Taxonomic redescription of the species of subfamily Chilocorinae (Coleoptera: Coccinellidae) from Jammu and Kashmir, India

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Abstract
Ladybugs are diverse group of living organisms. They belong to family Coccinellidae of order Coleoptera. The family has been subdivided into six subfamilies: Sticholotidinae, Chilocorinae, Scymninae, Coccinellinae, Coccinellinae and Epilachninae. These are universal predators and occupy important place in biological control. In this paper four species of the subfamily Chilocorinae have been collected and redescibed as no taxonomic work has been done on this group in Kashmir, India. This paper provides a detailed taxonomy of Chilocorus infernalis, Chilocorus rubidus, Priscibrumus arogyialis and Platynaspidius saundersi on the basis of advanced taxonomic character that is male genitalia. Detailed description of adults, male genitalia and taxonomic keys are provided for each species along with color plates.

Keywords: Chilocorinae, Kashmir, male genitalia, taxonomy, taxonomic keys.

Introduction
Coccinellids are commonly known as ladybird beetles. These are known for their predacious nature. They belong to the order Coleoptera, suborder Polyphaga, super-family Cucujoidea and family Coccinellidae. The family Coccinellidae comprises 6,000 described species worldwide and is divided into six subfamilies: Sticholotidinae, Chilocorinae, Scymninae, Coccinellinae, Coccinellinae and Epilachninae although a recent phylogeny suggests a seventh subfamily, Ortalininae (Fursch 1990; Kovar 1996; Slipinski 2007) [8, 17, 29]. Of these sub-families Epilachninae is phytophagous and rests are predatory (Slipinski 2007) [29]. The sub-family Chilocorinae occupies the most important position as its members possess predacious nature against scale insects, aphids, mealy bugs and psyllids (Hayat et al. 2017) [11]. The individuals of this sub-family are shiny color and usually have no spots or patterns on their elytra. This sub-family was investigated by many authors throughout the world like (Kirsch 1871; Crotch 1874; Bedel 1892; Andres1913; Stephens 1832) [16, 6, 7, 4, 2, 32]. It was Dobzansky (1926) that laid the foundation of the modern classification of the genus Coccinella based on the structure of male and female genitalia. From Indian subcontinent, Joshi and Sharma (2008) [12] recorded Brumoides suturalis (Fabricius) and Chilocorus nigritus (Fabricius) from Haridwar district, Uttarakhand, India. Harit (2015) [10] reported the occurrence of Brumoides suturalis in Brinjal crop in Bengaluru Karnataka, Singh and Sharma (2010) [28] reported the Chilocorus nigritus and Brumoides suturalis from Punjab. Poorani (2003) [25] in her checklist mentioned 36 species of the sub-family Chilocorinae from India. Diversity of predaceous coccinellids from temperate agro-ecosystems Jammu and Kashmir has been studied by many workers such as Verma and Joshi (1988) [31] reported Chilocorus infernalis Mulsant and Priscibrumus (Exochomus) arogyialis (Mulsant), Bhagat et al. (1988) [3], Pawar and Parray (1989) [24], Azim and Bhat (2005) [3] published the taxonomic notes on Chilocorus infernalis and Shah and Khan (2014) [25] published 17 species of predaceous coccinellids from agro ecosystems of Kashmir, belonging to 15 genera and three subfamilies viz. Coccinellinae, Chilocorinae and Platynaspidinae. The above cited literature reveals that a very little taxonomic works have been done on this aspect in India as well as in Jammu and Kashmir. In the present study a comparative redescription of each species was given along with synonyms, past record, present record, distribution and remarks.
Materials and Methods
Collection of ladybird beetles was carried out from the selected localities during 2016 and 2017 in the active season of Ladybird beetles. The survey was conducted in ten districts of Kashmir region and two districts of Ladakh region, during the period from May to September. Each locality was visited fortnightly. The method of Majerus and Kearns (1989) [19] with some modification was followed for dissection and genitalia extraction. With the help of two entomological needles, abdomen was detached from the body and boiled in 10% potassium hydroxide (KOH) solution for half an hour to dissolve extra body tissues and some partially clear dense body formations. The abdomen was then washed in hot water and transferred to pure glacial acetic acid for five minutes. To dehydrate it, abdomen was washed in 80% Ethanol and then in absolute alcohol for 5 minutes, respectively. The processed abdomen will be put in a cavity glass slide containing one or two drops of glycerin. After that abdomen was opened with the help of two entomological needles under binocular florescent microscope and the genitalia was extracted. The extracted genitalia was mounted on a Canada balsam after a brief dip in xylene. The permanent slides were kept for identification.

