



Bio-Spectrum of Flower Visiting Insects and Their Role in Pollination Service of An Indigenous Himalayan Shrub (*Deutzia Staminea* R.Br. Ex Wall.)

Manoj Kumar Arya^{1*}, Aarti Badoni², Ambika Tiruwa³, Diksha Johari⁴

¹*Insect Biodiversity Laboratory, Department of Zoology, D.S B. Campus, Kumaun University, Nainital, 263002, Uttarakhand, India. Email: dr.manojkumar19@rediffmail.com, ORCID ID: 0000-0001-6677-5763*

²*Department of Zoology, School of Life and Allied Sciences, BFIT Group of Institutions, Dehradun, 248007, Uttarakhand, India, Email: aarubadoni@gmail.com, ORCID ID: 0000-0001-6062-3566*

³*Insect Biodiversity Laboratory, Department of Zoology, D.S B. Campus, Kumaun University, Nainital, 263002, Uttarakhand, India. Email: ambikatiruwa23@gmail.com*

⁴*Insect Biodiversity Laboratory, Department of Zoology, D.S B. Campus, Kumaun University, Nainital, 263002, Uttarakhand, India. Email: dikshajohari30@gmail.com*

***Corresponding Author: Manoj Kumar Arya**

Insect Biodiversity Laboratory, Department of Zoology, D.S B. Campus, Kumaun University, Nainital, 263002, Uttarakhand, India. Email: dr.manojkumar19@rediffmail.com

Abstract

Deutzia staminea is a deciduous or rarely evergreen shrub, indigenous to Himalayas. It is widely known for its ornamental role. The present study aiming to investigate Bio-spectrum of flower visiting insects and their role in pollination service of *Deutzia staminea* during blooming season in Kumaun Himalayas, Uttarakhand. A total of 324 individuals, belonging to 25 species under seven families from three orders were recorded visiting the selected plant species. On the basis of total number of individuals, Lepidoptera was the dominant order followed by Hymenoptera and Diptera. In terms of number of species Nymphalidae was the most dominant family whereas, Riodinidae, Vespidae, Syrphidae were the least dominant families. *Apis mellifera* was recorded as most abundant species whereas, *Calliphora vicina* was found to be the least abundant species during the study period.

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Keywords: Abundance, Diversity, Flower visitor, Insect, Pollinator.

INTRODUCTION

Insects are cosmopolitan and available in different geographical regions from hot Tropics to frozen Antarctica, in aquatic medium, land, air, deserts, and high mountains (Wang et al., 2022, Arya & Badoni, 2023). Insects shows mutualistic relationship with plants (specially with flowering plants). Plants are pollinated by insects and in most situations, insects obtain food (nectar and pollen) and shelter in exchange. (Haddad et al., 2009, Arya et al., 2018, Badoni & Arya, 2022a). Bright colour of petals attracts insects significantly, the tempting fragrance, edible pollen and the availability of nectar (Badoni & Arya, 2022a & b). Insect play important role in conserving biological diversity in agro and forest ecosystems. Insects benefit society by enhancing the yield and quality of many horticultural and agricultural crops (Klein et al., 2007, Garibaldi et al., 2016, Arya & Badoni, 2023).

The genus *Deutzia*, as the second largest genus of the tribe Philadelphae (Family: Hydrangeaceae), with about 72 species of deciduous shrubs is a native plant to Eastern and, Central America, Central Asia and also Europe. The highest species diversity of the plant is reported in China with 50 species (Hwang et al., 2001; Hufford, 2004; Gupta et al., 2018, Xu et al., 2023). A total of seven species of Genus *Deutzia* are present in India, of which *Deutzia staminea* is native to Himalayas (Gupta et al., 2018). As the species of *Deutzias* are indigenous to temperate regions of Asia, some species like *Deutzia setchuenensis* are native to China, widely introduced as ornamental plants (Hutchinson, 1909; Rehder, 1911; Rehder, 1940; Brickell & Zuk, 1996; Masierowska, 2006; Xu et al., 2023). Their decorative value derives from their beautiful and numerous flowers. Species of *Deutzias* usually do not grow well when planted in regions of harsh climate, especially with low rainfalls. However, *Deutzia carnea* has been reported as a relative winter hardy shrub, immune to diseases and resistant to drought as well as to pollutions by dust and smoke (Gupta et al., 2018; Xu et al., 2023). It is already published that *Deutzias* can be a good source of nectar for insects (Masierowska, 2006). Even though it is a rich source of nectar, there is limited literature on flower-visiting insects or pollinators (Masierowska, 2006, Masierowska, 2012). Therefore, the present study is conducted to understand Bio-spectrum of flower visiting insects and their role in pollination service of *Deutzia staminea* R. Br. ex Wall.

