Tropical Ecology **58**(1): 211–215, 2017 ISSN 0564-3295

www.tropecol.com

Diversity of native bees on *Parkinsonia aculeata* L. in Jammu region of North-West Himalaya

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Abstract: A study was conducted in Jammu region of Jammu and Kashmir State to determine the species composition and relative abundance of pollinators on *Parkinsonia aculeata* L., (Family Fabaceae) is a perennial flowering plant, growing as an avenue tree on roadsides. *Parkinsonia* flowers attracted 27 species of insects belonging to orders Hymenoptera, Diptera and Lepidoptera. They included *Megachile bicolor* (Fabricius), *Megachile hera* (Bingham), *Megachile lanata* (Fabricius), *Megachile disjuncta* (Fab.), *Megachile cephalotes* (Smith), *Megachile badia* (Fab.), *Megachile semivestita* (Smith), *Megachile vigilans* (Smith), *Megachile relata* (Fab.), *Megachile femorata*, *Andrena* sp., *Amegilla zonata* (Linnaeus), *Amegilla confusa* (Smith), *Apis dorsata* (Fab.), *Apis cerana* (Fab.), *Apis florea* (Fab.), *Ceratina smaragdula* (Fab.)., *Xylocopa latipes* (Drury), *Nomia iridescens* (Smith), *Nomia curvipes* (Fab.), and seven species of unidentified insects. *Megachile* bees were most abundant and constituted more than 95% of the insects visiting *Parkinsonia aculeata* flowers. Species diversity measured by Shannon Wiener index showed a high value of H' = 2.03, reflecting a diverse pollinator community in the area. The foragers of all the species were found to be most active between 11.00 and 15.00 hrs and the population of flower visitors declined thereafter. Information on diversity of native pollinators from disturbed habitats and their specific dependence on *P. aculeata* during dearth period will provide a base for conservation of pollinators.

Key words: Diversity, land use pattern, *Megachile* bees, native pollinators, *Parkinsonia aculeata*, species composition.

Handling Editor: David Jenkins

In recent years, incidence of diseases in honey bees has lead to decline in their populations in several countries (Kluser & Peduzzi 2007), raising concern that a potential global ‘pollination crisis’ might threaten our food supply (Holden 2006; Kremen & Ricketts 2000; Westerkamp & Gottsberger 2002). In the USA alone, the number of commercial honeybee colonies declined from 5.9 million (1940s) to 2.7 million (1995) (Maheshwari 2003). Similar declines have occurred throughout the world. Though honeybees are considered as the major pollinators of many crops (Bohart 1972; Westerkamp 1991; Williams 1996), several species of solitary bees also hold great promise (Abrol 2011). Crane (1990) lists over 50 species of bees that were managed for pollination. Exploration and conservation of non-*Apis* bees such as *Megachile* species opens new avenues for pollination security of plants.

The present study was undertaken to explore the spectrum of flower visiting insects on *Parkinsonia aculeata* or Jerusalem thorn, which is a species of perennial flowering tree grown as an avenue tree on roadsides, railway tracks and other uncultivated barren lands. It is highly attractive to pollinating insects due to its peculiar colour

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patterns on flowers. UV-absorbing petal bases and UV-reflective apices function as nectar guides, enhancing pollinator orientation. The tree grows to a height of 10 metres (33 ft). The flowers are yellow-orange and fragrant, 20 mm (0.79 in) in diameter, growing from a long slender stalk in groups of eight to ten. The major flush of flowering occurs in the month of April–May followed by a second flush of sparse flowering in the month of September. The flowers are extensively visited by bees for nectar and pollen during the period when other resources are scarce. A detailed study was made to determine the abundance and species composition of different insect visitors on *P. aculeata* flowers.

The study was conducted on flowering plants of *P. aculeata* in a stretch of 80 km tract along the roadsides of national highway of Jammu and in some semi urban landscapes of Samba and Kathua districts of Jammu region (32°17′ and 58°N, 76°26′and 80°30′E and 81°E, 270 meters above sea level).

Observations were made at ten different sites. Five plants per site were observed with three randomly marked branches per tree by different observers at different sites concurrently. The same marked branches on same trees were observed throughout the flowering period by multiple people at different sites. The data were recorded on alternate days for 15 different days during the entire flowering period. *P. aculeata* was the major forage plant for bees. The other plants growing along the stretch were *Cassia fistula, Delonix regia, Sesamum indicum, Lantana camara, Ziziphus zuzube, Pongamia pinnata*, *Vitex negundo, Acacia species* and *Nerium indicum.* All of these plant species did not have a uniform spatial distribution along the transect and had sparse or no flowers at the time when *P. aculeata* was in bloom. Hence no comparisons were made and studies were directed exclusively on *P. aculeata* flowers.

