 $1.29\times$ as long as T2. T4-T7 setose, dark brown. Hind coxa $1.78\times$ as long as T1, reaching almost posterior margin of T3.

Remarks

Key diagnostic characters of the new species comprise: (i) face with median longitudinal carina; (ii) POL: OOL ratio 2; (iii) fore wing dusky with dark apical patch; (iv) T1-T3 forming carapace (T1 and T2 yellowish); and (v) hind inner tibial spur $0.77\times$ hind basitarsus. *Diolcogaster andamanensis* n. sp. is morphologically close to *D. narendrani* Rema & Sheeba, 2004 (see Supplementary File 1, Fig. S2) sharing with it a median longitudinal carina on face but differs in POL: OOL ratio (2 vs 1) and in the ratio of hind inner tibial spur to the hind basitarsus (0.77 vs 0.60) (Rema & Sheeba, 2004).

Diolcogaster duocolor n. sp.

Type-host: Not known.

Type-locality: Karnataka (13.0805°N, 76.7070°E), Mudigere, India.

Type-material: Holotype, one female on card, 07.vii.2012, malaise trap (Fig. 3A), leg. NBAII (NBAII/Bra/Mic/Diol/70712-A). Paratype, one female on card, with same data as for the holotype (NBAII /Bra/Mic/Diol/70712-B).

Etymology: The name is derived from the Latin words *duo* (two) and *color* (colour) and refers to the distinct bi-coloured antenna.

Description (Fig. 3A–E)

Female [Measurements based on the holotype.] Body length 2.69 (Fig. 3A). **Colour.** Body black except lateral sides of first 3 metasomal tergites; labial and maxillary palps white; ocelli pale testaceous; region below clypeus yellow; eyes grey; mandibles yellow, with apical margins black. Antennae with scape and pedicel ventrally yellow, flagellomeres F1-F4 dark brown, F5-F7 white, F8 white basally and ventrally, F9 (apical half)-F16 dark brown. Pronotum and propleuron bi-coloured, random mixture of yellow and brown patches. Mesoscutum black, with extreme lateral corners on apical margin brown; tegula pale yellowish.

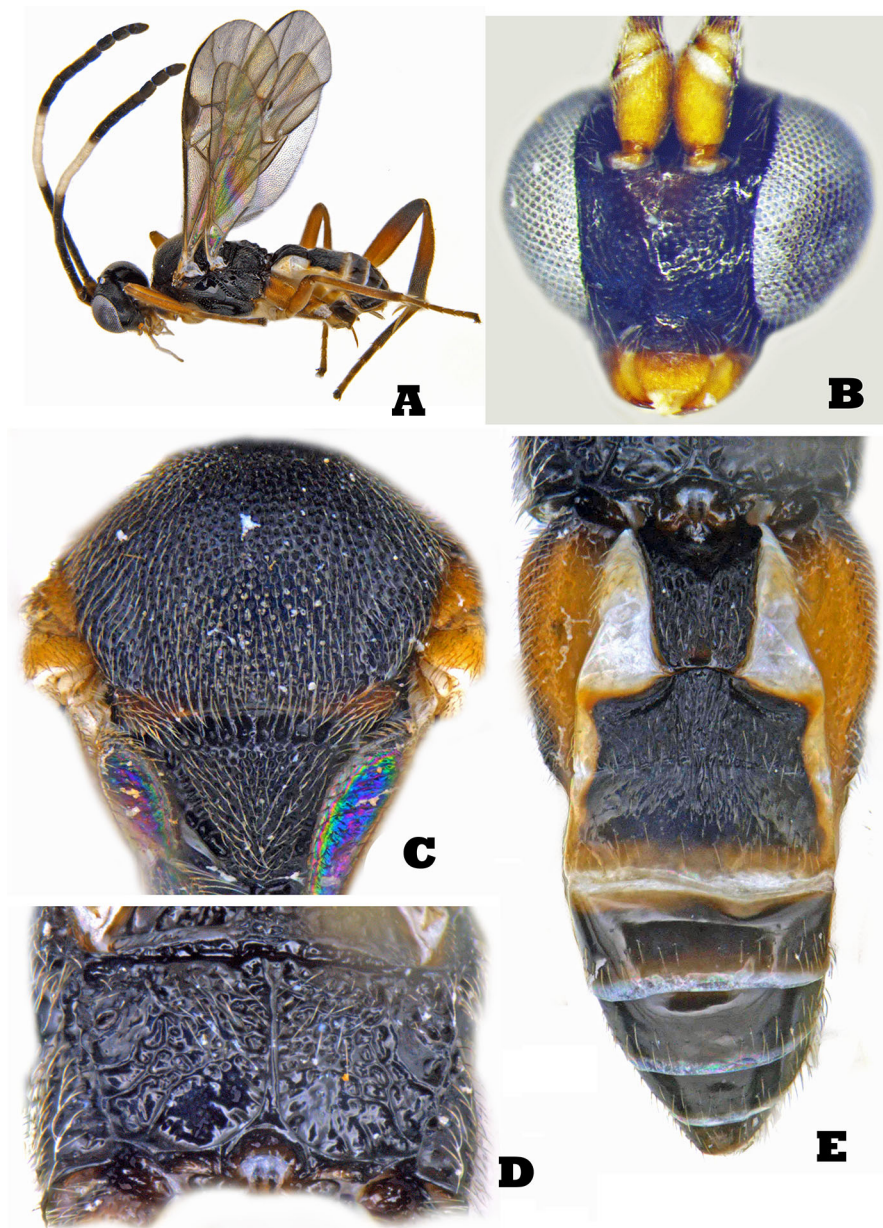


Fig. 3 *Diolcogaster duocolor* n. sp. (female). A, Profile view; B, Head, frontal view; C, Mesosoma, in part; D, Propodeum; E, Metasoma

