

RESEARCH PAPER

## Review of Indian *Closterocerus* (Hymenoptera: Chalcidoidea: Eulophidae), with description of two new species

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**Abstract.** The Indian species of *Closterocerus* Westwood, 1833 (Hymenoptera: Chalcidoidea: Eulophidae: Entedoninae) are reviewed; eight species are included of which two are described as new: *C. pakyongensis* sp. nov. and *C. junubi* sp. nov. One species: *C. longiscapus* (Bouček, 1986), is recorded from Uttar Pradesh for the first time. An identification key to species occurring in India is also given.

**Key words.** Hymenoptera, Chalcidoidea, Eulophidae, Entedoninae, new record, new species, India, Oriental Region

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### Introduction

The species of the genus *Closterocerus* Westwood, 1833 (Chalcidoidea: Eulophidae) are known to be endoparasitoids of leaf mining insects, gall inducing insects, armored scale insects and jumping plant lice (HANSSON 1994). They are potential agents in the bio-control of gall producing pests of economically important plants. However, the scope of the genus is somewhat controversial. BOUČEK (1988) synonymised *Chrysocharella* Girault, 1913 with *Closterocerus*, and *Neochrysocharis* Kurdjumov, 1912 with *Chrysonotomyia* Ashmead, 1904. On the contrary, HANSSON (1994) regarded *Chrysonotomyia*, *Closterocerus* and *Neochrysocharis* as separate genera and synonymised ten more genera with *Closterocerus*. GUMOVSKY (2001) further synonymised *Neochrysocharis*, *Asecodes* Förster, 1856, *Hispinocharis* Bouček, 1988 and *Mangocharis* Bouček, 1986 with *Closterocerus*. Later BURKS et al. (2011) removed *Asecodes* and *Neochrysocharis* from synonymy with *Closterocerus* and reinstated them as valid genera.

In this paper we give a brief diagnosis of the genus and describe two new species from India. We further provide an identification key to Indian species of *Closterocerus*.

### Material and methods

The terminology largely follows that of GIBSON (1997). The body length for the new species is given in millimetres. All other measurements are relative taken from the divisions of a linear scale of an ocular micrometer. These measurements were taken at 100× magnification of the microscope (one ocular micrometer division = 0.01 mm). The photomicrographs of card mounted specimens were taken with a Nikon DS-Fi2 digital camera attached to a Nikon SMZ25 stereo zoom microscope, and the photomicrographs of slide mounted parts were taken with a Nikon DSFi1c digital camera attached to a Nikon Eclipse Ci compound microscope.

The following abbreviations are used in the text:

C1, C2, etc.	clava segments 1, 2, etc.;
F1, F2, etc.	funicle segments 1, 2, etc.;
OOL	minimum distance between a posterior ocellus and the corresponding eye margin;
POL	minimum distance between the posterior ocelli;
T1, T2, etc.	gasteral tergites 1, 2, etc.;

The following acronyms are used for the depositories:

BMNH	The Natural History Museum, London, United Kingdom;
IARI	Indian Agricultural Research Institute, Delhi, India;



SJCA St John's College, Agra, India;  
 ZDAMU Insect collections, Department of Zoology, Aligarh Muslim University, Aligarh, India;  
 ZSIC Zoological Survey of India, Calcutta, India.

## Systematics

### Genus *Closterocerus* Westwood, 1833

*Closterocerus* Westwood, 1833: 419. Type species: *Closterocerus trifasciatus* Westwood, 1833, by monotypy.  
*Achrysocharis* Girault, 1913a: 104. Type species: *Achrysocharis bifasciata* Girault, 1913, by monotypy. Synonymy by HANSSON (1994: 2).  
*Achrysocharis* Girault, 1913b: 100. Type species: *Achrysocharis magnifica* Girault, 1913, by original designation. Synonymy by HANSSON (1994: 2).  
*Achrysocharella* Girault, 1913c: 171. Type species: *Achrysocharella dubia* Girault, 1913, by original designation. Synonymy by HANSSON (1994: 2).  
*Chrysocharella* Girault, 1913c: 169. Type species: *Chrysocharella pulchra* Girault, 1913, by original designation. Synonymy by BOUČEK (1988: 724).  
*Pseudochrysocharis* Girault, 1913c: 171. Type species: *Pseudochrysocharis speciosa* Girault, 1913, by original designation. Synonymy by HANSSON (1994: 2).  
*Wolffiella* Krausse, 1917: 26. Type species: *Wolffiella ruforum* Krausse, 1917, by monotypy. Synonymy by HANSSON (1994: 2).  
*Halocharis* Erdős, 1951: 209. Type species: *Halocharis transsylvanica* Erdős, 1951, by original designation. Synonymy by HANSSON (1994: 2).  
*Halochariessa* Erdős, 1956a: 334. Replacement name for *Halocharis* Erdős, 1956, a name preoccupied in the Coelenterata. Synonymy by HANSSON (1994: 2).  
*Chrysocharidia* Erdős, 1956b: 389. Type species: *Chrysocharidia fimbriata* Erdős, 1956, by original designation. Synonymy by HANSSON (1994: 2).  
*Moserina* Delucchi, 1962: 389. Type species: *Moserina maculata* Delucchi, 1962, by original designation. Synonymy by HANSSON (1994: 2).  
*Cecidiophaga* Erdős, 1966: 414. Type species: *Halochariessa germanica* Erdős, 1966, by original designation. Synonymy by HANSSON (1994: 2).  
*Hispinocharis* Bouček, 1988: 718. Type species: *Achrysocharella orientalis* Ferrière, 1933, by original designation. Synonymy by GUMOVSKY (2001: 132).  
*Mangocharis* Bouček, 1986: 403. Type species: *Mangocharis longiscapus* Bouček, 1986, by monotypy. Synonymy by GUMOVSKY (2001: 132).

**Diagnosis. Female.** Frontal grooves straight or V-shaped (Figs 4A, 6A); scrobal grooves join prior to frontal grooves or grooves extending to frontal grooves separately; clypeus not delimited; subtorular grooves present (Fig. 6A); mandibles tridentate; antennal scape and flagellum generally compressed or flattened (except for *C. pulcherimus* (Kerrich, 1970)); funicle 2-segmented and clava 3-segmented, with long spicula; middle lobe of mesoscutum with 1–4 pairs of setae. Fore wing with infuscate patch below stigmal vein or with 2–3 transverse infuscate bands containing modified setae (Figs 5B, 7B), very rarely hyaline (Fig. 3B); postmarginal vein subequal to or shorter than stigmal vein; row of setae radiating from stigmal knob; propodeum short, transverse, smooth and shiny; propodeal callus with 2 setae.

**Male.** Similar to female except for sexual dimorphism. Antennal scape subapically with sensory area near apical margin.

**Hosts.** Primary endoparasitoids of the larvae of leaf mining insects belonging to the orders Coleoptera, Lepidoptera, Hymenoptera and Diptera (SCHAUFF 1991).

