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Research Article

INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES
ISSN: 2231-4490

Studies on diversity, Distribution and Relative Abundance of Insect Pollinators on *Bergenia ciliata* (Haw.) Sternb. and *Vinca major* (Linneaus) in Shimla Hills, Himalaya

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Abstract

Medicinal plants are highly valuable and most of them depend on insect pollinators for their reproduction. Therefore, it is important to study the insect pollinators of medicinal plants. The present study on diversity and distribution reveals a total of 29 insect pollinators collected on two medicinal plants i.e. *Bergenia ciliata* (Haw.) Sternb. and *Vinca major* (Linnaeus) in different localities of Shimla Hills, Himachal Pradesh, India. Of these 29 insect pollinator's species, 8 species has been collected on *Bergenia ciliata* (Haw.) Sternb. belongs to 3 orders i.e. Coleoptera, Hymenoptera and Diptera. Whereas 24 species has been recorded and collected on *Vinca major* (L.) under four orders i.e. Coleoptera, Hymenoptera, Lepidoptera and Diptera. Beside diversity and distribution study has also been conducted on the relative abundance studies of insect pollinators on these two medicinal plants. During this study period it has been observed that dipterans were the most abundant insect pollinators of *Bergenia ciliata* (Haw.) Sternb. in all the four localities i.e. Dhalli (80%), Kufri (63.41%), IGMC (60.86%) and Fagu (64%), whereas lepidopterans were the most abundant insect pollinators of Vinca major (Linnaeus) at Dhalli (60.76%), Summerhill (58.46%), Chauda Maidan (58.95%), IGMC (57.42%), Kasumpti (63.20%) and Chotta Shimla (63.06%).

Keywords: Diversity; Distribution; Relative abundance; Insect pollinators; *Bergenia ciliate*; *Vinca major*

Introduction

Bergenia ciliata (Haw.) Sternb. (Saxifragaceae) is a high value medicinal plant of the Himalaya. It is a perennial herb with thick, stout, creeping rhizomes. *B.ciliata* is a threatened species in Nepal due to commercial harvest [1]. *Bergenia* (Haw.) Sternb. is mainly distributed in Asia, involved in East Asia, the southeastern regions of Central Asia and northern regions of South Asia [2,3]. *B.ciliata* is commonly known as Pashanabheda (Pashan means rock and bheda means piercing) or Patharchat and is found in Sirmour, Shimla, Mandi, Kullu, Chamba and Kinnaur districts of Himachal Pradesh. *Bergenia* is one of the most important folk medicinal herbs, in China, it is often used for treating cough, stop bleeding, increasing immunity and so on [4]. In India, the rhizomes of *Bergenia* have been used for centuries in the Ayurvedic formulations to dissolve kidney and bladder stones, abnormal leucorrhea, piles and pulmonary affections [5,6]. Flowering time of *Bergenia ciliata* is March to April, this provides a valuable alternative to foraging pollinators, when resources start declining and become scare successively in winter.

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Citation: Thakur MS, Katoch A. Studies on diversity, Distribution and Relative Abundance of Insect Pollinators on *Bergenia ciliata* (Haw.) Sternb. and *Vinca major* (Linneaus) in Shimla Hills, Himalaya. International Journal of Plant, Animal and Environmental Sciences. 12 (2022): 154-163.

Received: October 01, 2022
Accepted: October 20, 2022
Published: November 07, 2022

Thakur MS and Katoch A., Int J Plant Anim Environ Sci 2022
DOI:10.26502/ijpaes.4490141

Another most important medicinal plant of Himachal Pradesh is *Vinca major* (L.) the big periwinkle which is an evergreen shrub found in lower Himalayan ranges in Asia. In India, *V. major* (L.) is found in Himalayas near Mussoorie and Shimla, West Bengal and palni hills in Tamil Nadu. *V. major* is commonly grown ornamental plant in temperate gardens for its evergreen foliage, spring flowers and groundcover or vine use. *V. major* belongs to the family Apocynaceae (dogbane family) which is an important family of flowering plants that comprises a number of medicinally useful plants. All periwinkles have many medicinal uses and are used for bleeding, diarrhoea, to heal wounds and as an anti-dote to bites by poisonous animals [7]. Flowers of *Vinca* blooms from April to May. They are purple in colour and attract large number of insect pollinators.

Of the multiple roles that insects play, pollinating flowering plants is a process that is of the utmost importance in terrestrial environments and one which provides vital ecosystem services for human well-being. Diversity of pollinators reduces the risk of lack of pollination in absence of one insect species during critical period of crop flowering. Therefore, the present study was carried out on the diversity, distribution and relative abundance of insect pollinators of medicinal plants (*Bergenia ciliata* (Haw.) Sternb. and *Vinca major* (Linnaeus)).

