

STUDIES ON THE DIVERSITY OF PREDATORY COCCINELLID BEETLES (COLEOPTERA) IN DIFFERENT AGRO-CLIMATIC ZONES OF HIMACHAL PRADESH

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ABSTRACT

All the four agro-climatic zones of Himachal Pradesh varying from sub-tropical to dry- temperate conditions were surveyed for the diversity of predatory coccinellids from March 2011 to November 2013. In total 36 species of predatory coccinellids belonging to 24 genera, 11 tribes and 4 sub-families were recorded from different agro-climatic zones. Among these, 18 species viz. *Brumoides suturalis* (Fabricius), *Chilocorus nigrita* (Fabricius), *Rodolia octoguttata* Weise, *Sumnius vestita* (Mulsant), *Coccinella luteopicta* (Mulsant), *Coelophora bissellata* Mulsant, *Coelophora saucia* (Mulsant), *Phrynocaria perrotteti* (Mulsant), *Propylea dissecta* (Mulsant), *Psyllobora bisoctonotata* (Mulsant), *Cryptogonus orbiculus* Gyllenhal, *Cryptogonus trioblitus* (Gorham), *Ortalia vietnamica* Hoang, *Ortalia* sp., *Scymnus nubilus* Mulsant, *Stethorus* sp., *Pharoscyrnus flexibilis* Mulsant and *Pharoscyrnus horni* Weise were reported for the first time from the state. Species richness varied with agro-climatic conditions and was highest (22 species each) under sub-tropical and sub-temperate climate followed by 10 and 7 species under wet temperate and dry temperate conditions. *Coccinella septempunctata*, *Hippodamia variegata* and *Cheilomenes sexmaculata* occupied all the 4 agro-climatic zones, however, *Chilocorus infernalis*, *Harmonia eucharis*, *Propylea luteopustulata* and *Priscibrumus uropygialis* were confined to temperate climate. Since predatory coccinellids were active throughout the state against different pests, there is a need to conserve them by developing bio-intensive IPM strategies.

INTRODUCTION

Himachal Pradesh is a mountainous state of India situated in western Himalayas and is known for the cultivation of commercial crops especially apple and off-season vegetables. These crops are attacked by various insect pests and coccinellid beetles play important role in the suppression of different insect-pests throughout the world. The information on the predatory coccinellid beetles from Himachal Pradesh is, however, scanty. There are about 6000 species of these beetles known worldwide (Vandenberg, 2000), of which, nearly 400 species are present in the Indian sub-region (Poorani, 2002). As far as their food habits are concerned, some are specific, while, many are polyphagous. Ladybirds are also regarded as bio-indicators (Iperti and Paoletti, 1999) and provide more general information about the ecosystem in which they occur (Anderson, 1999). Coccinellid fauna of different parts of India has been studied and reported by various workers (Puttarudriah and Channabasavanna, 1953; Kapur, 1972; Pajni and Singh, 1982; Canepari, 1986; Bhagat and Mosoodi, 1988; Omkar and Parez, 1999; Sathe and Bhosale, 2001; Poorani, 2002; Kandibane *et al.*, 2005; Joshi and Sharma, 2008; Sharma and Joshi, 2010; Choudhary *et al.*, 2014). Nevertheless, these workers have not covered extensively or surveyed intensively, the Himachal Pradesh state of India. Himachal Pradesh also varies in agro-climatic conditions from most parts of the country. Within the state also there are extreme variations with regards to the altitude

and hence the agro-climatic conditions. Due to these variations, Himachal Pradesh is expected to vary greatly in coccinellid fauna from one place to another. The present study was, therefore, conducted to investigate the diversity of predatory coccinellid fauna of different agroclimatic zones of Himachal Pradesh, India.

