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Natural Enemies fauna associated with woolly apple aphid *Eriosoma lanigerum* Hausmann in Kashmir

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Abstract

With the intensification of apple cultivation there is considerable increase in insect pest fauna on apple in the state of Jammu and Kashmir and apple trees are usually attacked by several types of arthropod pests. Aphids are key pests in apple orchards worldwide and among these, Woolly Apple Aphid (WAA), *Eriosoma lanigerum* order Hemiptera and family Aphididae is one of the most important aphid pests of apples in most of the apple growing regions. Therefore in our present study survey was conducted during 2017 and 2018 in Budgam district of Kashmir Valley to identify the key natural enemies associated with woolly apple aphid. Eight predators including *Chilochorus infernalis*, *Adalia tetraspilota* *Hippodamia variegata*, *Coccinella septempunctata*, *Harmonia* spp., *Oenopia conglobata*, *Syrphus* spp. and *Chrysoperla zastrowi* were found associated with woolly apple aphid. Coccinellidae being most abundant 68 to 71 per cent, followed by Chrysopidae 13-14 percent and Syrphids ranging from 16-18 per cent of totals during 2017-2018. Survey of natural enemies indicated that there is considerable diversity of natural enemies associated with woolly apple aphid and will provide a basis for conservation of natural enemies and foundation of an integrated biological control program of this pest.

Keywords: WAA, survey, Coccinellidae, Chrysopidae, Syrphidae

Introduction

Apple (*Malus × domestica* Borkh) belonging to family Rosaceae is one of the economically important fruit crops of the temperate zones of world and is major fruit crop of China, U.S.A, Poland, Italy, France, Canada, Australia and other countries [15]. The total area under this crop is 5920.35 thousand hectares with the annual production of 84637.24 thousand metric tonnes worldwide [7]. In India, the area under apple cultivation is 322 thousand hectares with the annual production of 2203 thousand metric tonnes [1]. Jammu and Kashmir, Himachal Pradesh and Uttarakhand are the major apple producing states of India. In India, Jammu and Kashmir leads both in acreage and production of apple in the country with an area and annual production of 162.97 hectares and 1726.83 metric tonnes, respectively at the productivity rate of 10.60 metric tonnes per hectare [2]. With the intensification of apple cultivation there is considerable increase in insect pest fauna on apple in the state. Apple trees are usually attacked by several types of arthropod pests [13] and the most important are San jose scale (*Quadraspidiotus perniciosus* Comstock), European red mite (*Panonychus ulmi* Koch), Two spotted mite (*Tetranychus urticae* Koch), Woolly Apple Aphid (*Eriosoma lanigerum* Hausmann), Hairy caterpillar (*Lymantria obfuscata* Walker), Apple stem borer (*Aeolesthes sarta* Solsky) and thrips. Aphids are key pests in apple orchards worldwide [4] and among these, Woolly Apple Aphid (WAA), *E. lanigerum* belonging to order Hemiptera and family Aphididae is one of the most important aphid pests of apple in most of the apple growing regions of the world [9]. Depending upon the infestation and location of colonies, woolly apple aphid can cause serious threat to survival of apple trees [10]. Woolly apple aphid attacks both above (shoot) and below ground parts of plant. Under severe infestation honey dew is deposited on fruit by colonies present near spur. Cultivars with open calyx are susceptible because the insect enters the core through calyx causing direct infestation. WAA can be a significant phytosanitary issue for fruit exportation and an annoying pest during fruit harvesting [6]. A good natural enemy complex is reported to be associated with the aphid which in its natural ecosystem regulates the abundance of the pest effectively. The natural enemies of

the pest include an Eulopid parasitoid (*Aphelinus mali*), lady bird beetle (*Coccinella septempunctata*), *Chrysoperla zastrowi*, *Menochilus sexmaculatus* and other predators. The objective of this work was to conduct a survey to identify the key natural enemies associated woolly apple aphid and thus to provide a foundation for an integrated biological control program of this pest.

