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Taxonomic studies of Eulophid parasitoids (Hymenoptera: Chalcidoidea) collected from Uttarakhand, India

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Abstract: A sound taxonomic knowledge base is a prerequisite for effective conservation, environment assessment, ecological research, management and sustainable use of biological resources. Parasitoids are the major component of the biocontrol, so the correct identification of the parasitoid is very important task. Eulophidae is a large family of the superfamily Chalcidoidea and comprises promising biocontrol agents for the control of insect pests causing harm to agricultural ecosystem. The present study has been done to provide the account and occurrence of 4 genera belonging to subfamily Entedoninae, Eulophinae and Tetrastichinae. *Entedon costalis* Dalman, *Diglyphus horticola* Khan, *Hemiptarsenus varicornis* (Girault), and *Neotrichoporoides viridimaculatus* (Fullaway) was collected from Uttarakhand (India) and described in detail with additional morphological characters that aids in clear identification of the parasitoids. *Entedon costalis* is recorded from this region with additional characters for identification.

Keywords: Biocontrol, Chalcidoidea, Eulophidae, Parasitoids, Taxonomy

INTRODUCTION

A sound knowledge of biodiversity is a prerequisite for effective conservation and management but unfortunately, global biodiversity is fast depleting, largely due to the negligence of the society. Current estimate of about 8.7 million species suggested by taxonomic experts and it suggests that after 250 years of taxonomic classification only small fraction of species on earth (~14%) and in the ocean (~9%) have been indexed in a central database. Approximately 1.2 million species have so far been identified and described during the last 250 years (Mora *et al.*, 2011). India is one among the twelve mega bio-diversity hot spots of the world. Sound taxonomy is the foundation of all meaningful research in biology. In order to know which species are endangered or threatened we must know what they are and what we have to conserve (Narendran, 2006).

The Hymenoptera is one of the largest order of insects, comprising the sawflies, wasps, bees and ants etc. Parasitic micro-hymenopterans constitute the most diverse group within the order, containing 50% or more of the total described species (La Salle and Gauld, 1993). Over 130,000 species are recognized, with many more remaining to be described, and anywhere from 300,000 to 2.5 million species are estimated to be extant (Grissell, 1999). Parasitic insects, of which most are Hymenoptera, account for approximately 25 percent of all arthropods in both temperate, and tropical ecosystems.

Currently, the family Eulophidae is the largest family of super family Chalcidoidea consisting 297 genera and 4472 species (Noyes, 2004). Among these 150 genera are found in the Indo-Australian region and about 60 genera in the Indian subcontinent (Narendran and Fousi, 2002). The members of Eulophidae are promising parasitoids for the control of insect pests of agricultural importance over the world and maintain the agricultural ecosystem. The use of these biocontrol agents also avoids the harmful effect on human health and environment by the spraying of hazardous chemical pesticides. The correct identification and records of their ecological distribution must be made. The lack of proper information on their basic studies and incorrect identification many times did not give the desired results of major control projects. With a view to furnish more information on basic studies of parasitoids, the present work on taxonomic studies on parasitoids of family Eulophidae has been carried out.

MATERIALS AND METHODS

During the course of investigation 2012-13, fresh collections were made by surveying various important agricultural, horticultural and agro forestry areas of Uttarakhand to acquire fresh specimens for taxonomic studies. Parasitized eggs and different stages of host insects along with damaged material like pieces of barks, leaves, stems, twigs, pods or other plant parts were collected. However, sweep net collections were also made in order to acquire large amount and variety

of micro-hymenoptera in the shortest time, in most types of vegetation. The collected materials were brought to the laboratory in plastic bags and cleaned with brush for any dirt. These samples were reared in glass jars in a constant temperature cabinet running at 70°F with 70 per cent RH to expedite the emergence of parasitoids and adult host insect. The rearing glass jar was provided with few drops of water daily to maintain turgidity and avoid drying of the collected sample. The rearing jars were examined daily for the emerged parasitoids and adult host insect. The emerged parasitoids and host insects were collected using aspirator from jars and preserved in 75 per cent ethyl alcohol in glass vials for further study. The identification and drawings of the parasitoids was made using Camera Lucida by the author in the Biological Control Laboratory, Department of Entomology.

Preparation of permanent slides, measurements and illustrations: The standard procedure was followed to prepare permanent slides as described by Noyes (2004). Different important morphological structures of the parasitoids studied by preparing permanent slides following the normal process of dehydration, clearing and dissecting in clove oil, the various dissected parts were placed on a micro slide in a drop of Canada balsam and thus mounting was made under 22 mm cover slip. The permanent slides were examined under trinocular microscope in order to make drawings and detailed study of each structure with the help of Camera Lucida. This approach has revealed some characters which otherwise are likely to be overlooked in tag dry mount specimens. All measurements were made in millimeters. For description of Eulophid parasitoids morphological terminology as per Gibson (1997) has been adopted. The material is deposited at Biological control Laboratory, Department of Entomology, G.B. Pant University of Agriculture and Technology, Pantnagar.