Wings hyaline. Fore and mid coxa, trochanter and trochantellus pale testaceous, remaining yellowish; mid femur extreme tips and extreme basal tip and apical region of mid tibia brown; hind coxa yellow brown except small apical and basal patch black; one third apical region of hind femur and tibia, along with basal ring of hind femur dark brown, remaining portion yellow brown. Basitarsus dark brown (prominent in

hind basitarsus); hind tibial spurs yellow testaceous. Median tergal plates of first, second and third metasomal segments black, lateral sides pale testaceous to faint yellow, rest black. Junction of T3-T4 and T4-T5 pale testaceous. *Head* (Fig. 3B). Head shallowly punctate, without median longitudinal carina; eyes setose; face with sparse pilosity; setae much denser in clypeal region; head $0.75\times$ as long as wide; antenna

1.2× as long as body in profile view. Clypeus convex, smooth, shiny. Vertex with piliferous punctures, setose. Ocellar region smooth, shiny. Antenna length 3.24; head median length 0.54; head width 0.72; OOL: POL 0.11: 0.08; compound eye (height × width) 0.44 × 0.20; inter-toruli distance 0.05; inter-tentorial pit distance 0.17; clypeus height 0.07; clypeus width 0.21; width of face at dorsal clypeal edge 0.33. Measurements: scape 0.21 × 0.12; pedicel 0.09 × 0.11; F1 0.30 × 0.07; F2 0.30 × 0.07; F3 0.29 × 0.09. *Mesosoma* (Fig. 3C, D). Pronotum shallowly punctate and setose. Mesoscutum coarsely punctate, densely setose; punctations clear, well separated; scutellar sulcus with 10 costulae; scutellum coarsely punctate including apical tip. Propleuron shallowly pitted, setose, shiny. Mesopleuron anteriorly setose, punctate, posteriorly smooth, shiny; few fine shallow punctures scattered in the median region. Metapleuron mostly punctate except for anteriormost region. Dorsal scutellum 0.90× as long as wide. Propodeum 2.43× as wide as long; with strong median longitudinal carina; coarsely rugose except for shining patch on either side of median longitudinal carina in posterior half; punctations denser in basal half; spiracle oval, surrounded by carina. Measurements: mesosoma in dorsal view 1.53× as long as wide (1.10: 0.72); hind femur 0.86 × 0.20; hind tibia 0.93 × 0.17; scutellum 0.26 long. *Wings*. Fore wing dusky; 3.14× as long as wide; areolet more open, not slit-like. Hind wing vannal lobe convex, entire margin hairy. Fore wing 2.51 × 0.80; pterostigma (length × height) 0.61 × 0.17. Fore wing vein length measurements: C+SC+R 1.18; 1-R1 0.61; M+CU1 0.83; 1-SR 0.05; 2-SR 0.11; 2-M 0.09; 1-CU1 0.09; 2-CU1 0.23; 1-SR-M 0.31; 2-SR-M 0.10; m+cu 0.12. Hind wing vein length measurements: 1-M length 0.37; M+CU 0.33; 1 r-m 0.08; cu-a 0.15; 1-1A 0.23. *Metasoma* (Fig. 3E). Metasoma 1.18 × 0.49; T1 0.37 × 0.45, T1 tergal plate (basal width: apical width: height) 0.23: 0.13: 0.37. T2 0.16 × 0.46; T2 tergal plate (basal width: apical width: height) 0.39: 0.37: 0.16. T3 0.21 × 0.49; T3 tergal plate (basal width: apical width: height) 0.38: 0.43: 0.16. T4 0.38 × 0.22; T5 0.13 × 0.27. Hind coxa 0.66 × 0.24; 2.75× as long as wide; 1.78× as long as T1; distinctly punctate, setose. Inner hind tibial spur length: outer spur length 0.31: 0.18, inner tibial spur 0.63× as long as hind basitarsus (0.49). Hind coxa reaching middle of T3. Hind tibia 0.93 × 0.17. Exserted portion of ovipositor 0.22, pilosity in apical

half. T1-T3 with median tergal plates; T1 0.82× as long as wide, T1 tergal plate rugose, coarsely punctate, narrowing towards its apex (basal width 1.77× apical width); T2 tergal plate rugose, with longitudinal striations in middle, lateral sulci ending in angulate edges, tergal plate slightly widened anteriorly, with straight posterior margin; T3 tergal plate rugose, slightly widening posteriorly, remaining portion smooth. T4 onwards smooth, shiny.

Remarks

Key diagnostic characters of the new species comprise: (i) distinctly bi-coloured antenna, pronotum, metasoma and hind legs; (ii) POL: OOL ratio 0.72; and (iii) hind coxa reaching middle of T3. *Diolcogaster duocolor* n. sp. appears morphologically close to the Chinese species *Diolcogaster laetimedia* Zeng & Chen, 2011 in having bi-coloured antennae and similarity in metasomal tergites (Zeng & Chen, 2011). However, the new species differs in the following main characters: (i) colour of the antenna [F1-F4 dark brown, F5-F7 white, F8 white basally and ventrally, F9 (apical half)-F16 dark brown vs brown except F3-F4 white]; (ii) POL: OOL (0.72 vs 1.13); and (iii) hind coxa reaching middle of T3 (vs posterior margin of T3). *Diolcogaster duocolor* n. sp. is also similar to the Australian species *D. hadrommatus* Saeed, Austin & Dangerfield, 1999 in the key to the Australasian species (Saeed et al., 1999) but differs in POL: OOL ratio (1.38 vs 2.5–5.0); there are also substantial differences in the colouration of various body parts.

