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Morphology and chaetotaxy of *Henosepilachna ocellata* (Redtenbacher) (Coleoptera: Coccinellidae) larvae

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Abstract
Armature of coccinellid larvae is complicated, challenging but of considerable significance. Morphology and chaetotaxy of the *Henosepilachna ocellata* (Redtenbacher) mature fourth instar larvae is described here and differences with other instars highlighted. A novel attempt has been made to present the larval armature in the form of setal maps that can make the comparative study of different species comprehensive and handy.

Keywords: Armature, Chalaza, *Henosepilachna,* Larvae, Scolus

Introduction

Coccinellids had always been actively studied because of their economic importance. They have variety of food habits - majority of them being carnivorous on aphids, coccids, aleyrodids and chrysomelids serve as natural control agents of many aphid and coccid pests. Some of the coccinellds are harmful being phytophagous on the vegetable crops. The adult coccinellids have variously coloured patterns of spots not constant to a species and thus a lot of polymorphism exists in many species. The study of larval characters provides support to the taxonomists particularly those interested in the phylogeny of the group.

Initial studies on the larvae of Coccinellidae were made by Boving (1917) [1], Gage (1921) and Strouhal (1927). Kapur (1950) [11] presented notes on biology and external morphology of 14 species of larvae of coccinellids. He provided a general description of the larva of this subfamily, keys to the genera of Epilachninae and to species of *Epilachna* Chevrolat, and discussed the relationship to other coccinellids.

Savoiskaya (1960) [20] studied morphology and taxonomy of ladybird larvae. Kamiya (1965) presented comparative morphology of larvae of Japanese Coccinellidae and their phylogenetic relationships. Klausnitzer (1973) [12, 21] had studied the larvae of *Harmonia, Adonia* and *Tytthaspis*. Sasaji and Tjubokawa (1983) [19]. Also studied coccinellid larvae of Japan. Singh and Phaloura (1994) [22]. published the preliminary characterization of the of Genus *Henosepilachna* based upon the larval characters and introduced a new term 'setulae' present on the scoli of the members of genus *Henosepilachna*.

Illustrated / field keys to the larvae of Coccinellidae had also been presented. Read (1965) [15]. Published field recognition features of three aphid feeding larvae of Coccinellidae. Storch (1975) published field recognition key to the larvae in the potato fields of Aristook County. Phaloura and Singh (1993) [14] had presented field key to the larvae of genus *Harmonia*. Rees *et al.*, (1994) [16] provided illustrated key to the larvae of 46 genera of North American Coccinellidae and slightly modified the glossary of larval armature provided by Gage (1920) [6]. Descriptions of the immature stages of *Scymnus (Neopullus) sinuanodulus* Yu and Yao was given by Lu *et al.*, (2002) [8]. Casari and Teixeira (2015) [2] had studied the larval characters of *Epilachna vigintioctopunctata* (Fabricius), *E. cacica*, *E. clandestine*, *E. peanulata*, and *E. spreta.* Sifting of literature reveals that studies on the larvae of Indian Coccinellidae are scarce. The present work provides detailed study of morphology with particular reference to the chaetotaxy of *Henosepilachna ocellata* (Redtenbacher) larvae, hitherto undescribed.

Materials and Methods

Larvae were obtained after rearing field collected adults, in laboratory cages, from Mandal (altitude 2000m, latitude 30.43 N, Longitude 83.40 E, Uttarakhand) and killed and preserved in 70% alcohol after killing these according to the method given by Roy and Basu (1977) [17]. Permanent as well as temporary mounts of the setae were prepared after dissecting and clearing the larva in 10% KOH solution. Diagrams wherever required were drawn with the help of camera-lucida or with the help of graph-eye-piece of binocular microscope.

Chaetotaxy of only the mature fourth instar larva of *Henosepilachna ocellata* (Redtenbacher) has been presented, while the younger instars are simply compared to highlight the differentiating characters, if any. The setal armature of coccinellid larvae is quite complex and variable and it is difficult to describe various setose structures unless some strict terminology is adhered to. For this purpose terminology defined by Gage (1920) [6] and later on used by other workers (e.g. Emden 1949; Sasaji, 1968; Savoiskaya and Klausnitzer, 1973) [12, 21] and modified by Rees *et al.*, (1993) has been followed.