RESULTS AND DISCUSSION

Subfamily Entedoninae: Members are characterized by: scutellum with 1 pair of setae, submarginal vein with 2 setae, and frontofacial sutures when present separated from the anterior ocellus by at least one-third the distance from ocellus to torulus. In some genera (e.g., *Entedon*, *Pediobius*) the body is rather strongly sclerotized, but in other genera (e.g., *Omphale* or *Chrysocharis*) the body is weakly sclerotized and specimens often shrivel badly after death.

Genus *Entedon* Dalman: (Type species: *Entedon cyanellus* Dalman): Askew (1991) reviewed the species of *Entedon* Dalman having a complete frontal fork. Of the new synonyms *Acanthentedon* is based on the species which has slightly stronger, more acuminate pronotal shoulders, but the difference is only quantitative and bridged by several other species. In the holotype of *latticeps* these shoulders appear unusual, because the pronotum is loosened, dislocated

from the normal position (Dodd, 1917). *Entedonella* was declared a synonym of *Entedon* by Girault, 1917, but used again as valid name in 1927. The head and thorax in all the *Entedon* species are strongly sclerotized and conspicuously reticulate, but the pilosity is reduced to very few setae; these are conspicuous, strong, but only two pairs of them on the midlobe of mesoscutum; antennae long in both the sexes the flagellum with only one anellus and 5 conspicuous segments, the terminal 2 often especially, in all females, closely united into clava. The tentorial pits are not distinct; the clypeus is transverse, and broad, its lower margin often more or less produced and almost margined by a shallow groove. The upper margin of occiput forms a rectangular edge which is often sharply carinate. The pronotum is medially reduced, non carinate, but laterally forming bristle-bearing subconical projection. The notauli are not well defined in posterior half, the axillae are not distinctly advanced. The scutellum is convex, without any grooves, also at apex without admarginal grooves. The Propodeum is also characteristic with distinct median carina set in a elevated area which bears a lateral subconical projection behind the spiracles, and the elevation is delimited laterally and anteriorly by deep curving groove which may continue inside by a depression where normally a plica would be; the depression is posteriorly connected by a grooved supracoxal flange with a groove outside of the median carina. The female gaster is often sessile or shortly petiolate, in males the petiole is distinctly longer, often distinctly elongate.

Re-description of the species

***Entedon costalis* Dalman [Plate. I. Figs. 1-11]:** Female: Body length about 2 mm; head black with coarsely reflecting reticulate, setose, vertex with strong setae, eyes black setose; antennae brown except basal two third of scape; thorax metallic black, strong coarse reticulation; wings hyaline, legs coxae concolours with the thorax, all trochanter, femur, proximal half brown, remaining segments dull white; gaster dark brown.

Head: More than 1.2x wider in frontal aspect (0.46: 0.56) (Fig. 2), head frontal grooves absent; frontover-vertex width more than 1.5x the total head width (0.33: 0.56); vertexal suture absent, ocelli arranged in acute angled triangle; POL about 2.5x as long as OOL (0.065:0.17) (Fig. 3); compound eyes large, antennal toruli situated slightly above the lower level of eye margin; malar sulcus absent; malar space shorter than eye length (0.16: 0.31); mandibles bidentate, maxillary and labial palpi 1 segmented each; lower margin of clypeus narrow. Antennae (Fig. 1) are 7 segmented excluding 1 anelli, apical tip of antenna with spicule, antennal formula 11132; scape cylindrical more than 7.5x as long as wide (0.03: 0.24), scape apex not touching to mid ocelli; pedicel about 2x as long as wide (0.04: 0.08) and shorter than the length of the FS1; funicle 3 segmented, FS1 about 2.5x as long as

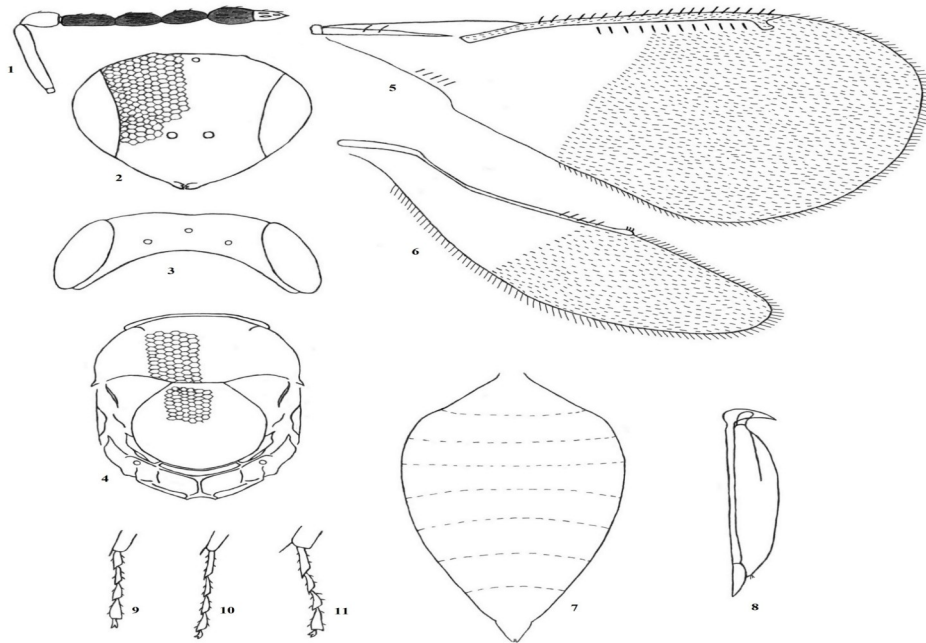


Plate. I. Figs. 1-11: *Entedon costalis* Dalman. 1. Antennae; 2. Head in frontal view; 3. Head in dorsal view; 4. Mesosoma; 5. Forewing; 6. Hindwing; 7. Metasoma; 8. Female genitalia; 9. Part of Fore leg; 10. Part of Middle leg; 11. Part of Hind leg.