Materials and Methods

The present investigation was carried out on diversity, distribution and relative abundance of various insect pollinators of *Bergenia ciliata* (Haw.) Sternb. and *Vinca major* (L.) in different localities of Shimla Hills, Himachal Pradesh, India. Shimla is a hilly place situated at an altitude of 2,206 meters and extends between 31°-6° N latitude and 77°-10° E longitude on a transverse spur of northwestern Himalayas. This town has average rainfall of 137.5 to 162.5 cm. In Shimla, during summer season, maximum temperature ranges from 31°C to 33°C and minimum varies between 10°C to 11°C, whereas, in winters maximum temperature lies between 15°C to 18°C and minimum between 0.5°C to 5°. The present studies were conducted during flowering season i.e. from April to May, 2019 and experimental sites where these were conducted are Kufri (2,437 m), Fagu (2,374 m), Dhalli (1,979 m), Kasumpti (1,892 m), Chotta Shimla (2,161 m), Chauda maidan (2,092 m), IGMC (1,877 m) and Summerhill (1,984 m). For collection of different insect pollinators aerial netting method was used. Captured insects were killed by using benzene and preserved as dried specimen into air tight wooden insect cabinets containing powdered naphthalene. Identification of insect pollinators was done with the help of different experts from different parts of country. The relative abundance of different insect pollinators on *Bergenia ciliata* (Haw.) Sternb. and *Vinca major* (Linnaeus) were determined in terms of their visit per 500 flowers/10 minutes [8]. The observation was recorded during 0900-1000, 1200-1300 and 1500-1600 hours of a day and average count at these hours give abundance of insect pollinators for that particular day [9]. The relative abundance of different species of pollinators was worked out by using the following formula and expressed in percent.

$$\text{Relative abundance of species} = \frac{\text{Total number of individual of species A}}{\text{Total number of individuals of all species}} \times 100$$

Similarly family number, family percentage, order number and order percentage were calculated for collected sites under study and the results were interpreted.

Results and Discussion

The present insect pollinator's diversity and distribution studies which were conducted on two medicinal plants revealed that, *Bergenia ciliata* (Haw.) Sternb. and *Vinca major* (L.) were visited by 29 species during entire flowering period, which belongs to 4 order and 10 families. Among these 29 species, 8 species has been collected on *Bergenia ciliata* (Haw.) Sternb., belongs to 3 families and 3 orders. Among these 29 species one species of Coleoptera i.e. *Coccinella septempunctata* of family Coccinellidae, 2 species of Hymenoptera i.e. Apis cerana and Ceratina sp. of family Apidae and 5 species of Diptera i.e. *Episyrphus balteatus*, *Episyrphus viridaureus*, *Eristalis tenax*, *Melanostoma orientale* and *Rhingia laticincta* of family Syrphidae were observed (Table 1, Figure 1).

During this study period 24 species of insect pollinators has been recorded and collected on *Vinca major* (L.), belongs to 10 families and 4 orders. Out of these 24 species of insect pollinators, 2 species belongs to Coleoptera

(*Coccinella septumpunctata*, *Oenopia sexareata*) of family Coccinellidae, 2 species of Hymenoptera (*Bombus*

Table 1: Diversity and distribution of different insect pollinators visiting *Bergenia ciliata* (Haw.) Sternb. flowers at different localities of Shimla hills, Himachal Pradesh.

S.No.	Insect species	Dhalli	Kufri	IGMC	Fagu
1	*Coccinella septempunctata* (Linnaeus)	-	-	+	+
2	*Apis cerana* (Fabricius)	+	+	-	+
3	*Ceratina* sp.	+	+	+	+
4	*Episyrphus balteatus* (De Geer)	+	+	+	+
5	*Episyrphus viridaureus* (Wiedemann)	+	+	+	+
6	*Eristalis tenax* (Linnaeus)	+	+	+	+
7	*Melanostoma orientale* (Wiedemann)	+	+	+	+
8	*Rhingia laticincta* (Brunetti)	-	+	-	-

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Thakur MS and Katoch A., Int J Plant Anim Environ Sci 2022
DOI:10.26502/ijpaes.4490141

haemorrhoidalis, Xylocopa sp.) of family Apidae, 13 species of Lepidoptera (*Celastrina huegelii*, *Celastrina lavendularis, Celastrina sp*., *Lampides boeticus*, *Dodona durga*, *Vanessa indica*, *Aglais cashmirensis*, *Pieris brassicae*, *Pieris canidia*, *Gonepteryx rhamni neplensis*, *Celaenorrhinus leucocera*, *Hyarotis adrastus* and *Macroglossum pyrrhosticta*) of families Lycaenidae, Nymphalidae, Pieridae, Hesperidae and Sphingidae respectively and 7 species of Diptera (*Neoitamus graham*, *Episyrphus balteatus*, *Eristalis himalayensis*, *Eristalis tenax*, *Melanostoma scalare*, *Eumerus aurifrons* and *Tachina ursina*) of families Asilidae, Syrphidae and Tachinidae respectively (Table 2 and Figure 2).

