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Research article

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Parasitoids of the genus *Pholetesor* Mason, 1981 (Hymenoptera: Braconidae: Microgastrinae) from the leafminers Lepidoptera, with the description of three new species from India

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Abstract. *Pholetesor acrocercophagus* sp. nov., *P. camerariae* sp. nov. and *P. indicus* sp. nov. (Hymenoptera: Braconidae: Microgastrinae) are described as new to science. These three species were reared from *Acrocercops* sp., *Acrocercops phaeospora* Meyrick, 1916 and *Cameraria virgulata* Meyrick, 1914 (Lepidoptera: Gracillariidae), respectively. Characteristics of these new species and their affinities with related taxa are discussed. Data on habitat, host records and host plant species for all the parasitoid species is provided. A key to the Indian species of the genus *Pholetesor* Mason, 1981 reared from lepidopteran leafminers is also given.

Keywords. Hymenoptera, Braconidae, Microgastrinae, *Pholetesor*, parasitoids, Lepidoptera, leafminer, new species, India.

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Introduction

Leaf-mining insects are considered serious pests which damage plant leaves in a variety of ways. If leaves are seriously attacked, crop can be reduced or seedling plants may be totally destroyed (Spencer 1990). The majority of the leaf-mining larvae belong to the Lepidoptera Linnaeus, 1758, followed to a lesser degree by Diptera Linnaeus, 1758, Coleoptera Linnaeus, 1758 and Hymenoptera Linnaeus, 1758 (Csoka 2003). Among the lepidopteran leafminers, the family Gracillariidae Stainton, 1854 includes small-sized moths with white marks on the wings. Several species are considered serious pests in several parts of the world (Davis 1987). Parasitoid insects play the most important role as natural enemies of leafminers, because in some cases, they can cause more than 90% mortality and consequently have great potential in biological pest control programs (Hawkins *et al.* 1993). Parasitoids of leafminers are exclusively from the order Hymenoptera, with superfamilies Chalcidoidea Latreille, 1817, Ichneumonidae Latreille, 1802 and Braconidae Burmeister, 1829 being the most important groups associated with leafminers.

Mason (1981) erected the genus *Pholetesor* Mason, 1981 to accommodate Nixon's (1965) 'circumscriptus-group' and 'bucculatricis-group' of species of Microgastrinae Förster, 1862. This genus has 57 species recorded from the world, but only one species, *P. hayati* Akhtar & Ahmad, 2010, has been reported from India (Akhtar *et al.* 2010; Yu *et al.* 2016; Fernandez-Triana *et al.* 2020). Known hosts of various species of *Pholetesor* are almost exclusively leaf-mining Lepidoptera (Whitfield 2006). *Pholetesor* is characterized by the following characters: 1) short and hairy and relatively dorsally attached ovipositor sheaths; 2) strong sub-lateral setiferous lobes of the metanotum; 3) propodeal areola (when present) strongly pentagonal rather than oval or diamond-shaped (Whitfield 2006); 4) hypopygium medially folded but evenly sclerotized or only weakly translucent medially; 5) 2r-m of fore wing absent.

As far as India is concerned, there is a lack of information on braconid parasitoids, especially reared from leaf-mining lepidopteran hosts. There were only four microgastrine parasitoid wasps described from India (Wilkinson 1928; Ahmad *et al.* 2019). In the present, work three new parasitoid species, viz, *Pholetesor acrocercophagus* sp. nov., *P. camerariae* sp. nov. and *P. indicus* sp. nov. reared from *Acrocercops* sp., *Acrocercops phaeospora* Meyrick, 1916 and *Cameraria virgulata* Meyrick, 1914 (Lepidoptera: Gracillariidae), respectively, are described and illustrated, and their affinities with related taxa are discussed. A key to the Indian species of the genus *Pholetesor* reared from lepidopteran leafminers is provided. This work was initially started in 2004 by first author ZA during his post-doctoral project on rearing braconid parasitoids from India. A part of this work is included in the PhD thesis of the third author KP (Pandey 2006).

Material and methods

This study was conducted in the vicinity of western Uttar Pradesh (North India) in order to identify the parasitoids of leafminers along the roadside at AMU university campus. The parasitoids were reared from *Acrocercops* sp., *A. phaeospora* and *C. virgulata* on the tree leaves of *Achyranthes aspera* L., *Millettia pinnata* (L.) Panigrahi and *Syzygium cumini* (L.) Skeels, respectively, in the laboratory in glass jars. A complete data set such as the date of collection, locality and name of host plant was maintained. The emerged parasitoids were initially preserved in 75% alcohol with a few drops of glycerol. These specimens were later mounted on cards. The reared parasitoids were separated based on morphological characters. The *Pholetesor* species keys of Nixon (1973), Papp (1983) and Liu *et al.* (2016) were used for the identification. Van Achterberg (1993) is followed for the terminologies of various body parts and wing venation and Eady (1968) for the terminology of micro-sculpture. The types of new species were deposited in the Insect Collection of the Department of Zoology, Aligarh Muslim University, Aligarh, India (ZDAMU).