Diolcogaster longistria n. sp.

Type-host: Not known.

Type-locality: Karnataka (15.3172°N, 75.7138°E), Bangalore, Savandurga forests, India.

Type-material: Holotype, one female on card, 10.vi.2010, sweep net, leg. Ankita Gupta (NBAlI/Bra/Mic/Diol/10610-A). Paratype, one female on card, with same data as for the holotype (NBAlI/Bra/Mic/Diol/10610-B).

Etymology: From *longi* (Latin) meaning long and *stria* (Latin, noun) meaning groove, cut or depression. The name refers to the distinct, long and wide median longitudinal groove in the metasoma.

Description (Fig. 4A–F)

Female [Measurements based on the holotype; see also Table 1.] Body length 2.41 (Fig. 4A). **Colour.** Body black except first 2 metasomal tergites; labial and maxillary palps white; ocelli brown. Antenna with scape and pedicel yellow; 16 flagellomeres, first 4 yellowish-brown, F5–F6 little darker than basal four, rest dark brown; flagellomeres more yellowish ventrally; tegula yellowish-brown. Fore and mid leg light yellow brown (except coxa yellow brown); hind leg

with coxa black, trochantellus yellow; hind femur dark brown with apex yellow; hind tibia yellow white in middle (sub-basal), one fourth extreme base light brown and apical half dark brown; hind tibial spurs yellow testaceous; pterostigma dark brown and veins 1-CU1 and 2-CU1 pigmented; fore wing hyaline with distinct dark brown apical patch; first and second metasomal tergite yellow testaceous except for black spot at medio-posterior margin of second tergite surrounding median field; rest black. First 3 metasomal tergites forming carapace. **Head** (Fig. 4C). Ocelli

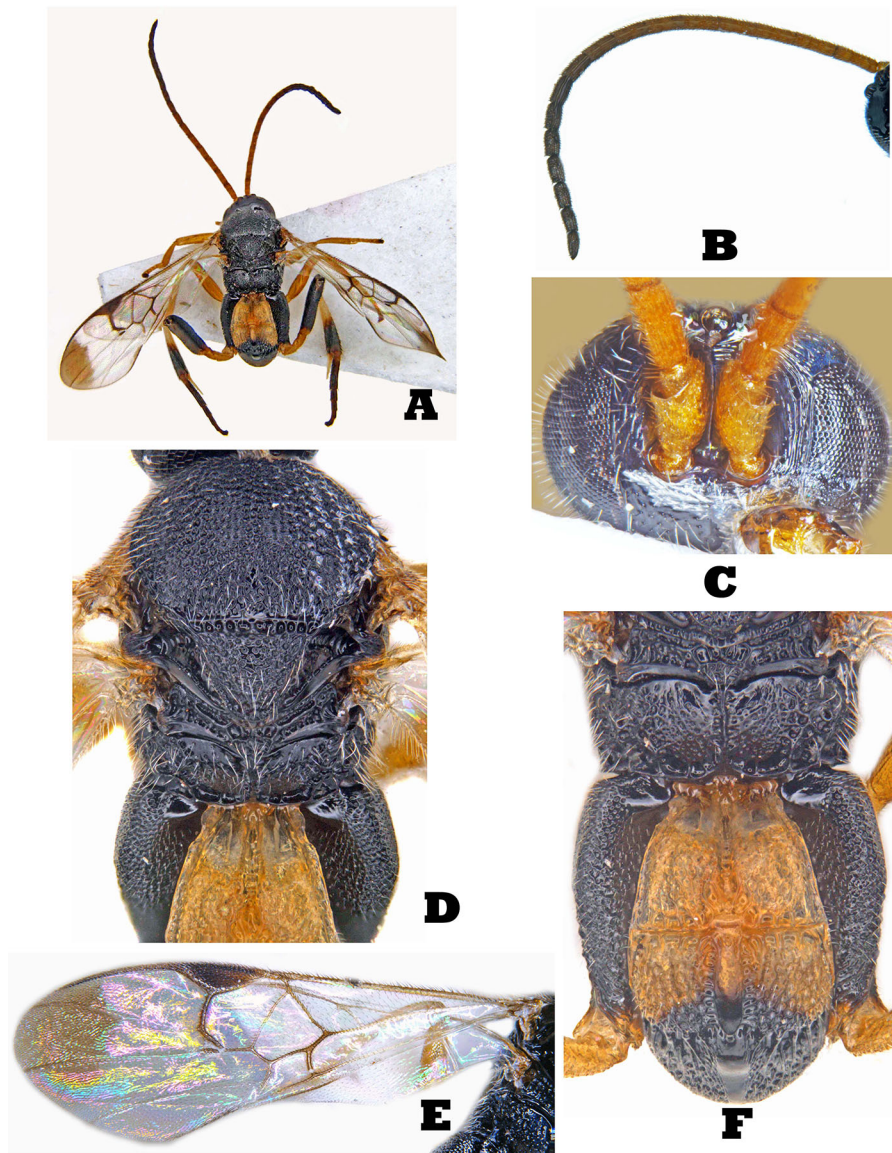


Fig. 4 *Diolcogaster longistria* n. sp. (female). A, Dorsal view; B, Antenna; C, Head, frontal view; D, Mesosoma and T1 in part; E, Wings; F, Metasoma