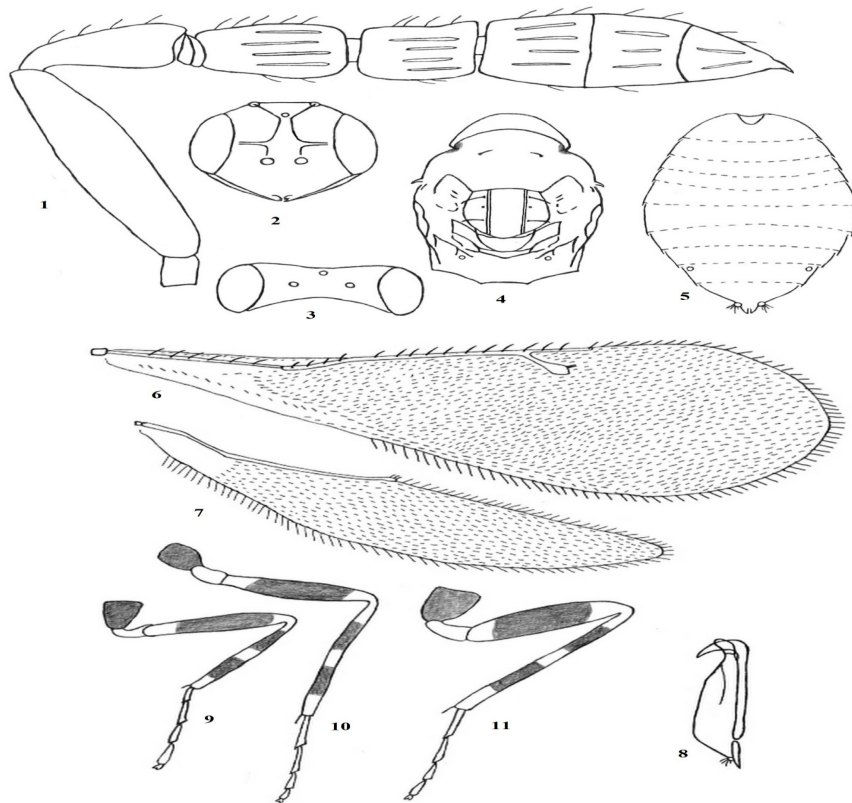


Plate. II Figs. 1-11: *Diglyphus horticola* Khan. 1. Antennae; 2. Head in frontal view; 3. Head in dorsal view; 4. Mesosoma; 5. Metasoma; 6. Forewing; 7. Hindwing; 8. Female genitalia; 9. Fore leg; 10. Middle leg; 11. Hind leg.

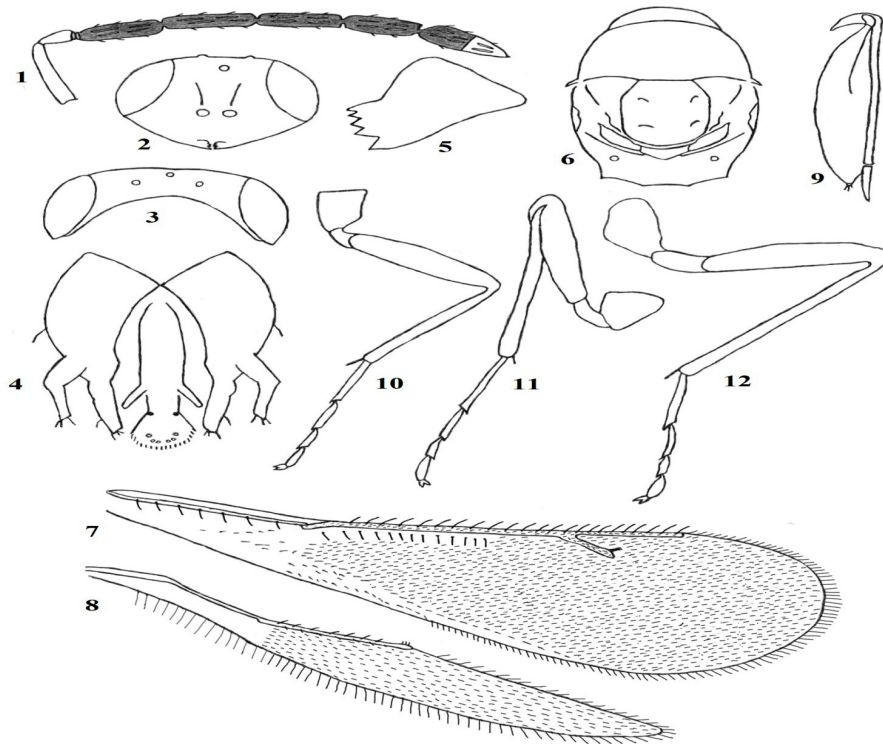


Plate. III. Figs. 1-12: *Hemiptarsenus varicornis* (Girault). 1. Antennae; 2. Head in frontal view; 3. Head in dorsal view; 4. Maxillae & Labium; 5. Mandible; 6. Mesosoma; 7. Forewing; 8. Hindwing; 9. Female genitalia; 10. Fore leg; 11. Middle leg; 12. Hind leg.

