Advances in Entomology, 2014, 2, 61-68
Published Online April 2014 in SciRes. http://www.scirp.org/journal/ae
http://dx.doi.org/10.4236/ae.2014.22011

Comparative Characterization of the Ladybird Beetles (Coleoptera: Coccinellidae) from Hazara University, Garden Campus, Mansehra, Pakistan*

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Received 21 December 2013; revised 29 January 2014; accepted 8 February 2014

Abstract

The ladybird beetles (Coleoptera: Coccinellidae) have great economic importance as natural enemies. Three hundred individuals belonging to 6 genera and 7 species of the subfamily, Coccinellinae and the tribe, Coccinellini was collected during March-May, 2011 from 3 study sites of Hazara University, Garden Campus, Mansehra, Pakistan. They were reported maximum (83.3%) from residential area and minimum (8%) from administration area. All collected species have glabrous hair on their slightly elongated or rounded bright colored body. The seven-spotted ladybug, *Coccinella septempunctata* (Linnaeus) has maximum (average: 6.7 ± 0.77 cm; n = 15) and *Adalia tetraspilota* (Hope) has minimum (average: 4.2 ± 0.15 cm; n = 14) body length. Moreover, transverse ladybird, *Coccinella transversalis* (Fabricius) has maximum (average: 4.8 ± 0.35 cm; n = 10) and *Oenopia sauzeti* (Mulsant) (n = 9) or adonis ladybird, *Hippodamia variegate* (Goeze) (n = 10) has minimum (3.1 cm) body width. Except six-spotted zigzag ladybird, *Menochilus sexmaculatus* (Fabricius) (n = 12), all collected species have black head, varied but attractive and dark in color pronotum and elytra, black scutellum except in fifteen-spotted ladybird, *Harmonia dimidiate* (Fabricius) (n = 10) which was brownish. The ventral side of body of *A. tetraspilota* was dark brown, however, *C. septempunctata*, *C. transversalis*, *H. variegate* and *O. sauzeti* were black; moreover, *H. dimidiata* was brownish-orange; further, *M. sexmaculatus* was brown. It is concluded that ladybird beetles of HU have great diversity. Their further studies have been needed for education and

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How to cite this paper: Perveen, F., Khan, A. and Habib, H. (2014) Comparative Characterization of the Ladybird Beetles (Coleoptera: Coccinellidae) from Hazara University, Garden Campus, Mansehra, Pakistan. *Advances in Entomology*, **2**, 61-68.
http://dx.doi.org/10.4236/ae.2014.22011

awareness.

Keywords

Characterization, Coccinellidae, Coleoptera, Hazara University, Ladybird Beetles

1. Introduction

The Hazara University, Mansehra, Pakistan is situated 14 km to the north of Mansehra town on the right side of Karakurum highway in a serene, peaceful, rural and pollution-free environment. The vast plain of Pakhal with its agricultural wealth irrigated by the river Siran and tea gardens surrounds the University (**Figure 1**) [1] [2].

The ladybird beetles (Coleoptera: Coccinellidae) are bright in colors. Female is larger than males. The haemolymph is repellent by having a repulsive smell with containing various alkaloid toxins. The bright red on black or black on red color of some adults is aposematic. Both are defensive mechanisms against predators [4]. They are associated with good fortune in many myths and legends. Scientists increasingly prefer the names of ladybird beetles or lady beetles, as they have great economic importance [5]-[7] as predators to many pests [8] and environmental or bio-indicator [9]. They may be entomophagous or phytophagous [10] and expose both potential and real effects on the life of their hosts. Cannibalism of eggs, larvae and pupae are common, especially when prey is scarce. They have several generations in a year and reproduction is slowed in winter, when adults may hibernate. They require 190.3 ± 10.2 days to complete a generation under laboratory conditions. The adonis ladybird, *Hippodamia variegate* (Goeze) completes 4 generations per season on the alfalfa crop, *Medicago sativa* L. [11].

There have typical differences in their behavior between 2 trophic groups. First one is feeding on aphids; development, age and movement will be faster, and is also typically larger and lays their eggs in clusters. Second one is feeding on scale insects which develops more slowly, lives longer, moves more slowly, and is typically smaller and lays their eggs singly [12].