MATERIALS AND METHODS

Study area: The present study was conducted in and around Nainital city, Uttarakhand, India from April 2024 to June 2024 during the blooming season of the plant *Deutzia staminea* R.Br. ex Wall. Nainital is known as lake city, a popular hill station of Uttarakhand state and headquarters of Nainital district in the Kumaun foothills of outer Himalaya. It is situated at an altitude of 1938m and lies between 29°24'N Latitude and 79°28'E Longitude. Nainital is surrounded by mountains containing oak dominant forests. The slopes of the nearby mountains are most populated with an elevation ranging from 1940 m to 2100 m. The year is divisible into three seasons, rainy (July-October), winter (November-February) and summer (March-June). The mean maximum temperature varies from 16 °C to 33 °C and the mean minimum temperature from -2 °C to 14 °C. The soil is mainly black, grey and brown in colour and it is a skeletal type in higher elevation. The present study area conserves a variety of wild fauna and flora along with oak and evergreen forest and contains mixed forest including trees of *Quercus leucotriphora*, *Quercus floribunda*, *Quercus semicarpifolia*, *Cedrus deodara*, *Cornus macrophylla*, *Cupressus torulosa*, *Acer caesium*, *Rhododendron arboretum* and *Aesculus indica*. For the present study, we selected *Deutzia staminea* R.Br. ex Wall plant located in and around Ayarpatta, Thandi sadak and D. S. B. Campus, Nainital on the basis of their abundance during its blooming season. Map 1 gives geographical map of the study area. Table 1 represents Characteristics features of different study sites select for the study.

General description of the plant: The species are deciduous shrub ranging from 1 to 4 m in height. Most are deciduous, but a few subtropical species are evergreen. The leaves are opposite, simple, with a serrated margin. Leave ovate, with long slender points, and a rounded or tapered base, unequally toothed, dull green and rough above, grey beneath, and thickly covered with minute starry scale. Flower in short racemes or corymbs 2 in. wide. The flowers are produced in panicles or corymbs; they are white in most species, sometimes pink or reddish and blooms in the month of April to the month of June. The fruit is dry capsule containing numerous small seeds. Figure 1 shows the overview of the plant *Deutzia staminea* during blooming season.

Morphological description of the plant *Deutzia staminea*: The observed plant species *Deutzia staminea* R.Br. ex Wall. is a deciduous shrub. Inflorescence originates from the axillary clusters and is longer than the leaves. Bark is dark gray, peeling off in thin longitudinal strips. Leaves are 2.5-4.5 cm long, 1-2 cm broad, lance shaped or ovate lance shaped, long-pointed, minutely toothed, rough above, gray velvety below. Leaf-stalk is 2-4mm long. Blooming generally observed between April to June. This plant species flowers available in clusters (approx. 8-15 flowers per cluster), in short 3-forked panicles, white, fragrant, 5-8 mm in diameter. Sepals are oblong to lance shaped, about 2 mm long, 1 mm broad, velvety. Petals are oblong, 7-12 mm long, 3-4 mm broad, velvety. Capsule is 3-4 mm in diameter, nearly spherical with flatted tip. Brown's *Deutzia* is found in NW Himalayas, Kashmir, Nepal and China, at 1000-3000m altitude. It is often found in open grassy fields, on banks and sunny hillsides.

Sampling, collection and identification of flower visitors: Sampling was taken once a week (direct sighting) during the blooming months of April, 2023 to June, 2023, from 7:00 am to 6:00 pm on every field

visit day using the direct method of sweeps netting and visual count, with field visits preferred mainly during bright days due to the activity of visitors. A Nikon D40 digital camera was used to photograph insect visitors in the field. Data was gathered from plants that were dispersed unevenly throughout the study area. Insects were identified in the field by using a field identification guide to identify insects during the field visits (Sondhi & Kunte, 2018). Collected species, including identified and unidentified, were labeled, preserved and identified by the Insect Biodiversity Laboratory at the Department of Zoology, D.S.B. Campus, Kumaun University, Nainital.