**Distribution.** Worldwide.

**Species.** World, 80; India, 8 (including 2 new species) (NOYES 2021, LI & LI 2021).

### Key to Indian species of *Closterocerus* (females)

- 1 Scape slender, at least 5× as long as broad (Fig. 2B). .. 2
  - Scape strongly compressed or flattened, at most 2.7× as long as broad (Figs 6B, 8B). ..... 3
- 2 Fore wing with brown infuscate patch below stigmal vein, with row of setae radiating from stigmal knob (Fig. 1B); middle lobe of mesoscutum with one pair of setae (Fig. 2E). ..... *C. longiscapus* (Bouček, 1986)
  - Fore wing hyaline, with two rows of setae radiating from stigmal knob (Fig. 3B); midlobe of mesoscutum with two pairs of setae (Fig. 4C). ..... *C. pulcherimus* (Kerrich, 1970)
- 3 Body length at least 2 mm; fore wing with middle band becoming broadened posteriorly (NARAYANAN et al. 1960: fig.1). ..... *C. agromyzae* Narayanan et al., 1960
  - Body length at most 1.35 mm; fore wing with middle band slightly broadened in middle or nearly uniform in width (Figs 5B, 7B). ..... 4
- 4 Fore wing with speculum opened and, with middle band slightly broadened medially (MANI 1971: fig.12). ..... *C. phytomyzae* Mani, 1971
  - Fore wing with speculum closed (Figs. 5B, 9B), with middle band nearly uniform in width. .... 5
- 5 Clava with C2 relatively more transverse, at least 2× as broad as long; hind wing relatively broad, at most 3.75× as long as broad. .... *C. insignis* Waterston, 1915
  - Clava with C2 relatively less transverse, at most 1.5× as broad as long; hind wing relatively narrow, at least 4.6× as long as broad. .... 6
- 6 Middle lobe of mesoscutum with 3 pairs of setae (Fig. 6D); hind wing 4.6–5.06× as long as broad. .... *C. scapiatus* Singh & Khan, 1996
  - Middle lobe of mesoscutum with 1 pair of setae; hind wing more than 6× as long as broad. .... 7
- 7 Clava 3.6× as long as broad; mesoscutum with polygonal reticulate sculpture, and with relatively larger cells (Fig. 8C); fore wing with proximal patch relatively broad and darker (Fig. 7B). ..... *C. pakyongensis* sp. nov.
  - Clava 1.7× as long as broad; mesoscutum with polygonal reticulate sculpture, and with relatively smaller cells, becoming faint posteriorly (Fig. 10C); fore wing with proximal patch relatively narrow and faint (Fig. 9B). ..... *C. junubi* sp. nov.

### *Closterocerus longiscapus* (Bouček, 1986)

(Figs 1–2)

*Mangocharis longiscapus* Bouček, 1986: 403, female, male. Holotype: ♀, India, Karnataka, Bangalore (BMNH), not examined.

*Mangocharis longiscapus*: KHAN et al. (2005): 136 (record: Karnal, Haryana).

*Closterocerus longiscapus*: GUMOVSKY (2001): 132 (synonymy).

**Material examined. INDIA:** KARNATAKA: Bengaluru, Hebbal, 1 ♀ 5 ♂♂; 1 ♂ 1 ♀ (on slide under four cover slip slide Nos. EUL.150, EUL.151);

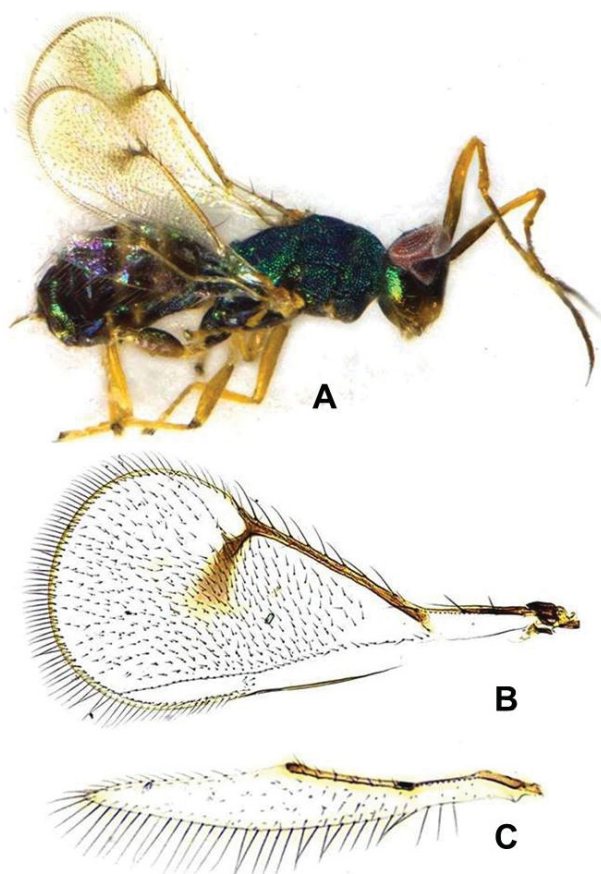


Fig. 1. *Closterocerus longiscapus* (Bouček, 1986). A – male, habitus; B–C – female: B – fore wing; C – hind wing.

2 ♂♂ (on cards), 16.vi.2014; 2 ♂♂ (on cards), 24.xi.2015, Coll. K. Veenakumari (ZDAMU). UTTAR PRADESH: Chandauli, Turang, 1 ♂ (on card), 18.vii.2010, Coll. F.R. Khan. (ZDAMU).

**Redescription. Female.** Length, 1.35 mm. Head with vertex bluish green; frons pale yellow to pale brown; gena bluish. Antenna dark brown except for scape medially in dorsal margin, F2 and first claval segment that are pale brown. Pronotum brown with bluish reflection; mesoscutum blue with greenish reflection; scutellum blue with pale suffusion; metanotum pale brown; propodeum bluish. Fore wing hyaline with brown infuscation below stigmal vein (Fig. 1B). Fore and middle legs with coxae dark brown, trochanters pale white, femora and tibiae pale yellow except for brown to dark brown tarsal segments of fore leg 1–3, last tarsal segment pale yellow; tarsal segments of middle leg 1 and 4 pale yellow, 2 and 3 brown to dark brown; hind leg with coxa, trochanter, femur, tibia in basal third dark brown, apical two-thirds of tibia and tarsi pale white. Petiole in basal half brown and apical half white. Gaster with terga T1–T3 bluish, T4–T7 greenish blue.

Head (Fig. 2A), in frontal view, 1.44× as broad as high; eye height 2.90× as high as malar space. Antenna (Fig. 2B) with scape 5.50× as long as broad, 2.90× as long as pedicel; pedicel 2.42× as long as broad, longer than all flagellar segments individually; flagellum with 2 distinct anelli; F1 1.28× as long as broad, distinctly shorter than F2; clava 5.58× as long as broad; C1 longer than C2 and C3 individually.

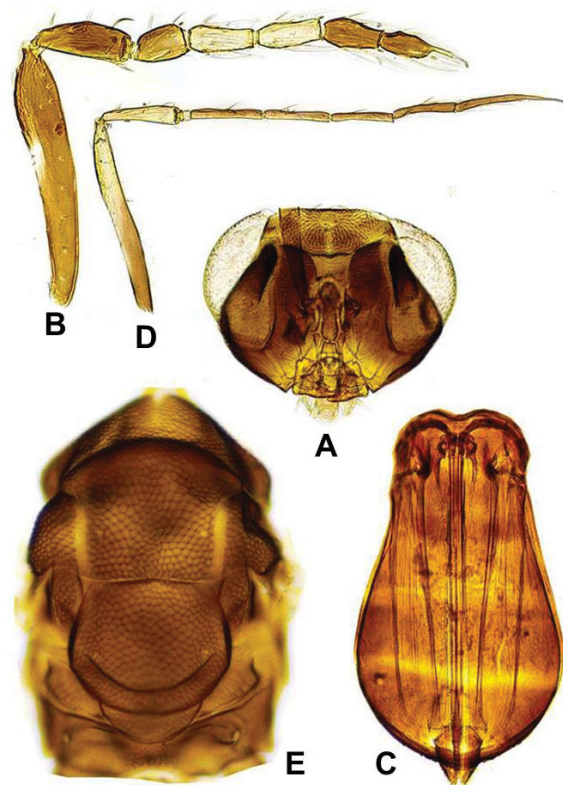


Fig. 2. *Closterocerus longiscapus* (Bouček, 1986). A–C – female: A – head, frontal view; B – antenna; C – ovipositor. D–E – male: D – antenna; E – mesosoma.