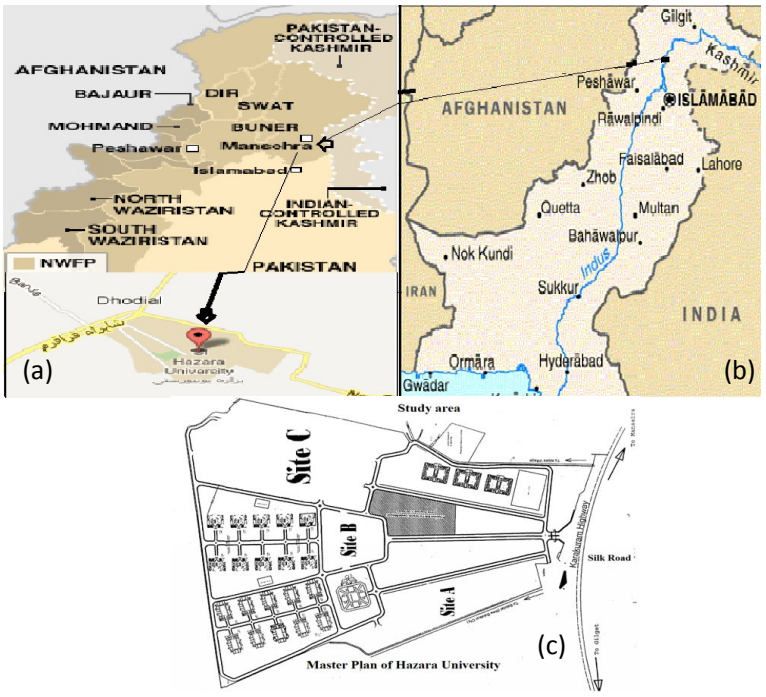

Figure 1. Map of study area, Hazara University (HU), Garden Campus is located in Mansehra which is in Khyber Pakhtunkhwa (a), one of the province of Pakistan (b); HU consists of three study sites: A: residential area; B: administration area; C: main campus [3].

They are of interest and importance in agriculture and forestry, since adults and larvae of the most species are predators of herbivorous pests such as aphids, *Aphis glycines* Matsumura; adelgids, *Adelges cooleyi* (Gillette); psyllids, *Psylla oblonga* Mathur; mealy bugs, *Maconellicoccus hirsutus* Green and scale insects, *Icerya purchase* Maskell. As such, they have been employed in biological control since the late 1800s [13] (Obrycki and Kring, 1998). They are also found in association with those insects infesting bean, *Phaseolus vulgaris* L.; wheat, *Triticum aestivum* L.; chilli, *Capsicum recipe* L.; sorghum, *Sorghum vulgare* L.; tobacco, *Nicotiana tabacum* L.; cotton, *Gossypium arboreum* L.; maize, *Zea mays* L.; potato, *Solanum tuberosum* (L.); lathyrus, *Lathyrus vernus* L.; soyabean, *Glycine max* (L.); sweet potato, *Ipomoea batatas* (L.); lentil, *Lens culinaris* Medikus; mustard, *Brassica campestris* L.; brinjal, *Solanum melongena* L.; groundnut, *Arachis villosulicarpa* Hoehne; sunflower, *Helianthus annuus* L.; and cabbage, *Brassica variants* L. [14] [15]. The proportion of females and average body length increased with altitude of the hibernaculum in seven-spotted ladybugs, *Coccinella septempunctata* (Linnaeus) when studied during two dormancy seasons in three hibernations sites in the Karkonosze mountains [16]. During the present study, the comparative characterization of the ladybird beetles collected from Hazara University, Garden Campus, Mansehra, Pakistan was determined for learning, awareness, education and research to everyone.

2. Materials and Methods

The ladybird beetles were collected from Hazara University (HU), Garden Campus, Mansehra, Khyber Pakhtunkhwa (KP), Pakistan by dividing it into 3 quadrates: residential area: A; administration area: B and main campus: C during March-May, 2011. Each locality was sampled twice daily during 2011 (morning: 06:00 - 08:00 am; evening: 04:00 - 08:00 pm). Several collecting methods were used, depending on the type of habitats sampled. Adult specimens were collected by sweep-net and hand picking. In some localities, more than one method was used for insect collection. Adult insects collected from various habitats were killed in a cyanide bottle and pinned, tagged and preserved in insect box, identified by Dr. Ather Rafi, Director, National Agricultural Research Council (NARC) Islamabad [17], photographed (Kodak 32 F 9.2 mega pixel lens digital camera, Tokyo, Japan) and were deposited in the Zoological Museum of the same university [2] [18] [19]. Data were analyzed by using one-way analysis of variance (ANOVA) with LSM (least standard deviation mean) at $P < 0.05$ and Scheffe's F-test at 5% [20].

