

Species Richness and Seasonal Activity of the Leaf Cutter and Resin Bees (Hymenoptera: Megachilidae) at Pantnagar

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Abstract: The investigation on diversity, species richness and seasonal activity of the native megachilid bees carried out in different ecosystems during March, 2013 to April, 2015 at Pantnagar revealed occurrence of 19 species including 7 leaf cutter bees (*Megachile albifrons*, *M. anthracena*, *M. bicolor*, *M. chlorigaster*, *M. conjuncta*, *M. relata*, *M. studiosa*), 5 resin bees (*M. cephalotes*, *M. disjuncta*, *M. hera*, *M. inepta*, *M. lanata*, *M. umbripennis*) and 7 other species viz. *M. binghami*, *M. elizabethae*, *M. femorata*, *M. gathela*, *M. rajasthaniensis* and *M. tetradenta*. Our results show that species richness of megachilid bees was maximum in the month of April (18 species) followed by March and May, and October- November when 10-11 species were recorded in the field. About 58 percent of the total species had two peaks of their activity with 2-3 generations in a year. Minimum activity of species of megachilid bees was recorded during Dec- Feb (0-5 species; winter season) and July- Sept (2-4 species; rainy season). The resin bees, *M. cephalotes* and *M. disjuncta* were multivoltine in nature and were active almost throughout the year. Effect of abiotic factors on the seasonal activity of the native megachilid bees has also been discussed.

Keywords: megachilid bees/ solitary bees/ diversity/ species richness/ seasonal activity

1. Introduction

Pollinators carry pollen from the male to the female parts of plants that leads to seed formation and thus supports agricultural diversity. 87% of all flowering plants are animal pollinated [1] and globally, honey bees, bumble bees and solitary bees are considered to be the most important group of pollinators, contribute 35 % of the world's food production [2]. Solitary bees of the family Megachilidae have excellent anatomical and behavioral adaptations and thus work as effective pollinators for many agricultural important crops [3]. Urbanization, use of pesticides and pests are major causes of native and managed pollinator's decline [4], raising concerns about a pollination crisis of wild plants and crops. Greater diversity of bee species resulted in higher seed production [5] and can help to meliorate the loss of important species [6]. To prevent pollinator decline it is necessary to find out the factors that influence species richness and their abundance in a wide range of habitats [7]. Megachilidae is the second largest bee family, containing more than 4000 described species in a wide diversity of habitats on all continents except Antarctica, ranging from lowland tropical rain forests to deserts and alpine environments [8, 9]. 500-600 species of megachilid bees in India were reported earlier [10] from which *M. bicolor*, *M. lanata*, *M. cephalotes*, *M. albifrons* and *M. disjuncta* are recorded in northern half of the country in Eastern Rajasthan, U. P. [11] and Uttarakhand [12].

Bees contribute significantly to the income for farmers by increasing yields in horticultural crops, seeds and graze through better conservation and management of pollinators. Their conservation implies the interactions between species conservation and careful management, to strengthen ecosystem linkages, sustainable production systems and poverty reduction. A few megachilid bee species such as *Megachile rotundata* and *Osmia* species now have been

developed as managed pollinators in European countries but still the lack of information on diversity and life history of most megachilid bee species affect their successful use in the management of crops. Studies on the diversity, species richness and abundance of bee pollinators are of vital importance to know their ethology, ecology, biology, improve reproduction success in plant communities and for their conservation and management [13]. With a view to document diversity, species richness and seasonal activity of native megachilid bees, systematic studies were conducted to know the pollinator fauna of the region.

2. Material and Methods

This study was carried out from March 2013 to April 2015 at Govind Ballabh Pant University of Agriculture and Technology Pantnagar, at an altitude of 243.84 meters above sea level, latitude 29° N and longitude 79.3° E. This location is situated in the foot hills of Shivalik range of Himalayas. The humid sub tropical climate here is characterized by hot dry summer and cold winter. The temperature rises up to 40°C, while it falls to 4°C in winter. Rainfall has been recorded with an average precipitation of 136 cm and relative humidity fluctuates around 90 ± 5 percent (at 7:00 am) during rainy season. The study area has rich floral diversity with more than 800 plant species.