Materials and Methods

Association of natural enemies and sequential presence of predators were recorded from three locations (high, medium and low) of district Budgam of Kashmir valley. In district Budgam, the locations were Khapura, Krimshore and Chadoora and one orchard from each location were selected for this purpose. Ten randomly infested trees containing 10 cm section of aphid colony were collected fortnightly and after visual inspection, each aphid colony first was inspected in situ for motile predators and then each sample unit was removed from the tree and placed in a self-sealing plastic bag. All of the collected colonies were kept in glass jar and then inspected for predators under a binocular microscope at division of Entomology, SKUAST-K. The identified natural enemies were authenticated by Taxonomists of division of Entomology, SKUAST-K.

Results and Discussion

Observations in respect of association of natural enemies with woolly apple aphid were recorded fortnightly from March 2017 to October 2018. Eight predators including *Chilocorus infernalis*, *Adalia tetraspilota*, *Hippodamia variegata*, *Coccinella septempunctata*, *Harmonia spp.*, *Oenopia conglobata*, *Syrphus spp.* and *Chrysoperla zastrowi* were found associated with woolly apple aphid during in Kashmir (Table-1 and Plate-1). Total no. of 123 and 154 predators were observed in 2017 and 2018, respectively. Coccinellidae, Syrphidae and Chrysopidae were the most common predator groups found associated with woolly apple aphid. The present studies are almost in consonance with the studies of Gontijol *et al.* [8] who sampled woolly apple aphid colonies in Central Washington apple orchards for observation of natural enemies

complex during 2006 to 2008 and most common predators reported were Syrphidae, Chrysopidae and Coccinellidae. Coccinellidae being most abundant 68 to 71 per cent, followed by Chrysopidae 13-14 percent and Syrphids ranging from 16-18 per cent of totals (Fig-1). Coccinellids were active during May- October whereas Syrphids and Chrysopids were most abundant during June-September (Table-2 and Table-3, Fig-2 and Fig-3). Activity of predators decreased from October onwards and hence no predator was found associated with the pest. Among coccinellids, *Coccinella septempunctata*, *Chilocorus infernalis* and *Harmonia spp.* were recorded as predominant predators. Midellel and Kamel [12] also reported *Coccinella algerica* as most abundant observed ladybird and its larvae and adult was observed at the beginning of April. Khan *et al.* [11] also found *C. septempunctata* to be predacious on almost every species of aphid. Similarly Yong *et al.* [16] monitored the population dynamics of *Harmonia axyridis* and its role in controlling *E. lanigerum* in China and reported *H. axyridis* as one of the important predatory insects for controlling woolly apple aphid in apple orchards in China. Chrysopidae was the second most abundant predator group in 2017 and 2018 surveys. The only species of Chrysopidae found was *Chrysoperla zastrowi* while as Gontijol *et al.* [8] found *Chrysopa nigricornis* Burmeister as common species in their surveys and this species was reported by Tauber *et al.* [14] as an important generalist predator that feeds on aphids and other soft-bodied arthropods. Syrphidae, third most predator group was found abundant during summer months which coincide with the mid-season peak of woolly apple aphid activity recorded by Beers *et al.* [3] during their experiment on seasonal phenology of Woolly Apple Aphid (Hemiptera: Aphididae) in Central Washington. These findings do tally with findings of Brown and Schmitt [5] who studied the population dynamics of *E. lanigerum* in sprayed and unsprayed apple orchards in West Virginia, USA and found that in an unsprayed orchard, peak abundance of arboreal populations was 22-24 colonies per tree in early June each year and sryphid larvae were found associated with 20% of aphid colonies.

