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Revision of the Indian species of the genus *Xenostryxis* Girault (Hymenoptera: Encyrtidae)

Farha Fatima and Shahid Bin Zeya

Abstract

The Indian species of the genus *Xenostryxis* Girault (Hymenoptera: Encyrtidae) are revised. One new species, *X. noyesi* Fatima & Zeya, sp. nov., is described. A key to the Indian species of this genus is also given.

Keywords: Encyrtinae, habrolepidini, *xenostryxis*, Indian species

Introduction

Scale insects are major agricultural pests and pose serious problems when introduced into new areas of the world without natural enemies^[1]. The species belonging to the genus *Xenostryxis* Girault are known to parasitize diaspidid scale insects (Hemiptera: Coccidoidea: Diaspididae). Until 2017, 9 species were known from the world^[12] which includes 3 Indian species namely *X. tenuicauda* Hayat (2003), *X. brevicauda* Hayat (2003) and *X. bella* Hayat & Badruddin (2008). In the present paper we revise the Indian species of *Xenostryxis*, and describe one new species, *X. noyesi* Fatima & Zeya, sp. nov, and provide a key to the Indian species of this genus. However, a brief diagnosis is also given for the genus and known species.

Materials and Methods

The body colour was noted from card-mounted specimens prior to mounting the specimens on slides in Canada balsam. Only body length is given in millimeters; other measurements are relative taken from the divisions of an ocular micrometer placed in the eye piece of a compound microscope at 100× magnification (1 division=0.01 mm) for slide-mounted parts and placed in the eye piece of a Stereo zoom microscope at 10× zoom 6 magnification (1 division=0.0161mm) from card-mounted specimens.

The photographs of card-mounted specimens were taken with a digital camera (Nikon DS-Fi2) attached to a stereo zoom microscope (Nikon SMZ25) and photographs of slide-mounted body parts were taken with a digital camera (Nikon DS-Fi 1c) attached to a compound microscope (Nikon Eclipse Ci).

The following abbreviations are used in the text:

F1, F2, etc. = Funicle segments 1, 2, etc.

(MT) = Malaise Trap. (This and two other abbreviations placed in brackets are used in the 'Material examined' sections to indicate the method of collection.)

(SN) = Sweep Net.

TI, TII, etc. = Gasteral tergites, 1, 2, etc.

(YPT) = Yellow Pan Trap.

The following acronyms are used for the depositories:

NBAIR = ICAR-National Bureau of Agricultural Insect Resources, Bengaluru, India.

NPC = National Pusa Collection, Division of Entomology, Indian Agricultural Research Institute, New Delhi, India.

ZDAMU = Insect Collections, Department of Zoology, Aligarh Muslim University, Aligarh, India.

Results and Discussions

Genus *Xenostryxis* Girault

(Figures 1–24)

Xenostryxis Girault, 1920: 41. Type species *Xenostryxis margiscutellum* Girault, by monotypy.

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Paraschedius Mercet, 1925: 328. Type species *Paraschedius ductor* Mercet, by original designation. Synonymy by Hayat, 2003: 203.

Diagnosis

Female. Head with frontovertex width 0.3–0.4× head width; head, in profile, subtriangular. Mandible with two teeth and a truncation, middle tooth may be rounded, a socketed peg-like structure present on ventral surface of mandible (Figs 1, 19). Maxillary palp 4-segmented, labial palp 3-segmented. Antennal formula, 1163; funicle segments slightly longer than broad to more than 2× as long as broad; clava shorter than funicle (Figs 2,7). Mesosoma with visible part of pronotum short; mesoscutum with notaular lines absent; scutellum with setae usually arranged in bilateral symmetry, and when 3 or 4 pairs of setae are present, posterior two pairs are dark and long. Fore wing with linea calva closed posteriorly by a line of setae; marginal vein at least 2× as long as broad, longer or shorter than stigmal vein; postmarginal vein either absent, or shorter than to slightly longer than stigmal vein; stigma with 3 circular sensilla (Fig.3). Gaster slightly to distinctly longer than mesosoma, apically either narrowly rounded or pointed; hypopygium extending to or nearly to apex of gaster; ovipositor exerted part variable, from about one-fifth to as long as gaster length.