Abbreviations for morphological terms used in the text

AOL = anterior ocellar line (distance between the inner edges of an anterior ocellus and lateral ocellus)
POL = posterior ocellar line (distance between the inner edges of lateral ocelli)
OOL = ocello-ocular line (distance from the outer edge of a lateral ocellus to the compound eye)
OD = ocellus diameter
F = flagellomere
T = metasomal tergite

Institutional abbreviations

ZDAMU = Department of Zoology, Aligarh Muslim University, Aligarh, India

Results

Taxonomic treatments

Class Insecta Linnaeus, 1758
Order Hymenoptera Linnaeus, 1758
Suborder Apocrita Latreille, 1810
Superfamily Ichneumonoidea Latreille, 1802
Family Braconidae Nees, 1811
Subfamily Microgastrinae Förster 1862
Genus *Pholetesor* Mason, 1981

Pholetesor acrocercophagus sp. nov.

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Fig. 1

Diagnosis

Pholetesor acrocercophagus sp. nov. is closely related to *P. circumscriptus* (Ness, 1834) in the European keys to the species of the ‘*circumscriptus*-group’ (Nixon 1973; Papp 1983) on the basis of the following characters: thorax in profile less elongate; metanotum strongly retracted from scutellum anteriorly, exposing mesothoracic postphragma; pterostigma almost $3.0\times$ as wide as long; vein 1-R1 (metacarp) clearly longer than pterostigma, r and 2-SR slightly curved, meeting less angularly; propodeum largely smooth; hind femur yellowish; T1 largely smooth, polished and strongly narrowed apically; T2 + 3 smooth and polished. However, it differs from *P. circumscriptus* in the following characters: T2 subtriangular $2.0\times$ as wide as long posteriorly, hence more transverse (T2 strongly triangular $2.6\times$ as wide as long posteriorly in *P. circumscriptus*); scutellar sulcus narrow with fine foveation (scutellar sulcus narrow with fine groove in which there is no obvious foveation in *P. circumscriptus*); forewing vein r arising medially of the pterostigma (forewing vein r arising distally of the pterostigma in *P. circumscriptus*); F2 $2.5\times$ as long as wide (F2 $3.6\times$ as long as wide in *P. circumscriptus*); body comparatively small, about 1.5 mm (body larger, about 1.80–2.00 mm in *P. circumscriptus*).

Etymology

The new species is named after its host insect.

Material examined

Holotype

INDIA • ♀; Uttar Pradesh, Aligarh; 27°54'53.3" N, 78°04'23.5" E; 11 Jul. 2005; Z. Ahmad leg.; ex. *Acrocercops* sp. on *Achyranthes aspera* L.; ZDAMU.

Paratype

INDIA • 1 ♀; same collection data as for holotype; ZDAMU.

Description

Female

MEASUREMENTS. Body length= 1.5 mm; Length of fore wing= 1.6 mm; Length of antenna= 1.5 mm.