Potential insect pollinator: The behavior of insect visitors was analyzed to identify the potential insect pollinator of *Deutzia staminea* at the following levels:

- (i) **Relative abundance:** On a daily basis, the number of flower visiting insects on the plant was counted per branch where major and subsidiary visitors were indicated by high and low abundance, respectively.
- (ii) **Sought floral resources:** Insects were divided into three groups based on their purpose for Collecting Pollen (Cp), Feeding on Nectar (Fn) and Feeding on Pollen (Fp).

Statistical analysis of data: The relative abundance of each species, the mean of data from floral visits was calculated with different diversity indices viz. Shannon-Weiner index, Margalef index and Evenness by using the program PAST version 3.4 (Hammer *et al.*, 2001).

RESULTS AND DISCUSSION

Species composition and abundance of plant visiting insects

A total of 324 individuals, belonging to 25 species under nine families from three insect orders were recorded visiting on the flowers of *Deutzia staminea* during the study period (Table 2 and Table 3). On the basis of total number of individuals recorded, Lepidoptera was the most abundant order with 74.38%, followed by Hymenoptera (18.82%), and Diptera with 6.79% (Table 2). *Apis mellifera* with 9.25%, was found to be major flower visitor insect of the *Deutzia staminea*, followed by *Venessa indica* (7.71%) and *Apis cerana* with 6.79%, whereas *Calliphora vicina* constituting 1.54% were found to be least abundant species during the entire study period. Considering all the nine families, Nymphalidae was the most dominant family on the basis of number of species with seven species, followed by Papilionidae (six species), Pieridae (three species), Lycaenidae, Apidae, Calliphoridae (two species each respectively), and Rionidae, Vespidae, Syrphidae with single species each respectively (Figure 2 and Table 2). Figure 3 provides photographs of flower visitor insects recorded on selected plant species during study period.

Potential insect pollinator of *Deutzia staminea*

(i) **Relative abundance:** *Apis mellifera* constituting 9.25%, were identified as the major flower visitor insects of the *Deutzia staminea*, followed by *Venessa indica* constituting 7.71% and *Apis cerana* constituting 6.79%, whereas *Calliphora vicina* constituting 1.54% were found to be least abundant, followed by *Graphium serpedon* constituting 1.85% and *Delias belladonna* constituting 2.16%, respectively during the entire study period (Table 3).

(ii) **Sought floral resources:** A total of 25 species of insects on the plant *Deutzia staminea*, 19 species of the order Lepidoptera and three species of the order Hymenoptera were determined to be only nectar feeders (Fn). Three species of each order Hymenoptera and Diptera were found to feed on pollen (Fp), whereas three species of order Hymenoptera i.e. *Apis cerana*, *Apis mellifera* and *Vespa* sp. collected pollen as well as fed on nectar and pollen respectively (Cp, Fn, & Fp) (Table 3).

The species richness, diversity and evenness calculated during the study period. Across the study period Shannon-Wiener diversity Index (H') was recorded maximum in the Order Lepidoptera constituting 2.886% followed by Order Hymenoptera constituting 1.071% and Order Diptera with 1.097%. Moreover, evenness calculated during the study period was found to be maximum in the Order Diptera constituting 0.998% followed by Order Hymenoptera with 0.972% and the Order Lepidoptera constituting 0.942% during blooming season respectively.

Month wise abundance of flower visiting insects of *Deutzia staminea*

Month wise occurrence of flower visitor insects on *Deutzia staminea* recorded maximum abundance during the month of April due to full bloom of the plant, followed by the month of May, whereas the minimum abundance of insect visitors was found to be recorded during the month of June (Figure 4).