Body largely yellow, with minimum of dark markings, but sides of scutellum with dark brown to black streaks. Fore wing hyaline to strongly infuscate in distal three-fourths, with a transverse hyaline band or two suboval hyaline spots distal to venation.

Male. Differs from female in antennal structure and genitalia. Antennal formula, 1161 (Fig.18). Body, in contrast to the female, liberally marked with brown to dark brown.

Hosts. Parasitoids of diaspidid scale insects (Hemiptera: Coccidoidea: Diaspididae)

Distribution. Afrotropical, Australian, Oriental and Palaearctic regions.

Species. World, 10; India, 4 (Including one new species described in this paper.)

Comments. *Xenostryxis* differs from the other genera of the Habrolepidini mainly in having a largely yellow body, and the hypopygium extending to or nearly to the apex of gaster. The publications by Noyes & Hayat (1984), Prinsloo (1986) and Trjapitzin (1989) made substantial contribution to the taxonomy of the genus *Xenostryxis*.

Key to Indian species of *Xenostryxis* (females)

Note. Additional, non-contrasting, characters are given in brackets.

1. Gaster apically pointed, and ovipositor sheaths thin, exerted part at least about two-thirds length of gaster (Figs 4, 11); ovipositor more than 2× as long as mid tibia; head with face between lower margins of toruli and mouth margin dark brown (Fig. 1,6); basal triangle of fore wing largely bare (Fig. 3); fore wing largely hyaline or subhyaline, at most with a very pale infuscate streak below distal part of submarginal vein 2

-. Gaster apically narrowly rounded, and ovipositor sheaths exerted at most to one-fifth of gaster length (Fig.15); ovipositor at most about 1.4× as long as mid tibia; face between lower margins of toruli and mouth margin of same colour as rest of face; basal triangle of fore wing with a small bare area; fore wing strongly infuscated, either with a transverse hyaline band distal to venation or two suboval hyaline spots (Figs 14, 21) 3

2. Exerted part of ovipositor at least about as long as gaster

(Fig. 4); second valvifer 0.78× third valvula length; antenna with funicle segments all longer than broad, 1.5× to nearly 2× as long as broad, and F1–F3 each shorter than F4; clava as long as distal half of F3 and F4–F6 combined (Fig. 2); width of frontovertex about one-third head width 1. *X. noyesi* sp. nov.

-. Exerted part of ovipositor 0.65–0.76× gaster length (Fig. 11); second valvifer 1.20–1.35× as long as third valvula; antenna with F1 and F2 quadrate, F3–F5 each slightly longer than broad, F6 quadrate; F1 and F2 each shorter than F3; clava as long as F2–F6 combined (Fig. 7) width of frontovertex about 0.4× head width..... 2. *X. tenuicauda* Hayat

3. Fore wing strongly infuscate, with basal fourth hyaline, the infuscation becoming faint in about apical half, but with setae dark brown, and with two suboval hyaline spots adjacent to stigmal vein, one larger spot and one smaller spot (Fig. 14); ovipositor 1.08–1.18× as long as mid tibia; second valvifer 1.95–2.23× as long as third valvula 3. *X. brevicauda* Hayat

-. Fore wing strongly infuscate with basal fourth hyaline, the infuscation becoming faint apically, and with a transverse, broad, hyaline band adjacent to stigmal vein, the hyaline band medially narrowed by a convex extension of the proximal margin of the distal infuscation (Fig. 21); ovipositor 1.15–1.43× as long as mid tibia; second valvifer 2.07–2.52× as long as third valvula; 5. *X. bella* Hayat & Badruddin

1. *Xenostryxis noyesi* Fatima & Zeya, sp. nov. (Figures 1–5) Description

Female. Holotype. Length (excluding exerted part of ovipositor), 1.48 mm (0.85 mm). Head yellow, except a dark brown rectangular patch between toruli and mouth margin. Mandible apically reddish brown. Palps white. Antenna yellow, except clava brown. Mesosoma yellow, with pronotum laterally and scutellum on sides, dark brown; propodeum distal to spiracles brownish; mesopleuron yellow. Fore wing subhyaline, with an infuscate streak below submarginal vein (Fig.3). Hind wing hyaline. Legs, including coxae, yellowish, except mid and hind tibia each with a sub-basal dark brown patch. Gaster yellowish brown; ovipositor sheaths dark brown.