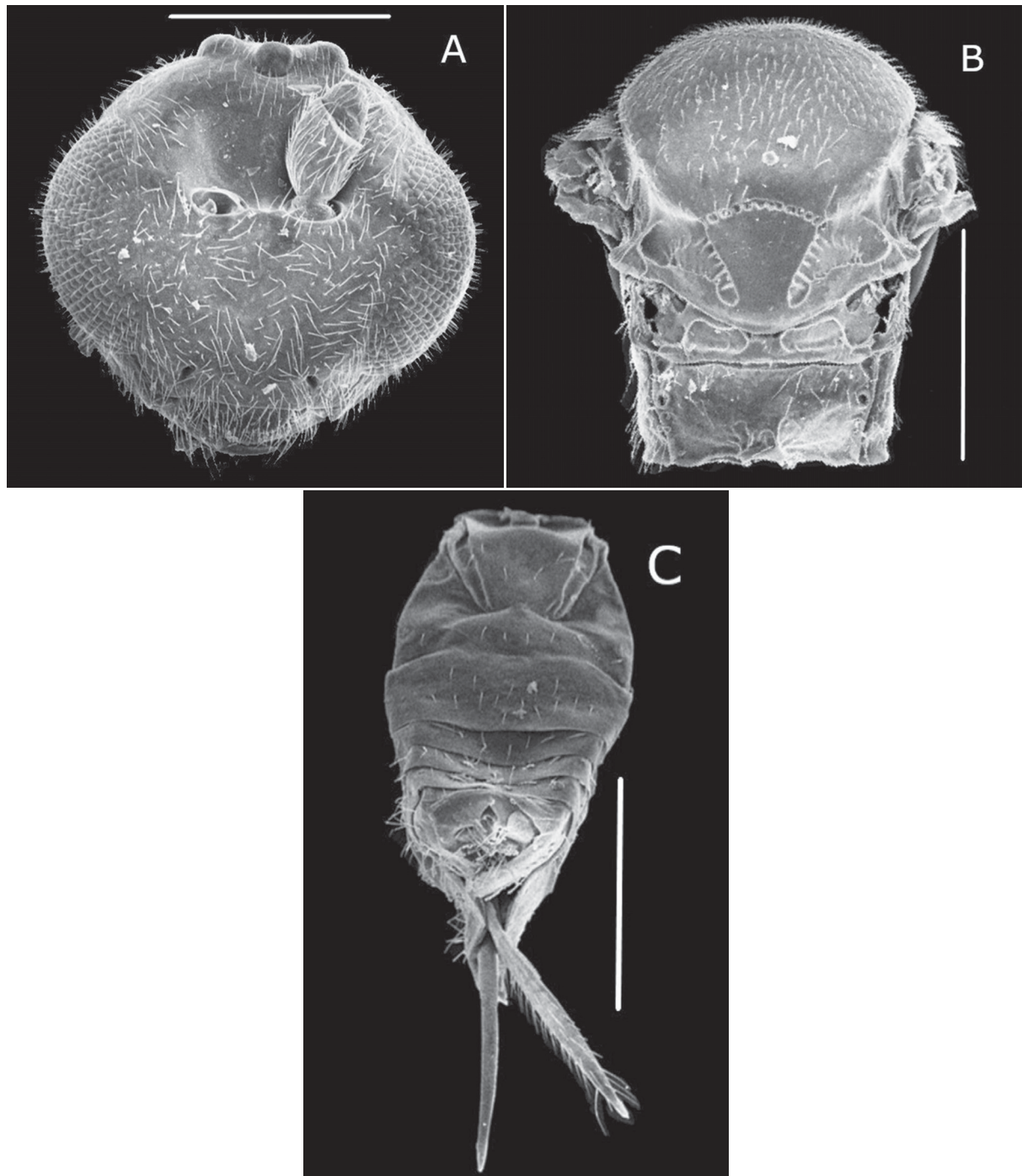


Fig. 1. *Pholetesor acrocercophagus* sp. nov., paratype, ♀ (ZDAMU). **A.** Head, frontal view. **B.** Mesosoma. **C.** Metasoma. Scale bars: 0.25 mm.

HEAD. Almost $2\times$ as wide as long; eyes $1.6\times$ as long as temple in dorsal view; temple and vertex smooth, shiny, punctate with hairs; eyes setose, $1.4\times$ as long as wide, OOL: POL: AOL: OD = 4: 3: 2: 2; frons concave, smooth and shiny, face medially convex, punctate with hairs; clypeus $3\times$ as wide as long, flattened, indistinctly punctate; malar space about as long as basal width of mandible; antennae about as long as body; scape $1.5\times$ as long as wide, pedicel slightly wider than long, F1 $3.0\times$ as long as wide, F2 $2.5\times$ as long as wide, flagellomeres gradually decreasing apically, apical flagellomere longer than F15 and pointed.

MESOSOMA. About as long as wide and $1.5\times$ its height; mesoscutum distinctly punctate with hairs, punctations becomes obscured posteriorly, scutellar sulcus narrow with fine foveation; scutellum smooth and shiny, side of scutellum smooth and shiny; propodeum about $2.0\times$ as wide as long at longest point, largely smooth; posteriorly with series of ridges extending obliquely on either side from nucha; propleuron smooth and shiny; mesopleuron antero-dorsally smooth and shiny, postero-laterally punctate with hairs.

LEGS. Hind coxa punctate with hairs; length of femur, tibia and basitarsus of hind leg 3.0, 5.0 and $4.2\times$ their width, respectively.

WINGS. Fore wing $2.6\times$ as long as wide, pterostigma almost $3.0\times$ as wide as long, 1-R1 $1.21\times$ as long as pterostigma, r and 2-SR slightly curved, meeting less angularly, r arising medially of pterostigma.

METASOMA. $2.4\times$ as long as wide; T1 about $3.0\times$ as long as its apical width, $1.8\times$ its basal width, strongly narrowed apically, smooth and shiny except few punctures; T2 $2.0\times$ as wide as long, subtriangular, smooth and shiny, shorter than T3; T3 rectangular, $1.40\times$ as long as T2, unsculptured; hypopygium weakly sclerotized, transparent, medially folded, blunt at apex, $2.0\times$ as long as hind basitarsus; ovipositor sheaths elongate-fusiform, thick and hairy throughout their length, arising about half of valvifer, $1.2\times$ as long as hind basitarsus; ovipositor pointed at apex and curved downwards.

COLOUR. Body black except for the following; hind femur, tibia and basitarsus infuscate; antennae, tegulae, latero-tergites dark brown; tip of hypopygium transparent; ovipositor reddish brown; tibial spurs, palpi creamish; fore leg except coxae, mid leg except coxae, hind tarsus except basitarsus and teleotarsus yellow.

Male

Unknown.

Distribution

India: Uttar Pradesh.

Host

Acrocercops sp.

Remarks

Pholetesor acrocercophagus sp. nov. can be distinguished from all previously described species by the unique combination of characters as follows: metanotum strongly retracted from scutellum anteriorly, exposing mesothoracic postphragma; propodeum about $2.0\times$ as wide as long at longest point, largely smooth; posteriorly with a series of ridges extending obliquely on either side from nucha; T1 about $3.0\times$ as long as its apical width, $1.8\times$ its basal width, strongly narrowed apically, smooth and shiny except few punctures; T2 $2.0\times$ as wide as long, subtriangular, smooth, shiny, shorter than T3; T3 rectangular, $1.40\times$ as long as T2, unsculptured; hypopygium weakly sclerotized, transparent, medially folded, blunt

at apex, $2.0\times$ as long as hind basitarsus; ovipositor sheaths elongate-fusiform, thick and hairy throughout their length, arising about half of valvifer; ovipositor pointed at apex and curved downwards.