Table 1: Natural Enemies fauna associated with Woolly Apple Aphid (*Eriosoma lanigerum* Hausmann) in Kashmir

S No.	Predator	Family	Order
1	<i>Chilocorus infernalis</i> (Mulsant)	Coccinillidae	Coleoptera
2	<i>Adalia tetraspilota</i> (Hope)	Coccinillidae	Coleoptera
3	<i>Hippodamia variegata</i> (Goeza)	Coccinillidae	Coleoptera
4	<i>Coccinella septempunctata</i> (Linnaeus)	Coccinillidae	Coleoptera
5	<i>Harmonia spp.</i>	Coccinillidae	Coleoptera
6	<i>Oenopia conglobata</i> (Linnaeus)	Coccinillidae	Coleoptera
7	<i>Syrphus spp.</i>	Syrphidae	Diptera
8	<i>Chrysoperla zastrowi</i> (Stephens)	Chrysopidae	Neuroptera



Chilocorus infernalis (Mulsant)



Adalia tetraspilota (Hope)



Adalia tetraspilota (Hope)

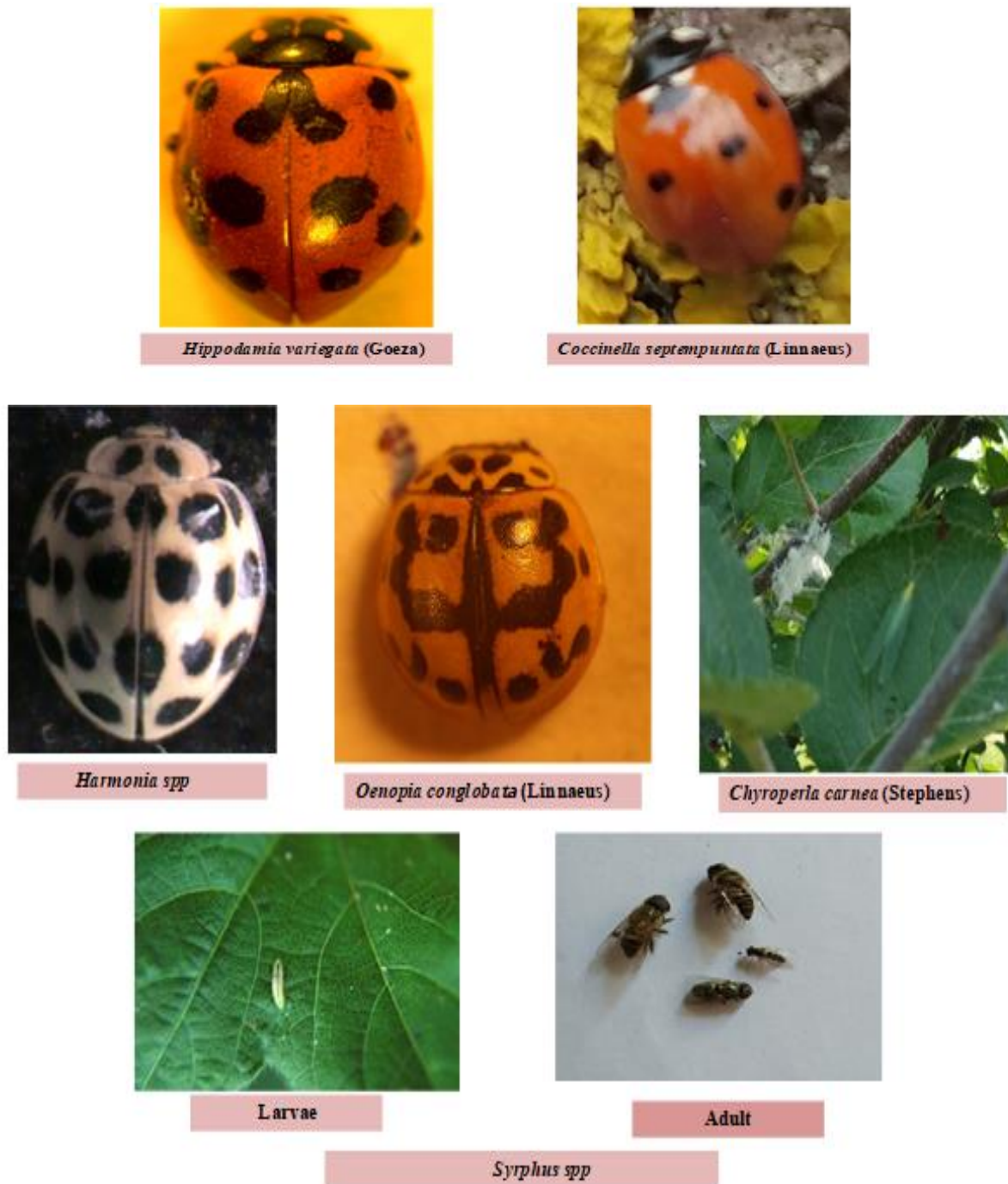


Plate 1: Natural enemies fauna associated with Woolly Apple Aphid (*Eriosoma lanigerum* Hausmann) in Kashmir

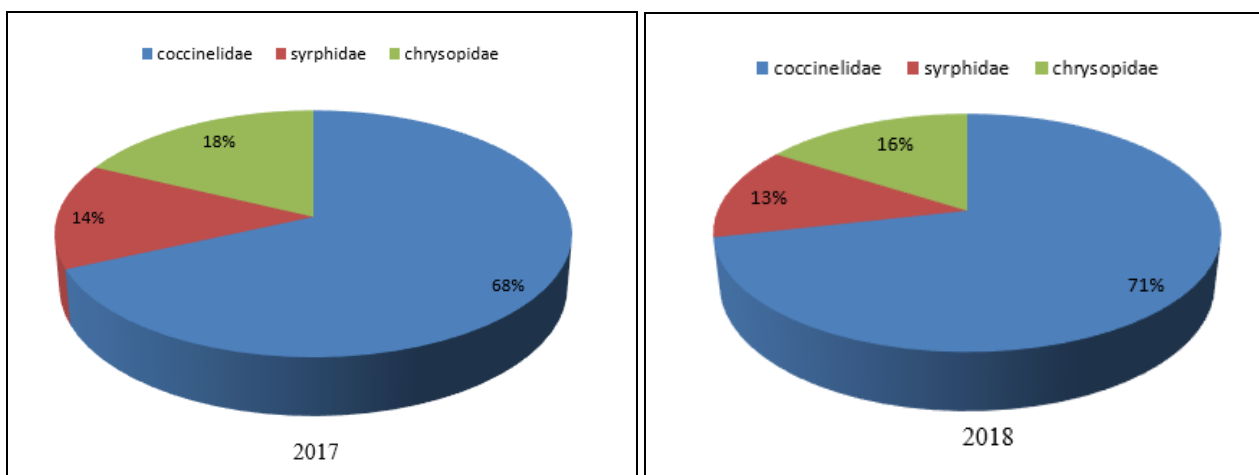


Fig 1: Percentage of predator groups found associated with woolly apple aphid colonies in Kashmir valley during 2017-2018

Table 2: Population abundance of various predators associated with Woolly Apple Aphid (*Eriosoma lanigerum*) at different locations and intervals in district Budgam during 2017