Apis mellifera (Order: Hymenoptera) was recorded as major dominant species in selected plant species during observational period. Similar finding was observed by different authors on different species of genus *Deutzia* Such as, Masierowska (2006) studied insect visitation on different species of *Deutzias* (*Deutzia discolor* Hemsl., *Deutzia gracilis* S. et Z., *Deutzia x magnifica* cv. Erecta Lem., *Deutzia scabra* Thunb., *Deutzia scabra* cv. Candidissima Froeb., *Deutzia scabra* cv. Watereri Lem.) in Lublin, Poland and reported *Apis mellifera* and *Bombus spp.* (Order Hymenoptera) as dominant species as compared to other visitor insects. Masierowska (2012) studied *Deutzia carnea* as a food source of urban bees in Lublin, Poland and reported insects, mainly bees as active forager of *Deutzia carnea*.

According to published literature *Deutzia* species flowers attracts numerous insects, mainly honey bees, bumble bees and solitary bees due to the availability of rich nectar (Masierowska, 2006). Therefore, during the study period, *Deutzia staminea* attracted by abundant number of insect visitors and also used as ornamental species. This is also an indigenous plant species of Himalayas. Therefore, this plant species is to be protected and managed to provide forage for flower visitors.

CONCLUSION

The present study provides the significant value of *Deutzia staminea* as a good source of food (pollen or nectar) for insect visitors from Kumaun Himalaya, Uttarakhand. *Deutzia* flowers attracted numerous insect visitors of Order Lepidoptera, Hymenoptera and Diptera under good weather conditions in the blooming season. These low maintenance plants are deer-resistant and are useful for erosion control. The potential flower visitors of order Lepidoptera considered as excellent indicator of ecosystem health, as they are sensitive to environmental pressures, thus extremely suitable for monitoring the health and detecting indications of environment. Hence, it is suggested that the ornamental plant *Deutzia staminea* indigenous to Himalayan region is provides the significant role in flower visitor insects abundance. Therefore, its conservation should be adopted as they interact with a broad spectrum of ecological niche and microhabitats. The present investigation focuses to create awareness for successful conservation of biodiversity. In order to increase nectar and pollen for the insect visitors, abundant use of this scrub in gardens and parks required to be encouraged.

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Table 1: Characteristics features of different study sites select for the study

Abbreviations	Study Sites	Altitude	Coordinates	Dominant Flora
SS-1	Ayarpatta	2084m	Latitude- 29°38'61.521N Longitude- 79°45'28.159E	<i>Quercus floribunda</i> , <i>Cupressus torulosa</i> <i>Berberis asiatica</i>
SS-2	D. S. B. Campus, Nainital	2014 m	Latitude- 29°38'61.521N Longitude- 79°45'28.159E	<i>Cedrus deodara</i> , <i>Cupressus torulosa</i> <i>Quercus leucotrichophora</i>
SS-3	Thandi Sadak	1972m	Latitude- 29°23'8.88N Longitude- 79°27'31.68E	<i>Quercus leucotrichophora</i> <i>Aesculus indica</i> <i>Platanus orientalis</i>

Abbreviations: D.S.B.-Dev Singh Bisht

Table 2: Percent contribution of a relative number of species and individuals with respective families of different insect orders recorded during the study period

S. No.	Orders	Families	No. of Species	Species (%)	No. of Individuals	Individuals (%)
1.	Lepidoptera	Nymphalidae	7	28	104	32.09
2.		Papilionidae	6	24	75	23.14
3.		Pieridae	3	12	34	10.49

4.		Lycaenidae	2	8	20	6.12
5.		Riodinidae	1	4	8	2.47
6.	Hymenoptera	Apidae	2	8	52	16.05
7.		Vespidae	1	4	9	2.77
8.	Diptera	Calliphoridae	2	8	13	4.01
9.		Syrphidae	1	4	9	2.77
Total			25	100.00	324	100.00

Table 3: Species composition, visiting activity (VA), and relative abundance (RA) of visitors recorded on *Deutzia staminea* during study period

