

Species – Specific Variation in the Structure of Male Genitalia of Ladybird Beetles (Coccinellidae: Coleoptera)

Neethu Roy D.^{1*}, Uma Maheswari T.², Sridevi G.³ and Raghavender B.⁴

¹Post Graduate student, Department of Entomology, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad, (Telangana), India.

²Department of Entomology, Associate Dean, Agricultural College, PJTSAU, Siricilla, (Telangana), India.

³Principle Scientist and Head, AINP on Pesticide Residues, PJTSAU, (Telangana), India.

⁴Ph.D. Scholar, Department of Entomology, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad, (Telangana), India.

(Corresponding author: Neethu Roy D.*)

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ABSTRACT: Present observations made on morphology of male genitalia of ladybird beetles (Coccinellidae: Coleoptera) belonging to 12 different species (*Brumoides suturalis*, *Chilocorus nigrita*, *Anegleis cardoni*, *Cheilomenes sexmaculata*, *Coccinella transversalis*, *Harmonia octamaculata*, *Hippodamia variegata*, *Illies cincta*, *Micraspis discolor*, *Propylea dissecta*, *Henosepilachna vigintioctopunctata* and *Scymnus nubilus*) from four subfamilies (Coccinellinae, Chilocorinae, Scymninae and Epilachninae) under stereozoom binocular microscope revealed that the variation in structure and size of genitalia which are species specific along with the morphometrics. Shape of the siphonal capsule, basal or median lobe being symmetrical or asymmetrical, shape of the parameres, length of the parameres in comparison to median lobe and shape of the median lobe which showed variation were recognized as important taxonomic signs of the male genitalia. The detailed diagnostic description of male genitalia were provided along with colour plates.

Keywords: Ladybird beetles, Coccinellidae, Male genitalia, Taxonomy, PJTSAU.

INTRODUCTION

Structure of male genitalia is species-specific and is the most important diagnostic character, in the absence of other reliable external diagnostic characters. Insects genitalia are complex and provide basis for species discrimination in most families and helps in family identification which are attached to the distal segments of the abdomen (Dobzhanskiy, 1926; Timberlake, 1943; Kapur 1958; Chapin, 1965; Shah and Khan, 2014). The uniqueness of male genitalia of a species lead to the use of the morphological study of genitalia as one of the most important keys in taxonomic identification of taxa below family level (Hoskins and Adrian, 2010; Chowdary *et al.*, 2015). Male genitalia of insects tend to be heavily sclerotized, rigid structures that are seemingly more diverse than female reproductive morphology, where species-specific male traits are more apparent to human investigators and are usually the primary focus of genital evolution studies (Richmond *et al.*, 2016). Structure of male genital tube in the order, Coleoptera was first time used as an important taxonomic tool, not only for the discrimination of different species of beetles, but also

their potential use in tracing out the phylogeny of various groups (Sharp and Muir, 1912). The study of genital structures has now been proved to be of considerable value to taxonomists when combined with data derived through other lines of investigation. Phylogeny of the Coccinellinae using male genitalia in addition to other morphological characteristics were studied (Watson, 1956). As ladybird beetles are important natural enemies of Agricultural pests, it is important to know the taxonomy with some of the scientific evidences including morphometric specifications structure of internal genital organs which ultimately help in proper identification of these predators. In this paper the general morphology of male genitalia of 12 different ladybird beetles were described along with their morphometrics.

MATERIAL AND METHODS

The present study was conducted at Department of Entomology, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad during *Kharif* 2019-2020. Ladybird beetle samples were collected from Student farm, College farm and ARI farm, Rajendranagar,

PJTSAU by net sweeping and hand picking. After collecting the beetles, they were killed by using ethyl acetate.

Preparation of male genitalia: Male genitalia were dissected according to the procedure given by Majerus and Kearns (1989) with few modification where the dry specimens of adult ladybird beetles were made soft by putting in hot water for 1 or 2 minutes. Later with the help of two entomological needles, abdomen was detached from the body and boiled in 10 per cent potassium hydroxide (KOH) solution for half an hour followed by cooling to room temperature and then were allowed to soak overnight in lactophenol solution to dissolve extra body tissues and some partially clear dense body formations. The processed abdomen was put in a cavity slide with a drop of glycerin and the abdomen was opened under stereozoom binocular microscope for the genitalia extraction. The extracted genitalia was mounted on a cardboard with the help of hydrosoluble glue which facilitates the entire abdomen to become completely transparent and permit to study the structure of genitalia.

