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Taxonomic studies of predacious coccinellid species on pulses in Guntur district, Andhra Pradesh

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Abstract

“Taxonomic studies of predacious coccinellid species on pulses in Guntur district” were conducted at the Department of Entomology, Agricultural College, Bapatla during 2015-16. The survey was conducted in ten major pulses cultivating mandals of Guntur district, Andhra Pradesh and collected coccinellid beetles from greengram, blackgram, redgram and cowpea fields. About 999 ladybird beetles were collected and described, identification was conducted on the basis of morphological characters and genitalia. Six species were identified in three sub families and three tribes of family Coccinellidae of Guntur region, A.P. Among these coccinellid beetles, four species, *Cheilomenes sexmaculata*, *Coccinella transversalis*, *Harmonia octomaculata* and *Micraspis discolor* belonged to subfamily Coccinellinae and tribe Coccinellini, *Scymnus (pullus) coccivora* Ayyar in subfamily Scymninae and tribe Scymnini, *Brumoides suturalis* belonged to subfamily Chilocorinae and tribe Chilocorini of family Coccinellidae were identified.

Keywords: Coccinellid beetles, coleoptera, taxonomy, pulses, Guntur, Andhra Pradesh

Introduction

Pulses are rich in proteins and found to be main source of protein to vegetarian people and second important constituent of Indian diet after cereals. India is the largest producer, consumer and importer of pulses in the world. Pulses are being cultivating in 24-26 M ha of area by producing 17-19 M t annually in India and occupied one third of the total world area and 20 per cent of total world production (Laxmipathi *et al.*, 2013) [11]. Pulses are attacked by sucking pests like aphids, whiteflies, thrips, mites, leaf hoppers, cowbugs, which are biologically controlled by coccinellid predators that are promising predatory biocontrol agents (Mandour *et al.*, 2013) [14]. The ladybird beetles have been known worldwide as predators on number of insects and distributed in many countries of Asia, including India (Singh and Brar, 2004) [16]. Greater number of coccinellid species are predators during the larval and adult stages upon aphids and mealybugs. *Coccinella transversalis* feed on many species of aphids (Mani *et al.*, 1995) [13]. The use of insecticide not only check the pest but also creates pollution in the atmosphere, physiological disorders in man and disturbs the regional agro-ecosystem and the natural balance. On the contrary predacious coccinellids have been successfully employed in control of some herbivorous insects. The spectacular success of the vedalia beetle [*Rodalia cardinalis* (Mulsant)] was in fact the harbinger of classical biological control. In 1929 scale insect was found notorious in India and it was successfully kept under check with the introduction of *R. cardinalis* from California (Hagar and Awadalla, 2015) [7]. Six subfamilies are recognized by the taxonomists from the family Coccinellidae, those are Chilocorinae, Coccinellinae, Coccidulinae, Scymninae, Sticholotidinae and Epilachninae. Of these six subfamilies, five are predacious and one is phytophagous *i.e.* Epilachninae (Ashfaq *et al.*, 2013) [1].

Materials and Methods

The survey was conducted to collect coccinellid beetles from 10 mandals in the Guntur district viz., Guntur, Bapatla, Mangalagiri, Chebrolu, Ponnur, Kakamanu, Pedanandipadu, Thadikonda, Thullur and Vatticherukur. Each village was visited thrice and collected ladybird beetles by hand picking and sweep net method from different habitats like greengram, blackgram, redgram and cowpea fields. The mandal and crop wise collected coccinellid

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specimens were kept separately in neat labeled plastic vials. Immature stages like eggs, grubs, pupae of coccinellids were also collected directly from the habitats and preserved in 70% ethyl alcohol in labeled plastic vials. The collected adult specimens were arranged in insect collection boxes and kept naphthalene balls to protect the specimens from other scavenging insects. All the specimens were maintained at Department of Entomology, Agricultural College, Bapatla for their taxonomic studies.

The village wise and crop wise collected adult lady bird beetles were killed with the help of cotton swab dipped in ethyl acetate. The died specimen were dried in hot air oven at 45-50°C for about 6 hours and the dried specimens were stored in small glass vials and labeled. The oven dried coccinellid specimens were mounted singly on white thick cardboard triangular points and glued on the ventral side of thoracic region in between middle and hind pair of legs to study the head, wings, legs and abdomen from all the desired angles. The printed label with the information regarding locality, date of collection, host and name of the collector, was fixed separately to the entomological pin containing the coccinellid specimen.