Figure 1: Insect pollinators foraging on *Bergenia ciliata* (Haw.) Sternb. flowers.

Present results on pollinator diversity and distribution are in accordance with the earlier observations. For example, Knuth [10] observed many pollinators on genus *Vinca* i.e. *Bombylius discolor*, *B.major*, *Anthophora pilipes*, *Apis mellifica*, *Bombus agrorum*, *B. hortorum*, *B. hypnorum*, *B. pratorum*, *B. terrester*, *B. vestalis*, *Osmia fusca*, *O. rufa* and *thrips*. *Apis sp*., *Bombus sp*., *Andrena sp*., *Aglais urticae* and various dipteran species were recorded on Bergenia flowers in England by Yeo [11]. Pandey et al. [12] reported 3 species of Hymenoptera i.e. Apis cerana, Bombus sp., Vespula sp., 3 species of Diptera i.e. Eristalis tenax, hoverfly, Musca domestica and 2 species of Lepidoptera i.e. Cynthia cardui, Aglais cashmiriensis on Bergenia flowers in East Sikkim. Stevens [13]; Stone [14]; More [15] also observed bees, hawkmoths and other insects pollinators on V. major because of their paired nectaries.

The data pertaining to number of insects visiting *Bergenia ciliata* (Haw.) Sternb. and *Vinca major* (L.) flowers were recorded at regular intervals from 9:00 hour in the morning to

Table 2: Diversity and distribution of different insect pollinators visiting *Vinca major* (Linnaeus) flowers at different localities of Shimla hills, Himachal Pradesh.

S.No.	Insect species	Dhalli	Summer Hill	Chauda Maidan	IGMC	Kasumpti	Chotta Shimla
1	*Coccinella septumpunctata* (Linnaeus)	+	+	+	+	+	+
2	*Oenopia sexareata* (Mulsant)	+	+	+	-	-	-
3	*Bombus haemorrhoidalis* (Smith)	+	+	+	+	+	+
4	*Xylocopa* sp.	+	+	+	+	+	+
5	*Celastrina huegelii* (Moore)	+	+	+	+	+	+
6	*Celastrina lavendularis* (Moore)	+	+	+	+	+	+
7	*Celastrina* sp.	+	+	+	+	+	+
8	*Lampides boeticus* (Linnaeus)	+	+	+	+	+	+
9	*Dodona durga* (Kollar)	+	+	+	+	+	+
10	*Vanessa indica* (Herbst)	+	+	+	+	+	+
11	*Aglais cashmirensis* (Kollar)	+	+	+	+	+	+
12	*Pieris brassicae* (Linnaeus)	+	+	+	+	+	+
13	*Pieris canidia* (Sparrman)	+	+	+	+	+	+
14	*Gonepteryx rhamni neplensis* (Doubleday)	+	+	+	+	+	+
15	*Celaenorrhinus leucocera* (Kollar)	+	+	+	+	+	+
16	*Hyarotis adrastus* (Cramer)	-	-	-	-	-	+
17	*Macroglossum pyrrhosticta* (Butler)	+	+	+	+	+	+
18	*Neoitamus graham* (Joseph and Parui)	-	+	+	+	+	-
19	*Episyrphus balteatus* (De Geer)	+	+	+	+	+	+
20	*Eristalis tenax* (Linnaeus)	+	+	+	+	+	+
21	*Eristalis himalayensis* (Brunetti)	-	-	+	-	-	-
22	*Melanostoma scalare* (Fabricius)	+	+	+	+	+	+
23	*Eumerus aurifrons* (Wiedemann)	+	-	-	-	-	-
24	*Tachina ursina* (Meigen)	-	+	-	-	-	-

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Thakur MS and Katoch A., Int J Plant Anim Environ Sci 2022
DOI:10.26502/ijpaes.4490141