large, brown, arranged in very low triangle; vertex shiny, with few shallow punctations; ocellar region smooth, shiny; eyes setose; frons fairly smooth, shiny, with sparse pilosity; median carina absent; head $0.54 \times$ as long as wide. Lateral sides of antennal sockets with longitudinal striations. Clypeus smooth, shiny. Antenna length 2.85, $1.19 \times$ body length; head median length 0.40, width 0.74; OOL: POL 0.09: 0.13; compound eye height 0.39; inter-toruli distance 0.09. Measurements: scape 0.23×0.11 ; pedicel 0.06×0.09 ; F1 0.19×0.08 ; F2 0.19×0.08 . *Mesosoma* (Fig. 4D). Mesoscutum convex, densely punctate, rugose; punctations coarser in apical half, contiguous; sparsely setose; scutellar sulcus with 11 costulae; scutellum coarsely punctate; mesopleuron punctate except for smooth shiny antero-median area. Metapleuron mostly punctate. Propodeum $2.32 \times$ as wide as long; with strong median longitudinal carina; punctate all over, punctations sparser and shallower as compared to mesoscutum and scutellum; punctures smaller in size near median apical region; spiracle surrounded by rugosity and punctations. Hind coxa reaching anterior margin of third tergite. Measurements: mesosoma in dorsal view $1.12 \times$ as long as wide, 1.19×1.06 ; scutellum 0.35×0.45 ; propodeum 0.38×0.88 ; hind femur 0.91×0.18 ; hind tibia 0.85×0.20 ; hind coxa 0.76 long, $1.72 \times$ as long as T1, distinctly punctate. Inner hind tibial spur length: outer spur length 0.39: 0.29; inner hind tibial spur $0.76 \times$ as long as hind basitarsus (0.51). *Wings* (Fig. 4E). Fore wing hyaline, with distinct dark brown apical spot, pterostigma $2.75 \times$ as long as wide; R1 0.49; areolet small, triangular, slit-like. Fore wing 2.68×1.02 ; pterostigma (length $\times$ height) 0.55×0.20 . Fore wing vein length measurements: 3-SR 0.01; 2-SR 0.15; 2-M 0.08; 1-SR 0.05; 1-SR-M 0.39; 2-SR-M 0.12; m-cu 0.11; 1-CU1 0.13; 2-CU1 0.18; 1-M 0.27; M+CU1 0.92; C+SC+R 1.23; 1-R1 0.49. Hind wing vein length measurements: 1-M 0.34; M+CU 0.40; r-m 0.09; cu-a 0.22; 1A 0.30. Hind wing vannal lobe slightly concave, hairy at base. *Metasoma* (Fig. 4F). Metasoma 1.04 long; T1 0.44×0.59 ; T2 0.44×0.59 ; infuscated region in T2 (median length: apical width) 0.20: 0.50; T3 0.39×0.29 (rounded apex). T1-T3 forming carapace; T1 median length $0.75 \times$ as long as apical width, widening posteriorly, with median longitudinal groove, little wider in posterior half; lateral fields coarsely rugose except basal one third; median groove of T2 deep, encircled by crenulate grooves, $3.75 \times$ as

long as wide, broadest medially, narrower at extremes; T2 yellow brown in basal two third, apical third with black infuscation, black colouration starts near middle of apical one third, spreads towards apical margin giving appearance of expanded inverted U-shaped infuscated region; lateral fields of T2 coarsely rugose. T3 completely black, with shallow smooth, shining median longitudinal field; median field narrows at apex; lateral sides with strong longitudinal striations with coarse rugosity. Suture between T1 and T2 more distinct as compared to suture between T2 and T3; ovipositor sheaths yellow brown, not visible in dorsal view, strongly decurved, hypopygium unsclerotised and setose.

Remarks

Key diagnostic characters of the new species comprise: (i) fore wing hyaline with distinct dark brown apical spot; (ii) T1 distinctly widened posteriorly; (iii) median field of T2 encircled by crenulate grooves; (iv) posterior margin of T3 rounded; and (v) ovipositor sheaths not visible in dorsal view. In general appearance *Diolcogaster longistria* n. sp. is similar to the Chinese species *D. chaoi* (Luo & You, 2003), as evident from the illustrations of this species in Zeng et al. (2011). Both species have similar colouration pattern of fore wings (including the presence of an apical infuscated region) and general colouration of the metasoma. However, the new species can be separated from the latter by the following characters: median carina on frons absent (*vs* present in *D. chaoi*); fore wing areolet with r-m hyaline (*vs* three sclerotised sides); ovate metasoma (*vs* elongated); and T2 median longitudinal groove oval shaped (*vs* sword-like). *Diolcogaster longistria* n. sp. is also morphologically close to *D. narendrani* Rema & Sheeba, 2004 (see Supplementary File 1, Fig. S2) in having similar colouration pattern of the fore wings and metasoma; however it can be separated from the latter in the colour of hind femur (dark brown to black except at apex *vs* bi-coloured) and in having a more open fore wing areolet (*vs* slit like) (Rema & Sheeba, 2004).

Diolcogaster solitarium n. sp.

Type-host: *Gatesclarkeana* sp. (Lepidoptera: Tortricidae) (Reg. No. NBAII/Lep/Tort/Gate/120314-H).

Type-locality: Karnataka (13.1185°N, 75.5047°E), Chikmagalur, Mallayamarutha, India.