An attempt has been made to draw the setal maps according to the method developed by Boving (1927) and revised by Pfaffenberger and Johnson (1976) [3] for bruchid larvae. But for the nomenclature of setae, Savoiskaya and Klausnitzer (1973) [12, 21] have been followed.

Results and Discussion

Kapur (1950) [11] considered the armature of the larvae of no importance but Savoiskaya and Klausnitzer (1973) [12, 21], Rees *et al.*, (1994) [16]. And Elora *et al.*, (2006) had found this

armature of considerable significance and of diagnostic value. Singh and Phaloura (1993) [14]. Had published a field key to the larvae of genus *Harmonia* and found these of utmost value. Similarly, Phaloura and Singh (1994) [22]. Studied and published preliminary larval characters of genus *Henosepilachna.* Considering the chaetotaxy of the larvae of importance the same is described here for Henosepilachna *ocellata* (Redtenbacher). Following descriptions unless otherwise stated pertain to the mature fourth instar larva. Measurements of different larval instars is given in table 1 and differences in chaetotaxy of younger larval instars are tabulated in table 2.

Table 1: Measurements of different larval instars of Henosepilachna ocellata (Redtenbacher)

Stage	Length	Breadth
Ist Instar	2.699 ± 0.073	0.731 ± 0.027
IInd Instar	4.930 ± 0.139	1.386 ± 0.057
IIIrd Instar	6.350 ± 0.211	1.413 ± 0.060
IVth Instar	10.220 ± 0.221	3.080 ± 0.122

Table 2: Comparative study of setal arrangement in different larval instars of *Henosepilachna ocellata* (Redtenbacher).

Fourth Instar Larva	Third Instar Larva	Second Instar Larva	First Instar Larva
Cranial Setae: Dorsally each parietal bears three setae on vertex and three along frontal suture; Frons bears eight, clypeus six, and labrum two pairs of setae. Ocellar region has two and subocellar three setae (Figs.1,2)	Similar to fourth instar larva.	Similar to fourth instar larva.	Positions of setae are similar to fourth instar but the two setae present on each parietal along frontal suture and a pair on frons where the frontal sutures diverge, are stout and capitate.
Setae of head appendages: Antenna bears 1-3 setae on second segment and many sensoria on second and third segments(Fig.3)	Antenna bears one seta on second segment and many sensoria on second and third segments.	Similar to third instar larva except dimensions of segments.	Similar to third instar larva except dimensions of segments.
Maxilla bears many setae on fused stipes and cardo and maxillary palpus, and their number and positions are not constant. Mala bears numerous curled setae (Figs.5,6)	Similar to fourth instar larva	Similar to fourth instar larva	Similar to fourth instar larva
Labrum bears three pairs of setae on submentum and four pairs on ligula (Fig. 5)	Similar to fourth instar larva	Similar to fourth instar larva	Similar to fourth instar larva
Mandible bears one long seta at outer basal end (Fig.4)	Similar to fourth instar larva	Similar to fourth instar larva	Similar to fourth instar larva
Thoracic setae: Prothorax with two dorsal plates, each having anteriorly the 'd' scolus 20-23 branched, 'l' scolus 16-20 branched and 'dl' unbranched, while a chalaza and six setae posteriorly (Fig.8; Pro-)	Prothorax with two dorsal plates, each having anteriorly 14- 16 branched'd' and 'l' scoli, and an unbranched 'dl ' scolus, while a chalaza and a seta posteriorly.	Prothorax with two dorsal platea, each having anteriorly 10- 12 branched'd' and ' I ' scoli and a un-branched 'dl' scolus, while a chalaza and a seta posteriorly.	Prothorax with two dorsal plates, each having anteriorly 5-7 branched'd' and 'l' scoli and an unbranched 'dl' scolus while a chalaza, a spatulate seta, and a group of hatching spines posteriorly.
'd', 'dl', and 'l' scoli of meso and meta segments 15-18 branched.	'd', 'dl' and ' I' scoli of meso and meta segments 10-12 branched	'd' and 'dl' scoli of meso and meta segments 7-B branched while ' I ' is five branched.	'd' and 'dl' scoli of meso and meta segments four branched but 'l' unbranched
Leg: Each leg consists of coxa~ trochanter, femur tibiotarsus and the tarsus, and bears many setae on each segment. Tibiotarsus bears many spatulate setae distally (Fig. 7).	Similar to fourth instar larva	Similar to fourth instar larva	Similar to fourth instar larva
Abdominal setae: 'd' I-VIII, 'dl' I-VIII and 'l' I-VII are formed by scoli, while '1' VIII by a verruca. and ninth and tenth terga bear setae only (Fig.9)	'd' I-VIII ', 'dl' VIII and '1' I-VI are represented by scoli, but '1' VII and VIII by verrucae, ninth and tenth terga similar to fourth instar.	'd' I-VIII,'dl ' I-VIII and '1' I-V are formed by scoli, but 'l' VI-VIII by verrucae, ninth and tenth terga similar to fourth instar.	'd' I-VIII, 'dl' I-VIII and '1' I-V are formed by scoli '1' VI-VIII by verrucae and ninth and tenth terga are similar to fourth instar.
'd', 'dl' and '1' I bear 14-16 branches (Fig. 9)	'd', 'dl' and '1' I bear 8-10 branches.	'd' and 'dl' I bear 6-8 while '1' I 4 branches.	'd' I and 'dl' I are 3-4 branched, while '1' I is unbranched.
Abdominal scoli bear 6-8 very fine setulae distributed all over the branches and main stem (Fig.9)	Abdominal scoli bear 3-5 fine setulae per scolus	Abdominal scoli bear 1-2 fine setulae per scolus.	Abdominal scoli lack the fine setulae altogether.
'v', 'vl' and 'pl' I-VIII are formed by verrucae, each having 4-6 setae (Fig.9)	'v', 'vl' and 'pl' I-VIII verrucae have 1-3 setae each.	'v', 'vl' and 'pl' I-VIII verrucae have 2-3 setae each.	'v', I-VIII verrucae have three setae each while 'vl' and 'pl' I-VIII are formed by a chalaza.