MATERIALS AND METHODS

Study area

The present study was carried out in the Himachal Pradesh state of India which is a mountainous state situated in western Himalayas covering an area of 55673 km² between 350 and 7000 m amsl at 30°22' 40" to 33°12' 40" N latitude and 75° 45' 55" to 79°04' 20" E longitude. Due to extreme variations in elevation, there is a great variation in agro-climatic conditions of different parts of the state. Climate varies from hot and sub-humid-sub-tropical in the southern tracts to cold, alpine and glacial in the northern and eastern mountain ranges. Himachal Pradesh also varies greatly in rainfall and has areas like Dharamshala which receives as high annual rainfall as about 3400 mm, as well as Lahal and Spiti that are cold deserts and almost rainless. Depending upon the agro-climatic conditions, Himachal is broadly divided into four zones. Zone-I is sub-tropical sub- montane region comprising of low hills and valley areas up to an elevation of 914 m amsl. Zone-II is sub-temperate sub- humid mid hills with an altitude ranging from 915 to

1523 m amsl. This region is characterized by moderate to heavy monsoon rains. Zone-III on the other hand, is a wet temperate zone with high hills spanning between an altitude of 1524 and 2472 m amsl. Zone-IV of the state is dry temperate high hills representing areas beyond 2472 m amsl. This zone is characterized by very low rainfall during summer (less than 50mm) and heavy snow fall (3-5 m) during winter.

Collection of beetles

Coccinellid beetles were collected periodically from all the four agro-climatic zones of Himachal Pradesh, India between March 2011 and November 2013. The beetles were collected as per procedure adopted by Sharma (1987), Joshi and Sharma (2008) and Sharma and Joshi (2010) which included the use of sweep nets, insect collection tubes and jars depending upon the habitat. The samples were collected from a wide variety of terrestrial habitats (agricultural fields, fruit plants, ground flora, forest shrubs, trees, weeds, etc.) throughout from each locality to ensure that the overall landscape of that locality was represented. Beetles collected from different localities were killed in insect killing jars using benzene fumes. Dead specimens were preserved in insect collection cabinets after proper labeling in the Biological control laboratory of Department of Entomology, Dr. YS Parmar University of Horticulture and Forestry, Solan (HP) India.

Identification of specimens

Field collected beetles were examined carefully for all morphological details under stereo zoom binocular microscope. Identification was made on the bases of available literature and reference collection maintained in the laboratory. The specimens were also sent to National Bureau of Agriculturally Important Insects, Bangaluru, India for identification and/or confirmation of their identity.

RESULTS AND DISCUSSION

During the course of study 36 species of predatory coccinellids viz. *Brumoides suturalis* (Fabricius), *Chilocorus infernalis* Mulsant, *Chilocorus nigrita* (Fabricius), *Priscibrumus uropygialis* (Mulsant) (Chilocorinae: Chilocorini), *Platynaspis saundersii* Crotch, (Chilocorinae: Platynaspidini), *Rodolia octoguttata* Weise (Coccidulinae: Noviini), *Sumnius vestita* (Mulsant) (Coccidulinae: Sumniini), *Adalia bipunctata* (Linnaeus), *Adalia tetraspilota* (Hope), *Cheilomenes sexmaculata* (Fabricius), *Coccinella septempunctata* Linnaeus, *Coccinella transversalis* Fabricius, *Coccinella luteopicta* (Mulsant), *Coelophora bissellata* Mulsant, *Coelophora saucia* (Mulsant), *Harmonia dimidiata* (Fabricius), *Harmonia eucharis* (Mulsant), *Hippodamia variegata* (Goeze), *Illeis* sp. nr. *cincta* (Fabricius), *Megalocaria dilatata* (Fabricius), *Oenopia kirbyi* Mulsant, *Oenopia souzeti* Mulsant, *Oenopia sexareata* (Mulsant), *Phrynocaria perrotteti* (Mulsant), *Propylea dissecta* (Mulsant), *Propylea luteopustulata* (Mulsant) (Coccinellinae: Coccinellini), *Psyllobora bisoconotata* (Mulsant) (Coccinellinae: Prylloborini), *Cryptogonus* sp nr. *orbiculus* Gyllenhal, *Cryptogonus trioblitatus* (Gorham) (Scymninae: Aspidimerini), *Ortalia vietnamica* Hoang, *Ortalia* sp. (Scymninae: Ortalini), *Scymnus posticalis* Sicaret, *Scymnus nubilus* Mulsant (Scymninae: Scymnini), *Stethorus* sp (Scymninae: Stethorini), *Pharoscygnus flexibilis* Mulsant and