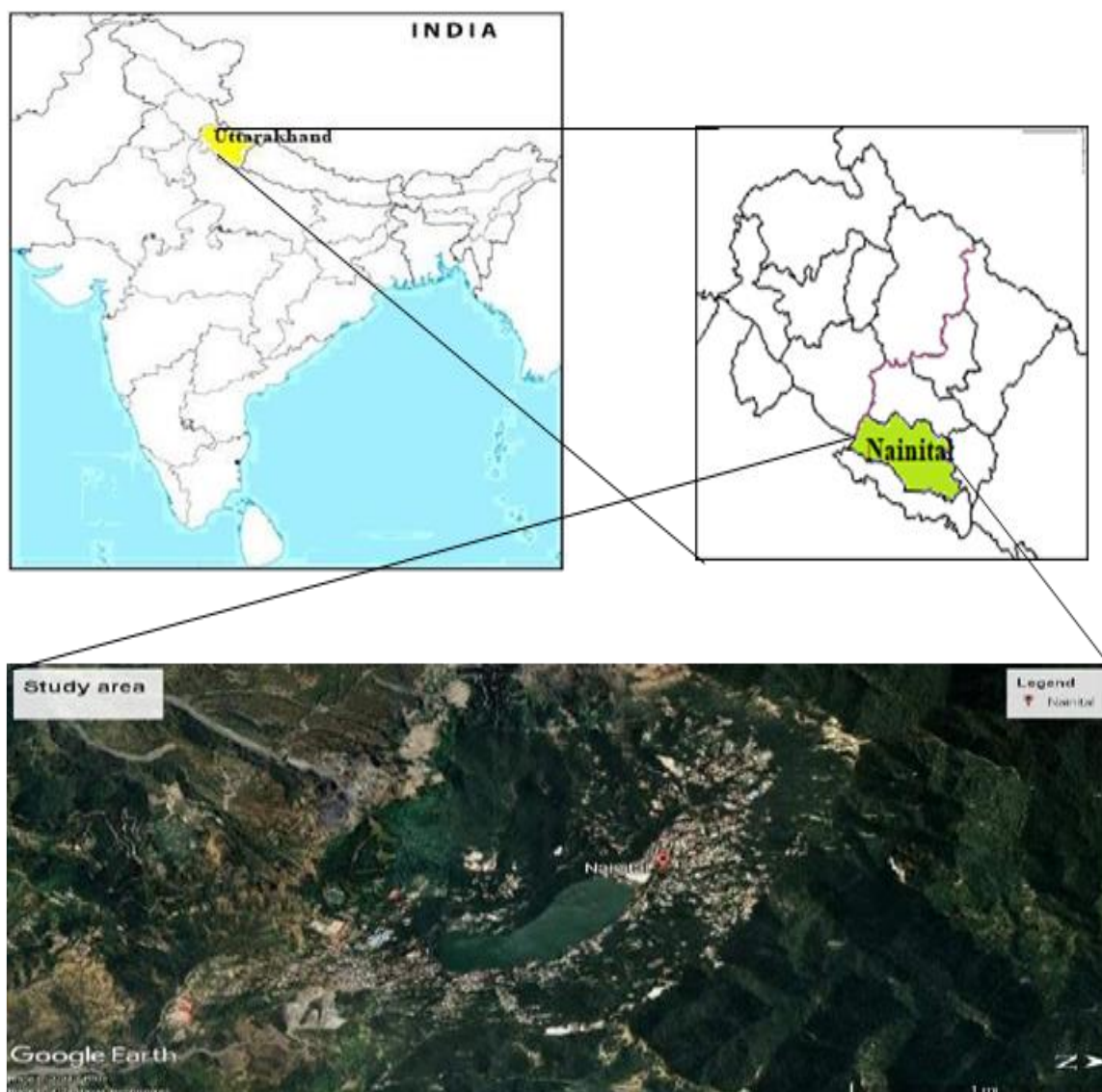
S. No.	Order	Families	Species Composition	Common Names	VA			RA
					Fn	Fp	Cp	
1.	Lepidoptera	Nymphalidae	<i>Aglais cashmirensis</i> (Kollar, 1848)	Indian tortoise shell	+	-	-	5.86
2.			<i>Athyma cama</i> (Moore, 1857)	Orange staff sergeant	+	-	-	2.78
3.			<i>Cyrestis thyodamas</i> (Boisdual, 1836)	Common map	+	-	-	3.70
4.			<i>Junonia iphita</i> (Cramer, 1779)	Chocolate pansy	+	-	-	5.55
5.			<i>Kaniska canace</i> (Linnaeus, 1763)	Blue admiral	+	-	-	3.39
6.			<i>Symbrenthia lila</i> (Hewitson, 1864)	Common Jester	+	-	-	3.08
7.			<i>Vanessa indica</i> (Herbst, 1794)	Indian red admiral	+	-	-	7.71
8.		Papilionidae	<i>Byasa polyeuctes</i> (Doubleday, 1842)	Common windmill	+	-	-	4.62
9.			<i>Graphium cloanthus</i> (Cramer, 1775)	Glassy bluebottle	+	-	-	6.17