The head (Fig 1, 2)

Head hypognathous, triangular with rounded corners, narrow anteriorly and broad posteriorly. Vertex covered by fleshy anterior margin of prothorax. Head capsule divided into usual areas of parietals and frons by inverted Y-shaped ecdysial cleavage line, with clear coronal and frontal sutures marked by light colour of yellow against otherwise dark brown head (Fig. l). Frons slightly depressed in the middle and separated from the clypeus by fronto-clypeal suture notched in the middle. Clypeus trapezoidal and labrum marked from the clypeus by clypeo-labral suture.

Ventrally, head shows large occipital foramen bearing post-occipital ridge, without any demarcation of occipital and postoccipital regions. Gula sub-rectangular, lying anterior to the foramen and membranous for most of its part (Fig. 2).

Cranial setae (Fig 1, 2)

Dorsally parietals bear three minute setae on the vertex arranged in a cephalo-caudal manner and three long setae along the frontal suture. Frons bears eight pairs of setae (Fig.1). Clypeus with four pairs of long setae along its flanks and two pairs of short setae placed medially. Labrum bears two pairs of setae. Ocellar area bearing two moderately long setae while sub-ocellar area with three setae (Figs 2,).

The head appendages and their setae

Antennae long, three segmented, (antenomeres of Casari and Teixeira, 2015) [2] with basal segment as long as wide, the second about 2½ times longer than wide, bearing two peg-like sensoria (peg-like setae of Gage,1920) [6] of unequal length apically and three sensilla trichodea along its length. The third segment is knob-like and bears 3-4 sensoria (Fig. 3), described as sensorial appendage (Delucchi, 1954) [3], preapical (Sasaji, 1968) [18], large spine-like seta (LeSage, 1991) [7] or stout seta (Lu *et al.*, 2002) [8].

Mandibles strongly sclerotised, triangular, without retinaculum, bearing four large and one small teeth distally, mesal margin of the teeth serrated. Outer basal margin of mandible bearing a long seta (Fig. 4).

Maxilla bearing fused cardo and stipes, chitinised, with lobes membranous. Maxillary palps three-segmented with apical segment 2½ times longer than its width (Fig. 5). Lacinia and galea completely fused to form mala losing their separate identities, mala transversely rectangular and bearing sparsely arranged sensory hairs on ventral surface and densely curled apically blunt setae orally at the distal end, palpifer bearing one seta, palpus 3 segmented, segment 1 and 2 almost of equal size and apical segment 3 longest and triangular bearing 2 setae ventrally (Fig.5, 6).

Labium membranous for most of its part and bearing three pairs of setae on submentum and 2-3 pairs of short setae on the ligula. Labial palpus two segmented, the apical one bearing sensillae distally (Fig. 5).