Type-material: Holotype, one female on card ex *Gatesclarkeana* sp. (Lepidoptera: Tortricidae) 12.iii.2014 (Supplementary File 1, Fig. S1A, B), leg. NBAII (NBAII/Bra/Mic/Diol/120314-A). Paratype, one female on card, with same data as for the holotype (NBAII /Bra/Mic/Diol/120314-B).

Etymology: The name is derived from the Latin word *solitarium* (noun) representing the solitary nature of the cocoon.

Description (Figs. 5A–F)

Female [Measurements based on the holotype.] Body length 2.34 (Fig. 4A), 2.53 (paratype, dorsal view). **Colour** (Fig. 5A). Head and mesosoma black, metasoma with first tergite, lateral plates of second tergite and anterior lateral corners of third and fourth tergite yellowish-brown, remaining black, ovipositor sheaths black. Antenna with flagellomeres F1–F6 yellowish-brown; F7–F16 black; flagellomeres lighter ventrally. Clypeal region black; labial and maxillary palps white; ocelli yellow brown; eyes black. Mesosoma black; tegula yellowish-brown; fore wing with faint infuscation scattered below and behind pterostigma in basal half of wing, pterostigma dark brown. Fore and mid leg light yellow brown (except dark pretarsus); hind leg including coxa yellowish-brown except apical half of hind tibia dark brown; hind tibial spurs testaceous, basal one third of hind basitarsus yellow, apical 2 thirds dark brown. **Head** (Fig. 5C). Head coarsely rugose with transverse striations in frons, striations not continuous from one eye margin to another; median carina absent; face convex; antennal sockets situated around centre of face; eyes densely setose; face setose; setae much denser around clypeal region; head $0.87\times$ as long as wide; antenna $0.72\times$ as long as body. Vertex shiny outside ocellar region. Ocelli small, ocellar region rugose with transverse striations. Clypeal region smooth. Antenna length 1.68; head median length 0.54; head width 0.67; OOL: POL 0.14: 0.12; compound eye (height $\times$ width) 0.36×0.15 ; intertoruli distance 0.07; inter-tentorial pit distance 0.16; clypeus height 0.05; clypeus width 0.18; width of face at dorsal clypeal edge 0.37. Measurements: scape 0.12×0.08 ; pedicel 0.04×0.08 ; F1 0.14×0.08 ; F2 0.12×0.07 ; F3 0.11×0.08 ; F15 0.07×0.06 ; F16 0.11×0.05 . **Mesosoma** (Fig. 5D). Mesosoma coarsely

punctuate and setose; punctations clear, well separated; scutellar sulcus with 8 costulae; scutellum shiny, shallowly punctate; propleuron punctate; mesopleuron punctate except at anterior middle region; metapleuron punctate except smooth anterior spot. Dorsal scutellum $1.07\times$ as long as wide. Propodeum $3.05\times$ as wide as long; with strong median longitudinal carina; coarsely punctate except for shining patch on either side of median longitudinal carina in posterior half; punctuations coarser in basal half; spiracle oval, surrounded by rugosity. Measurements: mesosoma in dorsal view $1.03\times$ as long as wide, $0.99: 0.96$; scutellum 0.31×0.29 ; propodeum 0.19×0.58 ; hind femur 0.62×0.25 ; hind tibia 0.71×0.14 . **Wings.** Fore wing hyaline except few infuscations, $2.73\times$ as long as wide; areolet quadrangular, not slit-like. Hind wing vannal lobe convex with setae absent in middle. Fore wing 2.28×0.87 ; pterostigma (length $\times$ height) 0.43×0.22 . Fore wing vein length measurements: r 0.15, straight; C+SC+R 1.05; 1-R1 0.46; M+CU1 0.79; 1M 0.26; 1-SR 0.05; 3-SR 0.01; 2-SR 0.09; 2-M 0.07; 1-CU1 0.14; 2-CU1 0.14; 1-SR-M 0.31, bend anteriorly; 2-SR-M 0.06; m+cu 0.08. Hind wing vein length measurements: 1-M 0.32; M+CU 0.29; 1 r-m 0.13; cu-a 0.17; 1-1A 0.26. **Metasoma** (Fig. 5E). Metasoma 1.18×0.50 ; T1 0.39×0.37 ; T2 0.16×0.51 ; T2 median plate 0.16×0.08 ; T3 0.24×0.59 ; T4 0.15×0.55 ; T5 0.10×0.39 ; T6 0.09×0.24 ; T7 median length 0.09. Hind coxa 0.69×0.26 ; $2.65\times$ as long as wide, $1.77\times$ as long as T1, distinctly punctate, setose. Inner hind tibial spur length: outer spur length 0.31: 0.14, inner tibial spur $0.84\times$ as long as hind basitarsus (0.37). Hind coxa reaching posterior margin of T3. T1 and T2 with shallow well-separated punctations; T1 $1.05\times$ as long as wide, widening posteriorly; median longitudinal groove all throughout T1, deeper in basal half; T2 with 2 submedian crenulated carinae, enclosed brownish black convex median field, much wider at base than apex (distance between 2 carinae at basal: apical end 0.15: 0.08, T2-T3 margin with median dent, T2 $0.67\times$ T3 median length, widening posteriorly. Tergites posterior to T2 smooth, shiny, with row of short setae before posterior margin, except last 2 segments scattered with short fine setae. Ovipositor sheaths dark brown (exserted portion of ovipositor 0.11, visible in lateral view), slightly widened apically, decurved, setose. Hypopygium large, partly sclerotised and partly membranous, with setae all over.