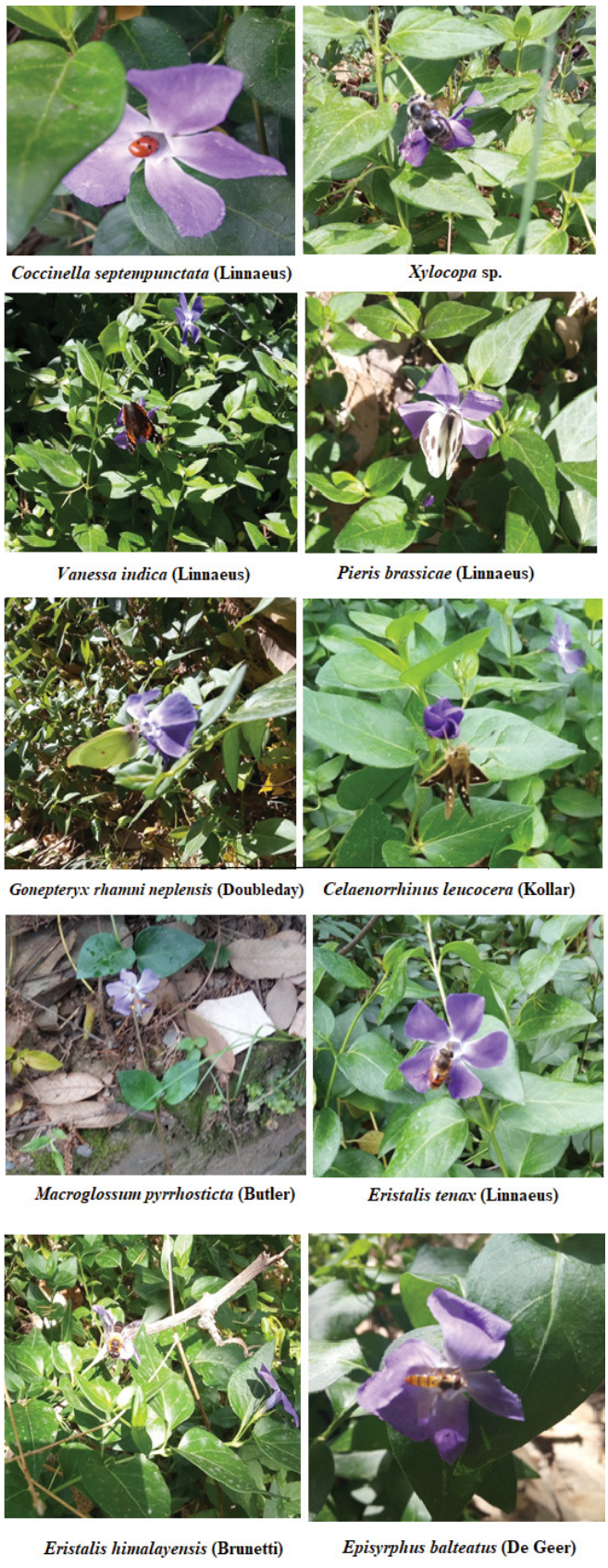

Figure 2: Insect pollinators foraging on Vinca major (Linnaeus) flowers.

17:00 hour in the evening and average counts at these hours gave abundance of an insect pollinator for that particular day and particular site. Using standard statistical tests their family percentage and order percentage was also determined.

The relative abundance studies which were conducted on insect pollinators of *Bergenia ciliata* (Haw.) Sternb. revealed that *Episyrphus balteatus* was the most abundant insect visitor in four localities i.e. Dhalli (35%), Kufri (17.07%), IGMC (21.73%) and Fagu (24%). Other important dipterans at Dhalli, Kufri, IGMC and Fagu were *Eristalis tenax* (0.75 ± 0.43, 15%, 1 ± 0.7, 9.75%, 0.5 ± 0.5, 8.69% and 1.25 ± 0.82, 20%), *Episyrphus viridaureus* (0.5 ± 0.5, 10%, 1.5 ± 0.86, 14.63%, 0.75 ± 0.82, 13.04% and 0.5 ± 0.5, 8%) and *Melanostoma orientale* (1 ± 0.7, 20%, 1.25 ± 0.82, 12.19%, 1 ± 0.7, 17.39% and 0.75 ± 0.43, 12%) respectively. *Rhingia laticincta* a dipteran (1 ± 0.7, 9.75%) was also found at Kufri. Among hymenopterans, *Apis cerana* (0.25 ± 0.43, 5%, 1.5 ± 0.86, 14.63%, 1 ± 0.7, 17.39 and 0.5 ± 0.5, 8%) and *Ceratina sp*. (0.5 ± 0.5, 10%, 2 ± 0.7, 19.51%, 0.25 ± 0.43, 4.34% and 0.75 ± 0.43, 12%) were also the important pollinators at Dhalli, Kufri, IGMC and Fagu respectively. *Coccinella septumpunctata* (0.25 ± 0.43, 5%, 0.25 ± 0.43, 2.43%, 1 ± 0.7, 17.39% and 1 ± 0.7, 16%) was the only coleopteran pollinator at Dhalli, Kufri, IGMC and Fagu respectively. Based on present studies it is suggested that dipterans were the most abundant insect pollinators of *Bergenia ciliata* (Haw.) Sternb. at Dhalli (80%), IGMC (60.86%), Kufri (63.41%) and Fagu (64%) (Table 1,3).