Head, in frontal view, 1.13× as broad as high; frontovertex width 0.32× head width; ocellar triangle with apical angle a right angle; posterior ocellus separated from eye margin by one-third diameter of ocellus; eye 1.31× as high as malar space; frontovertex with fine, polygonal reticulate sculpture; on face cells slightly elongate; malar space with fine, elongate reticulate to lineolate sculpture; setae white; eye setose, setae hyaline, and each seta shorter than a facet diameter. Mandible as in Fig. 1. Antenna (Fig. 2) with scape 4× as long as broad; pedicel 1.5× as long as F1; F1, 1.6×, F2, 1.8×, F3–F5 each, 2×, as long as broad; F6, 1.37×, as long as broad, and slightly shorter than F5; clava 3.5× as long as broad. *Relative measurements* (slide): head frontal width, 43; head frontal height, 38; frontovertex width, 14. Antennal segments, length (width): scape, 18 (4.5); pedicel, 6 (3.5); F1, 4 (2.5); F2, 4.5 (2.5); F3, 5 (2.5); F4, 6 (3); F5, 6 (3); F6, 5.5 (4); clava, 21 (6).

Mesosoma (Fig.4). Pronotum about 0.25× mesoscutum length; scutellum 0.75× mesoscutum length; mesoscutum with fine, polygonal reticulate sculpture; axilla with transversely elongate reticulations; scutellum (Fig.5) in a triangular area with slightly raised, slightly elongate polygonal reticulate sculpture, sides and posterior third

smooth; setae on thorax white; scutellum with 4 + 4 setae, posterior two pairs long [setae detached while the specimen was mounted on slide]; propodeum distal to spiracle with a single, silvery white, seta. Fore wing 2.64× as long as broad; venation and setation as in Fig 3. Mid tibia 3.14× as long as mid basitarsus; mid tibial spur sub-equal in length to mid basitarsus. *Relative measurements* (slide): fore wing length (width), 135 (51); mid tibia length, 55; mid basitarsus length, 17.5; mid tibial spur length, 17.

Metasoma (Fig. 4), on card, 1.25× as long as mesosoma; exerted part of ovipositor slightly longer than gaster length; second valvifer 0.78× third valvula length. *Relative measurements* (slide): ovipositor length, 170; third valvula length, 95; exerted part of ovipositor, 89. [Ovipositor 3× as long as mid tibia; third valvula 5.42× as long as mid basitarsus.]

Male. Unknown.

Material examined. Holotype, female (on slide under 4 coverslips, slide No. EH.2154), labelled "INDIA: ANDHRA PRAD.[ESH]: Vishakhapatnam, Araku Valley, 3.ii.2014, Coll. SK Ahmad" (ZDAMU, registration No. HYM.CH.770).

Host. Unknown.

Distribution. India: Andhra Pradesh.

Comments. This new species differs from *Xenostryxis tenuicauda* on the characters given in the key.

Etymology. This species is named in honour of Dr. J.S. Noyes, Natural History Museum, London, for his outstanding contributions to the world Encyrtidae.

2. *Xenostryxis tenuicauda* Hayat (Figures 6–11)

Xenostryxis tenuicauda Hayat, 2003: 235–236, female. Holotype, female, India, Kerala, Calicut University Campus (NPC)
Xenostryxis tenuicauda Hayat, 2006: 110, 111, key, figures, catalogue. Hayat *et al.*, 2015: 60, female, Kerala record.

Diagnosis

Female. Length, 0.96–1.16 mm. Body largely yellow; head with space between lower margins of toruli to mouth margin dark brown (Fig. 6). Antenna (Fig. 7) with scape yellow, apically slightly infusate; pedicel yellowish brown, with dorsal surface in basal two-thirds dark brown; funicle yellow; clava brown. Mesosoma with pronotum and anterior margin of mesoscutum brown; sides of scutellum with longitudinal black streaks; tegula largely dark brown; propodeum distal to spiracles brown to dark brown. Fore wing hyaline, with hardly discernible pale infuscation below venation (Fig. 8). Legs pale yellow; mid tibia with a distinct sub-basal black patch; hind tibia with a similar patch, and a faint infusate patch in distal third; hind coxa yellowish brown; tarsi yellowish brown. Gaster brownish yellow, with sides of TI and TII dark brown; exerted part of ovipositor sheaths brown to dark brown.