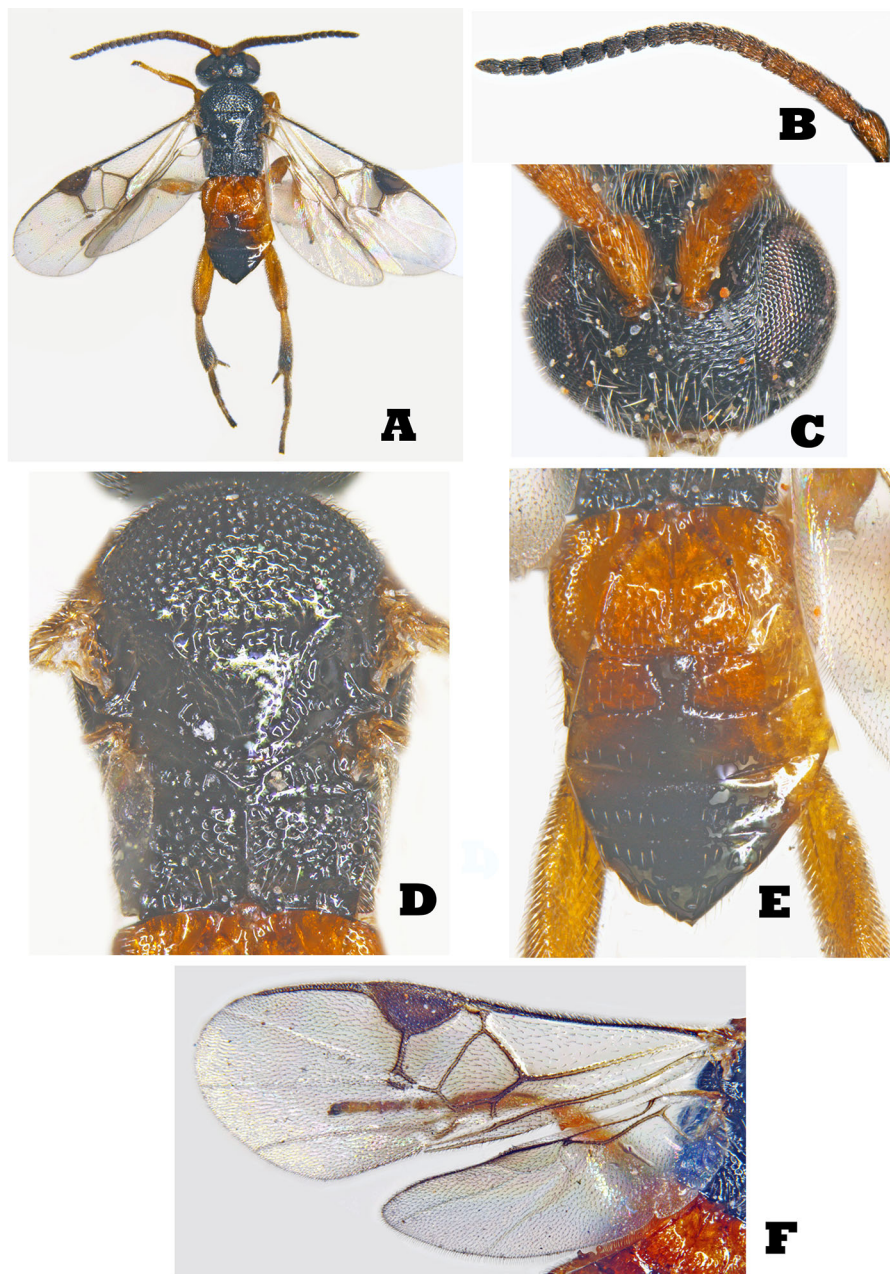


Fig. 5 *Diolcogaster solitarium* n. sp. (female). A, Dorsal view; B, Antenna; C, Head, frontal view; D, Mesosoma; E, Metasoma; F, Wings

Remarks

Key diagnostic characters of the new species comprise: (i) head coarsely rugose with transverse striations in frons; (ii) antenna $0.72\times$ as long as body in dorsal view; (iii) T2 with distinct dark brown median

field, remaining metasoma mostly dark brown (except yellowish-brown first tergite and lateral plates of second tergite); (iv) POL: OOL ratio 0.86; and (v) 1-CU1: 2-CU1 ratio being subequal. *Diolcogaster solitarium* n. sp. is morphologically similar to *D. tomentosae* (Wilkinson, 1930) n. comb. in having T2

with distinct median field, and T1, T2 and T3 not forming a carapace. Differences include the following characters: T2 with median field dark brown (vs yellowish-brown); POL: OOL ratio (0.86 vs 0.69); 1-CU1: 2-CU1 ratio (subequal vs 0.67); hind coxa: T1 length ratio (1.77 vs 1.97); T2: T3 median length ratio (0.66 vs 0.72) (Wilkinson, 1930).

***Diolcogaster tomentosae* (Wilkinson, 1930) n. comb.**

Host: Indeterminate caterpillar (Lepidoptera: Pyralidae: Epipaschiinae) feeding on *Terminalia cattappa* L. (Supplementary File 1, Fig. S1C) (Reg. No. NBAII/Lep/Pyr/Epi/20512-H).

Locality: Tamil Nadu (11.0168°N, 76.9558°E), Coimbatore, India.

Material: Four females and two males on card, 20.v.2012, leg. NBAII (NBAII/Bra/Mic/Diol/20512).