Predators	Altitude	April	May	June	July	August	September	October	Total
<i>Chilochorus infernalis</i>	High (1842m asl)	0	1	2	1	1	1	0	6
<i>Adalia tetraspilota</i>		0	1	1	1	1	1	0	5
<i>Hippodamia variegata</i>		0	2	3	1	0	0	0	6
<i>Coccinella septempunctata</i>		0	1	3	1	1	1	1	8
<i>Harmonia spp.</i>		0	0	2	3	2	0	0	7
<i>Oenopia conglobata</i>		0	1	2	0	1	0	0	4
<i>Syrphus spp.</i>		0	0	1	3	2	0	0	6
<i>Chrysoperla zastrowi</i>		0	0	0	3	4	2	0	9
<i>Chilochorus infernalis</i>		0	0	2	1	1	0	0	4
<i>Adalia tetraspilota</i>	Medium (1770m asl)	0	0	2	1	0	0	0	3
<i>Hippodamia variegata</i>		0	1	2	1	0	0	0	4
<i>Coccinella septempunctata</i>		0	1	3	1	1	0	1	7
<i>Harmonia spp.</i>		0	1	1	2	0	0	0	4
<i>Oenopia conglobata</i>		0	0	1	0	0	0	0	1
<i>Syrphus spp.</i>		0	0	2	1	0	1	0	4
<i>Chrysoperla zastrowi</i>		0	0	0	2	2	1	0	5
<i>Chilochorus infernalis</i>		0	2	1	0	0	0	0	3
<i>Adalia tetraspilota</i>		0	1	2	0	0	0	0	3
<i>Hippodamia variegata</i>	Low (1615m asl)	0	0	2	0	0	0	0	2
<i>Coccinella septempunctata</i>		0	0	1	2	0	1	0	4
<i>Harmonia spp.</i>		0	0	1	2	0	0	0	3
<i>Oenopia conglobata</i>		0	0	1	0	0	0	0	1
<i>Syrphus spp.</i>		0	0	1	2	0	1	0	4
<i>Chrysoperla zastrowi</i>		0	0	0	1	2	1	0	4

*Each value is observation of 10 infested trees

Table 3: Population abundance of various predators associated with Woolly Apple Aphid (*Eriosoma lanigerum*) at different locations and intervals in district Budgam during 2018

Predators	Altitude	April	May	June	July	August	September	October	Total
<i>Chilochorus infernalis</i>	High (1842m asl)	0	2	3	3	1	0	0	9
<i>Adalia tetraspilota</i>		0	0	2	3	1	0	0	6
<i>Hippodamia variegata</i>		0	2	3	1	0	0	0	6
<i>Coccinella septempunctata</i>		0	1	3	3	2	0	2	11
<i>Harmonia spp.</i>		0	1	1	3	1	1	0	7
<i>Oenopia conglobata</i>		0	0	1	3	0	0	0	4
<i>Syrphus spp.</i>		0	0	1	4	1	1	1	8
<i>Chrysoperla zastrowi</i>		0	0	1	3	5	2	0	11
<i>Chilochorus infernalis</i>		0	0	3	2	1	0	0	6
<i>Adalia tetraspilota</i>	Medium (1770m asl)	0	1	2	1	0	0	0	4
<i>Hippodamia variegata</i>		0	1	2	1	0	0	0	4
<i>Coccinella septempunctata</i>		0	2	1	3	0	0	1	7
<i>Harmonia spp.</i>		0	1	2	2	0	0	0	5
<i>Oenopia conglobata</i>		0	0	0	1	1	0	0	2
<i>Syrphus spp.</i>		0	0	1	2	1	1	0	5
<i>Chrysoperla zastrowi</i>		0	0	0	2	3	1	0	6
<i>Chilochorus infernalis</i>		0	1	2	1	0	0	0	4
<i>Adalia tetraspilota</i>		0	1	1	1	1	0	0	4
<i>Hippodamia variegata</i>	Low (1615m asl)	0	0	2	0	0	0	0	2
<i>Coccinella septempunctata</i>		1	0	2	1	0	2	0	6
<i>Harmonia spp.</i>		0	0	2	1	0	0	0	3
<i>Oenopia conglobata</i>		0	0	1	0	0	0	0	1
<i>Syrphus spp.</i>		0	0	0	3	0	0	0	3
<i>Chrysoperla zastrowi</i>		0	0	0	1	2	0	0	3