10.			<i>Graphium sarpedon</i> (Linnaeus, 1758)	Common bluebottle	+	-	-	1.85
11.			<i>Papilio polytes</i> (Linnaeus, 1758)	Common mormon	+	-	-	4.62
12.			<i>Papilio protenor</i> (Cramer, 1775)	Spangle	+	-	-	3.08
13.			<i>Pachliopta aristolochiae</i> (Fabricius, 1775)	Common rose	+	-	-	2.77
14.		Pieridae	<i>Delias belladonna</i> (Gray, 1793)	Hill jezebel	+	-	-	2.16
15.			<i>Eurema hecabe</i> (Linnaeus, 1758)	Common grass yellow	+	-	-	4.01
16.			<i>Pieris brassicae</i> (Linnaeus, 1758)	Large cabbage white	+	-	-	4.32
17.		Lycaenidae	<i>Lycaena pavana</i> (Kollar, 1848)	White bordered copper	+	-	-	2.78
18.			<i>Heliophorus sena</i> (Kollar, 1844)	Sorrel sapphire	+	-	-	3.39
19.		Riodinidae	<i>Dodona eugenes</i> (Bates, 1867)	Tailed punch	+	-	-	2.46
20.		Hymenoptera	Apidae	<i>Apis cerana</i> (Fabricius, 1789)	Asian honey bee	+	+	+