Mesosoma 1.30× as long as broad; pronotum 0.33× mesoscutum; mesoscutum slightly longer than scutellum; notauli almost complete, faint posteriorly; middle lobe of mesoscutum with 1 pair of setae; scutellum slightly broader than long, with 1 pair of setae; pronotum, mesoscutum, scutellum and axillae with polygonal reticulate sculpture; dorsellum 4.90× as broad as long, with longitudinal sculpture; propodeum narrow with faint transverse reticulate sculpture, sides with rugose reticulate sculpture. Fore wing (Fig. 1B) 1.92× as long as broad; marginal vein + parastigma 1.78× as long as submarginal vein, 4.80× as long as stigmal vein; postmarginal vein 0.50× stigmal vein; longest marginal seta 0.10× maximum wing width. Hind wing (Fig. 1C) 5.90× as long as broad; longest marginal seta 0.63× maximum wing width.

Metasoma. Petiole 3.60× as broad as long; gaster longer than mesosoma; ovipositor (Fig. 2C) occupying more than two-thirds of gaster length, slightly exerted beyond apex of gaster; ovipositor 2.42× as long as hind tibia.

*Relative measurements* (slide, at 100×). Head height : width, 34 : 49; eye height, 25; malar space, 8.50. Antennal segments length : width: scape, 25.00 : 4.50; pedicel, 8.50 : 3.50; F1, 4.50 : 3.50; F2, 6.25 : 2.25; C1, 6.25 : 2.50; C2, 5.50 : 3.00; C3, 5.00 : 2.25; spicula, 2. Mesosoma length : width, 60 : 46. Fore wing length : width, 96 : 50; longest marginal seta, 5; submarginal vein length, 23; parastigma length, 5; marginal vein length, 36; postmarginal vein length, 4; stigmal vein length, 8.50. Hind wing length : width, 89 : 15; longest marginal seta, 9.50. Hind tibia length, 28. Metasoma. Petiole length : width, 3 : 11; gaster length, 71; ovipositor length, 68.

**Male.** Similar to female except for antenna and sexual characters. Antenna (Fig. 2D) slender; scape  $9.80\times$  as long as broad,  $2.70\times$  as long as pedicel; pedicel  $4.15\times$  as long as broad; pedicel as long as F1; flagellum narrow; gaster short and narrow.

**Relative measurements** (slide, at  $100\times$ ). Head height : width, 31 : 42; eye height, 22.50; malar space, 8.50. Antennal segments length : width – scape, 37.00 : 3.75; pedicel, 13.50 : 3.25; F1, 13.50 : 1.75; F2, 11.25 : 1.75; C1, 11.00 : 1.50; C2, 11.25 : 1.75; C3, 15.00 : 1.50; spicula, 5. Mesosoma length : width, 52 : 37. Fore wing length: width, 82 : 41; longest marginal seta, 7; submarginal vein length, 21; parastigma length, 5; marginal vein length, 29; stigmal vein length, 7; postmarginal vein length, 3.50. Hind wing length : width, 72 : 12; longest marginal seta, 9. Hind tibia length, 25. Metasoma. Petiole length: width, 3 : 9; gaster length, 50.

**Differential diagnosis.** *Closterocerus longiscapus* looks similar to *C. pulcherrimus*, but differs from the latter in the following characters: scape  $5.50\times$  as long as broad; clava  $5.58\times$  as long as broad; dorsellum with rugose sculpture,  $4.90\times$  as broad as long; fore wing with brown infuscate patch below stigmal vein. In *C. pulcherrimus*: scape  $4.20$ – $4.80\times$  as long as broad; clava  $4.90$ – $5.16\times$  as long as broad; dorsellum smooth,  $5.30$ – $6.80\times$  as long as broad; fore wing hyaline.

**Host.** Unknown.

**Distribution in India.** Haryana, Karnataka, Tamil Nadu (NOYES 2021), Uttar Pradesh (new record).

### *Closterocerus pulcherrimus* (Kerrich, 1970)

(Figs 3–4)

*Achrysocharis pulcherrimus* Kerrich, 1970: 330, female. Holotype: ♀, Malawi, Bvumbwe (BMNH), not examined.

*Achrysocharis pulcherrimus*: KERRICH (1974): 629 (record: Pakistan, Shujabad).

*Chrysonotomyia latipennis* Khan & Shafee, 1981: 350, female. Holotype: ♀, India, Aligarh, Hardwagunj (ZDAMU), examined. Synonymy by HAYAT et al. (2005: 8).

*Chrysonotomyia latipennis*: HUSAIN & KHAN (1986): 215 (catalogue).

*Chrysonotomyia pulcherrima*: HUSAIN & KHAN (1986): 215 (catalogue).

*Closterocerus pulcherrimus*: NARENDRAN & SUDHEER (2005): 10 (record).

**Type material examined.** *Chrysonotomyia latipennis*: HOLOTYPE: ♀, (on three slides under coverslip), INDIA: UTTAR PRADESH: Aligarh, Hardwagunj, 31.xii.1974, Coll. M.Y. Khan. (ZDAMU, registration. No. HYM. CH.187).

**Additional material examined.** INDIA: KARNATAKA: Bengaluru, Hebbal, 3 ♀♀ (on slide under four coverslips, slide Nos. EUL.32, EUL.180, EUL.181); 2 ♀♀ (on cards); 1 ♂ (on slide under four coverslips, EUL.182), (YPT), 25.xi.2014, Coll. K. Veenakumari. (ZDAMU).

**Redescription. Female.** Length, 1.15–1.40 mm. Head green, except for pale brown frons, mouth pale yellow. Antenna pale brown except for scape that is pale white in basal half. Mesoscutum and scutellum largely metallic green except for scutellum that is pale brown laterally; axillae metallic green (Fig. 3A). Wings hyaline. All legs pale white except for brown coxae. Gaster with T1 green, T2 and T3 pale brown, T4 dark brown, T5 and T6 medially pale brown, laterally dark brown, T7 and ovipositor sheath dark brown.

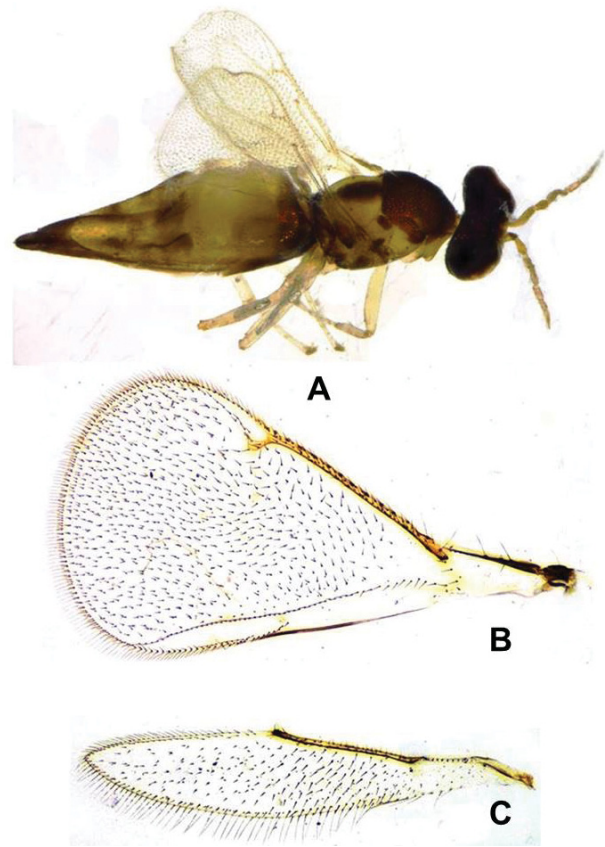


Fig. 3. *Closterocerus pulcherrimus* (Kerrich, 1970), female: A – habitus; B – fore wing; C – hind wing.