3. Results

Seven species from 6 genera belonging to the single subfamily, Coccinellinae and the single tribe, Coccinellini, which were present in this area, *i.e.*, the ladybird beetle, *Adalia tetraspilota* (Hope, 1831); seven-spotted ladybug, *Coccinella septempunctata* (Linnaeus, 1758); transverse ladybird, *Coccinella transversalis* (Fabricius, 1781); fifteen-spotted ladybird, *Harmonia dimidiata* (Fabricius, 1781); adonis ladybird, *Hippodamia variegata* (Goeze, 1777); six spotted zigzag ladybird, *Menochilus sexmaculatus* (Fabricius, 1781) and ladybird beetle *Oenopia sauzeti* (Mulsant, 1866). Total 300 individuals were collected from 3 study sites of HU, Garden Campus, Mansehra, Pakistan. Their distribution was: residential area: 83.3% > main campus: 23.7% > administration area: 8% (**Figure 2**).

The comparative characterization of the ladybird beetles (Coleoptera: Coccinellidae) collected from HU was determined. It was found that all collected species have hair on body, which was glabrous. However, *A. tetraspilota* has body shape oval with oranges' yellow on upper side. The body color and shape of *C. septempunctata* and *C. transversalis* were orange and slightly elongated, however, for *H. dimidiate* were orange and slightly elongated, moreover, for *H. variegate* were yellow and elongated, further, for *M. sexmaculatus* were yellowish orange and rounded, furthermore, for *O. sauzeti* were yellow and rounded (**Table 1**). It was found that the male was usually smaller, darker and not common than the female. The male will often be found riding on top of the female ladybird beetle.

When the length of collected species of ladybird beetles was compared, it was (n = 2 - 15): *C. septempunctata*: 6.7 ± 0.77 cm > *M. sexmaculatus*: 6.3 ± 0.86 cm > *C. transversalis*: 6.2 ± 0.16 cm > *H. variegata*: 5.0 ± 0.59 cm > *O. sauzeti*: 4.7 ± 0.82 cm > *H. dimidiata*: 4.6 ± 0.41 cm > *A. tetraspilota*: 4.2 ± 0.15 cm. The width of the same was (n = 9 - 15): *C. transversalis*: 4.8 ± 0.35 cm > *C. septempunctata*: 4.6 ± 0.54 cm > *H. dimidiata*: 4.1 ± 0.5 cm > *A. tetraspilota*: 3.8 ± 0.15 cm > *M. sexmaculatus*: 3.7 ± 0.67 cm > *O. sauzeti*: 3.1 ± 0.68 cm = *H. variegata*: 3.1 ± 0.64 cm (**Figure 3**).

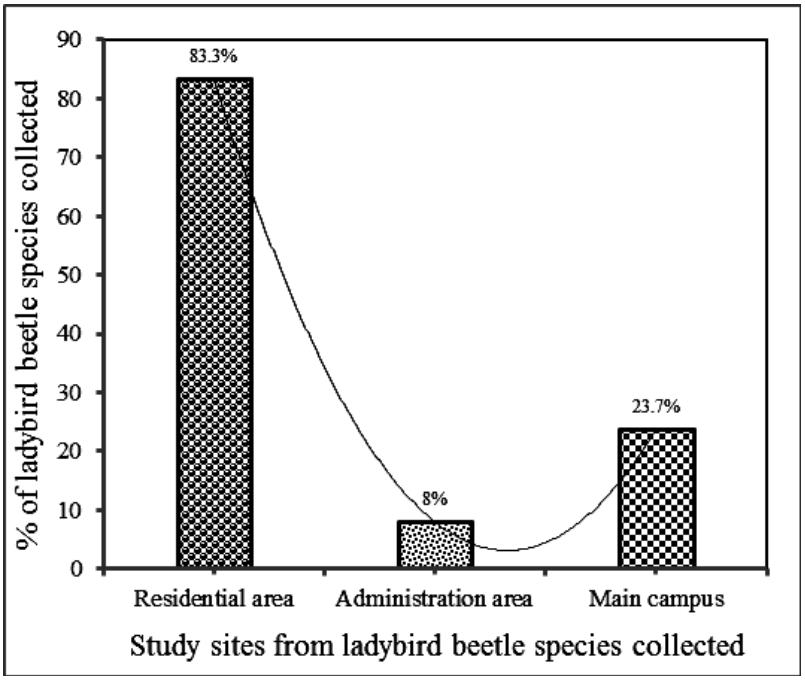

Figure 2. The percentage of ladybird beetles collected (n = 300) from 3 quadrants of the study sites of Hazara University, Mansehra, Pakistan during March-May 2011; trend line: polygonal.