Dissection of genitalia and mouthparts of coccinellid adults

To identify the sex of the collected coccinellid beetles dissections were conducted under microscope. For dissection of both male and female genitalia, the coccinellid specimens were gently supported on a dissection tray on its back. The abdomen was detached from the thoracic region under the binocular microscope with the help of micro needles by pressing at the junction of thorax and abdomen. The detached abdomen was transferred with the help of camel hair brush to the cavity blocks containing a few milliliters of freshly prepared 10 per cent KOH and kept them overnight at room temperature to facilitate digestion of soft tissues. The abdomen was removed from KOH solution and transferred gently with the help of blunt needles to a glass cavity dish containing distilled water. The digested soft tissues were pressed out. After repeated washings in distilled water, the abdomen was transferred to a glass slide containing one or two drops of glycerine for genitalia dissection. The above said treatments facilitate the entire abdomen to become completely transparent and permit to study the genitalia.

The same procedure was followed for digestion of the hard tissues for dissecting the mouth parts. After completion of dissection, the permanent slides were prepared with dissected parts. The above village wise crop wise collected specimens were identified based on their morphological characters like antennae and elytra with the help of training manual of University of Agricultural Sciences Bangalore on Taxonomy of Insects and Mites 2014. All the species identified by Dr. J. Poorani, Systematist in Coccinellidae and also by using keys published in pertinent literature and the check list (Poorani, 2002) [15] to confirm the identifications based on male and female genitalia structures.

Results and Discussion

A total of 999 collected coccinellid specimens were examined and found six genera during the present study. Out of which, four species namely *Cheilomenes sexmaculata* (473 no.), *Coccinella transversalis* (444 no.), *Harmonia octomaculata* (53 no.) and *Micraspis discolor* (15 no.) were belonged subfamily Coccinellinae, one species *Scymnus (pullus)*

coccivora Ayyar (9 no.) belonged to subfamily Scymninae and one species *Brumoides suturalis* (5 no.) belonged to subfamily Chilocorinae were identified based on their morphological characters and genitalia.

Key to the Subgenera of the Genus Scymnus

1. Antennae 10 segmented; postcoxal line incomplete, curved forward apically; male 5th and 6th abdominal sterna truncate or emarginated apically -----
-----[-----*Scymnus (Scymnus)*.
- 1' Antennae 11-segmented; postcoxal line complete, recurved apically, reaching base of first abdominal sternum; 5th and 6th abdominal sterna moderately to strongly emarginate and impressed posteriorly -----
-----*Scymnus (Pullus)*.

Key to the Genera of Subfamily Coccinellinae

1. First abdominal line arched. Body oval to slightly elongated-----*Adalia*
- 1'. First abdominal line curving outward to sides of body. Body not oval-----2
2. Epipleura moderately broad and horizontal. Presternal carinae indistinct-----
-----*Coccinella*
- 2'. Epipleura very broad. Presternal carinae distinct-----
-----3
3. Prosternum with two carinae terminating before anterior margins. Anterior margins of meso-sternum distinctly emarginated-----4
- 3'. Prosternum with two carinae reaching anterior margins. Anterior margins of meso sternum slightly emarginated-----5
4. Antenna 11 segmented, last segment of antennae bulged, post coxal line straight not reaching the anterior line, femoral line slightly curved and reaching the posterior margin legs densely hairy tarsus four segmented and ending with a pair of claws-----
-----*Illeis*
- 4' Antenna 11 segmented, last segment of antennae beak shaped, post coxal line straight and complete, femoral line straight but incomplete legs simple pseudotrimerious or cryptotetramerous tarsi with apically bifid claw -----*Micraspis*
5. Antennal club loose, antennal last segment rounded at apex. Epipleura reaching to anterior margins-----
-----*Propylea*
- 5'. Antennal club compact, antennal last segment truncate -----6
6. Clypeus with anterior margins arched-----
-----*Cheilomenes*
- 6'. Clypeus with anterior margins not arched-----
-----7
7. Clypeus with anterior margins deeply excavated. Tibia with two distinct spurs-----
-----*Aiolocaria*
- 7'. Clypeus with anterior margins straight. Tibial spurs lacking or indistinct-----8
8. Elytral base broader than pronotal base, elytra bordered. First abdominal line complete-----
-----*Harmonia*
- 8'. Elytral base equal to pronotal base, elytra not bordered. First abdominal line incomplete-----
-----*Calvia*

Identification of Species of Subfamily Chilocerinae

Very few number of *Brumoides suturalis* (Fabricius) (5) adults were examined all collected specimens were females only.

Coccinella suturalis: Fabricius, 1798: 78 [5].

Brumus suturalis: Mulsant, 1850: 494 [14] Kapur, 1942: 56 [9]

Brumoides suturalis: Chapian, 1965: 237 [3]

Diagnosis and adult external morphology: Head, antennae and pronotum brown; elytra yellowish brown with two longitudinal black stripes on each elytron, starting from the humeral angle and ending before reaching the reddish area at the tip of the elytron. Legs brown in colour. The ventral side of the body brown to dark brown. Body oval, glabrous, moderately convex above. Head with a prominent pair of eyes which, when the head is retracted, are slightly covered by the

pronotum. Frons widened posteriorly, antennal insertions covered by the expanded clypeal margin. The antennae 9 segmented with small sensory hairs all over. Anterior margin of pronotum deeply, trapezoidally concave, lateral portions strongly descending below; elytral base distinctly broader than pronotal base. Scutellum triangular. A median longitudinal black stripe which extends from the scutellum to the apex of the elytra; Coxal line complete, tibiae angulate externally and legs with a pair of simple claws at the terminal tarsal joint.