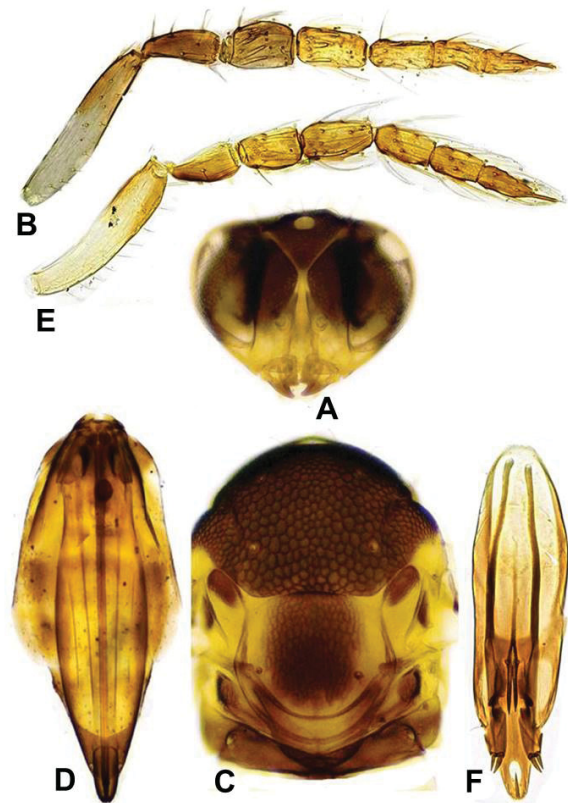


Fig. 4. *Closterocerus pulcherrimus* (Kerrich, 1970). A–D – female: A – head, frontal view; B – antenna; C – mesosoma; D – metasoma. E–F – male: E – antenna; F – genitalia.

Head (Fig. 4A), in frontal view, 1.32–1.39× as broad as high; eye height 4.80–5.40× as long as malar space; antennal toruli situated above lower eye margin. Antenna (Fig. 4B) with scape 4.20–4.80× as long as broad, 2.60× as long as pedicel; pedicel 1.91–2.00× as long as broad; flagellum with 2 distinct anelli; F1 slightly longer than broad, shorter than F2; clava 4.90–5.16× as long as broad.

Mesosoma (Fig. 4C) 1.19–1.40× as long as broad; pronotum narrow, hardly visible in dorsal view; mesoscutum as long as scutellum, with polygonal reticulate sculpture; notauli incomplete, present in anterior half; middle lobe of mesoscutum with 2 pairs of setae; scutellum slightly broader than long, medially with faint polygonal reticulate sculpture, laterally smooth with 1 seta near each lateral margin; dorsellum smooth, 5.30–6.80× as broad as long; propodeum smooth. Fore wing (Fig. 3B) 1.75–1.87× as long as broad; marginal vein + parastigma 1.76–1.90× as long as submarginal vein, 7.70–8.60× as long as stigmal vein; postmarginal vein as long as stigmal vein; longest marginal seta 0.08–0.09× maximum wing width. Hind wing (Fig. 3C) 4.85–5.80× as long as broad; longest marginal seta 0.34–0.42× maximum wing width.

Metasoma (Fig. 4D). Petiole 3.25–3.70× as broad as long; gaster distinctly longer than mesosoma; ovipositor occupying whole length of gaster, second valvifer touching posterior margin of petiole, slightly exerted beyond apex of gaster; ovipositor 2.56–3.13× long as hind tibia.

*Relative measurements* (n = 3; slide, at 100×). Head height : width, 28–33 : 37–46; eye height, 22.5–27.0; malar space, 4.50–5.00. Antennal segments length : width – scape, 15–17 : 3.50–3.75; pedicel, 5.75–6.50 : 3.00–3.25; F1, 3.75–5.75 : 3.25–4.50; F2, 4.75–6.50 : 2.75–3.50; C1, 4.00–5.50 : 2.75–3.00; C2, 4.50–5.00 : 2.00–2.75; C3, 4.00–5.00 : 2.00–2.50; spicula, 2. Mesosoma length : width, 41–50 : 32–42. Fore wing length : width, 88–98 : 47–56; longest marginal seta, 4.50; submarginal vein length, 21.00–22.50; parastigma length, 4–5; marginal vein length, 33–38; postmarginal vein length, 4.50–5.50; stigmal vein length, 4.75–5.00. Hind wing length : width, 76–85 : 13.00–17.50. Hind tibia length, 30–32. Metasoma. Petiole length : width, 4.00–4.50 : 13.00–16.50; gaster length, 78–84; ovipositor length, 82–94.

**Male.** Similar to female except for sexual dimorphism. Genitalia as in Fig. 4F.

**Differential diagnosis.** *Closterocerus pulcherrimus* comes close to *C. partifuscipennis* (Girault, 1916), but it differs from the latter in the following characters: eye height 4.80–5.40× as long as malar space; middle lobe of mesoscutum with 2 pairs of setae; fore wing 1.75–1.87× as long as broad; postmarginal vein as long as stigmal vein. In *C. partifuscipennis*: eye height 2.7× as long as malar space; middle lobe of mesoscutum with 1 pair of setae; fore wing 2.1× as long as broad; postmarginal vein 0.2× as long as stigmal vein.

**Host.** Unknown.

**Distribution in India.** Gujarat, Karnataka, Kerala and Uttar Pradesh (NOYES 2021).

### *Closterocerus agromyzae*

Narayanan, Rao & Ramachandra, 1960

*Closterocerus agromyzae* Narayanan, Rao & Ramachandra, 1960: 168, female. Holotype: ♀, India, Delhi (IARI), not examined.

*Closterocerus agromyzae*: REJI et al. (2003): 30 (record).

**Diagnosis. Female.** Length, 2.00–2.10 mm. Head with greenish reflection on frons. Mesosoma with metanotum and propodeum with bronze reflection. Fore wing smoky with three fuscous transverse bands across disc, one at apex, second just below stigmal vein and third almost below in middle of marginal vein. Legs fuscous except for pale yellow middle tibiae and tarsi; middle tibia with prominent stout spine.

Head transverse, occiput minutely reticulate; vertex with punctate reticulate sculpture with 2 setae anterior to each lateral ocelli; POL 2× OOL; antennal toruli situated slightly above lower eye margin. Antennal scape narrow basally, broad distally, longer than flagellum; pedicel 0.5× scape; flagellum with one anellus; flagellar segments are transverse except for conical last flagellar segment; first three flagellar segments subequal; fourth segment slightly shorter, distinctly narrower than preceding ones.

Mesosoma. Pronotum narrow with punctate reticulate sculpture; mesoscutum and scutellum with reticulate sculpture; mesopleura with one prominent stout seta on either side; propodeum without median carina. Fore wing with marginal vein more than 2× as long as submarginal vein with 13 long dorsal setae of equal size; stigmal vein thick and spatulate; postmarginal vein very short.

Metasoma ovate, slightly longer than mesosoma; T1 conspicuously longer than remaining tergites; ovipositor slightly exerted beyond apex of gaster.

**Differential diagnosis.** Diagnosis of *Closterocerus agromyzae* is based on the original description and illustration given by NARAYANAN et al. (1960). However, it comes close to *C. javanus* Perkins, 1912, but differs from the latter in the following characters: pedicel shorter than anellus, F1 and F2 combined; fore wing with three fuscous bands across wing. In *C. javanus* pedicel longer than anellus, F1 and F2 combined; fore wing with distinct roundish smoky spot in middle of disc (NARAYANAN et al. 1960).

**Host.** *Agromyza* sp. (Diptera: Agromyzidae) (NARAYANAN et al. 1960).

**Distribution in India.** Delhi, Kerala (NARAYANAN et al. 1960).

### *Closterocerus phytomyzae* Mani, 1971

*Closterocerus phytomyzae* Mani, 1971: 595, female. Holotype: ♀, India, Uttar Pradesh, Agra (SJCA), not examined.

*Closterocerus phytomyzae*: DUBEY (1974): 418 (record); HUSAIN & KHAN (1986): 216 (catalogue); KHAN et al. (2005): 98 (redescription).

**Diagnosis. Female.** Length, 1 mm. Head metallic green with faint violet tinge on clypeus. Antenna with scape and pedicel metallic green, flagellum dark brown. Mesosoma light metallic green. Wing subhyaline. Fore and middle legs with coxae and femora dark brown; fore tibia largely pale brown but slightly infumate basally; middle tibia in basal half infumate and in apical half pale brown; hind

leg with coxae, femora, tibiae dark brown with metallic shine; tarsi of all legs pale brown. Gaster dark brown with metallic shine.