The leg (Fig. 7)

Leg bearing an oblique coxa, a triangular trochanter and the femur slightly shorter than tibiotarsus. Pretarsus formed by a distinct hooked claw. All segments bearing numerous setae. The tibiotarsus additionally bearing many spatulate setae distally (Fig. 7).

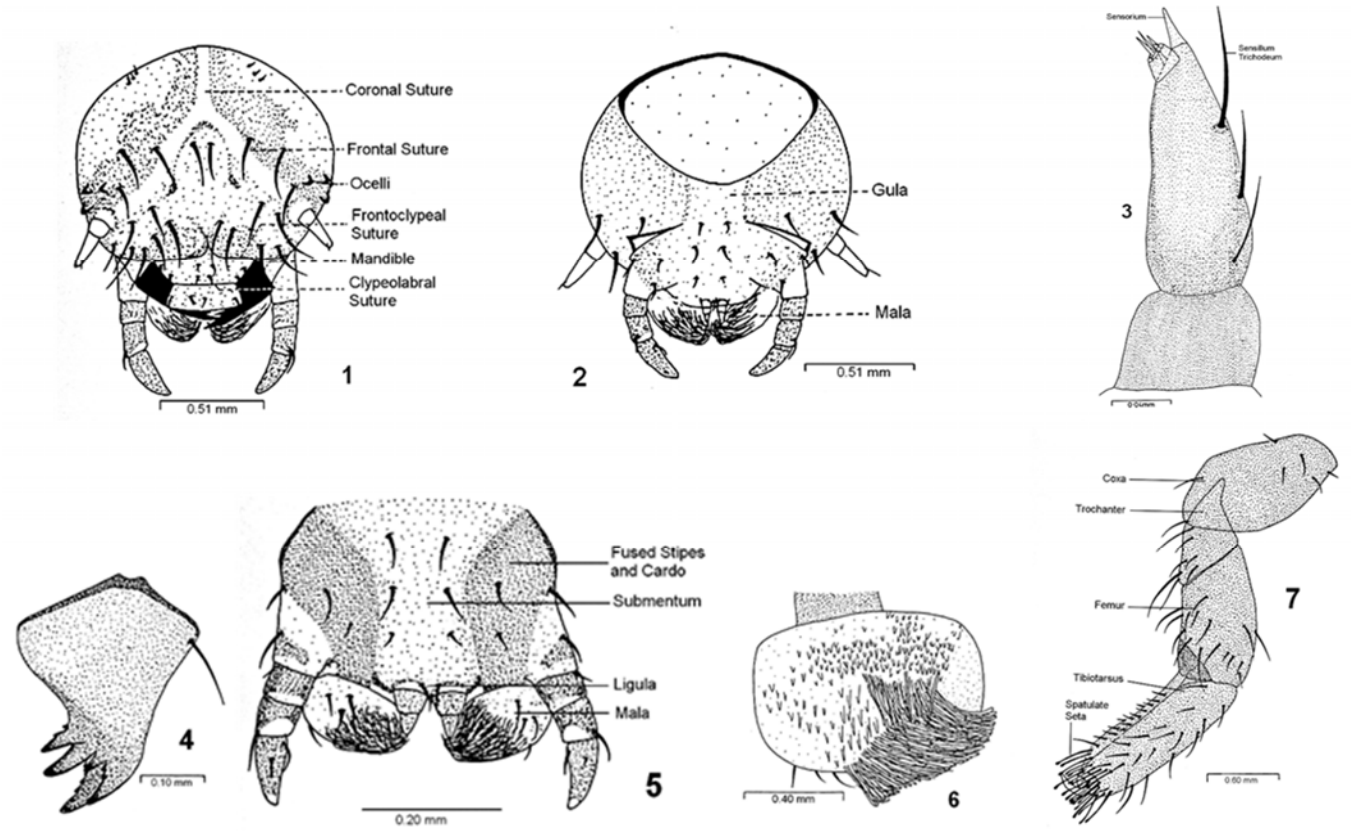

Fig 1-7

The thoracic setae (Fig. 8)