Genitalia

Female genitalia

Spermatheca elongated, kidney shaped, basally rounded with very small accessory gland. Infundibulum present (Plate 1).

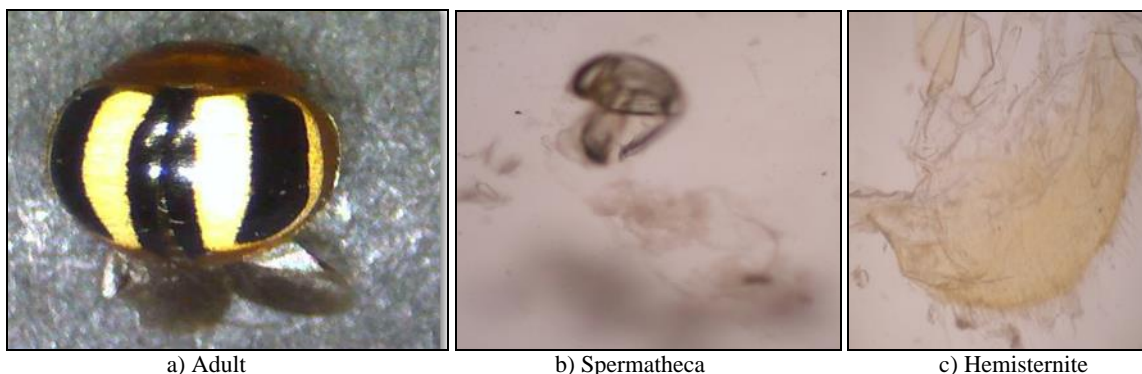


Plate 1: Female genitalial structures of *Brumoides suturalis*

Identification of species of subfamily scymninae

Very few (9) number of *Scymnus (Pullus) coccivora* Ayyar female (4) and male (5) adults were examined.

Scymnus coccivora: Ayyar, 1925: 491 [2].

Scymnus (Pullus) coccivora: Korschefsky, 1931: 142 [10].

Pullus coccidivora: Chelliah, 1963: 165 [4].

Diagnosis and adult external morphology: Adult was small, elongated-oval, moderately convex in shape. Body brownish yellow with dark purplish brown markings on elytra. Elytra had a glass shape longitudinal spot on basal half, completely devoid of markings. Eyes small; labrum slightly notched; terminal segment of labial palp small pointed. Tibia with hairs. Postcoxal line semicircular; postcoxal process slightly notched; terminal sternite with posterior margin with hairs

entire.

Genitalia

Male genitalia

Sipho pointed, anteriorly thick, siphonal capsule screw driver shaped; tegmen basal piece short, trigonal with thick margins; median lobe longer than parameres, terminally slightly upwarded; parameres short, spotted, straight (Plate 2).

Female genitalia

Genital plates elongated and trigonal in shape; 10th tergite narrow medially with elongated lateral arms; spermathecal capsule with only elongated oval cornu, basally broader and oval (Plate 3) the part between cornu and basal region narrow and constricted.