Head with frontovertex width 0.4× head width; frontovertex with fine reticulate sculpture, the cells transversely elongate; malar space with fine lineolate reticulate sculpture. Antenna as in Fig.7. Mesoscutum with fine, wide-meshed reticulations; scutellum with sculpture deeper than on mesoscutum, and with elongate to lineolate reticulate on sides; mesoscutum with about 34 setae; scutellum with 6 (3 + 3) long setae (Fig.10). Fore wing (Fig.8) 2.9× as long as broad; linea calva closed posteriorly by a line of setae; basal triangle largely

bare; marginal vein longer than stigmal vein; postmarginal vein about half the length of stigmal vein (Fig.8). Gaster 1.18× as long as mesosoma, but on slide, 1.46× as long as mesosoma; ovipositor originating from near base of gaster, and exerted part 0.65–0.76× (holotype, 0.65×) gaster length; second valvifer 1.20–1.35× (holotype, 1.35×) as long as third valvula. [Ovipositor 2.20–2.29× (holotype, 2.22×) as long as mid tibia.]

Male. Unknown.

Material examined (ZDAMU collections). INDIA: KERALA: Ernakulam, Kozhencherry, 12.i.2012, Coll. F.R. Khan (1 female, on card). Determined by M. Hayat, 2012.

Additional material examined. INDIA: KARNATAKA: Bengaluru, Jarakabande Kaval, 7.vi.2014 (MT), Coll. K. Veenakumari (1 female, on slide, No.EH.2155). SIKKIM: Ranka, 1.xi.2014 (SN), Coll. K. Veenakumari (1 female, on slide, No. EH.2156) (1 female in NBAIR; 1 female in ZDAMU).

Hosts. Unknown.

Distribution. India: Karnataka (**new record**), Kerala, Sikkim (**new record**).

Comments. The above diagnostic characters are based up on the description and figures given by Hayat (2003), and on the specimens examined by the authors. As noted by Hayat (2003), this species is very similar to the type species, *X. margiscutellum* Girault, but differs as follows: antenna with pedicel slightly longer than F1 and F2 combined; funicle segments short, distinctly broadened distally, so that F6 is nearly 2× as broad as F1; clava distinctly broader than F6 and as long as F2–F6 combined; scutellum with 6 long setae; fore wing 2.9× as long as broad. In *X. margiscutellum*: pedicel shorter than F1 and F2 combined; funicle segments, except quadrate F1, longer than broad, subequal in length and width; clava at most one-fourth as broad as F6, and not longer than F3–F6 combined; scutellum with 8 setae; fore wing 2.75–2.81× as long as broad. Based on the redescription given by Prinsloo (1986) and by Dahms & Gordh (1997).

3. *Xenostryxis brevicauda* Hayat (Figures 12–18)

Xenostryxis brevicauda Hayat, 2003: 236–238, female, male. Holotype, female, India, Kerala, Trichur, Peechi (NPC). [Non-type female from Chebrolu near Guntur, Andhra Pradesh.]

Xenostryxis brevicauda Hayat, 2006: 111, key, figures, catalogue. Manickavasagam & Rameshkumar, 2011: 117, female, Tamil Nadu record. Hayat & Veenakumari, 2014: 20, female, Karnataka record.

Diagnosis

Female. Length, 0.78 mm. Body colour similar to *X. tenuicauda*, except as follows: head entirely yellow, including face between toruli and mouth margin. Antenna with scape and pedicel yellow; funicle pale brownish yellow; clava brownish yellow to yellowish brown. Mesosoma with scutellum on sides and in about posterior half pale infusate brown; tegula brown. Fore wing infuscation as in Fig. 14; note the two sub-oval hyaline areas adjacent to venation completely interrupted by brown setae and some infuscation in the holotype, but in one specimen from Karnataka, the two hyaline areas are only partly interrupted by a few brown setae. Leg colour similar to *X. tenuicauda*; mid tibia with a sub-

basal dark brown ring; hind tibia with a similar dark brown ring, and a faint spot in apical third. Gaster with brown spots on each side at base of TI, sides of TV adjacent to cercal plates with a dark brown spot, otherwise TV and TVI very faintly infusate brown.