Photography
In order to examine the adult specimens and fine details of genitalia, Binocular Florescent Microscope BX 43 and Stereo Zoom microscope SZX7 were used. Adult specimens and their genitalia was photographed with attached digital camera having image capturing and measuring software.

Identification
Identification was conducted on the basis of morphological characteristics and male genitalia. The collected specimens were identified up to species level with the help of available taxonomic keys, by comparison with already identified species in reference collections and with the help of internal or external experts.

Results and Discussion
Chilocorus infernalis, Mulsant 1853.
Chilocorus infernalis Mulsant, 1853: 189
Chilocorus bijugus Mulsant, 1853: 189
Chilocorus bijugus Kapur, 1956:259

Diagnostic characters
Body blackish, shiny, convex, oblong, bulged dorsally and narrowed posteriorly. Head is deeply inserted and not visible from above. Pronotum bears square shaped projection on anterior margins. Scutellum is clearly visible. Four yellowish-orange spots or reddish testaceous spots are present in middle portion of elytra. Inner spots are little larger than outer spots. Epipleura of elytra is very broad (figure 1a).

Male genitalia
Phalobase: Trab long in size, thin at base and distally slightly broad. Parameres have uniform thickness from base to apex, tips rounded provided with short dense hairs. Median lobe similar in length with Parameres, gradually tapering towards apex (figure 1b).

Siphon: Siphonal capsule asymmetrical, inner arm thin and long form hook like structure directed towards siphonal tube. Outer arm is short and thick. Siphonal tube is curved, then straight upto apex, more or less uniform in thickness. Siphonal apex thin slightly curved, covered with transparent membrane (figure 1b).

Remarks
This is one of the important predators of apple scale insects (Q. Penicicous). There exists controversy about the validity of its name. Some authors like Mulsant (1850) [25] declared C. infernalis and C. bijugus as two distinct species on the basis of minor differences. Crotch (1874) [6, 7] declared these two species as same. Kapur (1958) [13] supported the Crotch’s view and regarded both as synonyms. Miyatake (1970) [21] consider C. bijugus as its valid name. Khan et al. (2007) reported this species as Chilocorus infernalis from Kashmir, India. Recently, Gordon (1987) [9] and Poorani (2002) [26] considered C. infernalis as its valid name. Therefore we also name it C. infernalis.

Host plant
Apple, pear, willow, walnut, kikar and hedges feeding on scale insects.

Past record
Khan et al. (2007) reported this species from Srinagar, Kashmir.

Present record
During the present study it was recorded throughout the Kashmir valley, Minji and Sclinkchey (District kargil).

Seasonal occurrence
This species was found in May-September in Kashmir and July-August in kargil.

Distribution
India, Pakistan, China and Nepal.

Chilocorus rubidus, Hope 1831.
Chilocorus rubidus Hope, 1831: 31-Mulsant, 1850 [22]: 453.- Crotch, 1874 [6, 7]: 183
Chilocorus tristis: Mulsant, 1850 [22]: 452; Crotch, 1874 [6, 7]: 183

Diagnostic characters
Body larger than Chilocorus infernalis, completely black, strongly convex and narrowed posteriorly. Head small, not visible from above. Pronotum bears square shaped projections on anterior margins. Scutellum black, triangular. Epipleura is very broad (figure 2a).

Male genitalia
Phalobase: Trab long, uniform in thickness. Parameres possess uniform thickness, tip rounded provided with short hairs. Median lobe shorter than Parameres, gradually narrow, apex pointed (figure 2b).