Field observations were made during peak flowering of *P. aculeata* in the months of April and May during two consecutive years (2013–2014). Visual observations on randomly selected plants were made in different locations as per the method described by Abrol (2010) with some modifications. Marked flower bunches were monitored regularly at peak flowering period between 07:00 to 19:00 h for 5 minutes at 2-hourly intervals in the beginning of each hour for flower visitors. For this purpose, three branches of each selected tree were marked randomly and the mean of these three observations for each hour was used for further analysis. Observations were recorded on alternate days during the entire flowering period. The flower visitors were collected and identified by sorting samples to recognizable taxonomic units (RTUs; Gadagkar *et al*. 1990; Krell 2004; Oliver & Beattie 1993) initially and subsequently confirmed using available literature and with the help of taxonomists.

The collected data were analysed to work out the magnitude of pollinator diversity and species richness in the field. Species richness was calculated using Margalef's index as

$$R_{Mg} = (S-1)/\ln(N)$$

where S is the number of species recorded and N is the total number of individuals and Menhinick's index $D_{Mn} = S/\sqrt{N}$ where S is the number of species recorded and N is the total number of individuals (Magurran 1988). Species diversity was calculated using Shannon-Wiener's index.

$$H' = -\Sigma p_i \ln p_i$$

where H' is the index of species diversity and p_i is the proportion of the individuals of the ith species (Magurran 1988).

Foraging behaviour of insects was also monitored to determine plant pollinator interaction. Data on number of species and frequency of occurrence were pooled over two years of study for statistical analysis. Analysis of Varience (ANOVA) (two factor without replication) was performed using SPSS 16.0 version to compare the differences in frequency of occurrence for each pollinator group and to recognize the most dominant and potential insect pollinator of this important tree species.

A variety of insects visited flowers of *P. aculeata* (Table 1). A total of 27 morpho-species of insects belonging to the orders Hymenoptera, Diptera and Lepidoptera were found to visit the flowers to collect nectar and pollen. Hymenopterans were the most abundant represented by 20 morpho-species, belonging to four major families, namely Megachilidae (43%), Apidae (17%), Halictidae (9%) and Andrenidae (4%) followed by Dipterans which were represented by five morpho species belonging to two families *viz.* Syrphidae (13%) and Muscidae (4%) and Lepidopterans with two morpho species belonging to the families Pieridae (4%) and Lycanidae (4%). The family Megachilidae was the most dominant with ten species followed by Apidae (3 species). Two morpho species of Halictidae and one of Andrenidae were also recorded. Broad spectrum of entomoforagers using *P. aculeata* flowers clearly indicated the importance of the plant under study as a reservoir for native pollinating insects.

Margalef's species richness (D_{Mg}) was 2.55, and when calculated based on Menhinick's index (D_{Mn}) was 0.64, indicating high richness of species of entomoforagers among various families of three major orders. Species diversity measured by Shannon Weinner's index also showed a high value of $H' = 2.03$ which reflected the diverse pollinator community in the area. Abundance of major flower visiting insects, when plotted, indicated major dominance of a few genera followed by almost uniform occurrence of the remaining groups in terms of flower visitation (Fig. 1). Analysis of variance showed significant differences between various flower visitors of *P. aculata* in their flower visitation frequency with a clear dominance of four species of Megachilidae, namely, *M. bicolor, M. vigilans, M. lanata* and *M. hera* (CD =0.174, $P < 0.05$. The emergence of *Megachile* bees and their foraging rhythm synchronizes with the flowering of *Parkinsonia aculeata* thereby indicating a specific adaptation between the two participating organisms. The finding was strongly supported by the other plant pollinator interaction data generated throughout this study. The remaining 14 species of flower visiting insects were also found to be significantly different in their foraging activity based on their frequency of occurrence. *P. aculeata* clearly serves as an important species in the conservation of native pollinators in altered

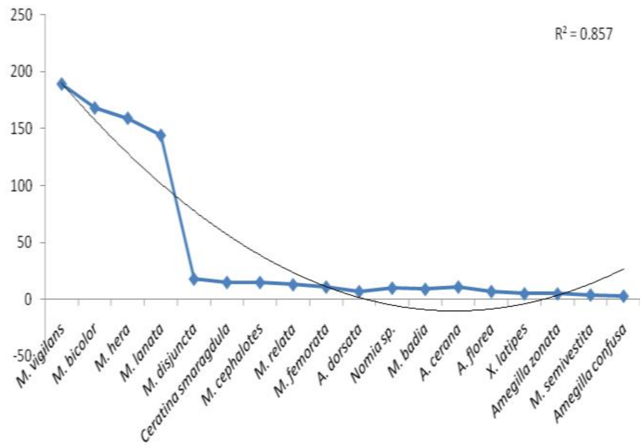

Fig. 1. Rank abundance plot for various major insect foragers on *P. aculeata.*

habitats due to increasing effect of urbanization and change in land use patterns.