Description (Fig. 6A–F)

Female. Body length 2.28 (habitus view), 2.34–2.44 (dorsal view). **Colour** (Fig. 6A). Head and mesosoma black, metasoma (except black ovipositor sheaths) and antenna yellowish-brown; clypeal region dark brown; labial and maxillary palps white; eyes black; ocelli yellow brown. Antenna with scape, pedicel and flagellomeres (F1–F2) yellowish, remaining flagellomeres brown; in general flagellomeres more yellowish ventrally. Mesosoma black; tegula yellowish-brown. Fore wing with faint infuscation in the middle, pterostigma dark brown. Fore and mid leg light yellow brown (except dark pretarsus); hind leg including coxa yellow testaceous except apical half of hind tibia dark brown; hind tibial spurs yellow testaceous; hind tarsi dark brown. **Head** (Fig. 6D). Head $0.87\times$ as long as wide, coarsely punctate, with longitudinal striations above clypeus; eyes densely setose; face with sparse pilosity; setae much denser around clypeal region; antenna $0.70\times$ as long as body in dorsal view. Ocellar region shiny and shallowly rugose. Antenna length 1.64; head median length 0.54; head width 0.62; OOL: POL 0.13: 0.09; compound eye (height $\times$ width) 0.36×0.17 ; inter-toruli distance 0.09; inter-tentorial pit distance 0.11; clypeus (height $\times$ width) 0.04×0.16 ; width of face at dorsal clypeal edge 0.30. Measurements: scape 0.13×0.08 ; pedicel $0.03 \times$

0.06 ; F1 0.13×0.06 ; F2 0.12×0.07 ; F3 0.11×0.06 . **Mesosoma** (Fig. 6E). Mesosoma coarsely punctate and sparsely setose; punctations clear, well separated; scutellar sulcus with 12 costulae; scutellum shallowly punctate; propleuron smooth, shiny except crenulate posterior edge; mesopleuron punctate in diagonal posterior half, anterior half smooth, shiny; metapleuron mostly smooth except crenulate margins. Dorsal scutellum $0.86\times$ as long as wide. Propodeum $2.52\times$ as wide as long, with distinct median longitudinal carina; coarsely punctate except for shining patch on either side of median longitudinal carina in anterior half; punctations coarser in basal half; spiracle oval, surrounded by rugosity. Measurements: mesosoma in dorsal view $1.22\times$ as long as wide, 1.01×0.83 ; scutellum 0.31×0.36 ; propodeum 0.23×0.58 ; hind femur 0.66×0.15 ; hind tibia 0.61×0.14 . **Wings** (Fig. 6C). Fore wing hyaline except few infuscations; $2.92\times$ as long as wide; areolet large, more open, not slit-like. Hind wing vannal lobe convex. Fore wing 2.45×0.84 ; pterostigma (length $\times$ height) 0.49×0.21 . Fore wing vein length measurements: C+SC+R 1.01; 1-R1 0.44; M+CU1 0.81; 1-SR 0.05; 2-SR 0.11; 2-M 0.12; 1-CU1 0.12; 2-CU1 0.18; 1-SR-M 0.32; 2-SR-M 0.06; m+cu 0.11. Hind wing vein length measurements: 1-M 0.35; M+CU 0.32; 1 r-m 0.11; cu-a 0.16; 1-1A 0.26. **Metasoma** (Fig. 6F). Metasoma 1.13×0.57 ; T1 0.31×0.44 , T2 0.21×0.55 ; T3 0.29×0.54 ; T4 0.14×0.55 ; T5 0.13×0.42 ; T6 0.22×0.11 ; T7 median length 0.06. Hind coxa 0.65×0.27 , $2.41\times$ as long as wide, $1.97\times$ as long as T1; distinctly punctate with sparse pilosity. Inner hind tibial spur length: outer spur length 0.33: 0.20, inner tibial spur $0.87\times$ as long as hind basitarsus (0.38). Hind coxa reaching anterior half of T3. T1 and T2 with shallow punctations remaining smooth; T1 $0.70\times$ as long as wide, widening posteriorly; three quarters of anterior region with median longitudinal groove in a depression; T2 with 2 submedian carinae giving appearance of pentagonal enclosed region, wider at base and narrower at apex (distance between 2 carinae at basal: apical end 0.11: 0.05); T2–T3 margin with curve, T2 $0.72\times$ T3 median length, widening posteriorly; ovipositor sheaths dark brown, exerted portion of ovipositor (0.11), visible in lateral view.

Male. Almost similar to female except few colour variations: metasoma yellowish except dark brown colour extending from middle of posterior margin of