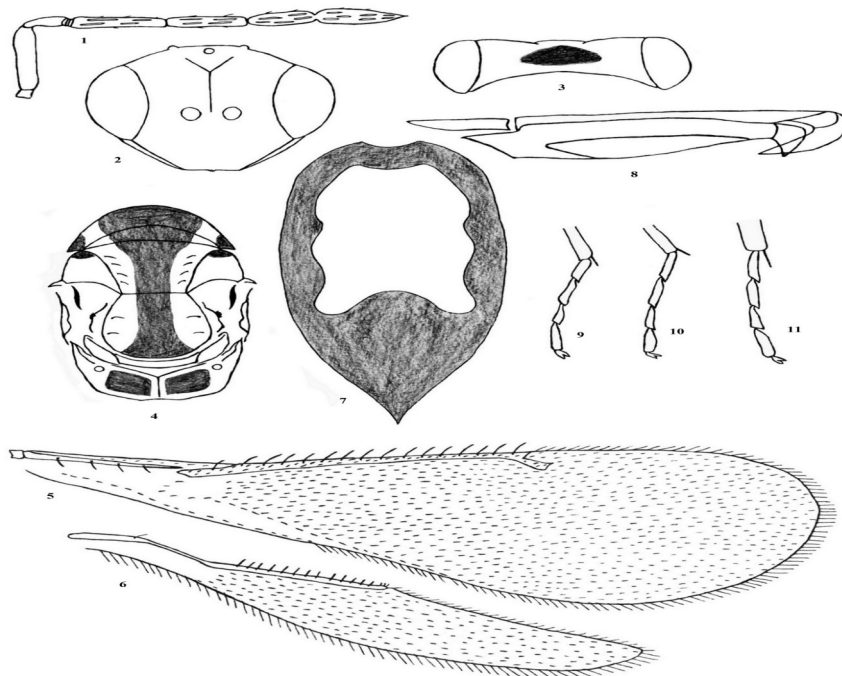


Plate. IV. Figs. 1-11: *Neotrichoporoides viridimaculatus* (Fullaway). 1. Antennae; 2. Head in frontal view; 3. Head in dorsal view; 4. Mesosoma; 5. Forewing; 6. Hindwing; 7. Metasoma; 8. Female genitalia; 9. Part of Fore leg; 10. Part of Middle leg; 11. Part of Hind leg

wide (0.045: 0.12), FS2 and FS3 equal with about 2x as long as wide (0.05: 0.10); club 2 segmented about 2.4x as long as wide (0.07: 0.17), shorter than preceding two funicle segments combined.

Mesosoma: Pronotum bearing 3 pairs of setae at its posterior margin, anterior margin concave in the middle, postero-lateral margins with projected corners; mesoscutum more than 2x as wide as long (0.55: 0.27); mesoscutum having 2 pairs of setae, coarsely strongly reticulate, notauli absent, axilla slightly advanced; axillae not meeting to each other at mid of transcupal articulation; scutellum longer than mesoscutum, and as wide as long (0.35: 0.35) without longitudinal grooves and 1 pairs of setae situated on scutellum; metanotum narrow about 3x of the length of propodeum (Fig. 4); propodeum with median carina and with paraspiracular carinae, smooth; propodeal spiracles large and well separated from the anterior margin of propodeum with less than its own diameter, spiracle rim fully exposed. Fore wings (Fig. 5) are about 2x as long as wide (1.45: 0.75); more than 1.2x longer than hind wing length (1.45: 1.18); costal cell long, broad; SMV with 2 setae directed upwards, shorter than MV (0.48: 0.56); MV bearing small setae on front edge; PMV smaller than the length of SV; marginal fringe short; basal vein absent; cubital vein wanting, subcubital line of hairs also absent. Hind wings (Fig. 6) are more than 3.6x as long as wide (0.32: 1.18) with moderately sharp apex; vein length more than 1.6x of the length of wing (0.73: 1.18). Fore Legs (Fig. 9) are smooth, tibial spur short. Mid legs (Fig. 10) with tibial spur small; spur shorter than basitarsi. Hind legs (Fig. 11) without two long tibial spurs, coxae with a spine like projection on the dorsal side.

Gaster: slightly elongate, petiolate sessile; more than 1.6x as wide as long (Fig. 7), gaster surface hairy, 1st gasteral tergum small, metasoma longer than mesosoma (0.77: 1.1); ovipositor (Fig. 8) sheaths slightly exerted; first valvifer semicircular; anterior margin of basal part of second valvifer curved; third valvulae distinctly present; cercal setae short; hypopygium not reaching middle of gaster.