Table 1. The comparative characterization of the ladybird beetles (Coleoptera: Coccinellidae) collected from Hazara University, Garden Campus, Mansehra, Pakistan during March-May 2011.

SNo	Common name	Scientific name	n[1]	Body color	Hair on body	Body shape
1.	Ladybird beetle	*Adalia tetraspilota*	14	Orange-yellow	Glabrous	Oval
2.	Seven-spotted ladybug	*Coccinella septempunctata*	15	Orange	Glabrous	Slightly elongated
3.	Transverse ladybird	*Coccinella transversalis*	10	Orange	Glabrous	Slightly elongated
4.	Fifteen-spotted ladybird	*Harmonia dimidiata*	10	Orange	Glabrous	Slightly elongated
5.	Adonis ladybird	*Hippodamia variegata*	10	Yellow	Glabrous	Elongated
6.	Six-spotted Zigzag ladybird	*Menochilus sexmaculatus*	12	Yellowish orange	Glabrous	Rounded
7.	Ladybird beetle	*Oenopia sauzeti*	9	Yellow	Glabrous	Rounded

[1]n: number of specimen observed; collection has been made from 3 study sites, *i.e.*, residential area, admiration area and main campus.

All collected species head was black, except in *M. sexmaculatus*, which was yellowish brown. The pronotum and elytra of all species showed great variation in color, however, they were mostly attractive and dark. All collected species scutellum was black, except in *H. dimidiate*, which was brownish (**Table 2**).

The ventral side of body of *A. tetraspilota* was dark brown, however, the same of *C. septempunctata*, *C. transversalis*, *H. variegate* and *O. sauzeti* were black, moreover, the same for *H. dimidiata* was brownish orange, further, *M. sexmaculatus* was brown (**Figure 4**).

4. Discussion

During the present survey, the study area was divided into 3 quadrated, *i.e.*, residential area, administration area and main campus, and visited 2 h in each morning and evening. In total 300 individuals, 7 species from 6 genera belonging to subfamily Coccinellinea and tribe Coccinellini were collected.

Different species of the ladybird beetles were reported by Gilani [21] from Faisal Abad, Shah [22] from Pe-

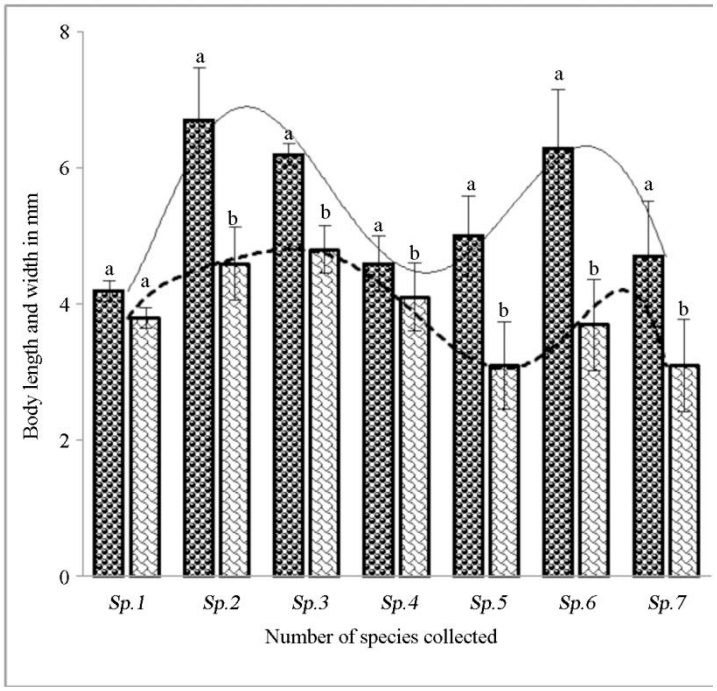

Figure 3. Comparison of the length and width of ladybird beetles collected from Hazara University Garden Campus *Sp.* 1: *Adalia tetraspilota*; *Sp.* 2: *Coccinella septempunctata*; *Sp.* 3: *Coccinella transversalis*; *Sp.* 4: *Harmonia dimidiata*; *Sp.* 5: *Hippodamia variegata*; *Sp.* 6: *Menochilus sexmaculatus*; *Sp.* 7: *Oenopia sauzeti*; M ± SD (cm): mean ± standard deviation; n = 9 - 15: number of specimen observed; collection has been made from 3 study sites, *i.e.*, residential area, admiration area and main campus; ▩: length; ▨: width; trend line: polygonal, for length: —, for width: ---; data were analyzed by one-way Anova. Horizontal bars on columns indicate SD; different superscript alphabets show significantly different between two factors, *i.e.*, length and width of different ladybird beetle species (at $P < 0.05$); df: 6; F-value: 19.26.