Measurement of different parts of the male genitalia including length of tegmen, trabe, siphon and width of the siphonal capsule was made under stereozoom binocular microscope attached with computerized pixel TCapture software. Ten specimens of each of the species used for taking measurements in millimeter to get average values.

RESULT

Present studies on structure of male genitalia of 12 different species of ladybird beetles revealed that structure of the male genitalia is species-specific having parts viz., tegmen and siphon and was found to be the most important diagnostic character for identification of ladybird beetle species. However, for taxonomic identification, male genitalia varied structurally in terms of shape of the siphonal capsule, basal or median lobe being symmetrical or asymmetrical, shape of the parameres, length of the parameres in comparison to median lobe and shape of the median lobe which showed variation (Fig. 1).

(i) *Brumoides suturalis* (Fabricius). Phallobase; trabe was long, thin at the base and swallowing at its tip. Basal piece being short and sub circular, median lobe remained broader and round. Parameres were thin, cylindrical and slightly shorter than the median lobe. Outer arm of the Siphon was short while inner arm was long and swollen too. Siphonal tube remained thick throughout its length which formed broad loop and tips being slightly swollen.

(ii) *Chilocorus nigrata* (Fabricius). Parameres were thick, basally depressed and clothed with long hairs on dorsal side except at the base. Median lobe was longer than parameres and was broad for most of its length except at the apex which was pointed. Siphonal capsule asymmetrical, simple, outer arm long provided with membrane. Tube was circular from base to one third of its length than almost it was straight up to sub apex and apex remained turning inward.

(iii) *Anegleis cardoni* (Weise). Trabe of Phallobase was short and distally thick. Basal piece remained long and rectangular. Median lobe was distally expanded; tip deeply excavated. Siphonal capsule was large, outer arm long and inner arm was small hook like. Siphonal tube was bent, long, thick at the base, then straight and gradually narrowed towards the apex.

(iv) *Cheilomenes sexmaculata* (Fabricius). Siphon appeared strongly curved at the base and thread like apically; the siphonal capsule was well developed with the inner processes being rounded and external processes pointed. Siphonal capsule was asymmetrical, outer arm remained longer and inner arm was shorter. Tegmen trabe was long and broad distally where the basal piece was oblong. Parameres were long, thick, cylindrical and slightly bent at the base. Subapical portion broad and possess long hairs on subapical portion. Median lobe remained shorter than parameres and was thick for most of its length. However, outer side was straight and inner side remained convex slightly constricted apically. Apophysis of ninth abdominal segment was broad and bifid caudally.

(v) *Coccinella transversalis* (Fabricius). Tegmen was Y shaped and phallobase trabe was short and thick, where basal piece remained very broad and rectangular. Median lobe longer than parameres, wide deeply emarginated in the distal half of its length and tip remained extended forming a tongue like structure. Siphon was short and curved at the base and pointed at the apex. Siphonal capsule has inner processes that were hooked and bifid and external processes remained broad. Apophysis of ninth abdominal segment was bifid caudally, broad and rounded at the tip.

(vi) *Harmonia octamaculata* (Fabricius). Tegmen has short and broad lateral lobes with hairs at apex, median lobe shorter than lateral lobes where shape of the median lobe was characteristic. Siphon remained strongly curved at the base and straight apically where apex of the siphon remained spoon shaped with membranous projection; siphonal capsule inner processes were hooked and outer processes remained broadened. Apophysis of ninth abdominal segment was broad caudally and rounded or oval at the tip anteriorly.

(vii) *Hippodamia variegata* (Goeze). Trabe of phallobase was short, broad, apex wide and deeply concave. Basal piece was quadrate, equal in length to median lobe and median lobe was equal in size to parameres. Siphonal capsule was simple, tube forming loop, wide in the middle, when seen from below two arm like structures were observed as protruded which abruptly tapered up to the apex.

(viii) *Illies cincta* (Fabricius). Tegmen with elongated lateral lobes which was densely hairy at the apex, median lobe longer than lateral lobes. Siphon was strongly curved basally and apically. Apex of the siphon was spatula like and inner processes of siphonal capsule short and round, outer processes pointed. Apophysis of ninth abdominal segment remained elongated and bifid caudally.