While studying the relative abundance of insect pollinators on *Vinca major* (L.) it has been reported that *Coccinella septumpunctata*, *Episyrphus balteatus* and *Gonepteryx rhamni neplensis* were the most abundant pollinators of *Vinca major* (Linnaeus) at 6 localities i.e. Dhalli (2.25 ± 0.82, 6.61%, 2.25 ± 0.43, 6.61% and 2.25 ± 0.43, 6.61%), Summerhill (2.5 ± 0.86, 7.69%, 2.5 ± 0.86, 7.69% and 3 ± 1.08, 9.23%), Chauda Maidan (2.25 ± 0.82, 6.71%, 2.75 ± 0.55, 8.20% and 2.5 ± 0.5, 7.46%), IGMC (2.25 ± 0.82, 8.91%, 2.75 ± 0.55, 10.89% and 2.5 ± 0.5, 9.90%), Kasumpti (2 ± 0.7, 7.54%, 2.5 ± 1.11, 9.43% and 1.75 ± 0.82, 6.60%) and Chotta Shimla (2 ± 0.7, 7.20%, 2.5 ± 0.86, 9.00% and 2.75 ± 0.55, 9.90%) respectively. Among them other important insect pollinators i.e. Celastrina huegelii (1.75 ± 0.43, 5.14%, 2.25 ± 0.82, 6.92%, 1.75 ± 0.82, 5.22%, 1.5 ± 0.5, 5.94%, 2.25 ± 0.86, 8.49% and 1.25 ± 0.43, 4.50%), Lampides boeticus (2 ± 0.7, 5.88%, 1.75 ± 0.82, 5.38%, 2 ± 0.7, 5.97%, 1 ± 0.7, 3.96%, 1.5 ± 0.86, 5.66% and 1.75 ± 0.75, 6.30%) Dodona durga (2.25 ± 0.86, 6.61%, 1.75 ± 0.82, 5.38%, 2.25 ± 0.86, 6.71%, 1.25 ± 0.43, 4.95%, 1.25 ± 0.43, 4.71% and 1.5 ± 0.86, 5.40%) and Pieris brassicae (1.25 ± 0.82, 3.67%, 1.5 ± 0.5, 4.61%, 2.25 ± 0.82, 6.71%, 1.75 ± 0.43, 6.93%, 1.5 ± 0.86, 8.49% and 1.75 ± 0.43, 6.30%) were also recorded at Dhalli, Summerhill, Chauda maidan, IGMC, Kasumpti and Chotta Shimla respectively. Based on these studies it is suggested

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Thakur MS and Katoch A., Int J Plant Anim Environ Sci 2022
DOI:10.26502/ijpaes.4490141

Table 3: Relative abundance of different insect pollinators visiting *Bergenia ciliata* (Haw.) Sternb. flowers from different localities of Shimla hills.

Locality	Order	Coleoptera	Hymenoptera		Diptera				
	Family	Coccinellidae	Apidae		Syrphidae				
	Species	*Coccinella septumpunctata* (Linnaeus)	*Apis cerana* (Fabricius)	*Ceratina sp.*	*Episyrphus balteatus* (De Geer)	*Episyrphus viridaureus* (Wiedemann)	*Eristalis tenax* (Linnaeus)	*Melanostoma orientale* (Wiedemann)	*Rhingia laticincta* (Brunetti)
	Parameters								
Dhalli	X ± SE	0.25 ± 0.43	0.25 ± 0.43	0.5 ± 0.5	1.75 ± 0.82	0.5 ± 0.5	0.75 ± 0.43	1 ± 0.7	
	Percent Population	5	5	10	35	10	15	20	
	Family number	0.25	0.75	0.75	4	4	4	4	
	Family percent	5	15	15	80	80	80	80	
	Order number	0.25	0.75	0.75	4	4	4	4	
	Order Percent	5	15	15	80	80	80	80	
Kufri, Shimla Hills	X ± SE	0.25 ± 0.43	1.5 ± 0.86	2 ± 0.7	1.75 ± 0.82	1.5 ± 0.86	1 ± 0.7	1.25 ± 0.82	1 ± 0.7
	Percent Population	2.43	14.63	19.51	17.07	14.63	9.75	12.19	9.75
	Family number	0.25	3.5		6.5	6.5	6.5	6.5	6.5
	Family percent	2.43	34.14		63.41	63.41	63.41	63.41	63.41
	Order number	0.25	3.5		6.5	6.5	6.5	6.5	6.5
	Order Percent	2.43	34.14		63.41	63.41	63.41	63.41	6.5
IGMC, Shimla Hills	X ± SE	1 ± 0.7	1 ± 0.7	0.25 ± 0.43	1.25 ± 1.08	0.75 ± 0.82	0.5 ± 0.5	1 ± 0.7	
	Percent Population	17.39	17.39	4.34	21.73	13.04	8.69	17.39	
	Family number	1	1.25	1.25	3.5	3.5	3.5	3.5	
	Family percent	17.39	21.73	21.73	60.86	60.86	60.86	60.86	
	Order number	1	1.25	1.25	3.5	3.5	3.5	3.5	
	Order Percent	17.39	21.73	21.73	60.86	60.86	60.86	60.86	
Fagu, Shimla	X ± SE	1 ± 0.7	0.5 ± 0.5	0.75 ± 0.43	1.5 ± 0.75	0.5 ± 0.5	1.25 ± 0.82	0.75 ± 0.43	
	Percent Population	16	8	12	24	8	20	12	
	Family number	1	1.25	1.25	4	4	4	4	
	Family percent	16	20	20	64	64	64	64	
	Order number	1	1.25	1.25	4	4	4	4	
	Order Percent	16	20	20	64	64	64	64	

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Table 4: Relative abundance of different insect pollinators visiting *Vinca major* (Linnaeus) flowers from different localities of Shimla hills.