Head (Fig.12) with frontovertex width 0.41–0.44× head width. Antenna (Fig. 13) with F1–F6 each longer than broad, either all segments subequal in length (in Karnataka specimen) or F1 and F2 each slightly shorter than F3; clava slightly longer than F4–F6 combined. Mesosoma (Fig.15) with sculpture on scutellum slightly deeper than on mesoscutum; mesoscutum (Fig.16) with about 60 setae; scutellum (Fig.17) with 12–24 (holotype, 18, and 4 additional, minute setae) setae. Fore wing (Fig.14) 2.6× as long as broad; linea calva closed posteriorly by one line of setae; basal triangle with a small bare area; postmarginal vein absent in holotype, but present and short in other specimens. Gaster (Fig.15), from slide, 1.16× as long as mesosoma; ovipositor with second valvifer 1.95–2.23× (holotype, 2.23×) as long as third valvula; ovipositor, on slide, exerted to one-fifth gaster length. [Ovipositor 1.08–1.18× (holotype, 1.18×) as long as mid tibia.]

Male. Length, 0.53–0.67 mm. Similar to female, but liberally marked with dark brown. Body orange yellow to yellow; vertex-occipital margin white; face between toruli and mouth margin pale brown; malar space pale yellow. Antenna (Fig. 18), except pale ventral third or so, and pedicel dark brown; flagellum brown with dark brown setae. Mesosoma brownish yellow, with pronotum, anterior third of mesoscutum; base, sides and apex of scutellum, metanotum, propodeum, mesopleuron and metasternum, dark brown to black, with violet shine; posterior half of scutellum, except the dark posterior margin, infusate yellowish brown; axilla largely orange; tegula in basal half white, in distal half brown; prepectus and anterior half of mesopleuron white. Wings hyaline. Legs pale yellow, except as follows: fore femur with a brown patch in apical half; fore tibia with a similar patch in basal half; mid femur with a black patch; mid tibia with a lightly infusate patch in about middle; hind femur pale brown except base and apex; hind tibia with two patches; fore and mid tarsi and last segment of hind tarsus dark brown.

Head with frontovertex width about 0.6× head width; antennal torulus situated above, separated from mouth margin by 3× torulus height. Antenna as in Fig.18. Fore wing 2.37× as long as broad.

Type material examined. Paratypes, 4 males (ZDAMU, HYM.CH.540) with data as given in the original description.

Material examined (ZDAMU Collections). INDIA: A.[NDHRA P.[RADESH]: Chebrolu [near Guntur], 12.ii.1993, S.B. Zeya & S.I. Kazmi (1 female, on slide No. EH.631). KARNATAKA: Bengaluru, Kengeri, 4.x.2012 (YPT), Coll. K. Veenakumari (1 female, on slide No. EH.1581).

Hosts. Unknown.

Distribution. India: Andhra Pradesh, Karnataka, Kerala, Tamil Nadu.

Comments. The above diagnosis is partly based up on the original description and partly on the specimens examined by the authors. This species differs from *X. bella* by the characters given in the key.

4. *Xenostryxis bella* Hayat & Badruddin (Figures 19–24)

Xenostryxis bella Hayat & Badruddin, in Hayat *et al.*, 2008: 110–111, female. Holotype, female, India, Punjab, Pathankot, Dodhpur Kulian (NPC)
Xenostryxis bella Hayat & Badruddin: Hayat & F.R. Khan, 2009: 80, female, West Bengal record. Hayat & Veenakumari, 2014: 19–20, female, Karnataka record.

Diagnosis

Female. Length, 0.58 – 0.79 mm; one specimen, 0.96 mm (holotype, 0.75 mm). Body almost entirely golden yellow, except as noted below: head with vertex and inter-torular area very pale brown. Antenna with scape golden yellow; pedicel and flagellum very light brownish yellow. Mesosoma with pronotal collar brown; scutellum on sides narrowly dark brown; tegula brown; propodeum on sides brown to dark brown; mesopleuron posteriorly brownish yellow; metapleuron dark brown. Fore wing with hyaline and infusate areas as in Fig.21; base proximal to infusate band and the transverse hyaline band distal to venation with hyaline setae. Legs golden yellow, except as follows: mid tibia with a pale brown sub-basal ring; hind tibia in basal third with a dark brown patch, and a very pale brown, easily overlooked, incomplete band in apical half. Gaster with tergites lightly infusate brown on sides; ovipositor sheaths golden yellow.