Head broader than thorax, in frontal view,  $1.27\times$  as broad as high; POL subequal to OOL; frons finely reticulate; clypeus smooth; antennal toruli situated at level of lower eye margin. Antennal scape  $2.6\times$  as long as broad, subequal to pedicel + flagellum combined; pedicel  $0.37\times$  scape length; F1  $0.37\times$  pedicel; F2  $0.75\times$  pedicel; C1 shorter than F1 and F2 individually; C2 subequal to C1; C3 shorter than C1 and C2 individually,  $0.66\times$  as broad as long.

Mesosoma with fine reticulate sculpture; notauli deep and complete; scutellum  $0.8\times$  mesoscutum with 1 pair of setae. Propodeum smooth,  $2\times$  as long as metanotum. Fore wing  $2.3\times$  as long as broad with three transverse bands; apical band medially broad, broader than middle band with 3–6 rows of moderate setae; middle band darkest with 6–7 rows of setae; proximal band shortest; submarginal vein  $0.66\times$  marginal vein; postmarginal vein subequal to stigmal vein.

Metasoma slightly shorter than mesosoma.

**Male.** Unknown.

**Differential diagnosis.** The above diagnosis is based on the original description and illustrations given by MANI (1971). However, it comes close to *C. trifaciatus*, but differs from the latter in the following characters: head and side lobes without bluish tinge; basitarsi of all legs pale brown; postmarginal vein subequal to stigmal vein. In *C. phytomyzae*: head and side lobes with bluish tinge; middle and hind basitarsi fuscous or blackish; postmarginal vein  $0.3\times$  as long as stigmal vein.

**Host.** Larva of *Phytomyza syngenesiae* (Hardy, 1849) (Diptera: Agromyzidae) (MANI 1971).

**Distribution in India.** Bihar, Kerala, Tamil Nadu, Uttar Pradesh, Uttarakhand (NOYES 2021).

### *Closterocerus insignis* Waterston, 1915

*Closterocerus insignis* Waterston, 1915: 330, female. Holotype: ♀, Sri Lanka, not examined.

*Closterocerus insignis*: MANI (1971): 591 (record); HUSAIN & KHAN (1986): 216 (checklist); BALAKRISHNAN et al. (1986): 89 (record), THAREJA & HAYAT (2004): 4 (biology).

**Diagnosis. Female.** Length, 1.25 mm. Head with occiput bluish green; vertex and frons dark blue with greenish lustre around ocellar triangle; clypeus violet. Mesosoma with mesoscutum and scutellum largely bluish green with bluish reflection laterally; metanotum and propodeum dark violaceous or purple. Fore wing with dark venation. Hind wing hyaline. Legs with coxae and femora, hind trochanters, hind tibiae and first hind tarsal segments black; fore and middle trochanter smoky; fore and middle tibiae, with their tarsi and last three hind tarsal segments pale yellow. Metasoma dark violaceous or purple.

Head with vertex and frons reticulate; clypeus faintly reticulate. Antenna compressed; scape triangular, dilated apically,  $2.50\times$  as long as broad, longer than pedicel, F1 and F2 combined; pedicel subquadrate, convex laterally; funicle segments broader than long with oval and elongate sensilla.

Mesosoma densely punctate reticulate; middle lobe of mesoscutum and scutellum broad; scutellum with one pair of setae; metanotum and propodeum narrow. Fore wing  $2\times$  as long as broad with three infusate bands. Hind wing  $3.75\times$  as long as broad.

Metasoma round and oval with slight reticulation on T3–T5.

**Differential diagnosis.** *Closterocerus insignis* comes close to *C. scapiatus*, but differs from the latter in the following characters: F2 at most  $2\times$  as broad as long; C2 relatively more transverse, at most  $2\times$  as broad as long; C3 flattened; fore wing with apical band narrow; gaster dark violaceous and purple. In *C. scapiatus*: F2 at least  $1.5\times$  as broad as long; C2 relatively less transverse, at most  $1.5\times$  as broad as long; C3 oblong; fore wing with apical band broad; gaster dark brown.

**Host.** *Oscinis theae* Green, 1895 (Diptera: Agromyzidae) (MANI 1971).

**Distribution in India.** Delhi, Karnataka, Kerala, Tamil Nadu (NOYES 2021).

### *Closterocerus scapiatus* Singh & Khan, 1996

(Figs 5–6)

*Closterocerus scapiatus* Singh & Khan, 1996: 158, female. Holotype: ♀, India, Uttarakhand, Pantnagar, University Campus (ZSIC), not examined.

*Closterocerus scapiatus*: KHAN et al. (2005): 97 (record).

**Material examined. INDIA: UTTARAKHAND:** Dehradun, FRI Campus, 1 ♀ (on slide under four coverslips, slide No. EUL.149), 22.iii.2016, Coll. M.M. Jamali. **UTTAR PRADESH:** Hathras, 2 ♀♀ (on slide under four coverslips, slide Nos. EUL.60, EUL.68), 6.iii.2013, Coll. S.K. Ahmed & M.T. Khan. (ZDAMU).

**Redescription. Female.** Length, 1.10–1.23 mm. Head dark brown, vertex with bluish reflection. Antenna dark brown. Mesosoma with pronotum, middle lobe of mesoscutum and scutellum bluish; side lobes of mesoscutum and propodeum dark brown (Fig. 5A). Fore wing subhyaline, with three transverse dark brown infusate bands as in Fig. 5B. Fore leg: coxa and femur dark brown; trochanter pale yellow; tibia in basal third brown, rest pale brown; tarsus pale white; middle leg: coxa brown; femur dark brown; tibia in basal third brown, rest pale brown; tarsal segments 1–3 brown, last tarsal segment pale yellow; hind leg: coxa, femur, tibia dark brown; first tarsal segment dark brown, 2–4 pale white. Petiole and gaster dark brown.

Head (Fig. 6A), in frontal view,  $1.42$ – $1.57\times$  as broad as high; eye height  $4.70$ – $5.10\times$  as long as malar space; antennal toruli situated much above lower eye margin. Antenna (Fig. 6B) with scape  $2.35$ – $2.46\times$  as long as broad,  $2.85$ – $3.08\times$  as long as pedicel; pedicel  $0.85$ – $0.96\times$  as long as broad; flagellum with single anellus; F1 subequal to F2; clava  $1.73$ – $1.79\times$  as long as broad.

Mesosoma (Fig. 6C)  $1.20$ – $1.34\times$  as long as broad; pronotum  $0.09$ – $0.10\times$  mesoscutum; notauli incomplete, faint posteriorly; middle lobe of mesoscutum (Fig. 6D) with 3 pairs of setae; scutellum as long as mesoscutum with 1 pair of setae; pronotum, mesoscutum, scutellum and axillae with polygonal reticulate sculpture; metanotum with dorsellum smooth,  $3.25$ – $4.60\times$  as broad as long; sides of

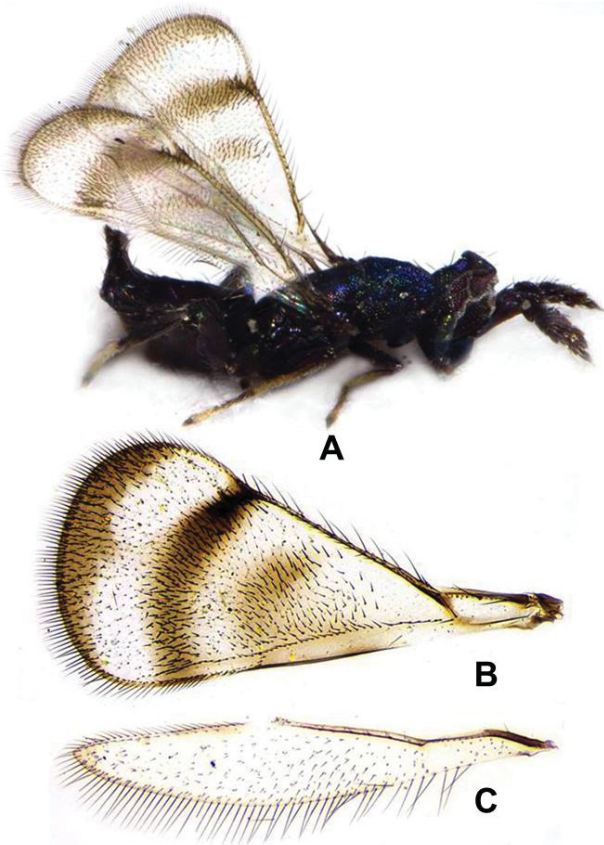


Fig. 5. *Closterocerus scapiatus* Singh & Khan, 1996, female: A – habitus; B – fore wing; C – hind wing.