Pharoscygnus horni Weise (Scymninae: Sticholotidini) belonging to 24 genera, 11 tribes and 4 sub-families were recorded from different agro-climatic zones of Himachal Pradesh (Table 1). Out of the collected species, 18 species viz. *Brumoides suturalis*, *Chilocorus nigrita*, *Rodolia octoguttata*, *Sumnius vestita*, *Coccinella luteopicta*, *Coelophora bissellata*, *Coelophora saucia*, *Phrynocaria perrotteti*, *Propylea dissecta*, *Psyllobora bisoconotata*, *Cryptogonus orbiculus*, *Cryptogonus trioblitatus*, *Ortalia vietnamica*, *Ortalia* sp., *Scymnus nubilus*, *Stethorus* sp., *Pharoscygnus flexibilis* and *Pharoscygnus horni* were reported for the first time from the state. Rests of the species were earlier reported from the state by Sharma (1976), Kotwal (1981), Sharma (1987) and Poorani (2002). However, species like *Leis 10-maculatus*, *Harmonia 13-guttata*, *Ortalia malkini* and *Chilocorus circumdatus* which were earlier reported by Sharma (1976) from Solan area of Himachal Pradesh could not be retrieved in the present survey.

Different agro-climatic zones of Himachal Pradesh varied greatly in diversity of coccinellid beetles. Zone-I and Zone-II which are characterized by sub-tropical and sub-temperate climate, respectively, were more rich in diversity (22 species each) than zone III (9 species) and zone IV (7 species) which are mainly wet temperate and dry temperate zones, respectively. The coccinellid fauna of Zone I was comprised of *Brumoides suturalis*, *Chilocorus nigrita*, *Platynaspis saundersii*, *Sumnius vestita*, *Adalia tetraspilota*, *Cheilomenes sexmaculata*, *Coccinella septempunctata*, *Coelophora bissellata*, *Coelophora saucia*, *Harmonia dimidiata*, *Hippodamia variegata*, *Ortalia vietnamica*, *Ortalia* sp., *Oenopia kirbyi*, *Oenopia souzeti*, *Oenopia sexareata*, *Phrynocaria perrotteti*, *Propylea dissecta*, *Scymnus posticalis*, *Scymnus nubilus*, *Pharoscygnus flexibilis*, and *Pharoscygnus horni*. Similarly the coccinellid community of zone II had 22 species namely *Brumoides suturalis*, *Platynaspis saundersii*, *Rodolia octoguttata*, *Adalia bipunctata*, *Adalia tetraspilota*, *Cheilomenes sexmaculata*, *Coccinella septempunctata*, *Coccinella transversalis*, *Coelophora bissellata*, *Harmonia dimidiata*, *Hippodamia variegata*, *Illeis* sp. nr. *cincta*, *Megalocaria dilatata*, *Oenopia kirbyi*, *Oenopia souzeti*, *Oenopia sexareata*, *Propylea dissecta*, *Psyllobora bisoconotata*, *Cryptogonus* sp nr. *orbiculus*, *Cryptogonus trioblitatus*, *Scymnus posticalis* and *Pharoscygnus flexibilis*. Zone III and zone IV on the other hand were less diverse and consisted of species like *Chilocorus infernalis*, *Cheilomenes sexmaculata*, *Coccinella septempunctata*, *Harmonia eucharis*, *Hippodamia variegata*, *Oenopia kirbyi*, *Oenopia sexareata*, *Propylea luteopustulata* and *Pharoscygnus flexibilis* in zone III and *Chilocorus infernalis*, *Priscibrumus uropygialis*, *Cheilomenes sexmaculata*, *Coccinella septempunctata*, *Coccinella luteopicta*, *Hippodamia variegata* and *Propylea luteopustulata* in zone IV. Low diversity of coccinellid beetles in zone III and IV could be due to the harsh cold climatic conditions of the region. Further, in these zones the major crop grown is apple which receives more application of pesticides as compared to other crops. Dry temperate conditions and cold desert (very less wild vegetation) like situation of zone IV is further responsible for less diversity.