*Each value is observation of 10 infested trees

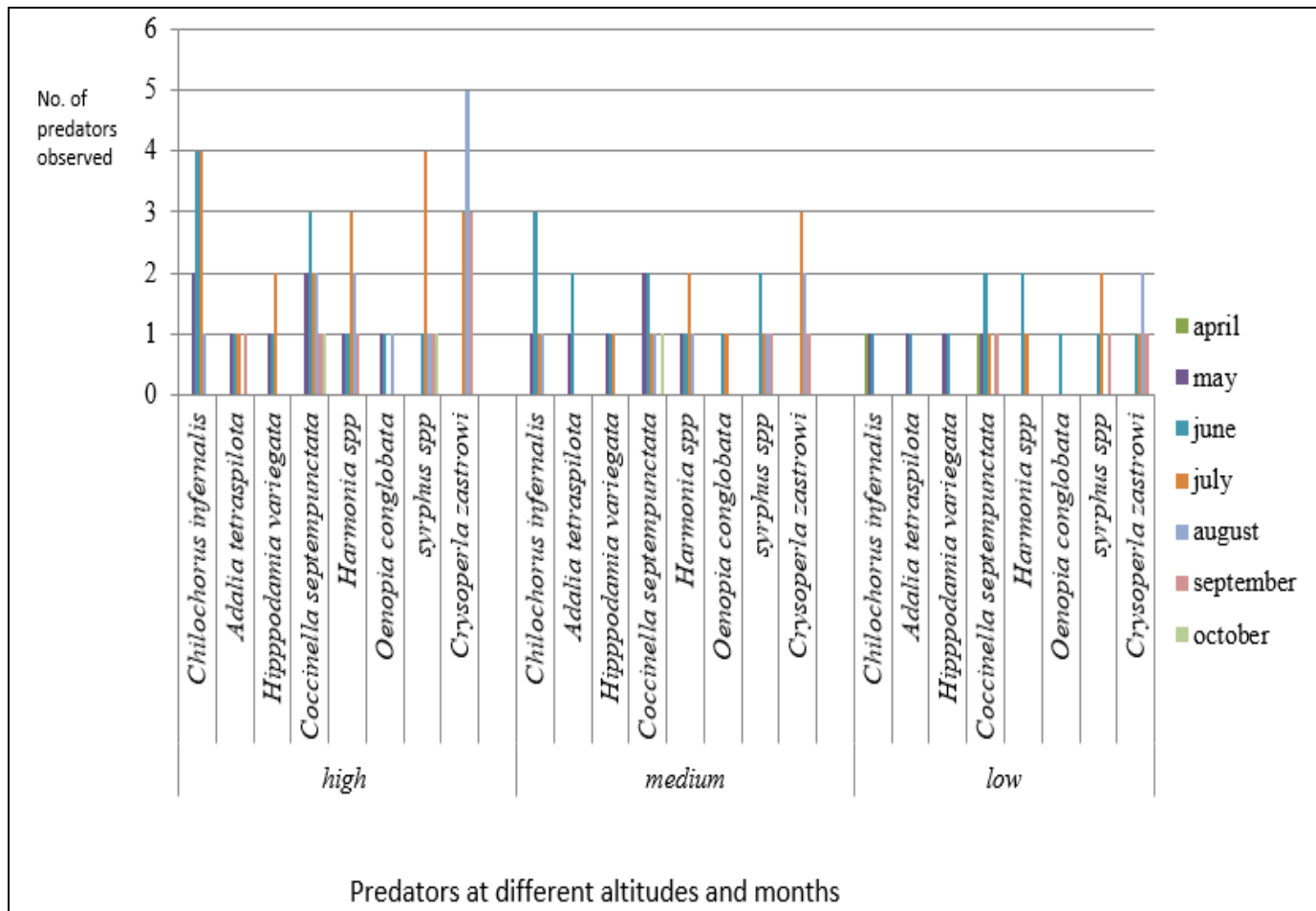


Fig 2: Population abundance of various predators associated with Woolly Apple Aphid (*Eriosoma lanigerum*) at different locations and intervals in Kashmir valley during 2017