Male: Not known

Host: Unknown

Material examined: 3♀, one dissected and mounted on slide. India: Uttarakhand, Pantnagar, sweep net collection, 04-xi-12, Hym. Eulo. Nr. SA 10, coll. Sandip More.

Subfamily Eulophinae: The Eulophinae appear to be the most primitive subfamily because they have less-specialized features. Members have the submarginal vein smoothly joining the parastigma; a long postmarginal vein (usually longer than the stigmal vein); and the dorsal surface of the submarginal vein with 3 or more setae. A different state of any of these characters will usually indicate one of the other subfamilies.

Genus: *Diglyphus* Walker

(Type species: *Diglyphus poppoea* walker): The genus *Diglyphus* Walker, can be easily recognized from

other eulophid genera by the distinguishing characters given in detail by Peck *et al.* (1964) and Gordh and Hendrickson Jr. (1979), Kamijo (1978) has dealt elaborately with the genus by giving descriptions of 4 species of *Diglyphus isaea* Walker, *D. minoews* Walker, *D. pusztensis* Erdos and Novicky and *D. albiscapus* Erdos which were reared from Agromyzid leaf miners such as *Agromyza albipennis*, *A. oryzae*, *Chromatomyia horticola* and *Chromatomyia ranunculi*.

Khan (1985) has done remarkable contribution to the first time from India. He has described 3 new species in detail and provided key to species of the genus. Arifa and Khan (1991) described two species of the genus *Diglyphus* viz., *D. indicus* Arifa and Khan and *D. frontolatus* Arifa and Khan from *Pseudonapomyza asiaticus* and *Liriomyza taraia* respectively.

Redescription of the species

***Diglyphus horticola* khan [Plate. II. Figs. 1-11]:** Female: Body length about 1.48 mm, general body colour dark brown with golden reflections, and head dark brown with golden reflections and eyes red; Antennae dark brown with funicle segments and club white; Thorax dark brown with golden reflections with fine reticulate sculpture; Wings hyaline. Coxa dark brown colour with golden reddish tinge, femur and tibia have a pattern of dark brown and white colour. Tarsi segments are light brown except last segment brown coloured; gaster sessile, elongate.

Head: Wider than long in facial view (0.35: 0.30); head frontal grooves present; width of frons between eyes more than one half of the head width (0.19: 0.35); frontovertex wide, wider than long; ocelli arranged in obtuse angled triangle (Fig. 2); POL slightly more than OOL (0.08: 0.05) (Fig. 3); distance between two antennal sockets less than their distance from eye rim (0.04: 0.06); mandibles pentadentate with three sharp outer teeth, the inner two short and saw-like; maxillary and labial palp two and one segmented, respectively; lower margin of clypeus broad and straight. Antennae (Fig. 1) with scape cylindrical, five times longer than wide (1.73: 0.35); pedicel long, almost two times as long as wide (0.80: 0.36), shorter than first funicle segment, two anelli intervening between pedicel and first funicle segment; funicle two segmented, first funicle segment (0.64: 0.47) distinctly longer than second segment (0.55: 0.48); club three segmented, about 2.3 times longer than wide (1.43: 0.60), longer than funicle segments combined.

Mesosoma: Posterior margin of pronotum with eight setae; mesoscutum is about 1.5 times as wide as long (0.3: 0.2); with two pairs of long, strong setae; notauli incomplete well defined anteriorly and obscured posteriorly, axilla slightly advanced; scutellum slightly smaller than mesoscutum (0.16: 0.2), as wide as long (0.16: 0.16); with conspicuous longitudinal grooves and 3 pairs of setae situated adjacent to grooves (Fig. 4); metanotum broad; propodeum without median carina and paraspiracular carinae. Fore wings (Fig. 6) are densely setose,

more than two and a half times longer than wide (1.35: 0.5), longer than the hind wing (1.35: 1.02); submarginal vein with six strong dorsal setae, longer (0.48) than marginal vein (0.32); postmarginal vein (0.12) longer than stigmal vein (0.09); costal cell narrow; marginal fringe medium; basal vein present; cubital vein present, subcubital line of hairs also present. Hind wings (Fig. 7) are more than 4.5 times as long as wide (1.02: 0.22) with tapering apex; apex of marginal vein with three curved hooklets; wing length more than two times the length of vein (1.02: 0.48); marginal fringe long. Fore legs (Fig. 9) with coxa, trochanter and femora except apical one to fourth dark brown, apical one fourth of femora and basal tip of tibiae whitish, rest of the tibiae yellowish brown with faint brown patches on basal half and an apical half; tarsal segments yellowish brown. Middle legs & hind legs (Figs. 10 and 11) with coxa, trochanter and femora except basal tip and apical one-fourth dark brown, rest of the leg yellowish with dark brown bands on basal half and on apical half of tibiae; last tarsal segments brownish.

Metasoma: Longer than thorax (Fig. 5); first valvifer triangular; second valvifer long with thickened dorsal margin throughout; third valvulae short movably articulated with second valvifer; outer plates of ovipositor (Fig. 8) narrow at base and broad at apex, basal three fourth with thickened dorsal margin and a ridge in the middle, ovipositor slightly exerted.