Among different species collected during the present study,

Table 1: Species composition of predatory coccinellid beetles in different agro-climatic zones of Himachal Pradesh

SN	Name of the species	Agro-climatic zone			
		Zone-I	Zone-II	Zone-III	Zone-IV
1.	Chilocorinae				
a)	Chilocorini:				
i)	<i>Brumoides suturalis</i> (Fabricius)	+	+	-	-
ii)	<i>Chilocorus infernalis</i> Mulsant	-	-	+	+
iii)	<i>Chilocorus nigrita</i> (Fabricius)	+	-	-	-
iv)	<i>Priscibrumus uropygialis</i> (Mulsant)	-	-	-	+
b)	Platynaspini:				
i)	<i>Platynaspis saundersii</i> Crotch.	+	+	-	-
2	Coccidulinae:				
a)	Noviini:				
i)	<i>Rodolia octoguttata</i> Weise	-	+	-	-
b)	Sumniini:				
i)	<i>Sumnius vestita</i> (Mulsant)	+	-	-	-
3	Coccinellinae:				
a)	Coccinellini:				
i)	<i>Adalia bipunctata</i> (Linnaeus)	-	+	-	-
ii)	<i>Adalia tetraspilota</i> (Hope)	+	+	-	-
iii)	<i>Cheilomenes sexmaculata</i> (Fabricius)	+	+	+	+
iv)	<i>Coccinella septempunctata</i> Linnaeus	+	+	+	+
v)	<i>Coccinella transversalis</i> Fabricius	-	+	-	-
vi)	<i>Coccinella luteopicta</i> (Mulsant)	-	-	-	+
vii)	<i>Coelophora bissellata</i> Mulsant	+	+	-	-
viii)	<i>Coelophora saucia</i> (Mulsant)	+	-	-	-
ix)	<i>Harmonia dimidiata</i> (Fabricius)	+	+	-	-
x)	<i>Harmonia eucharis</i> (Mulsant)	-	-	+	-
xi)	<i>Hippodamia variegata</i> (Goeze)	+	+	+	+
xii)	<i>Illeis</i> sp. nr. <i>cincta</i> (Fabricius)	-	+	-	-
xiii)	<i>Megalocaria dilatata</i> (Fabricius)	-	+	-	-
xiv)	<i>Oenopia kirbyi</i> Mulsant	+	+	+	-
xv)	<i>Oenopia souzeti</i> Mulsant	+	+	-	-
xvi)	<i>Oenopia sexareata</i> (Mulsant)	+	+	+	-
xvii)	<i>Phrynocaria perrotteti</i> (Mulsant)	+	-	-	-
xviii)	<i>Propylea dissecta</i> (Mulsant)	+	+	-	-
xix)	<i>Propylea luteopustulata</i> (Mulsant)	-	-	+	+
b)	Prylloborini:				
i)	<i>Psyllobora bisoctonotata</i> (Mulsant)	-	+	-	-
4	Scymninae:				
a)	Aspidimerini				
i)	<i>Cryptogonus</i> sp nr. <i>orbiculus</i> Gyllenhal	-	+	-	-
ii)	<i>Cryptogonus trioblittus</i> (Gorham)	-	+	-	-
b)	Ortalini:				
i)	<i>Ortalia vietnamica</i> Hoang	+	-	-	-
ii)	<i>Ortalia</i> sp.	+	-	-	-
c)	Scymnini:				
i)	<i>Scymnus posticalis</i> Sicaret	+	+	-	-
ii)	<i>Scymnus nubilus</i>	+	-	-	-
d)	Stethorini:				
i)	<i>Stethorus</i> sp				
e)	Sticholotidini:				
i)	<i>Pharoscymnus flexibilis</i> Mulsant	+	+	+	-
ii)	<i>Pharoscymnus horni</i> weise	+	-	-	-
	Total	22	22	9	7