Locality	Order	Coleoptera		Hymenoptera		Diptera						
	Family	Coccinellidae		Apidae		Asilidae	Syrphidae					Tachinidae
Dhalli	Species	*Coccinella septumpunctata* (Linnaeus)	*Oenopia sexareata* (Mulsant)	*Bombus haemorrhoidalis* (Smith)	*Xylocopa sp.*	*Neoitamus graham* (Joseph and Parui)	*Episyrphus balteatus* (De Geer)	*Eristalis tenax* (Linnaeus)	*Melanostoma scalare* (Fabricius)	*Eristalis himalayensis* (Brunetti)	*Eumerus aurifrons* (Wiedemann)	*Tachina ursina* (Meigen)
	Parameters											
	N ± SE	2.25 ± 0.82	0.5 ± 0.5	0.5 ± 0.5	1 ± 0.7	0.5 ± 0.5	2.25 ± 0.43	1.75 ± 0.82	2.25 ± 0.43		1.75 ± 0.75	
	Percent Population	6.61	1.47	1.47	2.94	0.32	6.61	5.41	6.61		5.14	
	Family Number	2.75	2.75	1.5	1.5	0.5	8	8	8		8	
	Family Percent	8.46	8.46	4.61	4.61	1.53	24.61	24.61	24.61		24.61	
	Order Number	2.75	2.75	1.5	1.5		8.5	8.5	8.5		8.5	
	Order Percent	8.46	8.46	4.61	4.61		26.15	26.15	26.15		26.15	
Summer hill	N ± SE	2.5 ± 0.86	0.5 ± 0.5	0.75 ± 0.82	0.75 ± 0.82	1.5 ± 0.86	2.5 ± 0.86	2.5 ± 0.86	2 ± 0.7			0.5 ± 0.5
	Percent Population	7.69	1.53	2.3	2.3	4.61	7.69	7.69	6.15			1.53
	Family Number	3	3	1.5	1.5	1.5	7	7	7			0.5
	Family Percent	9.23	9.23	4.61	4.61	4.61	21.53	21.53	21.53			1.53
	Order Number	3	3	1.5	1.5							9
	Order Percent	9.23	9.23	4.61	4.61							27.69
Chauda Maidan	N ± SE	2.25 ± 0.82	0.75 ± 0.43	1.25 ± 0.82	1 ± 0.7	1.5 ± 0.86	2.75 ± 0.55	2 ± 0.86	1.75 ± 0.82	0.5 ± 0.5		
	Percent Population	6.71	2.23	3.73	2.98	4.47	8.2	5.97	5.22	1.49		
	Family Number	3	3	2.25	2.25	1.5	7	7	7	7		
	Family Percent	8.95	8.95	6.71	6.71	4.47	20.89	20.89	20.89	20.89		
	Order Number	3	3	2.25	2.25		8.5	8.5	8.5	8.5		
	Order Percent	8.95	8.95	6.71	6.71		25.37	25.37	25.37	25.37		

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IGMC	N ± SE	2.25 ± 0.82	0.5 ± 0.5	0.75 ± 0.82	0.5 ± 0.5	0.75 ± 0.82	2.75 ± 0.55	1.5 ± 0.86	1.75 ± 0.82			
	Percent Population	8.91	1.98	2.97	1.98	2.97	10.89	5.94	6.93			
	Family Number	2.75	2.75	1.25	1.25	0.75	6	6	6			
	Family Percent	10.89	10.89	4.95	4.95	2.97	23.76	23.76	23.76			
	Order Number	2.75	2.75	1.25	1.25		6.75	6.75	6.75			
	Order Percent	10.89	10.89	4.95	4.95		26.73	26.73	26.73			
Kasumpti	N ± SE	2 ± 0.7	0.5 ± 0.5	0.75 ± 0.43	0.5 ± 0.5	0.5 ± 0.5	2.5 ± 1.11	1.25 ± 0.43	1.75 ± 0.43			
	Percent Population	7.54	1.88	2.83	1.88	1.88	9.43	4.71	6.6			
	Family Number	2.5	2.5	1.25	1.25	0.5	5.5	5.5	5.5			
	Family Percent	9.43	9.43	4.71	4.71	1.88	20.75	20.75	20.75			
	Order Number	2.5	2.5	1.25	1.25		6	6	6			
	Order Percent	9.43	9.43	4.71	4.71		22.64	22.64	22.64			
Chotta Shimla	N ± SE	2 ± 0.7	0.5 ± 0.5	0.75 ± 0.82	0.75 ± 0.43	0.5 ± 0.5	2.5 ± 0.86	1.25 ± 0.82	2 ± 0.86			
	Percent Population	7.2	1.8	2.7	2.7	1.8	9	4.5	7.2			
	Family Number	2.5	2.5	1.5	1.5	0.5	5.75	5.75	5.75			
	Family Percent	9	9	5.4	5.4	1.8	20.72	20.72	20.72			
	Order Number	2.5	2.5	1.5	1.5		6.25	6.25	6.25			
	Order Percent	9	9	5.4	5.4		22.52	22.52	22.52			