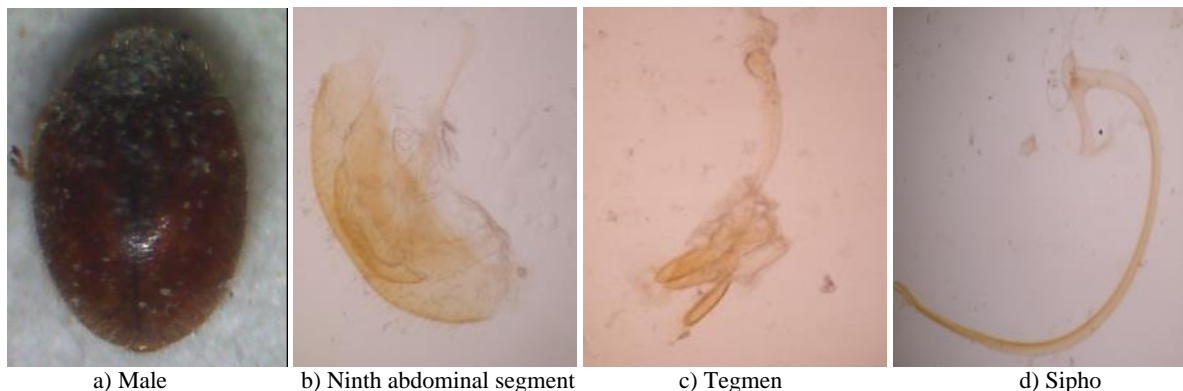


Plate 2: Male genitalial structures of *Scymnus (pullus) coccivora* Ayyar

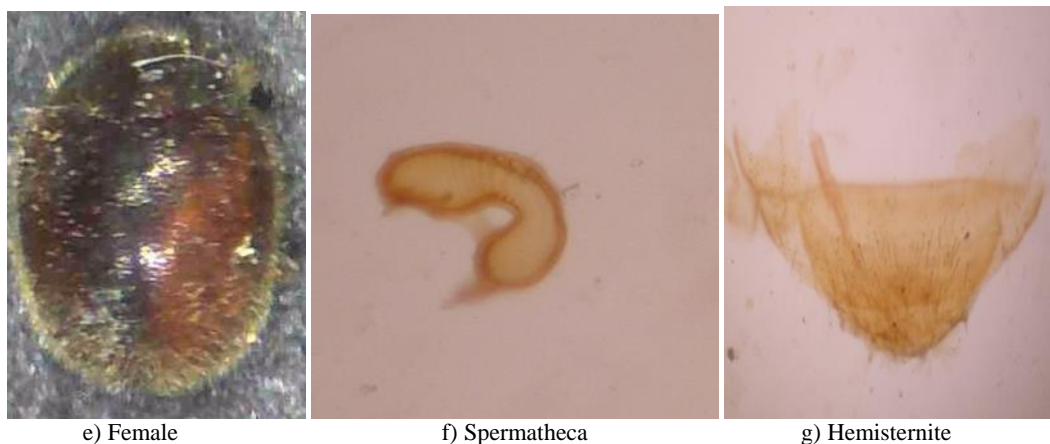


Plate 3: Female genitalial structures of *Scymnus (pullus) coccivora* Ayyar

Identification of species of subfamily coccinellinae

Cheilomenes sexmaculata:

Out of 473 number of *Cheilomenes sexmaculata*, female (214) and male (249) adults were examined.

Coccinella sexmaculata: Fabricius, 1781: 96 [5].

Cheilomenes sexmaculata: Mulsant, 1850: 444 [14].

Menochilus sexmaculatus: Timberlake, 1943: 40 [18].

Diagnosis and adult external morphology: Medium sized beetles with broadly oval to rounded body, glabrous, shiny and moderately convex. Bright orange to yellow in colour. Head pale yellow to yellowish, not visible from above completely covered by pronotum and punctate. Pronotum with a T shaped median band on anterior side, connected to a broad black band on posterior margin. Eyes black in colour, antennae 11 segmented and mouth parts brown in colour. Scutellum is brown in colour. Elytra brownish yellow with six black markings including two transverse zig zag patches and a posterior round black spot. Sutural line with a broad black stripe. On each elytra first patch may be small inverted V shaped, the second complete W shaped. Narrow longitudinal brownish black band along the line of junction of elytra. Ventral side of the body brown in colour. Legs brown to black

in colour with pseudotrimerous tarsi end with a pair of claws and tarsal segments densely hairy. Females are larger than males, colour variable, elytra with or without markings. Femoral line strongly curved reaching the posterior margin of sternum.

Genitalia

Male genitalia

Sipho strongly curved at base and thread like apically; the siphonal capsule well developed, the inner processes rounded and external processes pointed. Siphonal capsule outer arm longer and inner arm shorter. Siphon curved at base and thread like apically. Basal piece oblong. Parameres cylindrical slightly bent at base. Long hairs on subapical portion. Apophysis of ninth abdominal segment broad and bifid caudally (Plate 4).

Female genitalia

Spermatheca short, stout and curved; in ventral view spermatheca kidney shaped, broadened at base, and attached to the infundibulum with the help of thread or spring like processes. Hemisternite cone shaped with stylus slightly hairy at base (Plate 5).