Siphon: Capsule asymmetrical, outer arm broad, inner arm narrow, hook like directed towards siphonal tube. Siphonal tube is curved at base, then straight upto apex but base is not much circular as in Chilocorus infernalis. Siphonal apex thin slightly curved (figure 2b).

Remarks
This species is widely distributed both in Palaeartic and...
oriental zone. This is an important predator of scale insects. Superficially it resembles with C. infernalis but *Chilocorus rubidus* is larger than *Chilocorus infernalis*.

**Host plant**
Apple, pear, Euonymus hedges feeding on scale insects.

**Past record**
Kapur (1954) [14], Khan et al. (2007) recorded this species from Kashmir.

**Present record**
During the present study it was recorded from Shalimar, Nishat, Talibal (District Srinagar), Gadoora, Shalabugh, Fatehpooora (District Ganderbal).

**Seasonal occurrence**
Specimens were collected from May to August.

**Distribution**
India, Pakistan, Afghanistan, Nepal.


**Diagnostic characters**
Body small sized, oval shaped, brownish yellow in colour with small thin silky hairs. Head is black and not visible from above. Pronotum and Scutellum is completely black. Yellowish margins are present on lateral sides of Pronotum. Thin short hairs are present on the whole body except mid elytral portion, that possess no hairs. 10 irregular black elytral spots are present. Four spots on each elytra, one large spot on anterior portion of mid-dorsal line, while another spot on posterior side of same (figure 4a).

**Male genitalia**
Phalobase: Trab long proximally thin, distally expanded and curved at apex end. Median lobe thick, longer than parameres, broad at middle portion, then narrowed, pointed at apex. Parameres thin, slightly curved, tip provided with apical thorns (figure 4b). Siphon: Siphonal capsule asymmetrical, highly thickened, no clear distinction for outer and inner arm. Siphonal tube thick and semicircular at base, then gradually becomes straight, narrow upto apex, apex slightly constricted (figure 4b).

**Remarks**
Initially this species was reported as platynaspis saundersi from India and Afghanistan. Miyatake (1961) [20] shifted this species to *Platynaspis saundersi*. It has been reported as an accidental predator of certain aphids (Agarwala and Ghosh, 1988) [1].

**Host plant**
Apple, pear and wild apple.

**Past record**
Khan et al. (2007) recorded this species from Kashmir.

**Present record**
During the present research work the specimens were collected from chadoora, Narkara (District Budgam), Naranag, kanga, Akhal (District Ganderbal).

**Seasonal occurrence**
Specimens were collected from May to September.

**Distribution**
India, Pakistan, Afghanistan, Nepal.

Key to the species of sub-family Chilicorinae from Jammu and Kashmir

1. Body completely black-----------------------------------------------2
Body not completely black with four yellowish-orange spots or reddish testaceous spots present on middle portion of elytra. Basal piece oblong. Trab distally slightly broad. Parameres oblong, oval shaped, median lobe similar in length with parameres, gradually slightly tapering towards apex, base of siphonotube highly circular-------------------Chilocorus infernalis.

2. Elytra completely black. Basal piece not oblong. Trab uniform in thickness. Median lobe shorter than parameres, base of siphonotube is not much circular as in Chilocorus infernalis-------------------Chilocorus rubidus.

---Elytra not completely black------------------3

3. Elytra reddish brown with triangular black spot at anal portion. Male genitalia with parameres longer than median lobe, broad at base, highly depressed at middle, and then widen, round and bulb like distally. Siphonal capsule is asymmetrical, inner arm thin form hook like structure; siphonal tube is highly circular-------------------Pricibrumus uropygialis.

--- Elytra with variable number of black spots on elytra. Siphonal capsule triangular, highly thickened, no clear distinction for outer and inner arm. Parameres thin, slightly curved, tip provided with apical thorns-------------------Platynaspidius saundersi.

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Fig 1: Chilocorus infernalis a: Adult; b: male genitalia (Phalobase, siphon)

Fig 2: Chilocorus rubidus a: Adult; b: male genitalia (Phalobase, siphon)

Fig 3: Pricibrumus uropygialis a: Adult; b: male genitalia (Phalobase, siphon)

Fig 4: Platynaspidius saundersi a: Adult; b: male genitalia (Phalobase, siphon)

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