that lepidopterans, dipterans and coleopterans were the most abundant insect pollinators of Vinca major) (Linnaeus) at Dhalli (60.76%, 26.15% and 8.46%), Summerhill (58.46%, 27.69% and 9.23%), Chauda Maidan (58.95%, 25.37% and 8.95%), IGMC (57.42%, 26.73% and 10.89%), Kasumpti (63.20%, 22.64% and 9.43%) and Chotta Shimla (63.06%, 22.52% and 9.00%) respectively. Whereas hymenopterans were the least abundant pollinator on this medicinal plant in all six localities i.e. Dhalli (4.61%), Summerhill (4.61%), Chauda Maidan (6.71%), IGMC (4.95%), Kasumpti (4.71%) and Chotta Shimla (5.40%) (Table 2,4,5).

Very few studies on relative abundance of these two medicinal plants have been found but reports on other medicinal plants are available which are in accordance with the above studies. Gupta and Thakur [6] observed pollinators *Apis mellifera* and *Apis cerana indica* on the flowers of *Rubus ellipticus* at Solan, Himachal Pradesh, India. *Apis mellifera* constitue 73% of total insects during the day than *Apis cerana indica*, other hymenopterans, dipterans and lepidopterans. Ghazoul [5] recorded 2,952 visits of insect pollinators on *Raphanus raphanistrum*. The most common pollinators accounting for 61% of flower visitors were bees

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DOI:10.26502/ijpaes.4490141

Table 5: Relative abundance of insect pollinators visiting *Vinca major* (Linnaeus) flowers from different localities of Shimla Hills.

Locality	Order	Lepidoptera												
	Family	Lycaenidae					Nymphalidae		Pieridae			Hesperiidae		Sphingidae
Dhalli	Species	*Celastrina huegelii* (Moore)	*Celastrina lavendularis* (Moore)	*Celastrina* sp.	*Lampides boeticus* (Linnaeus)	*Dodona durga* (Kollar)	*Vanessa indica* (Herbst)	*Aglais cashmirensis* (Kollar)	*Pieris brassicae* (Linnaeus)	*Pieris canidia* (Sparrman)	*Gonepteryx rhamni neplensis* (Doubleday)	*Celaenorrhinus leucocera* (Kollar)	*Hyarotis adrastus* (Cramer)	*Macroglossum pyrrhosticta* (Butler)
	Parameters													
	N ± SE	1.75 ± 0.43	2 ± 0.7	1.75 ± 0.43	2 ± 0.7	2.25 ± 0.86	1 ± 0.7	1.5 ± 0.86	1.25 ± 0.82	0.75 ± 0.43	2.25 ± 0.43	1.75 ± 0.75		1.5 ± 0.86
	Percent Population	5.14	5.88	5.14	5.88	6.61	2.94	4.41	3.67	2.2	6.61	5.41		4.41
	Family Number	9.75	9.75	9.75	9.75	9.75		2.5				1.75		1.5
	Family Percent	30	30	30	30	30		7.69				5.38		4.61
	Order Number													19.75
	Order Percent													60.76
Summer hill	N ± SE	2.25 ± 0.82	1.5 ± 0.5	1.25 ± 0.43	1.75 ± 0.82	1.75 ± 0.82	1 ± 0.5	0.75 ± 0.43	1.5 ± 0.5	1 ± 0.7	3 ± 1.08	2 ± 0.7		1.25 ± 0.82
	Percent Population	6.92	5.23	3.84	5.38	5.38	3.07	2.3	4.61	3.07	9.23	6.15		3.84
	Family Number	8.5	8.5	8.5	8.5	8.5	1.75	1.75	5.5	5.5	5.5	2		1.25
	Family Percent	26.15	26.15	26.15	26.15	26.15	5.38	5.38	16.92	16.92	16.92	6.15		3.84
	Order Number													19
	Order Percent													58.46
Chauda Maidan	N ± SE	1.75 ± 0.82	1.25 ± 0.43	1.5 ± 0.5	2 ± 0.7	2.25 ± 0.86	1.25 ± 0.82	1.5 ± 0.5	2.25 ± 0.82	0.75 ± 0.43	2.5 ± 0.5	2 ± 0.7		0.75 ± 0.43
	Percent Population	5.22	3.73	4.47	5.97	6.71	3.73	4.47	6.71	2.23	7.46	5.97		2.23
	Family Number	8.75	8.75	8.75	8.75	8.75	2.75	2.75	5.5	5.5	5.5	2		0.75
	Family Percent	26.11	26.11	26.11	26.11	26.11	8.2	8.2	16.41	16.41	16.41	5.97		2.23
	Order Number													19.75
	Order Percent													58.95
IGMC	N ± SE	1.5 ± 0.5	1 ± 0.7	0.75 ± 0.43	1 ± 0.7	1.25 ± 0.43	0.5 ± 0.5	0.75 ± 0.43	1.75 ± 0.43	0.5 ± 0.5	2.5 ± 0.5	2 ± 0.7		1 ± 0.7
	Percent Population	5.94	3.96	2.97	3.96	4.95	1.98	2.97	6.93	1.98	9.9	7.92		3.96
	Family Number	5.5	5.5	5.5	5.5	5.5	1.25	1.25	4.75	4.75	4.75	2		1
	Family Percent	21.78	21.78	21.78	21.78	21.78	4.95	4.95	18.81	18.81	18.81	7.92		3.96
	Order Number													14.5
	Order Percent													57.42