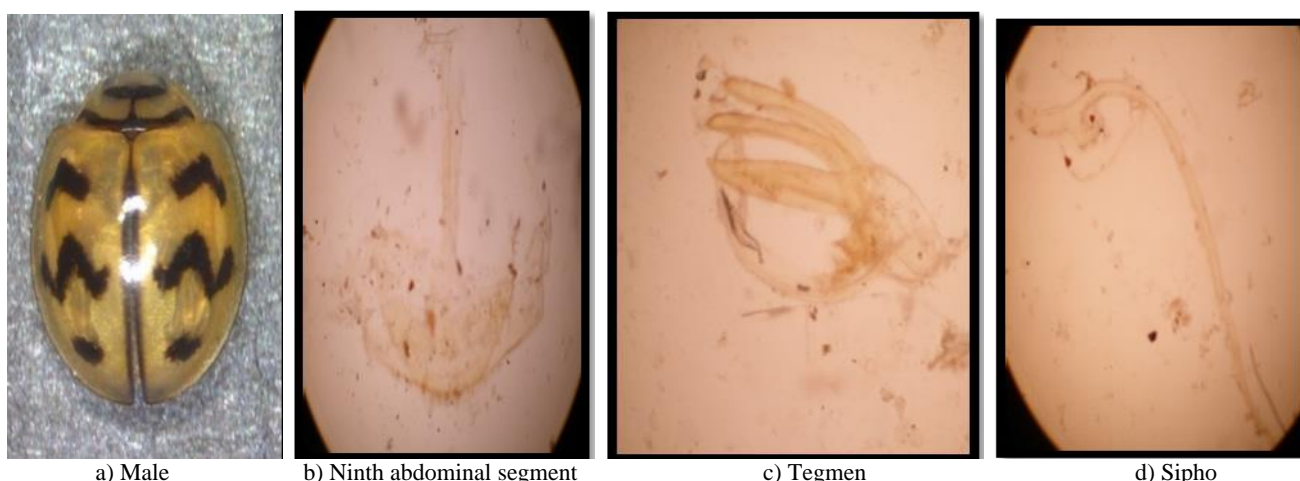


Plate 4: Male genitalial structures of *Cheilomenes sexmaculata*



Plate 5: Female genitalial structures of *Cheilomenes sexmaculata*

Coccinella transversalis

Out of 444 number of *Coccinella transversalis*, female (241) and male (203) adults were examined.

Coccinella transversalis: Fabricius, 1781: 97^[5] -Mulsant, 1850: 126^[14].

Coccinella repanda: Thunberg, 1781^[17]: 18-Mulsant, 1850: 1022^[14].

Diagnosis and adult external morphology: Body oval in shape, strongly convex with dark yellowish orange to brick red colour. Mouth parts, antenna, eyes, pronotum and scutellum were black to dark brown in colour. Head black in colour, with two pale yellow spots on each side near eyes. Head, pronotum and elytra densely punctate. Pronotum broad with orange to yellow anterior lateral areas. Elytra sparsely punctate with black markings, commissural line black. Epipleuron well developed. Legs and ventral side of the body fully black. Antenna 11 segmented, last segment rounded.

The scape broad, long twice than pedicel. Coxal line curved and complete femoral line angulate. Legs pseudotrimerous end with a pair of claws.

Genitalia

Male genitalia

Tegmen with Y shaped. Phalobase trab short and rectangular. Median lobe longer than parameres wide deeply emarginated in the distal half of its length tip extended forming a tongue like structure. Siphonal short and curved at base and pointed at apex. Apophysis of ninth abdominal segment caudally bifid, broad and rounded at tip (Plate 6).

Female genitalia

Hemisternite transverse oval to rounded and having stylus with sparsely setaceous. Spermatheca strongly curved and having infudibulum. Nodulus, ramus cannot be differentiated (Plate 7).