21.			<i>Apis mellifera</i> (Linnaeus,1758)	European honey bee	+	+	+	9.25
22.		Vespidae	<i>Vespa sp.</i>	Hornets	+	+	+	2.78
23.	Diptera	Calliphoridae	<i>Calliphoro vicina</i> (Robineau-Desvoidy, 1830)	Blue bottle fly	-	+	-	1.54
24.			<i>Orthellia indica</i> (Robineau-Desvoidy, 1830)	Blue bottle fly	-	+	-	2.46
25.		Syrphidae	<i>Eristalis tenax</i> (Charles De Geer, 1776)	Common drone fly	-	+	-	2.77

(Abbreviations: Cp: Collecting pollen, Fn: Feeding on nectar, Fp: Feeding on pollen)

Table 4: Diversity indices of plant visitors across different Orders of blooming season recorded during the study period

Diversity indices	Lepidoptera	Hymenoptera	Diptera
Dominance_D	0.071	0.474	0.475
Simpson_1-D	0.9411	0.648	0.665
Shannon_H	2.886	1.071	1.097
Evenness_e^H/S	0.942	0.972	0.998
Margalef	3.282	0.486	0.647



Map 1: Geographical map of the study area (Source: Google Earth Pro)



Figure 1: *Deutzia staminea* during blooming season

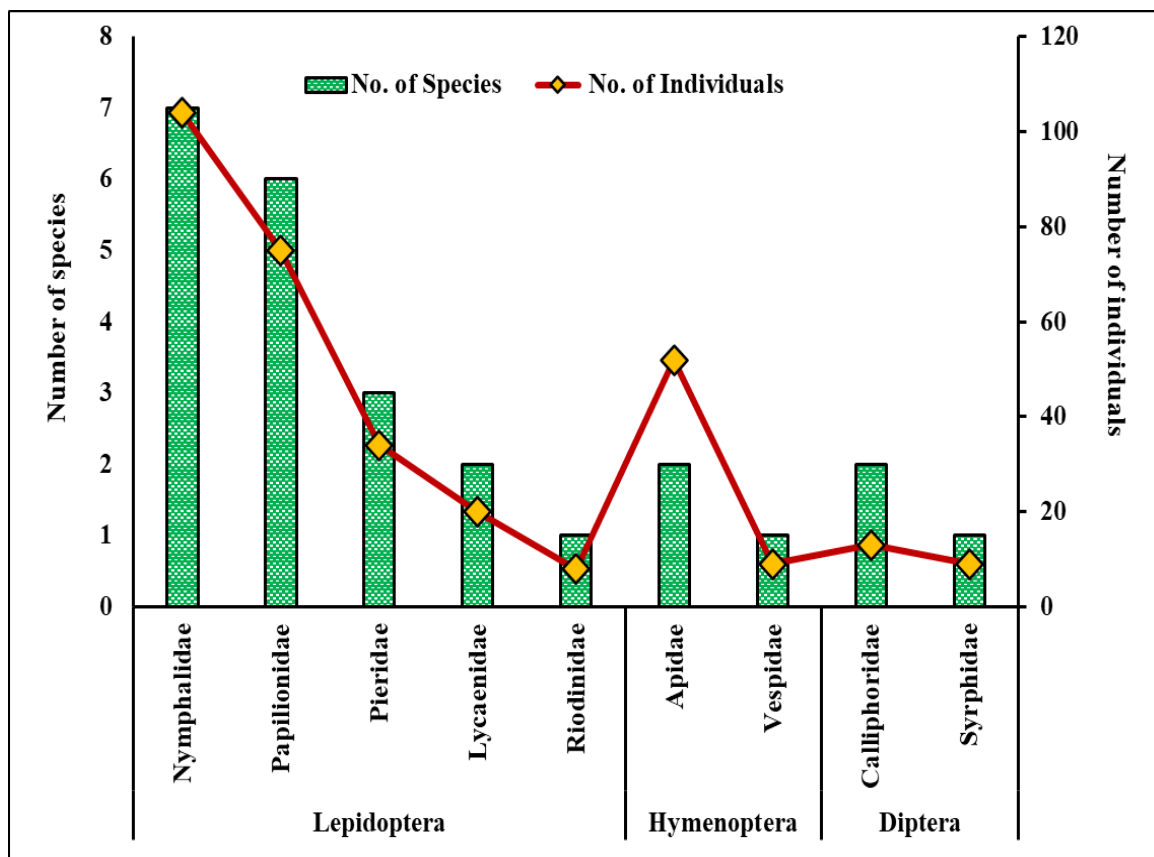


Figure 2: Number of species and individuals with respective families of different insect orders recorded during the study period