Pholetesor camerariae sp. nov.

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Fig. 2

Diagnosis

Pholetesor camerariae sp. nov. is closely related with Indian species, viz, *P. hayati*. However, it differs from *P. hayati* in the following characters: hind coxae somewhat enlarged so that distal ends of hind coxae reach nearly to posterior end of T3 (hind coxae not reaching beyond T2 in *P. hayati*); ovipositor sheaths long, slender basally, then tapering broader to a bluntly bevelled tip, approximately as long as hind basitarsi, arising at mid length of valvifer (ovipositor sheath short, fusiform, $0.55\times$ as long as hind basitarsi, arising slightly below the mid length of valvifer in *P. hayati*); T2 smooth and shiny (T2 sculptured with a smooth raised median area *P. hayati*); T1 $1.4\times$ as long as wide posteriorly (T1 $1.1\times$ as long as wide posteriorly in *P. hayati*).

Pholetesor camerariae sp. nov. is also closely related with *P. salalicus* (Mason, 1959) in the key to the Chinese species of the genus *Pholetesor* (Liu *et al.* 2016). However, it differs from *P. salalicus* in the following characters: T2 smooth except few hairs, trapezoidal, $1.5\times$ as wide as long, (T2 rugose, subtriangular to trapezoidal, $1.7\text{--}2.0\times$ as wide as long in *P. salalicus*); posterior margin of T2 usually weakly concave (posterior margin of T2 straight in *P. salalicus*); propodeum about $2\times$ as wide as long, shallowly rugulose to rugose, smooth at antero-lateral corners (propodeum about $1.7\times$ as wide as long at longest point, punctate to weakly rugulose antero-laterally, smooth and depressed in postero-lateral corners).

Etymology

The new species is named after its host insect.

Material examined

Holotype

INDIA • ♀; Uttar Pradesh, Aligarh; $27^{\circ}54'26.4''$ N, $78^{\circ}04'13.9''$ E; 4 Dec. 2005; Z. Ahmad leg.; ex. *Cameraria virgulata* Meyrick, 1914 on *Millettia pinnata* (L.) Panigrahi; ZDAMU.

Paratypes

INDIA • 17 ♀♀, 3 ♂♂; same collection data as for holotype; ZDAMU.

Description

Female

MEASUREMENTS. Body length=1.8 mm; Length of forewing=2.0 mm; Length of antenna=2.0 mm.

HEAD. Almost $2\times$ as wide as long in dorsal view; eyes as long as $2.0\times$ as temple in dorsal view; OOL: POL: AOL: OD = 4: 3: 2: 2; temple smooth, shiny, punctate with hairs; vertex convex, smooth, shiny, indistinctly punctate with hairs; frons concave, smooth and shiny; face $1.3\times$ as wide as long, medially convex, punctate with hairs; clypeus convex, punctate with hairs; malar space about as long as basal width of mandible; antennae longer than body length, apical four flagellomeres without double rank of placodes, F1–F7 equal in length, F8–F15 gradually decreasing in length apically, apical flagellomere slightly longer than F15.

MESOSOMA. $1.3\times$ as long as wide dorsally and just above the tegulae as wide as head; scutum shallowly punctate with hairs, becoming nearly impunctate at extreme posterior edge; scutellar sulcus almost straight and foveolate to crenulated; scutellum smooth with fine, shallow punctures; metanotum weakly retracted from scutellum; sublateral setiferous lobes nearly appressed to hind margin of scutellum; transverse carinae poorly developed; propodeum about $2\times$ as wide as long, shallowly rugulose, smooth at antero-lateral corners, with pair of ridges extending obliquely on either side from nucha; propleuron smooth and shiny; mesopleuron mostly smooth except few hairs anteriorly; metapleuron smooth and shiny except edges.

WINGS. Fore wing $2.5\times$ as long as wide; 1-R1 about as long as pterostigma; r slightly longer than 2-SR; r and 2-SR meeting angularly. Hind wing with Cu-a declivous; venal lobe evenly convex and hairy; pterostigma almost $3\times$ as long as wide.