Head (Fig.19) with width of frontovertex 0.42–0.46× head width; frontovertex with fine reticulate sculpture; face on sides of toruli with sculpture of same depth as on frons, but cells longitudinally elongate; behind malar sulcus lineolate reticulate. Antenna (Fig. 20) with scape 5× as long as broad; funicle segments all longer than broad, subequal in length, with F6 only slightly longer than F1; clava slightly longer than F4–F6 combined. Mesosoma with raised reticulate sculpture on pronotum, the cells transversely elongate and deeper than on mesoscutum; mesoscutum with very fine (visible at higher magnifications) polygonal wide-meshed reticulate sculpture, that on scutellum same, but cells in posterior half longitudinally elongate; scutellum with 12–20 (holotype, 18) setae. Fore wing (Fig. 21) 2.8× as long as broad; linea calva closed posteriorly by a single line of setae; basal triangle with a small bare area; marginal vein longer than short stigmal vein; postmarginal vein shorter (Fig.21) to slightly longer than stigmal vein (Hayat *et al.*, 2008:fig.8). Gaster, on card, very slightly (1.12×) longer than mesosoma, but on slide, 1.3× as long as mesosoma; exerted part of ovipositor, on card, 0.29× gaster length, but on slide, 0.17× gaster length; second valvifer 2.07–2.52× (holotype, 2.07×) as long as third valvula. [Ovipositor 1.15–1.43× (holotype, 1.37×) as long as mid tibia; third valvula 1.16–1.5× (holotype, 1.44×) as long as mid basitarsus.]

Male. Unknown.

Material examined (ZDAMU Collections). INDIA: W[EST] B[ENGAL]: Islampur, Sibdargi Para, 10.v.2008, Coll.: F.R. Khan (1 female, on slide No. EH.1205). Determined by M. Hayat, 2008.

Additional material examined. INDIA: ANDHRA PRADESH: Vizag [=Vishakhapatnam], Vadu Park, 20.iv.1991, Coll. Sudhir Singh (1 female, on slide No. EH.2038). UT.[TAR] PRAD.[ESH]: Etah, Jalesar, 9.iii.2013, Coll. S.K. Ahmad (1 female, on slide No. EH.2152) (ZDAMU).

INDIA: KARNATAKA: Doddaballapur, Gattisubbramanaya, 31.i.2014 (YPT), Coll. K. Veenakumari (1 female, on slide No. EH2153); Hessaraghatta, Fisheries Div.[ision],

28.iii.2014 (YPT), Coll. K. Veenakumari (1 female, on slide No. EH.2157) (1 female in ZDAMU; 1 female in NBAIR).

Hosts. Unknown.

Distribution. India: Andhra Pradesh (new record), Karnataka, Punjab, Uttar Pradesh (new record), West Bengal.

Comments. The diagnosis given above is partly based on the original description given by Hayat & Badruddin [5] and partly from the specimens studied by the authors. This species differs from *X. brevicauda* by the characters given in the key.

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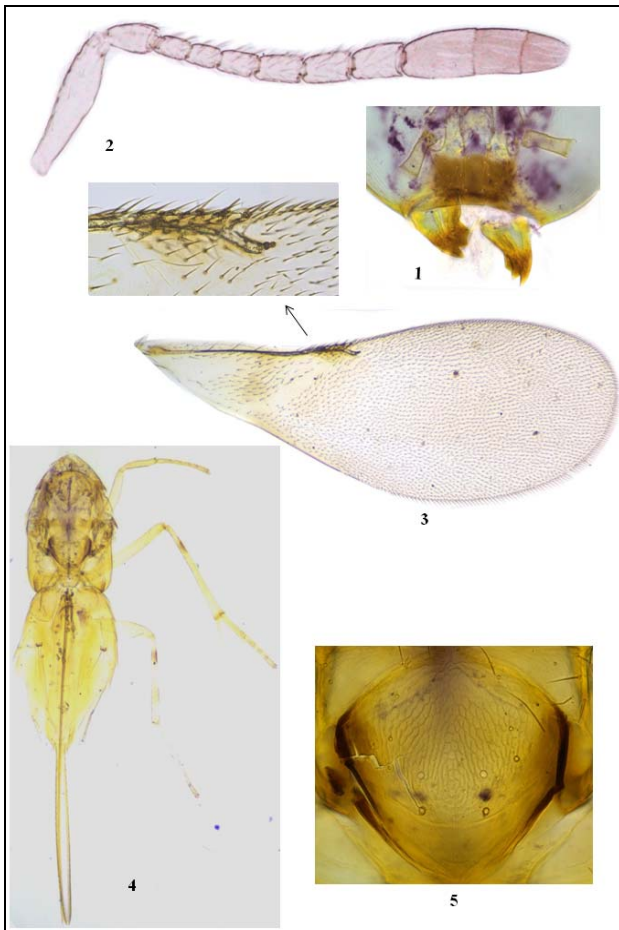