+ Recorded;- Not recorded

Coccinella septempunctata, *Hippodamia variegata* and *Cheilomenes sexmaculata* were the most common and abundant species distributed widely in all the agro-climatic zones. These species were also reported to be dominant in other parts of country (Joshi and Sharma, 2008; Sharma and Joshi, 2010). *C. infernalis*, *P. uropygialis* and *C. luteopicta* have been adapted well to the dry temperate conditions of zone IV and were found preying on aphids infesting radish crop grown for seed production and Sanjose scale and woolly

aphid of apple. *H. eucharis* was confined to the zone III of the state and was collected from coniferous trees. Earlier these beetles were also reported from temperate areas of Srinagar district of Jammu and Kashmir preying on scale and aphid pests of apple (Khan et al., 2009). *Oenopia kirbyi*, *Oenopia sauzeti*, *Oenopia sexareata* and *pharoscymnus flexibilis* were distributed from sub-tropical (zone I) (643m amsl) to wet-temperate conditions (zone III) (2186m amsl) of Himachal Pradesh. *O. kirbyi*, *O. sauzeti* and *O. sexareata* were associated

with aphids of cabbage, cauliflower, peach, eggplant, cucumber, apple and some wild flora; and *P. flexibilis* was found to prey on scale insects of nectarine, *Unimus*, citrus and apple. Earlier, *O. kirbyi* was reported from Solan area of Himachal Pradesh by Kotwal (1981) feeding on *Brevicoryne brassicae* on cole crops; *O. sauzetii* by Sharma (1976), Kotwal (1981), Sharma (1987) and Poorani (2002) feeding on aphids of chrysanthemum, wheat, barley, crucifers, maize, etc. and *O. sexareata* by Sharma (1976), Kotwal (1981), Sharma (1987) (as *Coelophora sexareata*) and Poorani (2002) preying on aphids of maize and crucifers. Beetles such as *R. octoguttata*, *M. delatata* (each preying on the peach leaf curl aphid, *Brachycaudus helichrysi*), *A. bipunctata* (collected from ground flora of peach orchard), *C. transversalis* (feeding on *Myzus persicae* on capsicum and *B. helichrysi* on peach), *C. orbiculus*, *Illeis* sp. (both from cucumber having unidentified aphids, the green house whitefly, *T. vaporariorum* and powdery mildew), *C. trioblitus* and *P. bisoconotata* (both collected from *Duranta* having aphids and powdery mildew) were recorded from sub-temperate areas (zone II) of Himachal Pradesh. Among these beetles, *A. bipunctata* and *C. transversalis* were also reported earlier from the state (Sharma, 1976; Sharma, 1987), whereas, others were recorded from the state for the first time, though, reported from other parts of India (Poorani, 2002; Joshi and Sharma, 2008; Sharma and Joshi, 2010; Joshi *et al.* 2012; Choudhary *et al.* 2014). *Chilocorus infernalis* and *Propylea luteopustulata* were recorded from wet and dry temperate zones of Himachal Pradesh feeding on Sanjose scale, *Quadraspidiotus perniciosus* of apple and aphids of radish crop, respectively. Both of them were also reported earlier from Himachal Pradesh (Sharma, 1976; Poorani, 2002) and Jammu and Kashmir (Khan *et al.*, 2009). Beetles like *C. nigrita*, *S. vestita*, *O. vietnamica*, *ortalia* sp, *Scymnus nubilus*, *P. horni*, *P. perrotteti* and *C. saucia* were confined to the agro-climatic zone I of the state which is characterized by sub-tropical conditions. *C. nigrita*, *P. perrotteti*, *O. vietnamica* and *Ortalia* sp were collected from citrus plants infested with scale and whiteflies, Nevertheless, *O. vietnamica* and *Ortalia* sp were also collected from fig plants not infested with any insect-pest. *S. vestita* and *S. nubilus* were collected from wild vegetation infested with unidentified aphids. *P. horni* was found preying on Sanjose scale, *Q. perniciosus* on nectarine, whereas, *C. saucia* was collected from a pomegranate plant. All these species were reported from the state for the first time, though, reported from other parts of the country (Poorani, 2002; Joshi and Sharma, 2008; Sharma and Joshi, 2010; Joshi *et al.*, 2012). Coccinellids such as *B. suturalis*, *P. saundersii*, *A. tetraspilota*, *C. bissellata*, *H. dimidiata*, *P. dissecta* and *S. posticalis* were distributed in both zone I and zone II of Himachal Pradesh. Among these beetles *B. suturalis*, *C. bissellata* and *P. dissecta* are new records for Himachal Pradesh and rest of the beetles were reported from the state earlier also (Sharma, 1976; Kotwal, 1981, Sharma, 1987; Poorani, 2002).