(ix) *Micraspis discolor* (Fabricius). Tegmen has elongated long lateral lobes with densely hairy, median

lobe shorter than lateral lobes and the apex of median lobe was pointed. Apophysis of ninth abdominal segment was rounded at the anterior end. Siphon was strongly curved at the base, straight at the apex; siphonal capsule was well developed, apex of the siphon was hooked processes.

(x) *Propylea dissecta* (Mulsant). Trabe of phallobase was moderately long, slender, curved and basal piece remained oblong. Parameres were slightly curved, cylindrical, tip rounded. Median lobe; uniformly thick, tubular, length was equal to parameres. Siphonal capsule was normal, arm sub-equal in size, tube remained abruptly bent at the base, then straight up to the apex, tip constricted and convoluted in the form of hair like structure.

(xi) *Henosepilachna vigintioctopunctata* (Fabricius). Phallobase: Trabe was short, curved and basal piece remained small, oblong. Parameres were with an apical thorn, covered with hairs. Median lobe has basal knife edge beginning at the foot of parameres and a bulge beyond the middle, after which it curved up into an apical hook. Second half had two rows of hairs, hairs shorter than parameres. Siphon was gently curved at the base, then straight, ending in a point.

(xii) *Scymnus nubilus* (Mulsant). Tegmen was sparsely hairy and has a short median lobe with elongate and slender lateral lobes. Apophysis of the 9th abdominal segment expanded broadly at the distal end. Siphon strongly curved at the base with pointed apex and thread like; the inner processes of siphonal capsule was narrow, longer and outer processes broad and short.

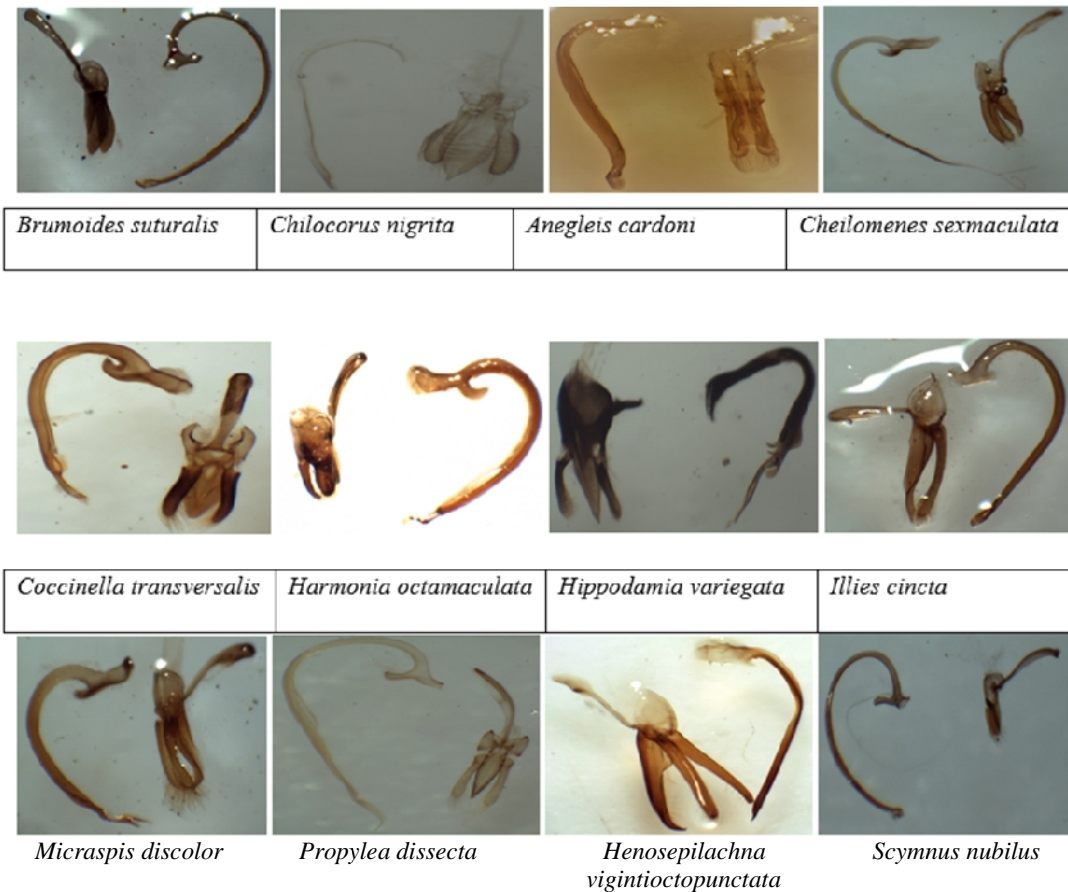


Fig. 1. Male genitalia of various ladybird beetles.