metanotum with longitudinal striations; propodeum smooth, without any carina. Fore wing (Fig. 5B) 1.89–1.92× as long as broad; marginal vein + parastigma 2.10–2.44× as long as submarginal vein, 6.40–7.30× as long as stigmal vein; postmarginal vein 0.6–0.83× stigmal vein; longest marginal seta 0.10–0.12× maximum wing width. Hind wing (Fig. 5C) 4.60–5.06× as long as broad; longest marginal seta 0.41–0.53× maximum wing width.

Metasoma (Fig. 6E). Petiole 2.28–2.66× as broad as long; gaster longer than mesosoma; ovipositor occupying more than two-thirds of gaster length, hardly exerted beyond apex of gaster; ovipositor 1.77–2.28× as long as hind tibia.

**Relative measurements** (n = 3; slides, at 100×). Head height : width, 28–33 : 44–47; eye height, 23.00–23.50; malar space, 4.50–5.00. Antennal segments length : width – scape, 18.50–20.00 : 7.50–8.50; pedicel, 6–7 : 7.00–7.50; F1, 3–4 : 7.50–8.00; F2, 4.50–5.00 : 7–8; C1, 4.25–4.50 : 6.50–7.50; C2, 3.50–4.00 : 5.25–5.50; C3, 4.00 : 2.50–2.75; spicula, 2.50–3.00. Mesosoma length : width, 50–56 : 38–44. Fore wing length : width, 88–104 : 46–54; longest marginal seta, 5.25–6.50; submarginal vein length, 18–21; parastigma length, 5.00–7.50; marginal vein length, 38–42; postmarginal vein length, 3–5; stigmal vein length, 6.00–7.50. Hind wing length : width, 81–94 : 16–19; longest marginal seta, 7.50–9.00. Hind tibia length, 24–31. Metasoma. Petiole length : width, 2.50–3.00 : 7–8; gaster length, 55–61; ovipositor length, 52–56.

**Male.** Unknown.

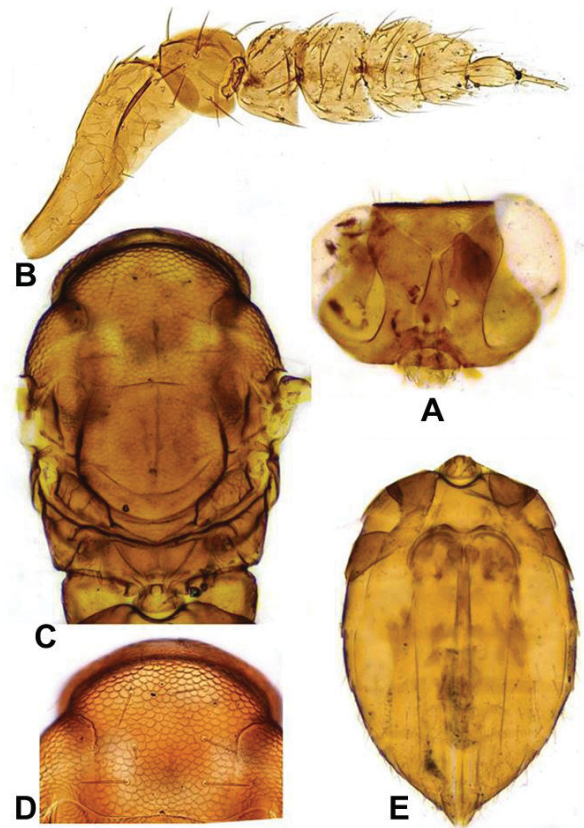


Fig. 6. *Closterocerus scapiatus* Singh & Khan, 1996, female: A – head, frontal view; B – antenna; C – mesosoma; D – mesoscutum, with 6 setae on mid lobe; E – metasoma.

**Differential diagnosis.** *Closterocerus scapiatus* resembles *C. phytomyzae*. However, it differs from the latter mainly in the following characters: antennal scape distinctly shorter than pedicel + flagellum combined; scutellum subequal to mesoscutum; fore wing with speculum closed; submarginal vein 0.47× marginal vein. In *C. phytomyzae*: antennal scape subequal to pedicel + flagellum combined; scutellum shorter than mesoscutum; fore wing with speculum opened; submarginal vein 0.66× marginal vein.

**Host.** Sisam leaf miner (SINGH & KHAN 1996).

**Distribution in India.** Uttar Pradesh, Uttarkhand (NOYES 2021).

#### *Closterocerus pakyongensis* sp. nov.

(Figs 7–8)

**Type material.** HOLOTYPE: ♀ (on slide under four coverslips, slide No. EUL.71), INDIA: SIKKIM: Pakyong, NRC campus, 2.xi.2014, (MT), Coll. K. Veenakumari. (ZDAMU). PARATYPES: 1 ♂ (on slide under four coverslips, slide No. EUL.70); 2 ♂♂ (on cards), with same data as for holotype (ZDAMU).

**Description. Female.** Holotype (Fig. 7A). Length, 0.91 mm. Head dark brown with bluish green reflection on vertex. Antenna dark brown. Mesosoma mostly dark brown, mesoscutum and scutellum with bluish green reflection. Fore wing subhyaline, with three brown infuscate bands (Fig. 7B). Fore leg: coxa and femur dark brown; tibia and tarsi pale yellow; middle leg: coxa pale yellow, femur dark brown, tibia yellow with dorsal margin brown, tarsi pale yellow; hind leg: coxa, femur and tibia dark brown, tarsi

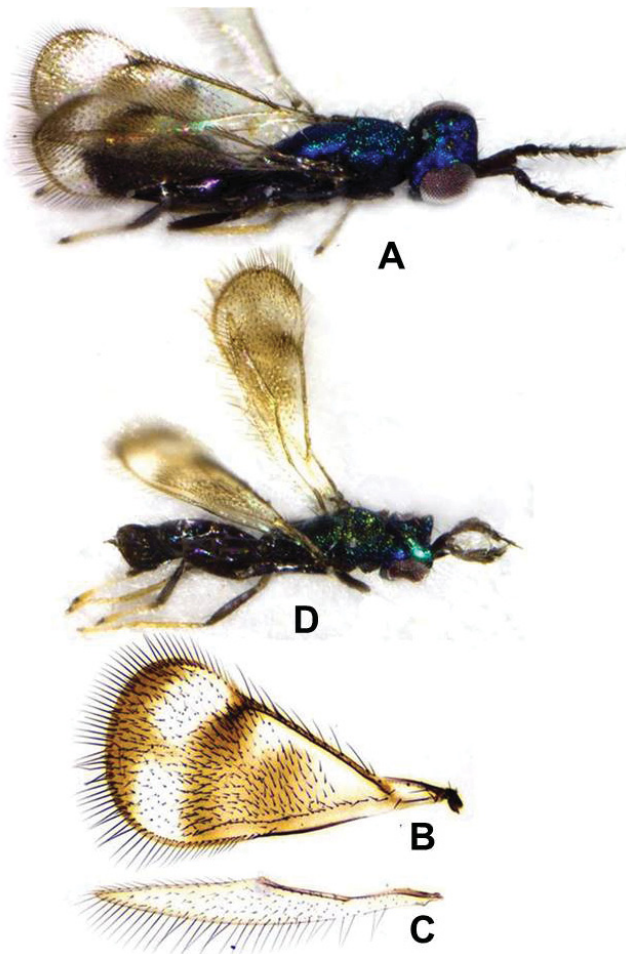


Fig. 7. *Closterocerus pakyongensis* sp. nov. A-C - female (holotype): A - habitus; B - fore wing; C - hind wing. D - male (paratype), habitus.

yellow except for brown first tarsal segment. Petiole and gaster dark brown except for bluish green T1.