Population dynamics of insect visitors were recorded throughout the day which revealed low activity during early hours of the day. The foragers were found to be most active between 11:00 to 15:00 hrs and the activity declined thereafter. Among different flower visitors, *Megachile vigilans*, *M. disjuncta*, *M. badia*, *M. bicolor* and *M. lanata* were active almost throughout the day, recording greater number of foraging bouts. Members of Apidae were found to be active mostly in around noon. A similar pattern was observed for the halictid and andrenid bees, with brisk activity towards noon and less thereafter.

The study has established that *Parkinsonia aculeata* is an important host for native bee populations in the changing habitats of Jammu and Kashmir. Chauhan *et al*. (2008) advocated large scale cultivation of *P. aculeata* to conserve native pollinators. An important feature of *P. aculeata* is that its flowers are available to pollinating insects during dearth periods when no other plants are in bloom. The foraging rhythm of megachilid bees coincided with the flowering of *P. aculeata.* Jain & Kapil (1980) in an earlier study on foraging behaviour of megachild bees on *Medicago sativa* and *Parkinsonia aculeata* observed that when both the species were in bloom there were 7–13 times as many megachilid bees on *Parkinsonia* as on *Medicago sativa*. They attributed this differential attractability to the high sugar content and attractive yellow flowers of *P. aculeata.* Abrol (1986) reported that the differential attractability was due to higher energy content per flower in *Parkinsonia* as compare to *Medicago.* Many earlier studies on pollinators of *P. aculeata* from different parts of the world have also suggested that this species is ideal for conservation of pollinator populations (Abrol & Kapil 1991; Jain 1993; Jain & Kapil 1980; Sajjad & Saeed 2010; Winfree *et al*. 2011). Presently, the world is heading towards a crisis due to decline of pollinators and conservation of pollinators in their natural habitats is important to overcome global food security problems. In the present study, focus has been given to explore and elucidate the native pollinators visiting *P. aculeata*, a fast growing agroforestry avenue tree with higher tolerance to anthropogenic stress, including habitat alteration in various parts of Jammu, India.

The study clearly indicated that this plant species needs extensive plantation for conservation of native pollinators, reclamation of degraded soils

Table. 1. List of flower visiting insects recorded on *Parkinsonia aculeata* from Jammu along with foraging dynamics of frequent visitors.

Systematic position of insects (Family: Order)	Scientific name	7:00–9:00	9:00–11:00	11:00–13:00	13.00–15:00	15:00–17:00	17:00–19:00	Mean
Megachilidae: Hymenoptera	*Megachile vigilans* Smith*	25	43	67	33	12	9	31.5
	Megachile bicolor Fabricius*	16	32	57	42	17	4	28
	Megachile. Hera Bingham*	20	36	52	37	10	4	26.5
	Megachile lanata Fabricius*	12	30	48	27	16	11	24
	Megachile disjuncta Fabricius	1	3	6	4	3	1	3
	Megachile cephalotes Smith	1	2	3	6	3	0	2.5
	Megachile relata Fabricius	1	1	3	5	2	1	2.16
	Megachile femorata Smith	0	1	4	3	3	0	1.83
	Megachile semivestita Smith	0	0	2	1	1	0	0.66
	Megachile badia Fabricius	1	1	3	2	2	0	1.5
Halictidae: Hymenoptera	*Nomia iridiscens* Smith	1	2	4	2	1	0	1.66
	Nomia curvipes Fabricius	Data on foraging dynamics was not included due to least visitation						
Apidae: Hymenoptera	*Ceratina smaragdula* Fabricius	0	2	6	5	2	0	2.5
	Apis cerana Fabricius	2	3	2	3	1	0	1.83
	Apis florae Fabricius	0	1	2	3	1	0	1.16
	Apis dorsata Fabricius	0	2	2	2	1	0	1.16
	Xylocopa latipes Drury	0	1	0	2	2	0	0.83
	Amegilla zonata	0	1	2	1	1	0	0.83
	Amegilla confusa	0	1	2	0	0	0	0.5
Andrenidae: Hymenoptera	*Andrena* sp.	Data on foraging dynamics was not included due to least visitation						
Syrphidae: Diptera	Gen1 sp.							
	Gen2 sp.							
	Gen3 sp.							
	Gen4 sp.							
Muscidae: Diptera	Gen1 sp.							
Lycanidae: Lepidoptera	Gen1 sp.							
Pieridae: Lepidoptera	Gen1 sp.							

*significantly dominant (P <0.05)

and providing food to variety of pollinators during dearth period. The large scale plantation of *P. aculeata* could halt the degradation of environment and at the same time conserve pollinator populations, which may eventually help in enhancing agricultural productivity.

Acknowledgments

Authors express their heartfelt thanks to Network Project on Insect Biosystematics (NPIB 21–17), Indian council of Agricultural Research, New Delhi for providing financial support to conduct this research work. Entomologists of Indian Agricultural Research Institute, New Delhi and University of Agricultural Sciences, Bangalore are gratefully acknowledged for their help in authenticating identification of collected insect specimens.

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(Received on 04.03.2015 and accepted after revisions on 16.07.2015)