Table 2. Comparison of different parts of body on the ground of coloration of ladybird beetles collected from Hazara University, Garden Campus, Mansehra, Pakistan during March-May 2011.

SNo	Common name	Scientific name	n[1]	Head	Pronotum	Scutellum	Elytra
1.	Ladybird beetle	*Adalia tetraspilota*	14	Black	Black, anterio-laterally orange	Black	Yellowish red
2.	Seven-spotted ladybug	*Coccinella septempunctata*	15	Black	Black, anterio-laterally orange-yellow	Black	Yellowish brown to reddish brown
3.	Transverse ladybird	*Coccinella transversalis*	10	Black	Black, anterio-laterally orange	Black	Dull orange to yellowish brown
4.	Fifteen-spotted ladybird	*Harmonia dimidiata*	10	Black	Straw yellow, black	Brownish	Brownish
5.	Adonis ladybird	*Hippodamia variegata*	10	Black	Yellowish white black large areas in form of four finger like projection in centre	Black	Yellow to orange
6.	Six-spotted zigzag ladybird	*Menochilus sexmaculatus*	12	Yellowish brown	Yellowish brown with transverse black band in the middle near the posterior margin	Black	Generally brownish yellow
7.	Ladybird beetle	*Oenopia sauzeti*	9	Black	Black, anterio-laterally yellowish white	Black	Yellowish white

[1]n: number of specimen observed; collection has been made from 3 study sites, *i.e.*, residential area, admiration area and main campus.

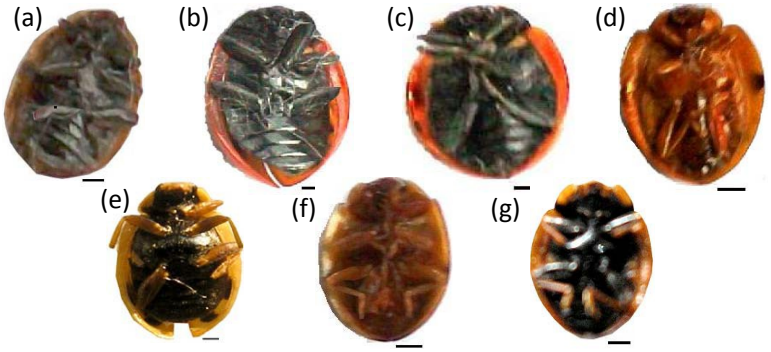

Figure 4. Comparison of ventral views of ladybird beetles collected from Hazara University, Garden Campus, Mansehra, Pakistan during March-May, 2011. (a) Ladybird beetle, *Adalia tetraspilota* (Hope); (b) Seven-spotted ladybug, *Coccinella septempunctata* (Linnaeus); (c) Transverse ladybird, *Coccinella transversalis* (Fabricius); (d) Fifteen-spotted ladybird, *Harmonia dimidiata* (Fabricius); (e) Adonis ladybird, *Hippodamia variegata* (Goeze); (f) Six spotted zigzag ladybird, *Menochilus sexmaculatus* (Fabricius); (g) Ladybird beetle *Oenopia sauzeti* (Mulsant); all species were collected from residential area, except *H. variegata* which was collected from administration area; bars in photographs indicate 5 cm.

shawar, Irshad [23] and Rehman *et al.* [24] from Pakistan. The present study reported them from Hazara University, Pakistan. Trehan and Malhotra [25] had reported from India and Zhang and Han [26] from China. Therefore, these studies showed that their species are cosmopolitan. However, no new species was collected. At the present, the distributions of these insects were different in three quadrants of the study sites, however, ecological conditions of these areas were more or less the same, and moreover, human activities were the highest in administration area and the lowest in residential area than main campus. When comparing the vegetation, we found that in residential area, the ladybird beetles were the densest, but in administration area, they were sparsely grown compared with main campus. There might be possibility that residential area was the most frequently visited and administration area was the most rarely visited.