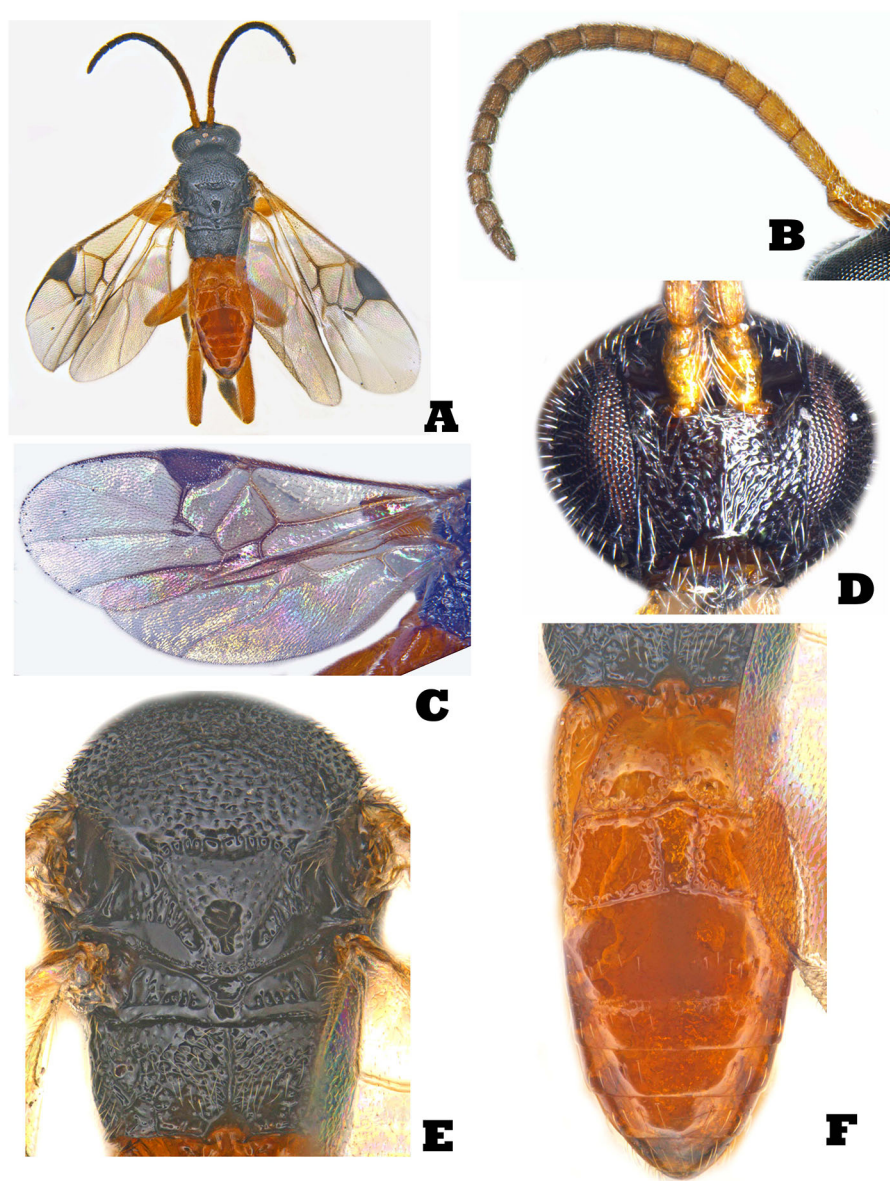


Fig. 6 *Diolcogaster tomentosae* n. comb. (female). A, Dorsal view; B, Antenna; C, Wings; D, Head, frontal view; E, Mesosoma; F, Metasoma

T3, median region of T4 up to the apex (in female only T7 dark brown rest yellowish-brown).

Remarks

This is the first documented record of gregarious cocoons along with parasitised host caterpillar for *Diolcogaster tomentosae* (Wilkinson, 1930) n. comb.

Key to the Indian species of *Diolcogaster* based on females

Note: Males of the Microgastrinae Forster, 1862 are difficult to key (Whitfield, 1997, 2006), as they strongly need to be associated with sibling females from the same host caterpillar, DNA barcodes, or host data (Fernández-Triana et al., 2014) for identification.

However, the male of *D. anadamanensis* n. sp. is thoroughly described in this paper.

- 1a Pronotum smooth and shiny 2
- 1b Pronotum rugose, or punctate 4
- 2a T1, T2 and T3 forming carapace (Supplementary File 1, Fig. S2D)
..... *D. narendrani* Rema & Sheeba, 2004
- 2b T1, T2 and T3 not forming carapace (Supplementary File 1, Fig. S3B) 3
- 3a T2 with well-defined median field (Supplementary File 1, Fig. S3B); T1 slightly wider at apex than base, 1.1× as long as its apical width
..... *D. malabarensis* Narendran & Sheeba, 2005
- 3b T2 with weak median field; T1 parallel sided, 2.5× as long as its maximum width
..... *D. punctatus* Rao & Chalikwar, 1976
- 4a Fore wing with distinct dark apical patch (Fig. 1A); T1, T2 and T3 forming carapace (Figs. 1F, 4F) 5
- 4b Fore wing without distinct dark apical patch (Figs. 3A, 5F, 6C); T1, T2 and T3 not forming carapace (Figs. 3E, 5E, 6F) 6
- 5a POL: OOL = 2; metasoma more elongated (Fig. 1F) *D. andamanensis* n. sp.
- 5b POL: OOL = 1.44; metasoma ovate (Fig. 4F)
..... *D. longistria* n. sp.
- 6a T2 with median field either partially visible/incomplete or with lateral sulci (Fig. 3E)
..... *D. duocolour* n. sp.
- 6b T2 with distinct median field (Figs. 5E, 6F) 7
- 7a POL: OOL > 1
..... *D. indicus* Rao & Chalikwar, 1970
- 7b POL: OOL < 1 8
- 8a POL: OOL = 0.86; T1 and lateral fields of T2 yellowish-brown, T2 with distinct dark brown median field, remaining metasoma mostly dark brown (Fig. 5E); 1CU1: 2CU1 subequal; hind coxa: T1 = 1.77; median length T2: T3 = 0.66
..... *D. solitarium* n. sp.
- 8b POL: OOL = 0.69; T1, T2 and remaining tergites completely yellowish-brown (Fig. 6F); 1CU1: 2CU1 = 0.67; hind coxa: T1 = 1.97; median length T2: T3 = 0.72
..... *D. tomentosae* (Wilkinson, 1930) n. comb.

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