Pro, meso and metathoracic segments distinct, prothorax bearing a pair of triangular sclerotised dorsal plates, and three scoli arising anteriorly from each plate. Dorsal group (d) represented by a scolus, five times longer of its width at the base and bearing 13-15 long and 7-8 short branches (Fig. 8, 'd' pro-), branches either ending in short or long setae and interspersed on these branches are a few short 'spatulate setulae'. Phaloura and Singh (1994) [22] reported these spatulate setae in genus *Henosepilachna* and called them 'setulae' and treated this to be a preliminary diagnostic larval character of the genus *Henosepilachna* separating it from *Epilachna*. Branches and main stem of this scolus brunneous apically but gradually becoming hyaline towards bases and their apical setae piceous. Dorso-lateral group ('dl' pro-) represented by an unbranched scolus, brunneous apically and bearing a terminal long seta approximately 2/3rd of its length. Lateral group ('l' pro-) formed by a scolus bearing 13-15 long and 3-5 short branches ending up in either short or long setae apically, branches and main stem brunneous apically and gradually turning hyaline towards base. Posteriorly, each dorsal plate bearing a chalaza and six moderately long setae (Fig.8; pro-). Meso and metathoraces bearing three pairs of scoli each, longer as compared to those on the prothorax and each bearing 17-19 branches, always bearing short thick setae apically. The'd' scoli brunneous at apices and hyaline for the rest of their parts. The 'dl' and 'l' scoli with their apices brunneous and gradually fading to hyaline towards bases. The pinaculi of'd' and 'dl' of meso- and meta- segments fused forming a pair of sclerotised plate on either segment, while pinaculi of 'l' scoli remaining distinctly separate (Fig. 8).

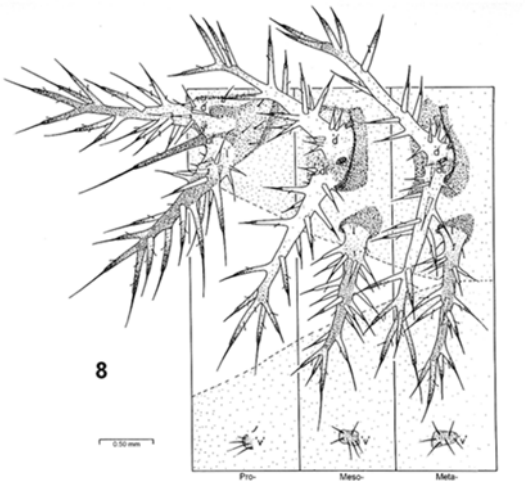

Fig 8

Ventrally, 'v' pro-, meso- and meta- are formed by verrucae each having 5-6 setae (Fig. 8).

The abdominal setae (Fig.9)

Abdomen ten segmented, 'd', 'dl', and 'l' groups of setose projections on first eight abdominal segments represented by branched scoli, that are long, about seven times of their width, and bearing 14-16 branches each ending in either a long or a short stout seta (Fig. 9). 'l' VIII formed by a verruca. Pinaculi of'd' I - VIII of either side fused to form common elliptical transverse plates while that of 'dl' I - VIII heart-shaped. The'd', 'dl' and 'l' scoli also differ in their pigmentation. 'l' I -VIII having main stems brunneous while hyaline for very little portion at the bases and their branches brunneous apically but hyaline basally (Fig. 9). 'd' I-VIII having main stems and branches brunneous only apically and hyaline for the rest of their lengths. 'dl' I-VI having main stems brunneous apically, gradually fading towards bases and their apical branches brown whereas basals hyaline. 'dl' VII-VIII having main stems and branches brunneous except for hyaline basal regions. Segments ninth and tenth bearing setae, not recognisable as distinct groups (Fig. 9).

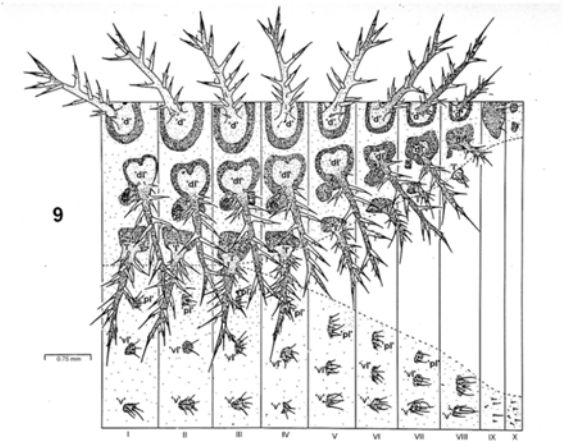

Fig 9

Ventrally, 'v', 'vl' and 'pl' I-VII formed by verrucae each having 4-8 long setae, 'vl' and 'pl' VIII merged and all groups merged on IX and X sterna (Fig. 9).

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