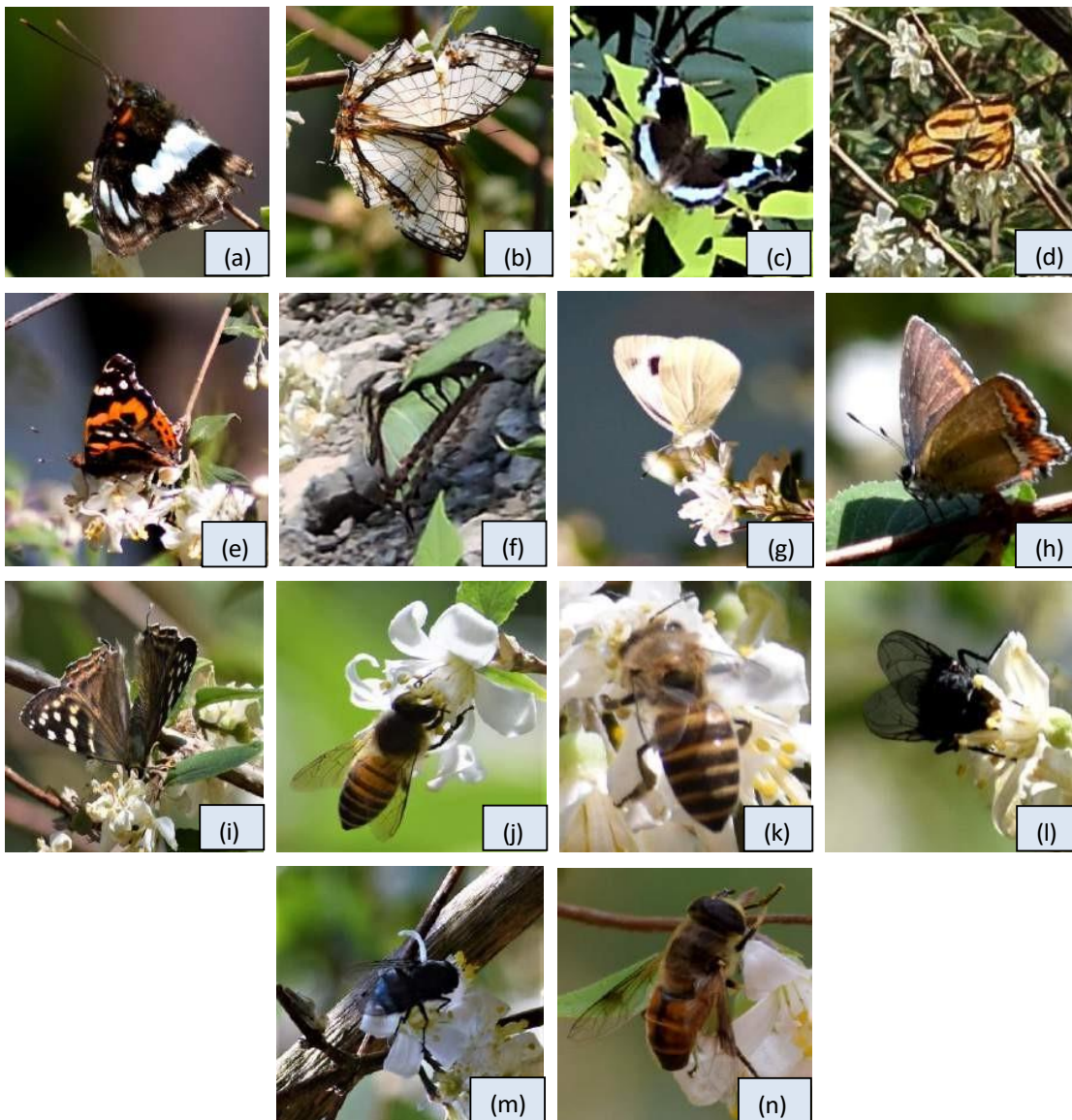


Figure 3: Insect visitors of *Deutzia staminea* recorded during the study period. (a) *Athyma cama*, (b) *Cyrestis thyodamas*, (c) *Kaniska canace*, (d) *Symbrenthia lilae*, (e) *Vanessa indica*, (f) *Graphium cloanthus*, (g) *Pieris brassicae*, (h) *Heliophorus sena*, (i) *Dodona eugenes*, (j) *Apis cerana*, (k) *Apis mellifera*, (l) *Calliphora vicina*, (m) *Orthellia indica*, (n) *Eristalis tenax*

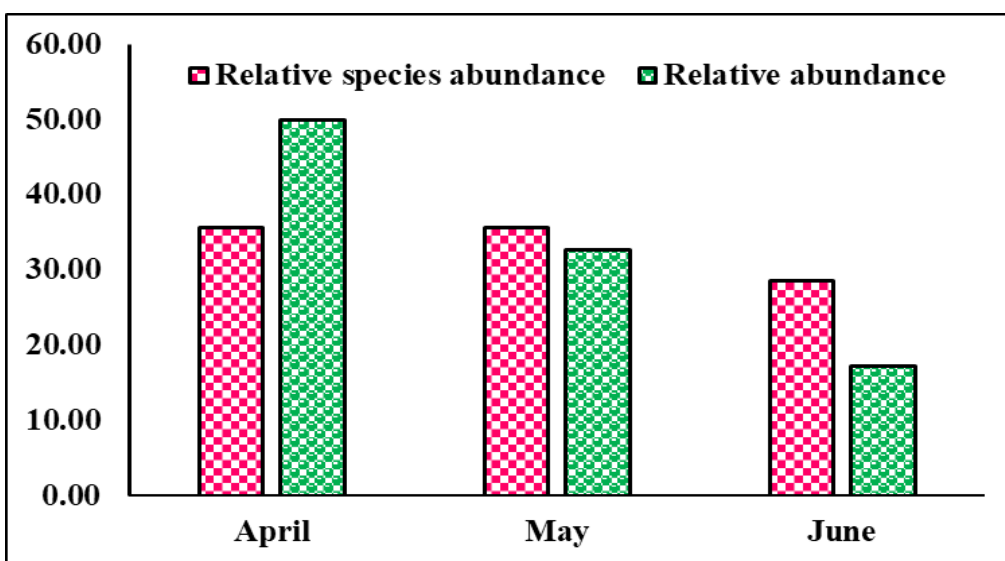


Figure 4: Month wise abundance of insect visitors during blooming seasons of the plant