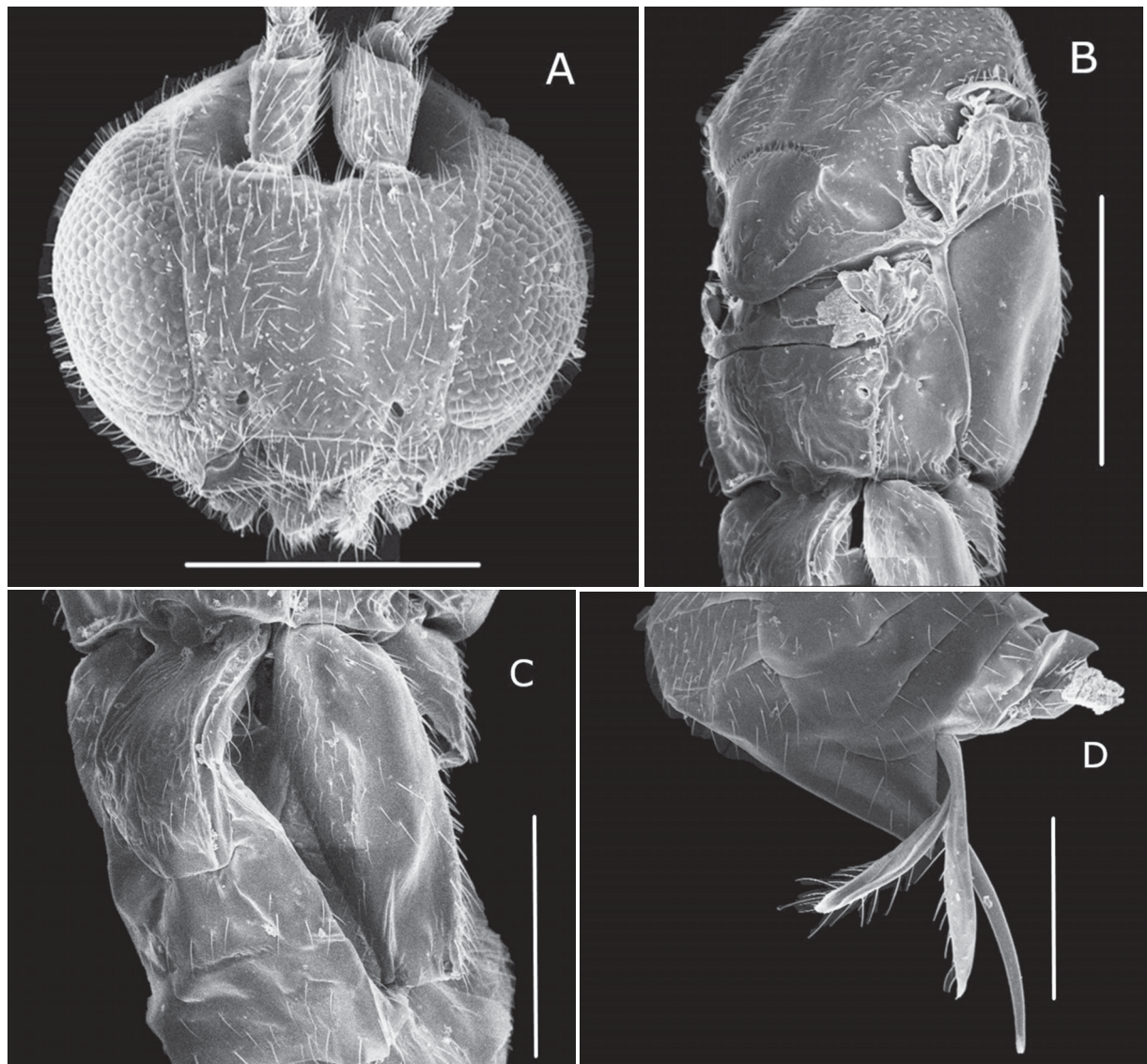


Fig. 2. *Pholetesor camerariae* sp. nov., paratype, ♀ (ZDAMU). **A.** Head, frontal view. **B.** Mesosoma, dorso-lateral view. **C.** T1 and T2, dorso-lateral view. **D.** Metasoma, lateral view. Scale bars: 0.25 mm.

LEGS. Hind coxa smooth and shiny, almost reaching posterior end of T3; length of femur, tibia, and basitarsus of hind leg 4.0, 6.0 and $6\times$ their width, respectively, longer tibial spur $0.41\times$ as long as basitarsus (12:5).

METASOMA. About $3\times$ as long as wide; T1 $2.5\times$ as long as its apical width, $1.66\times$ its basal width, parallel sided, only slightly narrowing apically, surface longitudinally aciculate anteriorly, posteriorly aciculo-rugose with less conspicuous longitudinal elements; T2 trapezoidal, $1.5\times$ as wide as long, smooth except few hairs, posterior margin of T2 usually straight and posteriorly marked by shallow groove; T3 rectangular, $1.30\times$ as long as T2, unsculptured; hypopygium weakly sclerotized basally, membranous apically, $1.5\times$ as long as hind basitarsus; ovipositor sheaths long, slender basally, then tapering broader to bluntly bevelled tip, hairy at apical half, approximately as long as hypopygium, arising at mid length of valvifer; ovipositor weakly decurved, approximately as long as hypopygium.

COLOUR. Body black except for the following: ocelli testaceous; scape, pedicel, F5–F16, mandible brown; maxillary palpi, labial palpi, tibial spurs creamish; legs, tegulae and latero-tergites yellowish; wings hyaline; pterostigma, vein 1-R1, C+SC+R slightly pigmented and remaining veins colourless.

Male

Same as holotype.

Host

Cameraria virgulata.

Distribution

India: Uttar Pradesh.

Remarks

The new species bears strong resemblance to another Indian species, *P. hayati*, in the colouration of the tegulae, wing veins, stigma and legs (except hind coxae), and the sculpturing of the propodeum and metasomal tergites (but not their exact shapes – *P. hayati* has a broader first tergite with rounded lateral margins and a somewhat longer second tergite). Also showing some resemblance in the Palearctic fauna is *P. laetus* (Marshall, 1885) and *P. salalicus*, both of which shares a number of colour and tergite features with *P. camerariae* sp. nov., but both the Palearctic species have more sculptured T2 than *P. camerariae* sp. nov., and scutellar sulcus reduced to a fine groove in which there is no obvious foveation, while *P. camerariae* sp. nov. has a distinct faveolated groove in scutellar sulcus.