In similar studies, various workers have studied the biodiversity of coccinellid beetles in other parts of the country. According to them 12 species have been reported from North India (Kapur 1948), 53 from Mysore region (Puttarudriah and Channabasavanna, 1953), 17 from Goa (Kapur, 1972), 30 from Chandigarh (Pajni and Singh, 1982; Pajni and Verma,

1985), 36 from Northern India and Nepal (Canepari, 1986), 4 from Kashmir valley of India (Bhagat and Masoodi 1988), 17 from Lucknow region (Omkar and Parvez, 1999 and 2000), 21 from Maharashtra (Sathe and Bhosale, 2001), 400 from Indian sub-region (Poorani, 2002), 520 including epilachnids, synonymies and new additions from Indian subcontinent (Poorani, 2004), 7 from Madurai, Tamil Nadu (Kandibane *et al.* 2005), 9 from Madurai, Tamil Nadu (Rekha *et al.* 2009) 31 from Hardiwar region, Uttarakhand (Joshi *et al.* 2008), 15 from Srinagar district of Jammu and Kashmir (Khan *et al.*, 2009), 25 from Dehradun region, Uttarakhand (Sharma and Joshi, 2010), 35 from Arunachal Pradesh (Hemchandra *et al.* 2010) 23 from Nainital region, Uttarakhand (Joshi *et al.*, 2012), 13 from Gudalur (Nilgiris) area of Tamil Nadu (Vinothkumar, 2013) and 16 from Jharkhand (Choudhary *et al.* 2014) preying on various host insects in difference cropping systems. Perusal of the above reports reveals that the species richness of the predatory coccinellid beetles in Himachal Pradesh is quite higher than many parts of India, though; only about 9 per cent of the total predatory coccinellids present in the Indian subcontinent were collected from the state. In the present survey, however, about 64 per cent more species than reported by earlier workers (Sharma, 1976; Kotwal, 1981; Sharma, 1987) were collected from the state. In the present study it was found the Himachal Pradesh is rich in coccinellid fauna. These beetles were associated with different key pests of economically important crops in all the agro-climatic conditions of the state. Coccinellid beetles are density dependent predators and can increase or decrease their action according to the prey density. Further these beetles are capable of migrating from one place to another depending upon the availability of prey (Mareida *et al.*, 1992). These beetles can therefore be utilized for the management of various crop pests, however, there is need to conserve them especially against indiscriminate use of insecticides.

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