Fig 1-5: *Xenostryxis noyesi* sp. nov., holotype female: 1, lower part of head showing mandibles; 2, antenna; 3, fore wing; 4, mesosoma and metasoma; 5, Scutellum enlarged.

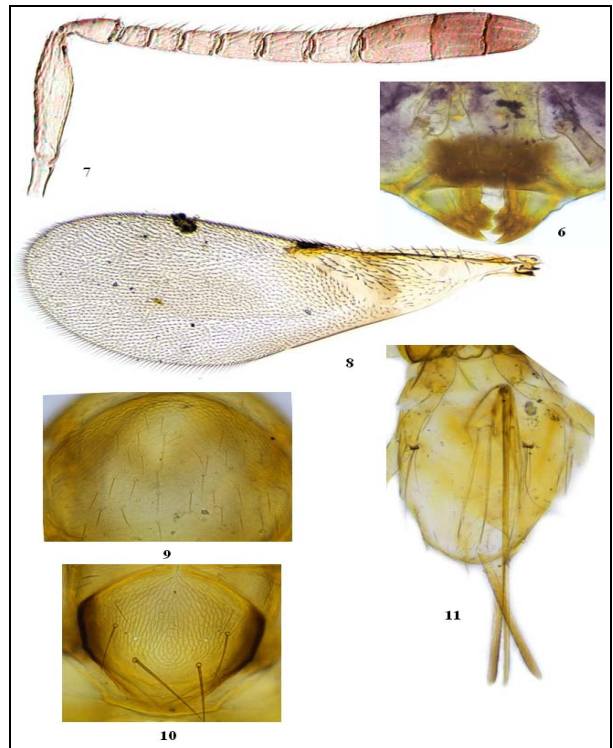


Fig 6-11: *Xenostryxis tenuicauda* Hayat female: 6, lower part of head showing mandibles; 7, antenna; 8, fore wing; 9, mesosoma enlarged; 10, scutellum enlarged; 11, metasoma showing ovipositor.

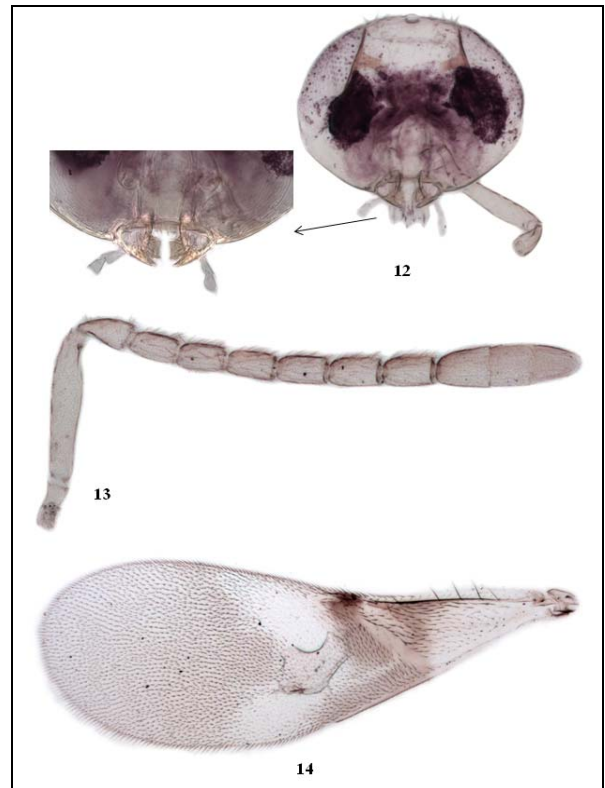


Fig 12-14: *Xenostryxis brevicauda* Hayat, female: 12, head front view; 13, antenna; 14, fore wing.