Pholetesor indicus sp. nov.

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Fig. 3

Diagnosis

Pholetesor indicus sp. nov. is closely related to *P. bicolor* (Ness, 1874) in the European keys to the species of 'circumscriptus-group' (Nixon, 1973; Papp 1983) on the basis of the following characters: metanotum strongly retracted from scutellum anteriorly, exposing mesothoracic postphragma; pterostigma almost $3.0\times$ as wide as long; vein 1-R1 (metacarp) clearly as long as or shorter than pterostigma, vein r and 2-SR meeting angularly; propodeum largely smooth; T1 largely smooth, polished and strongly narrowed apically; T2+3 smooth and polished, metasomal tergites and legs more often yellowish. However, it differs from *P. bicolor* in the following characters: mesoscutum punctations are prominent all along the mesoscutum surface (punctations becoming indistinct posteriorly near scutellum in *P. bicolor*); tegulae

blackish brown (tegulae yellowish to pale yellowish in *P. bicolor*) pterostigma about $3.0\times$ as wide as long (pterostigma about $2.5\times$ as wide as long in *P. bicolor*); hind coxae black (hind coxae often yellowish in *P. bicolor*); ovipositor sheaths $0.9\times$ as long as hind basitarsi, small and thick (ovipositor sheaths $1.1\text{--}1.2\times$ as long as hind basitarsi, comparatively large with blunt apex in *P. bicolor*); F2 $2.3\times$ as long as wide (F2 $3.5\times$ as long as wide in *P. bicolor*); F5–F11 with double rank of placodes (F5–F6 with double rank of placodes in *P. bicolor*).

The new species is also very similar to *P. circumscriptus*. However, it differs from *P. circumscriptus* in the following characters: vein 1-R1 (metacarp) as long as or shorter than pterostigma (vein 1-R1 (metacarp) clearly longer than pterostigma in *P. circumscriptus*); T2 subtriangular, $2.0\times$ as wide as