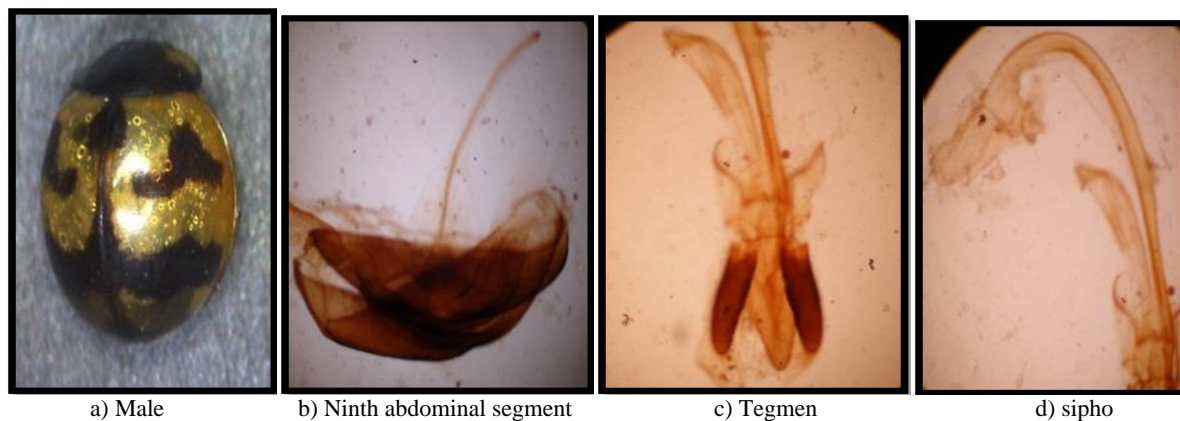


Plate 6: Male genitalial structures of *Coccinella transversalis*

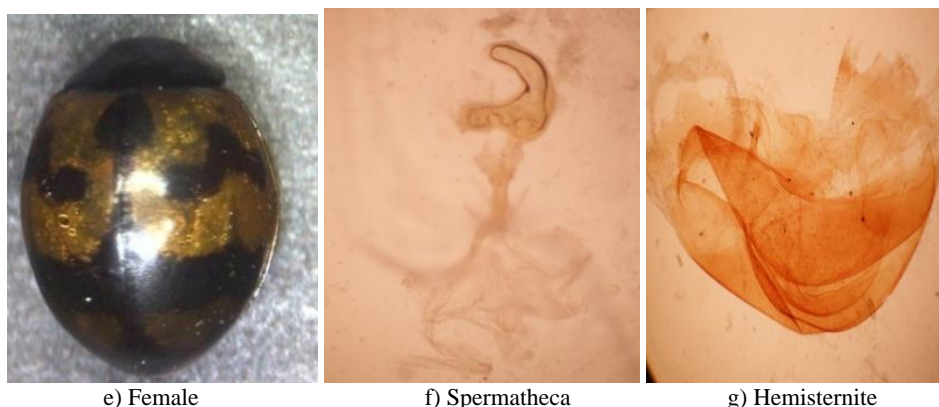


Plate 7: Female genitalial structures of *Coccinella transversalis*

Harmonia octomaculata

Out of 53 number of *Harmonia octomaculata*, female (29) and male (24) adults were examined.

Coccinella octomaculata: Fabricius, 1781: 97 [5].

Harmonia arcuata var. *Octomaculata*: Mulsant, 1850: 80 [14].

Harmonia octomaculata: Mulsant, 1850: 177 [14].

Diagnosis and adult external morphology: Oval shaped body widen at the middle of the body or elytra. Dorsally convex with reddish brown to orange in colour. Head broad orange to pale brown in colour with a pair of prominent black eyes. Pronotum reddish brown strongly trapezoidally excavated surface punctate. Antennae, mouthparts and legs, epipleuron reddish brown in colour. Antennae 11 segmented, the last segment bulged. Venter side of the body and scutellum were dark brown in colour. Epipleuron well developed with an inner carina that reached the elytral apex.

Scutellum triangular and basal margin longer than lateral margin. Legs simple with 4 segmented tarsi ending with a pair of claws. Elytra sparsely punctate. Post coxal line strongly curved and almost reached the anterior margin. Femoral line angulate.

Genitalia

Male genitalia

Tegmen with short and broad lateral lobes with hairs at apex. Siphon strongly curved at apex of siphon spoon shaped with membranous projection; siphonal capsule inner processes hooked and outer processes broadened. Apophysis of ninth abdominal segment broad at caudally, rounded oval tip anteriorly (Plate 8).

Female genitalia

Spermatheca strongly curved, C' shaped (Plate 9).