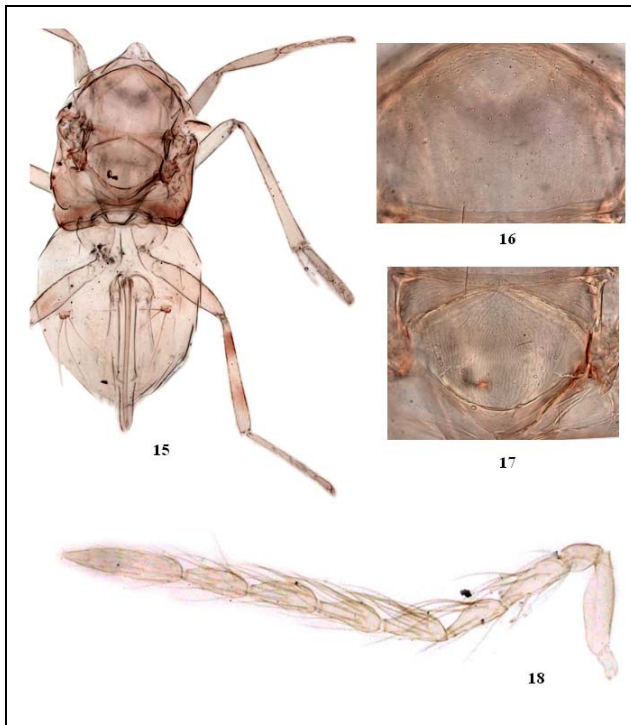


Fig 15-18: *Xenostyxis brevicauda* Hayat, female: 15, mesosoma and metasoma; 16, mesoscutum, enlarged; 17, scutellum enlarged; 18, male antenna.

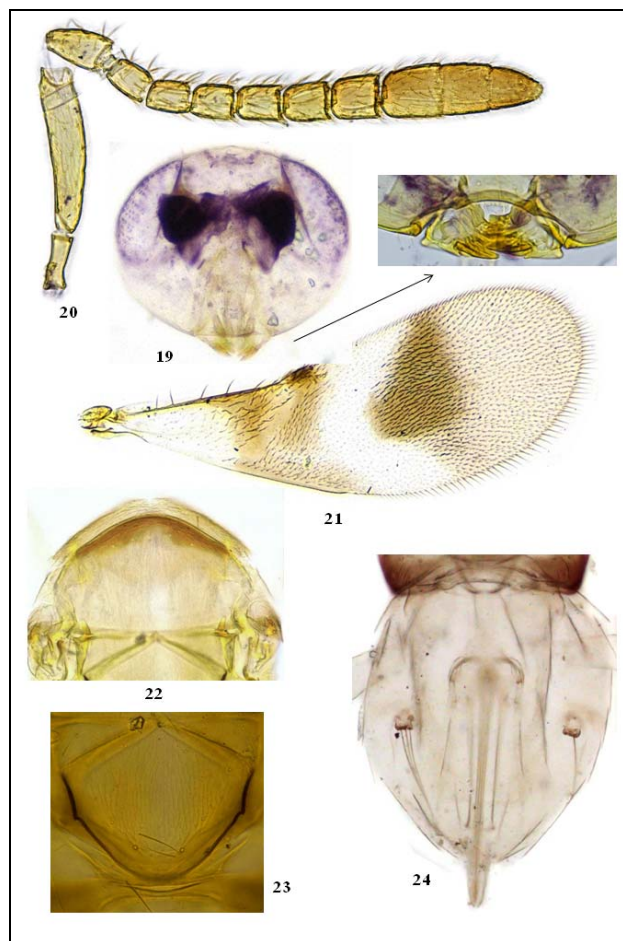


Fig 19-24: *Xenostyxis bella* Hayat & Badruddin, female: 19, head front view; 20, antenna; 21, fore wing; 22, mesoscutum, enlarged; 23, scutellum, enlarged; 24, metasoma.

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