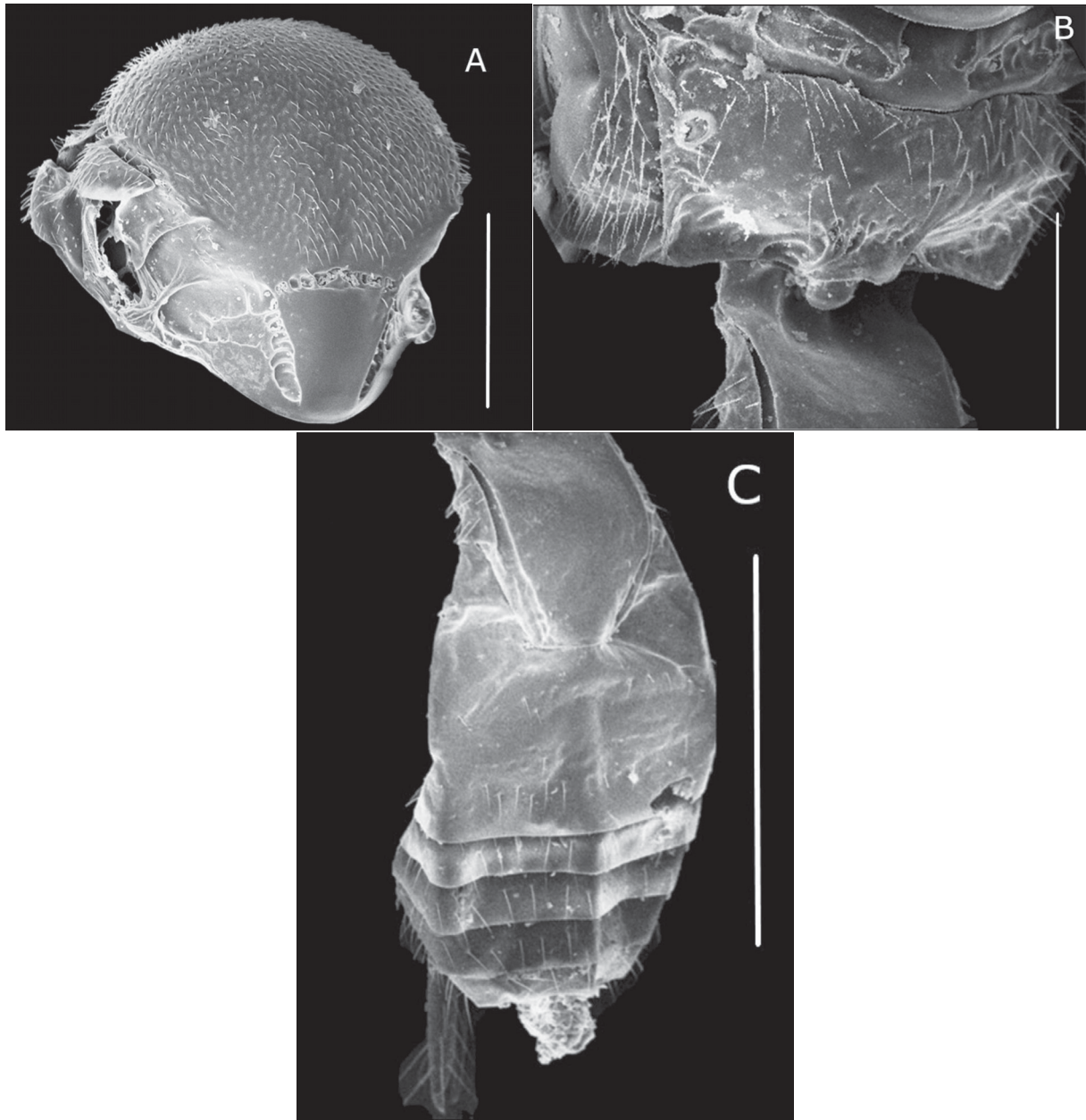


Fig. 3. *Pholetesor indicus* sp. nov., paratype, ♀ (ZDAMU). **A.** Mesosoma, dorsal view. **B.** Propodeum, dorsal view. **C.** Metasoma, dorsal view. Scale bars: 0.25 mm.

long posteriorly, hence more transverse (T2 strongly triangular, $3\times$ as wide as long posteriorly in *P. circumscriptus*); forewing vein r and 2-SR meeting angularly (forewing vein r and 2-SR meeting each other less angularly in *P. circumscriptus*).

Apart from the similarities with *P. bicolor*, the new species also runs close to *P. teresitergum* Liu & Chen, 2016 in the key to the Chinese species of the genus *Pholetesor* (Liu *et al.* 2016). However, it differs from *P. teresitergum* in the following characters: eyes $2.2\times$ as long as temple in dorsal view (eyes $1.6\times$ as long as temple in dorsal view in *P. teresitergum*); ocelli large (ocelli relatively small in *P. teresitergum*); scutellum highly polished (scutellum punctate with hairs in *P. teresitergum*); ovipositor sheaths small and thick, slender with a bluntly rounded tips, (ovipositor sheaths small and subfusiform in *P. teresitergum*); tegulae blackish brown (tegulae yellowish in *P. teresitergum*).

Material examined

Holotype

INDIA • ♀; Uttar Pradesh, Aligarh; 27°54'51.0" N, 78°04'24.7" E; 27 Oct. 2005; Z. Ahmad leg.; ex. *Acrocercops phaeospora* Meyrick, 1914 on *Syzygium cuminii* (L.) Skeels; ZDAMU.

Paratypes

INDIA • 5 ♀♀, 2 ♂♂; same collection data as for holotype; ZDAMU.

Etymology

The new species is named after its type locality.

Description

Female

MEASUREMENTS. Body length = 1.7–1.8 mm; length of antenna = 2.0 mm; Length of fore wing = 1.7 mm.

HEAD. Transverse, almost $2\times$ as wide as long in dorsal view; eyes $2.2\times$ as long as temple in dorsal view; eyes $1.3\times$ as long as wide, setose; temple and vertex punctate with hairs; OOL: POL: AOL: OD = 4: 3: 2: 2; frons concave, smooth, shiny, punctate with hairs; face medially convex, punctate with white pilosity, $1.3\times$ as wide as long; clypeus smooth, punctate with hairs; malar space $1.5\times$ as long as basal width of mandible; antennae longer than body, scape $1.2\times$ as long as wide, pedicel $0.66\times$ as long as wide, F2 $2.3\times$ as long as wide, F14 $1.5\times$ as long as wide, F5–F11 with double rank of placodes, apical segment pointed.

MESOSOMA. $1.5\times$ as long as wide; mesoscutum as wide as head and strongly punctate with hairs, punctations prominent all along mesoscutum surface; scutellar sulcus narrow and crenulate; scutellum smooth and polished, side of scutellum smooth and shiny; propodeum almost $2\times$ as wide as long, largely smooth except antero-medially punctate with long hairs, posterior corners somewhat weakly rugulose; propleuron smooth and shiny; mesopleuron concave, smooth and shiny, antero-lateral, punctate with hairs; metapleuron smooth and shiny with few hairs.

WINGS. Fore wings hyaline, about $3.0\times$ as long as wide, pterostigma about $3.0\times$ as wide as long, 1-R1, about $0.9\times$ as long as length of pterostigma, r and 2-SR meeting angularly; venal lobe of hind wing convex.

LEGS. Hind coxae hairy, length of hind femur, tibia and basitarsus 2.6 , 5.0 and $2.6\times$ their width, respectively, outer tibial spur $0.5\times$ as long as hind basitarsus.

METASOMA. 1.7 × as long as wide; T1 3.6 × as long as its apical width and 1.8 × its basal width, distinctly narrowed apically, smooth and shiny; T2 subtriangular, 3 × as wide as long, smooth except few punctations; hypopygium sclerotized, folded medially and blunt at apex; ovipositor sheaths small and thick, slender with bluntly rounded tips, 0.7 × as long as hypopygium and 0.9 × longer than hind basitarsi, hairy at apical one third, arising below at mid length of valvifer; ovipositor weakly curved downward.