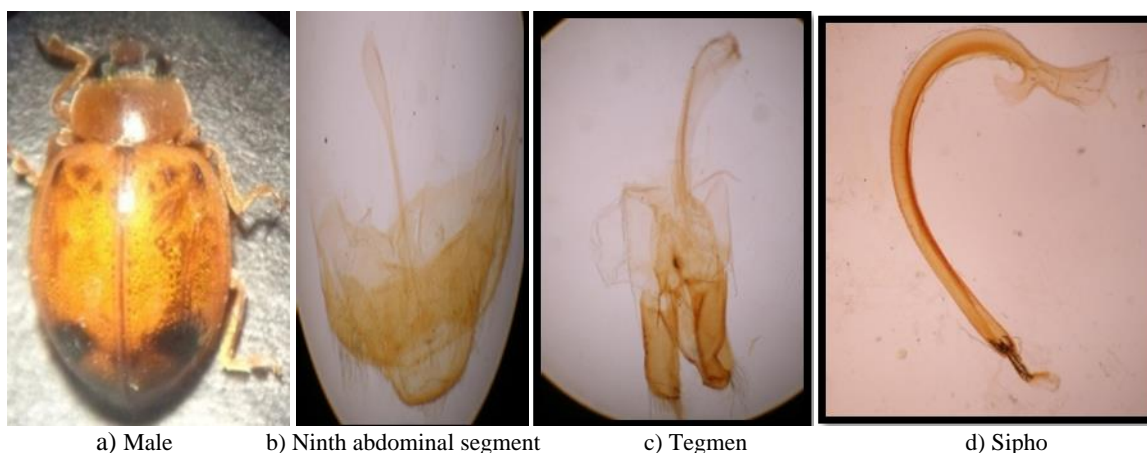


Plate 8: Male genital structures of *Harmonia octomaculata*

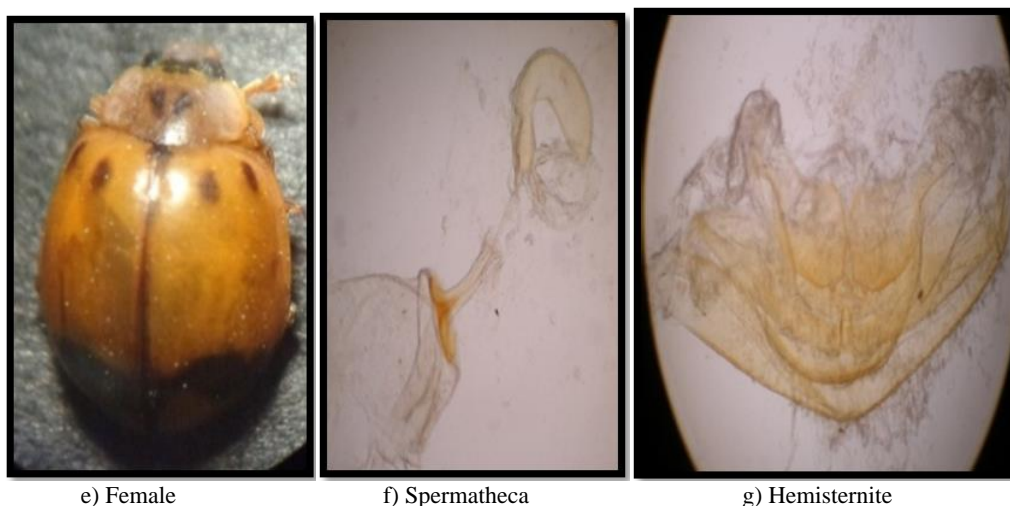


Plate 9: Female genital structures of *Harmonia octomaculata*

Micraspis discolor

Minimum number of (15) *Micraspis discolor* female (8), male (7) adults were examined.

Coccinella discolor: Fabricius, 1798: 77 [6].

Verania discolor: Mulsant, 1850: 369 [14].

Micraspis discolor: Kamaya, 1965: 60 [8].

Diagnosis and adult external morphology: Body is oval, convex dorsally and glabrous. Females bright orange in color and males pale yellowish to orange in colour. Head yellow

and compound eyes black in color. Antennae 11 segmented, last 3 segments formed club. Mouth parts and pronotum pale yellow to yellowish white in colour with black spots or patches towards proximal end. Pronotum having half moon shaped black marking at posterior end. Scutellum black, elytra orange in colour with black commissural line. Legs dark brown and simple, pseudotrimerous or cryptotetramerous tarsi with apically bifid claw. Post coxal line straight and complete. Femoral line straight but incomplete. The elytral epipleuron continuation up to underside or Epipleuron is well developed.

Genitalia

Male genitalia

Siphon strongly curved at base, straight at apex; siphonal capsule well developed, apex of siphon with hooked processes. Tegmen having elongated long lobes with densely hairy and the apex of median lobe is pointed. Apophysis of

ninth abdominal segment rounded at anterior end (Plate 10).

Female genitalia

Spermatheca curved and C shaped, the spermatheca attached to the inverted Y shaped infundibulum. Hemisternite transverse, oval in shape and stylus absent (Plate 11).

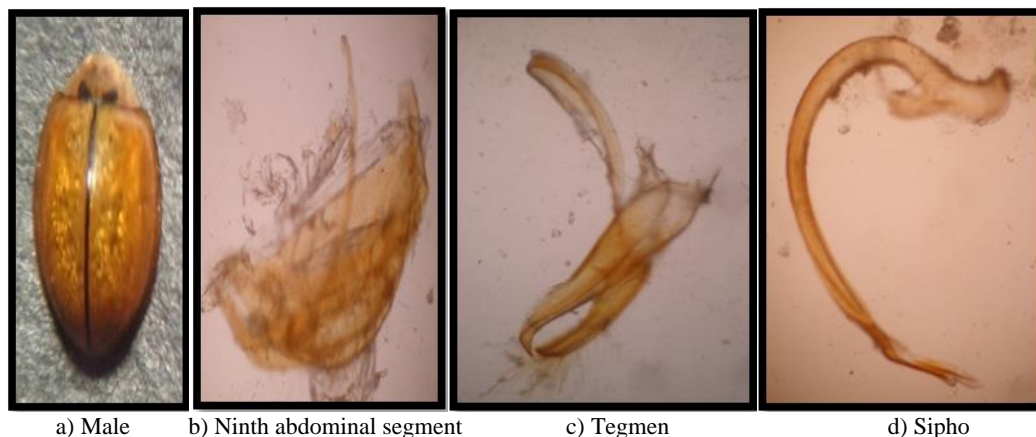


Plate 10: Male genital structures of *Micraspis discolor*



Plate 11: Female genital structures of *Micraspis discolor*

Table 1: Coccinellid beetles recorded from different mandals of Guntur district, A.P during 2015-16.