During the present study, the most encountered species was *C. septempunctata* whose in which 220 individuals were collected: 150 were from residential area and 70 were from main campus. Rahatullah *et al.* [27] reported total 50 specimens of *C. septempunctata* collected during a survey was conducted in district Dir Lower over a period of 2 years. This species was previously reported by Rehman *et al.* [24], Gilani [21], Shah [22] and Irshad [23] from Pakistan. Due to their broad habitat range and voracity, there has been concern that C7 (seven Coccinellids) may pose a threat to native *Aphidophagous coccinellids*. Sometimes *C. septempunctata* has been used as a model for polyphagous predators. Habitat choice and foraging behaviour have attracted considerable interest in studies of the ecology and life history of *C. septempunctata*. Since it is a polyphagous species, Vet and Dicke [28] hypothesized it, as a capacity for learning. Therefore, the present studies provide us awareness, education and learning.

At the present, the second most encountered species was the *H. variegate,* in which 32 individuals were collected: eight were from residential and 24 were from administration area of Hazara University. Gilani [21], Shah [22] and Irshad [23] also reported it from Pakistan. Therefore, this species is common in Pakistan.

An extensive survey of predatory Coccinellid beetles (Coleoptera: Coccinellidae) was conducted in the Chitral district, Pakistan, over a period of 7 months (April-October 2001). Total 2600 individuals of Coccinellids were collected from 12 different localities having altitudes from 1219.40 - 2651.63 m. Twelve different species belonging to 9 genera of 3 tribes and 2 sub-families were recorded. Two sub-families, *viz*., Coccinellinae and Chilocorinae were identified [29]. However, the present survey was conducted in terms of short duration (during March-May 2011), limited study area (only Hazara University is located between 34˚.14' and 35˚.11' north latitudes and 72˚.49' and 74˚.08' east longitude) and no finding, moreover, a total 300 specimens, 7 species from 6 genera belonging to subfamily Coccinellinea and tribe Coccinellini were collected. Further, only 4 more species were found by Khan *et al.* If an extensive survey will be done in the present study area, it will provide more information about the ladybird beetles.

Sathe and Bhosale [30] reported 21 species of ladybird beetles feeding on aphids and several soft-bodied ho-

mopterous pests of agricultural and forest plants from Maharashtra. Kandibane *et al*. [31] reported 7 species of predatory ladybird beetles in an irrigated rice ecosystem at Madurai, Tamil Nadu. Fish *et al.* [32] stated globally invasive hemipteran pests have adversely affected the production of many food, fiber and ornamental crops. The globalization and the concomitant increase in international travel and commerce are directly-correlated to the resultant enhancement in introduction and spread of exotic invasive species, which cause loss of biodiversity, modify the habitat and cause extensive environmental and economic harm. While predatory species are often used as biological control agents, introduced species of ladybirds such as *Coccinella septempunctata* in North America was outcompeted, displaced native coccinellids, and became pests in their own right. The present results suggested that the ladybird beetles community structure in 3 study sites with different vegetation differs greatly as described above. The number of species found in the administration area was minimum compared to main campus and residential area because of more construction with greater number of people there.

The diversity of ladybird beetles seen at 3 sites in the current study was in accord with Omkar and Bind [33] that reported only 6 - 7 species of the ladybird beetles from agricultural and horticultural plants of Utra Pradesh. Most species of ladybirds are considered beneficial because they are predators of Homoptera, many of which are considered to be pests. These predatory ladybirds contribute to the regulation of populations of their prey, and in some situations contribute a high level of regulation.

5. Conclusion

As 300 specimens of 7 predatory species of ladybird beetle from 6 genera were recorded belonging to the subfamily, Coccinellinae and the tribe, Coccinellini during March-May, 2011 from 3 study sites of Hazara University, Garden Campus, Mansehra, Pakistan. Therefore, it is suggested that this region may have a diverse and rich fauna of ladybird beetles.

Recommendation

Frequent survey should be conducted on large scale to fully evaluate the ladybird beetle fauna of Hazara division, as it is least documented region of KP, whatever their methodological shortcomings are important. Proper preventive measures should be taken in order to minimize the natural habitat loss, as ladybird beetles are dependent upon proper environmental conditions. Trying to raise awareness and educate the public about the ladybird beetles importance.

Acknowledgements

We are grateful to Dr Ather Rafi, Senior Scientist, National Insect Museum, NARC, Islamabad for identification of ladybird beetle and to Officials, Department of Zoology, Hazara University, Mansehra, Pakistan for providing laboratory facilities throughout the present research. The experiments comply with the current laws of the institution and country in which they were performed.

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