COLOUR. Body blackish brown except for the following: ocelli testaceous; palpi, labarum, fore leg, mid leg and hind leg yellowish except coxae; tegulae blackish brown; scape, pedicel, latero-tergites of T1 and T2 and ovipositor yellowish brown; antennae brown; ovipositor sheaths, fore, mid and hind coxae black; mid and hind femur infuscate; pterostigma, vein C+SC+R, 1-R1, 2-SR, Cu-a, 1-Cu1, 2-Cu1 and 2-M brown; remaining veins colourless, wings hyaline.

Male

Same as holotype except antennae longer than body length, F1–F3 with double rank of placodes.

Host

Acrocercops phaeospora.

Distribution

India: Uttar Pradesh.

Remarks

Pholetesor indicus sp. nov. can be distinguished from all previously described species by the unique combination of characters as follows: ocelli large; scutellum highly polished; propodeum almost 2 × as wide as long, largely smooth except antero-medially punctate with long hairs, posterior corners somewhat weakly rugulose; T1 3.6 × as long as its apical width and 1.8 × its basal width, distinctly narrowed apically, smooth and shiny; T2 subtriangular, 3 × as wide as long, smooth except few punctations; T3 rectangular, 1.40 × as long as T2, unsculptured; hypopygium sclerotized, folded medially and blunt at apex; ovipositor sheaths small and thick, slender with a bluntly rounded tips, 0.7 × as long as hypopygium, hairy at apical one third, arising below at mid length of valvifer; ovipositor weakly curved downward.

Key to the Indian species of the genus *Pholetesor* Mason, 1981 reared from lepidopteran leafminers

1. T1 sculptured all along the surface, usually parallel sided, weakly narrowing only posteriorly; T2 trapezoidal; tegulae yellowish 2
– T1 smooth except for few punctations, strongly narrowing posteriorly; T2 strongly triangular to subtriangular; tegulae dark brown to black 3
2. Ovipositor sheaths short and fusiform in shape; T2 sculptured with a smooth raised median area; legs completely yellow *P. hayati* Akhtar & Ahmad, 2010
– Ovipositor sheaths long, slender basally, then tapering broader to a bluntly bevelled tip; T2 completely smooth and shiny *P. camerariae* sp. nov.
3. Hypopygium heavily sclerotized; ovipositor sheaths small, nearly as long as hind basitarsi *P. indicus* sp. nov.
– Hypopygium weakly sclerotized; ovipositor sheaths long, more than 1.2 × as long as hind basitarsi *P. acrocercophagus* sp. nov.

Discussion

The genus *Pholetesor* almost exclusively attacks leaf-mining Lepidoptera (Whitfield 2006). Prior to the current study, only one species of *Pholetesor* was described from India. However, within such a large expanse of land, covering more 3.2 million km², many more species await discovery. Approximately 21% of the country's landmass is covered by forests (tree canopy density >10%), of which 12% comprises moderately or very dense forests (tree canopy density >40%) (CBD 2014). These include tropical rainforests of the Andaman Islands, the Western Ghats and Northeast India; coniferous forests of Himalaya; deciduous Sal (*Shorea robusta* Gaertn.) forest of Eastern India; the dry deciduous Teak (*Tectona* L.f. spp.) forest of Central and Southern India; and the Babul (*Acacia* Mill.) dominated thorn forest of the Central Deccan and Western Gangetic plain (Tritsch 2001).

Our findings of three species of the genus *Pholetesor* reared from the leaf-mining lepidopteran larvae from the trees near the agrarian ecosystem provide important evidence that the wild area, as well as suburban areas (city parks) near the agrarian ecosystem could have more species fauna in the surrounding territories (Owen *et al.* 1981; Ahmad & Ghramh 2018; Banaszak-Cibicka *et al.* 2018; Ahmad *et al.* 2019; Ghramh *et al.* 2019). The North Indian landscape is covered mostly by the agrarian ecosystem, where Lepidoptera are the key pests. The agrarian ecosystem is nevertheless rich in natural habitats, including small pockets of natural forests, and hosts a very diverse array of insects (CBD 2014). Indeed, the presence of a natural wild reserve, near to suburban areas, can play a crucial role as a biodiversity reservoir from which beneficial species can spill over and colonize or decolonize perturbed areas.

Among the three new species two, *P. acrocercophagus* sp. nov. and *P. indicus* sp. nov., are readily placed in the 'circumscriptus-group' of species of *Pholetesor*. Both the new species were differentiated from *P. circumscriptus* and *P. bicolor*, two species with a wide distribution range and demonstrating quite a large degree of variability in morphology according to their host and ecological preferences. Owing to this morphological variation, the delimitation of the new species is quite problematic. Shaw (2012) clearly addressed this problem and provides the detailed discussion about differentiating *P. bicolor* and *P. circumscriptus*. Shaw (2012) has added strong evidence (biological and morphological data) that support *P. bicolor* and *P. circumscriptus* being considered as different species and also mentioned that these species are likely to be a complex of cryptic species. Other two species, *P. camerariae* sp. nov. and *P. hayati* can be placed under 'ornigis-group' of species of the genus *Pholetesor* on the basis of the overall shape and sculpture patterns of propodeum and first metasoma tergite.

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