Male: Not known

Material examined: 5♀, one dissected and mounted on slide. India, U.K., Pantnagar, Host: Pea leaf miner, *Chromatomyia horticola* (Diptera: Agromyzidae) on field peas, *Pisum sativum* L., 20-iii-13, Hym. Eulo. Nr. SA 14, coll. Sandip More.

Genus *Hemiptarsenus* Westwood

(Type species *Hemiptarsenus fulvicollis* westwood): *Hemiptarsenus* Westwood, 1833, a moderate sized genus in Eulophinae, was erected for *Hemiptarsenus fulvicollis* Westwood, 1833. Now, it includes more than 23 species worldwide. Boucek (1959) has studied Central European *Hemiptarsenus*, and given a key to six species. Shafee and Rizvi (1988) have also studied Indian species of this genus, and gave a key of five species. In China, *H. unguicellis* (Zetterstedt) and *H. ornatus* (Nees) have been recorded and redescribed by Sheng (1989) from Jiangxi as parasitoids of *Phytomyza horticola* Goureaux; *H. varicornis* (Girault) has been recorded previously by Lee (1990) and Lin and Wang (1992) from Taiwan as parasitoid of *Liriomyza bryoniae* and *L. trifolii*. This genus comes very close to genus *Sympiesis* Foerster in many characters and it is quite likely will be merged with that genus when better known in future studies. For the present, it can be separated from *Sympiesis* mainly in having: (i) toruli well above level of lower margin of eye and hence apex of scape extending above level of vertex of (in *Sympiesis* toruli inserted at or lower level of ventral margin of eye

and hence apex of scape not extending above level of vertex; (ii) forewing atleast 2.6x as long as wide (in *Sympiesis* forewing shorter than 2.6x as long as wide) and (iii) Costal cell 10- 15x as long as wide (in *Sympiesis* costal cell less than 10x as long as wide).

Redescription of the species

***Hemiptarsenus varicornis* (Girault) [Plate. III. Figs. 1-12]:** Female: Body length about 1.35 mm; body colour metallic dark green to brown; head dark green metallic, finely reticulate; eyes gray, ocelli reflecting yellow; antennae funicular segments and dorsoapical part of scape dark brown, pedicel dark honey, scape dull yellow; thorax dark metallic green with deep and heavily reticulate sculpture; wings hyaline, veins light brown; legs all segments yellow except 4th tarsus, pretarsus, distal part of femur and tibia; gaster distinctly petiolate, dark brown with base upto first tergum yellow.

Head: About 1.3x wider than long in frontal aspect (0.28: 0.36), head frontal grooves present; frontovertex width more than 2x the total head width (0.17: 0.36) (Fig. 2); vertexal suture absent with, ocelli arranged in acute angled triangle; POL slightly more than 1.5x as long as OOL (0.102: 0.6) (Fig. 3); compound eyes large and smooth, antennal toruli situated just around at the center of the face; malar sulcus slightly curved; malar space shorter than eye length (0.14: 0.2); mandibles pentadentate with first one largest (Fig. 5); lower margin of clypeus narrow. Antennae (Fig. 1) are 8 segmented excluding 2 anelli, apical tip of antenna with/without spicule, antennal formula 11242; scape cylindrical more than 5x as long as wide (0.035: 0.2), scape apex touching to mid ocelli; pedicel more than 1.5x as long as wide (0.035: 0.06) and shorter than the length of the FS1; funicle 4 segmented, FS1 more than 3x as long as wide (0.05: 0.15), FS2 about 2.7x as long as wide (0.06: 0.166), FS3 about 2.8x as long as wide (0.055: 0.158), FS4 about 2.2x as long as wide (0.06: 0.135); club 2 segmented, more than 2.5x as long as wide (0.06: 0.17), shorter than preceding two funicle segments combined.

Mesosoma: Pronotum bearing 3 pairs of setae at its posterior margin, anterior margin concave in the middle, postero-lateral margins without projected corners; mesoscutum about 1.5x as wide as long (0.19: 0.3); mesoscutum having 3 pairs of setae, notauli absent, axilla slightly advanced; axillae not meeting to each other at mid of transcutal articulation; scutellum smaller than mesoscutum, quadrate without longitudinal grooves and 2 pairs of setae situated on scutellum (Fig. 6); metanotum broad; propodeum with median carina and with plica; propodeal spiracles small and well separated from the anterior margin of propodeum, spiracle rim fully exposed. Fore wings (Fig. 7) are more than 2.8x as long as wide (0.45: 1.34); more than 1.2x longer than hind wing length (1.1: 1.34); costal cell long, narrow; SMV with 7 setae directed upwards, shorter than MV (0.4: 0.45); MV bearing small setae on front edge; PMV more than 2.1x longer than SV (0.09: 0.19); marginal fringe

short; basal vein present; cubital vein present, subcubital line of hairs also present. Hind wings (Fig. 8) are about 5.5x as long as wide (1.1:0.2) with moderately sharp apex; vein length about 1.7x of the length of wing (0.64:1.1). Fore Legs (Fig. 10) are hairy, tibial spur short. Mid legs (Fig. 11) with tibial spur small; spur shorter than basitarsi. A hind leg (Fig. 12) with two long tibial spurs absent.