S. No	Coccinellid species	Different mandals of Guntur district										Total no of species
		Guntur	Bapatla	Mangalagiri	Chebrolu	Ponnur	Kakamanu	Pedanandipadu	Thadikonda	Thullur	Vatticherur	
A)	Sub family: Coccinellinae											
(I)	Tribe : Coccinellini											
1)	<i>Coccinella transversalis</i> (Fabricius)	100	49	40	60	50	40	25	30	10	40	444
2)	<i>Micraspis discolor</i> (Fabricius)	-	14	1	-	-	-	-	-	-	-	15
3)	<i>Cheilomenes sexmaculata</i> (Fabricius)	90	53	75	30	30	25	45	35	40	50	473
4)	<i>Harmonia octomaculata</i> (Fabricius)	11	12	6	-	5	3	7	4	-	5	53
B)	Sub family : Scymninae											
(II)	Tribe : Scymnini											

I)	<i>Scymnus (pullus) coccivora</i> Ayyar	2	3	4	-	-	-	-	-	-	-	9
C)	Sub family : Chilocorinae											
III)	Tribe : Chilocorini											
I)	<i>Brumoides suturalis</i> (Fabricius)	1	2	2	-	-	-	-	-	-	-	5
Total no of species		204	133	128	90	85	68	77	69	50	95	999

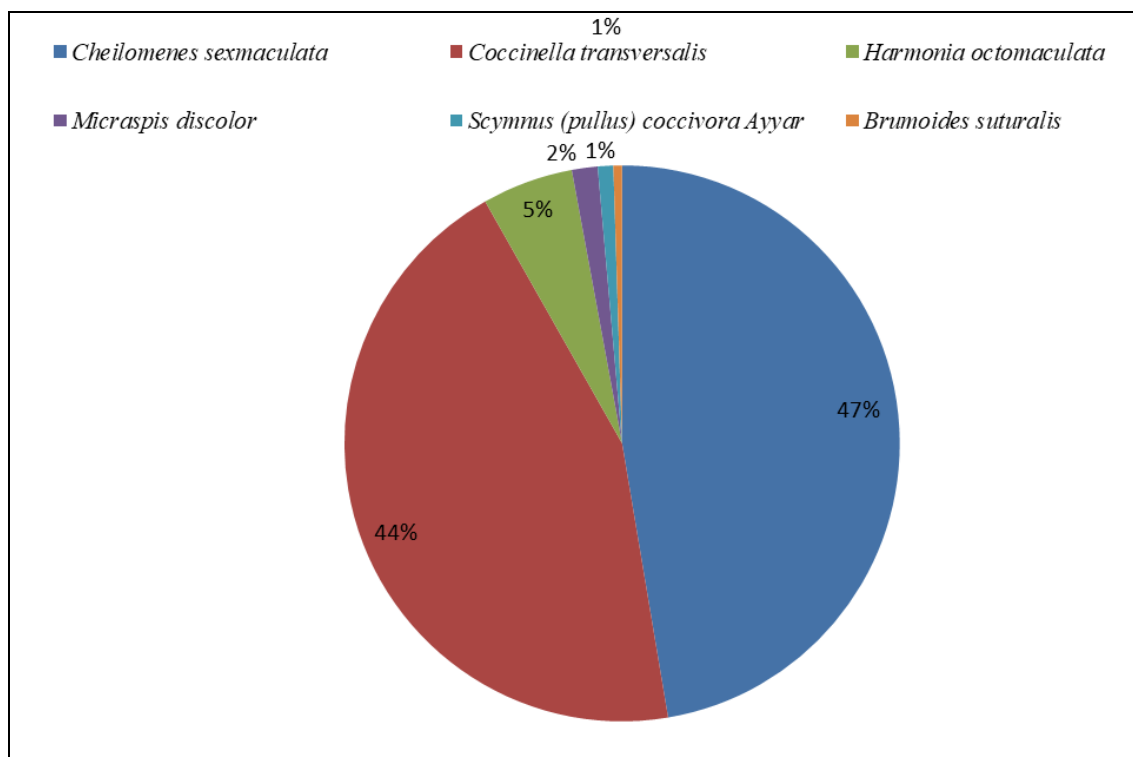


Fig 1: Mandal wise species composition of coccinellid predators in Guntur district, A.P.

Conclusions

The collected coccinellid specimens were described and identified with the help of literature, taxonomic keys given by different systematists Kapur, Kuznetsov, Canepari and Milanese, Inayatullah, and also by Poorani. A total of 999 collected coccinellid specimens were examined and found six genera during the present study. Out of which, four species namely *Cheilomenes sexmaculata* (473 no.) (♀214, 249♂), *Coccinella transversalis* (444 no.) (♀241, 203♂), *Harmonia octomaculata* (53 no.) (♀29, 24♂) and *Micraspis discolor* (15 no.) (♀8, 7♂) were *Scymnus nubilus* (9 no.) (♀4, 5♂) *Brumoides suturalis* (5♀ no.) were identified based on their morphological characters and genitalia. *Cheilomenes sexmaculata*, *Coccinella transversalis* and *Harmonia octomaculata* were the abundant and prevailing species in almost all pulse crop ecosystems of Guntur region, A. P. Hence, these species can be multiplied and supplied to the farmers as a part of IPM based management strategies especially against sucking pests like aphids in pulses

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