Head (Fig. 8A), in frontal view,  $1.18\times$  as broad as high; eye height  $6.16\times$  as long as malar space; antennal toruli situated above lower eye margin; head with sculpture as in figure 133. Antenna (Fig. 8B) with scape  $2.70\times$  as long as broad,  $3\times$  as long as pedicel; pedicel broader than long,  $0.90\times$  as long as broad; flagellum with single anellus; F1  $0.44\times$  as long as broad, slightly shorter than F2; clava  $3.60\times$  as long as broad.

Mesosoma (Fig. 8C)  $1.34\times$  as long as broad; pronotum narrow and visible in dorsal view; mesoscutum subequal in length to scutellum; notauli incomplete, furrows appear faint posteriorly; middle lobe of mesoscutum with 1 pair of setae; scutellum distinctly longer than broad with 1 pair of long setae; mesoscutum, scutellum and axillae with polygonal reticulate sculpture, more prominent on mesoscutum with relatively larger cells; metanotum with dorsellum smooth,  $4.50\times$  as broad as long; sides of metanotum with longitudinal striations; propodeum smooth medially, laterally with longitudinal reticulate sculpture. Fore wing (Fig. 7B)  $2.18\times$  as long as broad; marginal vein + parastigma  $2.32\times$  as long as submarginal vein,  $8\times$  as long as stigmal vein; postmarginal vein

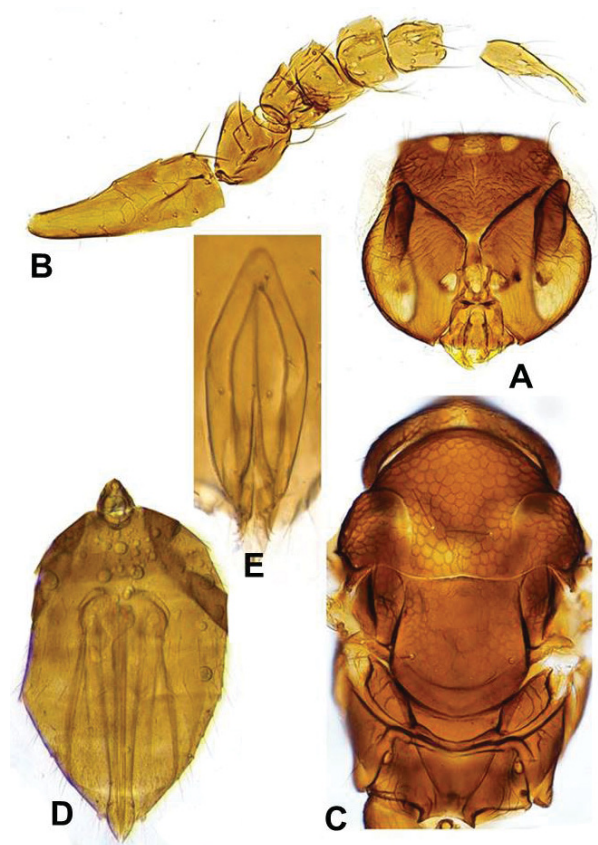


Fig. 8. *Closterocerus pakyongensis* sp. nov., A-D - female (holotype): A - head, frontal view; B - antenna; C - mesosoma; D - metasoma. E - male (paratype), genitalia.

$1.25\times$  as long as stigmal vein; longest marginal seta  $0.28\times$  maximum wing width. Hind wing (Fig. 7C)  $6.80\times$  as long as broad; longest marginal seta slightly longer than maximum wing width.

Metasoma (Fig. 8D). Petiole  $1.28\times$  as broad as long; gaster slightly longer than mesosoma; ovipositor occupying two-thirds of length of gaster, slightly exerted beyond apex of gaster; ovipositor  $1.65\times$  as long as hind tibia.

*Relative measurements* (holotype slide, at  $100\times$ ). Head height : width, 22 : 26; eye height, 18.50; malar space, 3. Antennal segments length: width—scape, 13.50 : 5.00; pedicel, 4.50 : 5.00; F1, 2.00 : 4.50; F2, 3 : 5; C1, 3.50 : 4.75; C2, 3.75 : 3.5; C3, 5.00 : 2.25; spicula, 3. Mesosoma length : width, 35 : 26. Fore wing length : width, 70 : 32; longest marginal seta, 9; submarginal vein length, 14; parastigma length, 3.50; marginal vein length, 29; postmarginal vein length, 5; stigmal vein length, 4. Hind wing length : width, 62 : 9; longest marginal seta, 9.50. Hind tibia length, 20. Metasoma. Petiole length : width, 3.50 : 4.50; gaster length, 38; ovipositor length, 33.

*Male*. Paratype (Fig. 7D). Similar to female except for antenna and sexual characters. Head in frontal view,  $1.29\times$  as broad as high; eye height  $4.25\times$  as long as malar space. Antenna with scape  $2.8\times$  as long as broad,  $2.5\times$  as long as pedicel; pedicel subquadrate; flagellum with single anellus; F1  $0.45\times$  as long as broad, shorter than F2; clava  $2.35\times$  as long as broad. Phallobase (Fig. 8E)  $0.45\times$  as long as hind tibia.



*Relative measurements* (slide, at 100 $\times$ ). Head height : width, 24 : 31; eye height, 17; malar space, 4. Antennal segments length : width – scape, 14 : 5; pedicel, 5.50 : 5.25; F1, 2.25 : 5.00; F2, 4 : 5; C1, 3.25 : 5.00; C2, 3.50 : 3.25; C3, 4.25 : 2.25. Fore wing length : width, 72 : 29; longest marginal seta, 9; submarginal vein length, 15; marginal vein length, 29; postmarginal vein length, 5; stigmal vein length, 5.50.

**Differential diagnosis.** *Closterocerus pakyongensis* sp. nov. looks similar to *C. scapiatus*, but differs from the latter in the following characters: clava 3.60 $\times$  as long as broad; postmarginal vein longer than stigmal vein; middle lobe of mesoscutum with 1 pair of setae. In *C. scapiatus*: clava 1.73 $\times$  as long as broad; postmarginal vein distinctly shorter than stigmal vein; middle lobe of mesoscutum with 3 pairs of setae.

**Etymology.** The species name is derived from the name of town locality Pakyong in Sikkim where the holotype was collected; adjective.

**Host.** Unknown.

**Distribution in India.** Sikkim.

***Closterocerus junubi* sp. nov.**

(Figs 9–10)

**Type material.** HOLOTYPE: ♀ (on slide under four coverslips, slide No. EUL.56), INDIA: ANDHRA PRADESH: Vishakhapatnam, Rajipeta, 3.ii.2014, Coll. M.T. Khan. (ZDAMU). PARATYPES: 4 ♀♀ (on slide under four coverslips, slide Nos. EUL.62, EUL.66, EUL.67, EUL.77) with same data as for holotype. (ZDAMU).

**Description. Female.** Holotype (Fig. 9A). Length, 0.75–0.96 mm (holotype, 0.95 mm). Head brown to dark brown except for metallic green vertex. Antenna brown to dark brown. Mesosoma with pronotum metallic blue; mesoscutum and scutellum metallic green, medially with bluish reflection; metanotum metallic blue. Fore wing subhyaline with two dark bands, and one infumate patch as in figure 9B. Legs with coxae, femora and tibiae dark brown except for fore tibia that are pale white with brownish suffusion; tarsi of all legs pale white except for brown last tarsal segments. Gaster brown to dark brown except for metallic blue T1.