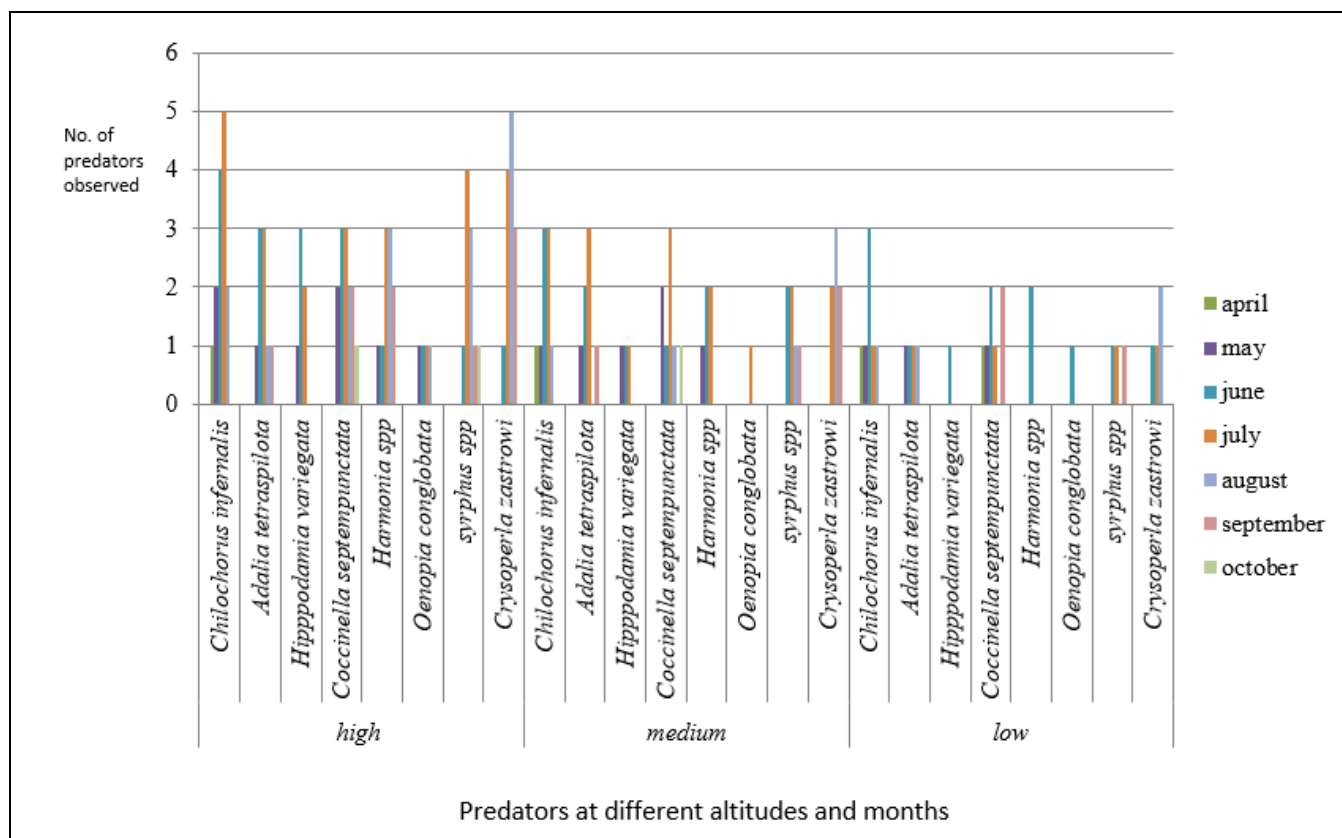


Fig 3: Population abundance of various predators associated with Woolly Apple Aphid (*Eriosoma lanigerum*) at different locations and intervals in Kashmir valley during 2018

Conclusion

Survey of natural enemies indicated that there is considerable diversity of natural enemies associated with woolly apple aphid and thus will provide a basis for conservation of natural enemies and foundation of an integrated biological control program of this pest.

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