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DOI:10.26502/ijpaes.4490141

Kasumpti	N ± SE	2.25 ± 0.86	1.25 ± 0.82	2.25 ± 0.82	1.5 ± 0.86	1.25 ± 0.43	1 ± 0.7	0.75 ± 0.43	1.5 ± 0.86	1 ± 0.7	1.75 ± 0.82	1.25 ± 0.82		1 ± 0.7
	Percent Population	8.49	4.71	5.66	5.66	4.71	3.77	2.83	8.49	3.77	6.6	4.71		3.77
	Family Number	8.5	8.5	8.5	8.5	8.5	1.75	1.75	4.25	4.25	4.25	1.25		1
	Family Percent	32.07	32.07	32.07	32.07	32.07	6.6	6.6	16.03	16.03	16.03	4.71		3.77
	Order Number													16.75
	Order Percent													63.2
Chotta Shimla	N ± SE	1.25 ± 0.43	1 ± 0.7	2 ± 0.7	1.75 ± 0.75	1.5 ± 0.86	1 ± 0.7	1.25 ± 0.82	1.75 ± 0.43	0.75 ± 0.43	2.75 ± 0.55	1 ± 0.7	0.75 ± 0.43	0.75 ± 0.43
	Percent Population	4.5	3.6	7.2	6.3	5.4	3.6	4.5	6.3	2.7	9.9	3.6	2.7	2.7
	Family Number	7.5	7.5	7.5	7.5	7.5	2.25	2.25	5.25	5.25	5.25	1.75	1.75	0.75
	Family Percent	27.02	27.02	27.02	27.02	27.02	8.1	8.1	18.91	18.91	18.91	6.3	6.3	2.7
	Order Number													17.5
	Order Percent													63.06

with the hoverflies accounting for about 38% of flower visitors. But occasional visits to flowers by butterflies (*Pieris brassicae*) and sphecid or eumenid wasps accounted for the remaining 1%. Sixteen species of solitary bees belonging to 4 families of order Hymenoptera visited *Cassia fistula* flowers was recorded by Mattu and Kumar [9]. Diversity and relative abundance data on Cassia bloom showed that *Xylocopa fenestrata* was the most dominant bee pollinator at both Nahan (31.65%) and Arki (27.05%). *Apis* sp. were maximum on *Brassica juncea* (L.), representing 74.52% of the total pollinators as founded by Das and Jha [3], whereas *A. mellifera* (35.18%) was also dominant sequentially followed by *A. cerana indica* (23.11%), *A. dorsata* (12.00%) and *A. florea* (4.23%). Considerably the dipteran flies also visited the crop (21.25%) of which, the Syrphids were most common.interpreted.

Conclusion

From the above study it has been recorded that the *Bergenia* and *Vinca* flowers were highly attractive to wide variety of insects. Coleopterans, hymenopterans, dipterans and lepidopterans were the main insect orders which visit these medicinally important plants. Among all the insect pollinators, dipterans especially *Episyrphus balteatus* was the most abundant insect visitor on *Bergenia*. Whereas in *Vinca*, lepidopterans were the dominant flower visitors followed by dipterans, coleopterans and hymenopterans.

Acknowledgements

We are grateful to Dr. Kailash Chandra Director, Zoological Survey of India, Kolkata for his cooperation for providing the facilities for identification. Thanks are due to Scientists who are heading various division of Zoological Survey of India, Kolkata for confirming the status of few species. Thanks are also due to the other scientists of ZSI, Kolkata for their cooperation.

Conflicts of Interest

The author declares no conflict of interest in the publication of this work.

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