Head (Fig. 10A), in frontal view, 1.23–1.40 $\times$  (holotype, 1.40 $\times$ ) as broad as high; eye height 3.00–3.75 $\times$  (holotype, 3 $\times$ ) as long as malar space; antennal toruli situated markedly above lower eye margin. Antenna (Fig. 10B) with scape in basal third narrow, apical two-thirds broad and flattened, 2.18–2.50 $\times$  (holotype, 2.25 $\times$ ) as long as broad, 2.58–3.10 $\times$  (holotype, 3.10 $\times$ ) as long as pedicel; scape shorter than flagellum; pedicel 1.20–1.30 $\times$  (holotype, 1.30 $\times$ ) as broad as long, longer than all flagellomeres individually; flagellum with one indistinct anellus; F1 0.46 $\times$  as long as broad, shorter than F2; clava 1.53–2.00 $\times$  (holotype, 1.74 $\times$ ) as long as broad; third claval segment conical.

Mesosoma (Fig. 10C) 1.27–1.48 $\times$  (holotype, 1.44 $\times$ ) as long as broad; pronotum reticulate, clearly visible in dorsal view; mesoscutum slightly longer than scutellum, with polygonal reticulate sculpture and, with smaller cells, becoming faint posteriorly; notauli almost complete but furrows appear faint and wide posteriorly; middle lobe of

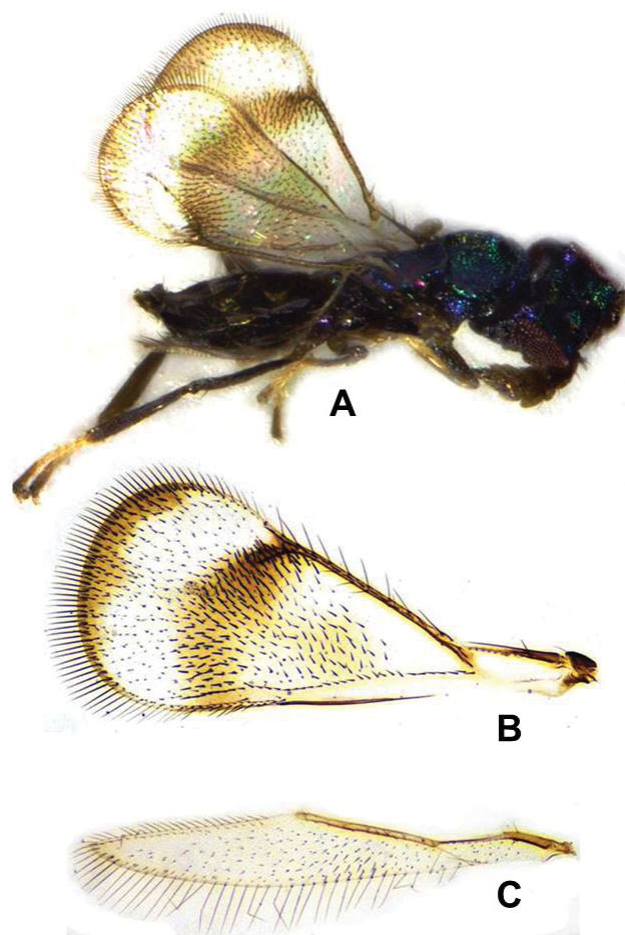


Fig. 9. *Closterocerus junubi* sp. nov. female (holotype): A – habitus; B – fore wing; C – hind wing.

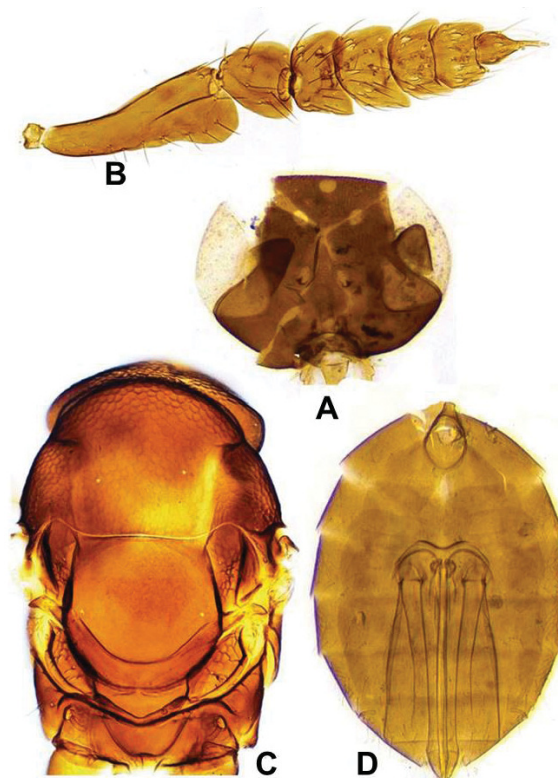


Fig. 10. *Closterocerus junubi* sp. nov. female (holotype): A – head, frontal view; B – antenna; C – mesosoma; D – metasoma.

mesoscutum with 2 setae; scutellum slightly longer than broad, almost smooth with 2 latero-medial setae; metanotum with dorsellum smooth, 3.16–3.80× (holotype, 3.16×) as broad as long; sides of metanotum with transverse striations; propodeum narrow, smooth and without any carina. Fore wing (Fig. 9B) 2.11–2.32× (holotype, 2.15×) as long as broad with closed speculum; setae on disc relatively shorter; marginal vein + parastigma 1.78–2.05× (holotype, 1.87×) as long as submarginal vein, 5.90–7.20× (holotype, 6.20×) as long as stigmal vein; postmarginal vein 0.80× stigmal vein; longest marginal seta 0.18–0.28× (holotype, 0.18×) maximum wing width. Hind wing (Fig. 9C) 6.20–7.00× (holotype, 6.30×) as long as broad; longest marginal seta 0.63–0.93× (holotype, 0.75×) maximum wing width.

Metasoma (Fig. 10D). Petiole 2.42–3.14× (holotype, 2.42×) as broad as long; gaster longer than mesosoma; ovipositor occupying three-fourths of gaster length, slightly exerted beyond apex of gaster; ovipositor 1.53–1.65× (holotype, 1.55×) as long as hind tibia.

*Relative measurements* (holotype slide, at 100×). Head height : width, 27 : 38; eye height, 19.50; malar space, 6.50. Antennal segments length : width – scape, 15.50 : 7.00; pedicel, 5.00 : 6.50; F1, 3.50 : 7.50; F2, 4.75 : 7.00; C1, 3.75 : 6.75; C2, 3.75 : 6.00; C3, 3.75 : 3.00; spicula, 2.50. Mesosoma length : width, 42 : 28. Fore wing length : width, 71 : 3; longest marginal seta, 6; submarginal vein length, 16.50; parastigma length, 5; marginal vein length, 26; postmarginal vein length, 4; stigmal vein length, 5. Hind tibia length, 22.50. Metasoma. Petiole length : width, 2.00 : 4.25; gaster length, 43; ovipositor length, 35.

**Male.** Unknown.

**Differential diagnosis.** *Closterocerus junubi* sp. nov. comes close to *C. phytomyzae*, but it differs from the latter in the following characters: antennal toruli situated markedly above lower eye margin; scape relatively short, longer than proximal 3 flagellomeres combined; fore wing with speculum closed. In *C. phytomyzae*: antennal toruli are situated at level of lower eye margin; scape long, subequal to flagellum; fore wing with speculum open (MANI 1971: fig. 12).

The new species differs from the Chinese species *C. separatus* Li & Li, 2021, in the following characters: antenna with terminal spine or apical spicula distinctly shorter than flagellar segment; middle lobe of mesoscutum with one pair of setae; scutellum almost smooth, while in *C. separatus* antenna has terminal spine or apical spicula as long as flagellar segment; middle lobe of mesoscutum with three pairs of setae; scutellum with reticulate sculpture.

**Etymology.** Species name is an arbitrary combination of letters and it should be treated as a noun in apposition.

**Host.** Unknown.

**Distribution.** India: Andhra Pradesh.

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