DISCUSSION

From the present study taken up on the measurement in variation in the structure of male genitalia of predatory ladybird beetles (10 no.) that were collected from different crop ecosystems feeding on aphids, leaf hoppers, whiteflies etc. Among all the beetles, it was clear that, the average length of the tegmen was found to be minimum of 0.36 mm in the case of *Scymnus nubilus* followed by *Brumoides suturalis* with 0.74 mm

and the longest tegmen of 1.28 mm was observed in *Chilocorus nigrita*. However, other species viz., *Propylea dissecta* with 0.90 mm, *Cheilomenes sexmaculata* with 0.95 mm, *Micraspis discolor* with 0.96 mm and *Coccinella transversalis* with 0.97 mm was recorded. More than 1 mm length of tegmen was observed in *Harmonia octamaculata* with 1.03 mm, *Anegleis cardoni* with 1.13 mm and *Hippodamia variegata* with 1.26 mm (Table 1).

Table 1: Morphometric measurements of male genitalia of different ladybird beetle species.*

Sr. No.	Name of the species	Length of the tegmen (mm)	Length of the trabe (mm)	Length of the siphon (mm)	Width of the siphonal capsule (mm)
1.	<i>Aneglies cardoni</i>	1.13	0.53	2.27	0.25
2.	<i>Brumoides suturalis</i>	0.74	0.61	2.93	0.32
3.	<i>Cheilomenes sexmaculata</i>	0.95	0.81	2.20	0.37
4.	<i>Chilocorus nigrita</i>	1.28	0.89	2.23	0.57
5.	<i>Coccinella transversalis</i>	0.97	0.73	2.23	0.55
6.	<i>Henosepilachna vigintioctopunctata</i>	2.59	1.32	3.92	0.73
7.	<i>Harmonia octamaculata</i>	1.03	0.88	3.58	0.72
8.	<i>Hippodamia variegata</i>	1.26	0.48	2.36	0.40
9.	<i>Illies cincta</i>	1.53	0.80	3.00	0.38
10.	<i>Micraspis discolor</i>	0.96	0.72	2.17	0.48
11.	<i>Propylea dissecta</i>	0.90	0.96	3.41	0.36
12.	<i>Scymnus nubilus</i>	0.36	0.54	1.89	0.25

* Average of 10 beetles

With regard to length of the siphon, the smallest was found in *Scymnus nubilus* measuring about 1.89 mm followed by *Micraspis discolor* of about 2.17 mm and the longest siphon was found in *Harmonia octamaculata* of 3.58 mm. However, other species viz., *Cheilomenes sexmaculata* with 2.20 mm, *Chilocorus nigrita* and *Coccinella transversalis* with 2.23 mm, *Aneglies cardoni* with 2.27 mm, *Hippodamia variegata* with 2.36 mm, *Brumoides suturalis* with 2.93 mm and *Propylea dissecta* with 3.41 mm. Apart from this, the phytophagous, *Henosepilachna vigintioctopunctata* has got longest tegmen which is measuring of 2.59 mm and the siphon of 3.92 mm and the mycophagous beetle, *Illies cincta* has the tegmen of measuring about 1.53 mm and the siphon of 3.0 mm (Table 1).

The length of tegmen and siphon of Coccinellids in pulses ecosystem viz., *Cheilomenes sexmaculata* with 1.2 mm tegmen and 2.0 mm siphon, *Coccinella transversalis* with 1.6 mm tegmen and 1.9 mm siphon, *Harmonia octamaculata* with 1.9 mm tegmen and 1.0 mm siphon and *Micraspis discolor* with 1.7 mm tegmen and 1.5 mm siphon (Rani, 2016).

The male genitalia of 12 different ladybird beetles were analysed belonging to the four subfamilies. Results obtained reflect the detailed dissections and observation of each part of the male genital structure that was being used in the taxonomy of the group. The characteristics of the male genitalia were used with great reliability for both identification and phylogenetic analyses for devising more consistent diagnostic characters for species and genera.

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Conflict of Interest. None.

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