Gaster: Petiole as long as broad with lateral teeth like projection, gaster surface finely reticulate smooth/hairy, 1st gasteral tergum small, metasoma shorter than mesosoma; ovipositor (Fig. 9) sheaths slightly exerted; first valvifer triangular; anterior margin of basal part of second valvifer not much curved; third valvulae distinctly present; cercal setae short; hypopygium reaching middle of gaster.

Male: Not known

Host: Unknown.

Material Examined: 5 ♀. One dissected and mounted on slide. India: Uttarakhand, Pantnagar, sweepnet collection, 17-x-12, Hym. Eulo. Nr. SA 4, coll. Sandip More.

Subfamily Tetrastichinae: This is the largest subfamily, and its species are widespread and common. The majority of species are recognized by the following combination of features: scutellum with submedian and sublateral grooves, and postmarginal vein greatly reduced (less than half the length of the stigmal vein) or absent. Small body size, uniform morphology, and a tendency for specimens to shrivel upon death make this an extremely difficult group to study.

Genus *Neotrichoporoides* Girault

(Type species: *Neotrichoporoides uniguttata* Girault)

This genus comes near *Aprostocetus* Westwood but can be easily distinguished by the following characters: (i) mesosoma long with a relatively large pronotum and short mesoscutum (In *Aprostocetus*, mesosoma moderate with short to medium pronotum and moderately long mesoscutum); (ii) propodeum with median carina and raised wide-meshed reticulations (In *Aprostocetus*, propodeum with median carina but no raised wide-meshed reticulations); (iii) MV at least 6x SV (In *Aprostocetus*, MV always less than 6x SV); (iv) malar sulcus always widening into a triangular subocular fovea (In *Aprostocetus*, subocular fovea rarely seen); (v) antenna with FS2 longer than FS3 (In *Aprostocetus*, FS2 not always longer than FS3); (vi) mesoscutum usually without median longitudinal sulcus (In *Aprostocetus*, mesoscutum may be with median longitudinal sulcus).

Redescription of the species

***Neotrichoporoides viridimaculatus* (Fullaway) [Plate. IV. Figs. 1-11]:** Female: Body length about 1.98 mm; body predominantly yellow with characteristic black pattern on upper face, ocelli area, dark band on middle mesosoma, apical corner of scapula, axillae, petiole and sides of metasoma; eyes brown, bare, ocelli reflecting brown; antennae dark brown; wings hyaline

with veins brownish yellow; legs yellow except third and fourth and pretarsus brown.

Head: About 1.1x wider than long in frontal aspect (0.54: 0.48) smooth, head frontal grooves present (Fig. 2); wider in dorsal view than mesosoma; vertexal suture absent, ocelli arranged in acute angled triangle; POL about 1.3x as long as OOL (0.13: 0.10) (Fig. 3); compound eyes large and smooth, occular margin straight in the middle, antennal toruli situated around the middle of the face; malar sulcus present straight; malar space shorter than eye length (0.17: 0.28); mandibles bidentate, maxillary and labial palpi with 2 and 1 segmented respectively; lower margin of clypeus bilobed. Antennae (Fig. 1) are 6 segmented excluding 3 anelli, apical tip of antenna with spicule, antennal formula 11331; scape cylindrical more than 4.8x as long as wide (0.24: 0.05), scape apex exceeds mid ocelli; pedicel about 2x as long as wide (0.08: 0.04) and shorter than the length of the FS1; funicle 3 segmented, FS1 and FS2 about 4.2x as long as wide (0.17: 0.04); FS3 about 3.7x as long as wide (0.15: 0.04); club 1 segmented, equal in length with FS1, shorter than preceding two funicle segments combined.

Mesosoma: Pronotum bearing 6 pairs of setae at its posterior margin, anterior margin concave in the middle, postero-lateral margins without projected corners; mesoscutum about 1.9x as wide as long (0.38: 0.2); mesoscutum finely reticulate having 4 pairs of setae, notauli complete (Fig. 4), axilla slightly advanced; axillae not meeting to each other at mid of transcutal articulation; scutellum smaller than mesoscutum, more than a little longer than wide (0.25: 0.23) with submedian and sublateral longitudinal grooves and 2 pairs of setae situated on scutellum; metanotum narrow; propodeum reticulation stronger than mesoscutum with median carina and without plica and paraspiracular carinae; propodeal spiracles small and well separated from the anterior margin of propodeum, spiracle rim fully exposed. Fore wings (Fig. 5) are more than 2.8x as long as wide (1.7: 0.6); more than 1.2x longer than hind wing length; costal cell long, narrow; SMV with 6 setae directed upwards, shorter than MV (0.45: 0.6); MV bearing small setae on front edge; PMV absent; MV more than 8.5x of SV (0.60: 0.07); marginal fringe short; basal vein present; cubital vein present, subcubital line of hairs also present, speculum setose. Hind wings (Fig. 6) are more than 5.9x as long as wide (1.3:0.22) with moderately sharp apex; vein length more than 1.7x of the length of wing (0.7: 1.3); marginal fringe long. Fore Legs (Fig. 9) are smooth, tibial spur short. Mid legs (Fig. 10) with tibial spur small; spur shorter than basitarsi. Hind legs (Fig. 11) are without two long tibial spurs.

Gaster: elongate, petiole transverse; gaster surface smooth, 1st gasteral tergum small (Fig. 8), metasoma longer than mesosoma (1.10: 0.75); ovipositor (Fig. 7) sheaths slightly exerted; first valvifer semicircular;

anterior margin of basal part of second valvifer curved; third valvulae distinctly present; cercal setae short; hypopygium reaching middle of gaster.

Male: Funicle with four segments, others characters are similar with female.

Host: Unknown

Material examined: 5♀, one dissected and mounted on slide. India: Uttarakhand, Pantnagar, sweep net collection, 07-x-12, Hym. Eulo. Nr. SA 7, coll. Sandip More.

Conclusion

The present investigation, support the identification of the *Entedon costalis*, *Hemiptarsenus varicornis*, *Neotrichoporoides viridimaculatus* and *Diglyphus horticola* with additional morphological characters such as ovipositor, mouth parts diagnosis. *Diglyphus horticola* reared from *Chomatomyia horticola* and other from sweep net collection. *Entedon costalis* is recorded from this region.

REFERENCES

- Arifa, N. and Khan, M.A. (1991). Some new chalcid parasitoids (Hymenoptera: Eulophidae) recorded from India. *J. Bombay Nat. Hist. Soc.*, 88(3): 428-438
- Askew, R. R. (1991). Review of species of *Entedon* Dalman having a complete frontal fork with redefinition of the species-group *cioni* Thomson (Hymenoptera: Eulophidae). *Entomol. Scand*, 22:219-229
- Boucek, Z. (1959). A study of central European Eulophidae, I: Eulophidae (Hymenoptera). *Acta. Ent. Mus. Nat. Pragae*, 33:117-170
- Dodd, A.P. (1917). Records and descriptions of Australian Chalcidoidea. *Trans. R. Soc. S. Aust.*, 41:344-368
- Gibson, G.A.P. (1997). Morphology and Terminology. annotated keys to the genera of nearctic chalcidoidea (Hymenoptera), *National Research Council Canada*, NRC Research Press, 794 pp
- Girault, A.A. (1917). Description of miscellaneous chalcid flies from California. *Insec. Insc. Menst.* 4(10-12): 109-121.
- Girault, A.A. (1927). Notes on and descriptions of chalcid wasps (Chalcididae) in the South Australian Museum. *Rec. S. Aust. Mus.*, 3:309-338
- Gordh, G. and Hendrickson Jr, R. (1979). New species of *Diglyphus*, a world list of the species, taxonomic notes and a key to New World species of *Diglyphus* and *Diaulinopsis* (Hymenoptera: Eulophidae). In *Proceedings of the Entomological Society of Washington*, 81(4): 666-684
- Grissell, E. E. (1999). Hymenoptera biodiversity: some alien notions. *Am. Entomol.*, 45(4): 235-244
- Kamijo, K. (1978). Chalcidoid parasites (Hymenoptera) of Agromyzidae in Japan, with description of a new species. *Kontyû*, 46(3): 455-469.
- Khan, M. A. (1985). Eulophid parasites (Hymenoptera: Eulophidae) of Agromyzidae in India. *J. Bombay Nat. Hist. Soc.*, 82(1): 149-159
- LaSalle, J. and Gauld, I. D. (1993). Hymenoptera and biodiversity. CAB International, Wallingford.
- Lee, H. S. (1990). Insecticides for the control of *Liriomyza bryoniae* (Kalt.) and the parasites survival on head mustard. *Chin. J. Entomol.*, 10(2): 183-189
- Lin, F.C. and Wang, C. L. (1992). The occurrence of parasitoids of *Liriomyza trifolii* (Burgess) in Taiwan. *Chin. J. Entomol.*, 12(4): 247-257
- Mora, C., Tittensor, D.P., Adl, S., Simpson, A.G. and Worm, B. (2011). How many species are there on Earth and in the ocean?. *PLoS Biol.*, 9(8): e1001127
- Narendran, T. C. (2006). An Introduction to Taxonomy. Zoological survey of India, Kolkata., pp. 80
- Narendran, T.C. and Fousi, K. (2002). A new genus and a new species of Eulophidae (Hymenoptera: Chalcidoidea) from the rice ecosystems of Central Kerala, India. *J. Ecobiol.*, 14(2): 137-141
- Noyes, J. S. (2004). Universal Chalcidoidea Database. World Wide Web electronic publication.
- Peck, O., Boucek, Z. and Hoffer, A. (1964). Keys to the Chalcidoidea of Czechoslovakia (Insecta: Hymenoptera). *Mem. Entomol. Soc. Can.* 96 (S34): 7-121
- Shafee, S. A. and Rizvi, S. (1988). Species of the genus *Hemiptarsenus* Westwood (Hymenoptera: Eulophidae) from India. *Indian J. Syst. Ent.*, 5(1): 11-17
- Sheng, J. K. (1989). Category of Jiangxi Chalcidoidea (Hymenoptera). *Acta Agric. Uni. Jiangx*, 1-99p.