To explore the diversity of megachilid bees, we used two approaches: (i) regular surveys at 15 days interval were conducted in the various ecosystems at different research centres of the University campus. These centre included Normen E. Borloug -Crop Research Centre, Vegetable Research Centre, Garden Section, Model Floriculture Research Centre, Agro Forestry Research Centre, University Apiary, Model Bee Research and Training Centre etc. The megachilid bees found foraging on the flowers and also on other substrates were collected with the help of sweep net or

directly in insect killing jar. (ii) Provided nesting avenues in the form of tunnels in wooden structures and one end open bamboo canes. For this, nesting wood shelters (Bee Post and Triangular Bee Nesting Shelter) were designed and installed at various locations namely Norman E. Borlaug Crop Research Centre, Garden Section, University Apiary and Model Floriculture Research Centre in March, 2013. Nesting Bee Post (modified from [14, 15]) had 5.5 feet wooden pole in the centre fitted with four wooden arms of 100 mm thickness on each side with holes of 85 to 92 mm having diameters of 5 -6 mm on one side arms and 9 - 10 mm holes on other side arms were made by drilling machine at a distance of 20 x 20 mm. In one Bee Post 274 - 327 nesting tunnels were provided to ensure more nesting shelters at one place. The other shelter, named as Triangular Bee Nesting Shelter (modified from [16, 17]) with hollow tunnels of various diameters ranging from 3.0 - 9.0 mm having tunnel length 100 and 250 mm were placed in groups of 25-30 sticks. The nest constructed by megachilid bees in these tunnels were marked during regular survey visits. After completion of the nest making activity, the nests were covered with glass vials till the emergence of adult bees. All the specimens, collected from sweep net and nest shelters were pinned with entomological needles and preserved in the Apiculture laboratory for further taxonomic identification. Individuals of native megachilid bees collected were got identified to species from Department of Zoology, Jai Narayan Vyas Krishi Vishwa Vidyalaya, Jodhpur (Rajasthan). Identification of the plant species was confirmed from the Department of Biological Sciences of this university.

The seasonal activity of various species of native megachilid bees was recorded during regular site visits at 15 days interval. The species, thus observed in the field during visits was considered as active.

3. Results and Discussion

Diversity of megachilid bees

A total of 19 species, all belonging to genus *Megachile* recorded in the study area during investigation period (Table 1) were: *Megachile albifrons*, *M. anthracena*, *M. bicolor*, *M. binghami*, *M. cephalotes*, *M. chorigaster*, *M. conjuncta*, *M. disjuncta*, *M. elizabethae*, *M. femorata*, *M. gathela*, *M. hera*, *M. inepta*, *M. lanata*, *M. rajasthaniensis*, *M. relata*, *M. studiosa*, *M. tetradenta*, and *M. umbripennis*. Among these, *M. albifrons*, *M. anthracena*, *M. bicolor*, *M. chorigaster*, *M. conjuncta*, *M. relata* and *M. studiosa* were the leaf cutter bees and *M. cephalotes*, *M. disjuncta*, *M. inepta*, *M. lanata* and *M. umbripennis* were observed as resin/mason bees. Remaining 7 species could not be categorised either as leaf cutter or as resin/mason bees since we had not observed their nest structure or the nesting resources during observation period of this study. Neither the available literature speaks about the nesting biology and other ecological parameters of these megachilid bee species. 9 genera with 57 species belonging to the Megachilidae family were reported earlier [18] from Uttarakhand, India. Our results on diversity indicated that this area has good potential to harbour great bee diversity owing its rich floral diversity and climate. The pollinator bees have particular profile of diversity and species richness [8] that strongly

affected by resource availability [19, 20, 21], extent and proximity of the surrounding habitat [22, 23] and abiotic factors. Other studies also concluded that where there is great plant diversity, there is great bee diversity [24, 25].

Seasonal activity and species richness of megachilid bees

The data recorded on the activity of megachilid bees revealed that these bees were active throughout the year except in the month of February when no Megachilid species was found in the field during observation days (Table 1). The data further revealed that among the 19 species recorded in the field, only two species, *M. cephalotes* and *M. disjuncta* were consistently active round the year. The species richness of megachilid bees varied in different months of the year (Table 1; Fig 2). Maximum number (18) of the Megachilid species was recorded in the month of April followed by in the months of March and May, and October- November when 10-11 species were recorded in the field (Fig 2). The matrix of seasonal activity of megachilid bees (Table 1; Fig 3) also showed that most of the species recorded had two peaks of their activity, first in the months of March to May when mean maximum and minimum temperature and RH% (2.00 pm) varied from 27.4 °C to 38.9 °C, 13.0 °C to 23.4 °C and 26% to 44% and second in the months of October- November when mean maximum and minimum temperature and RH% (2.00 pm) varied from 26.9 °C to 30.4 °C, 10.2 °C to 19.8 °C and 40 % to 59 %, respectively. It also appeared that higher relative humidity adversely affect the activity of megachilid bees (Fig 3). Minimum activity and minimum number of species of megachilid bees was recorded during winter season (Dec- Feb; 0-5 species) and the rainy season (July- Sept; 2-4 species). Also, the activity of *Megachile nana* and *Megachile flavipes* on alfalfa was studied [26] and positively correlated with environmental factors (air temperature, light intensity and solar radiation) and nectar sugar concentration. Species and population abundance of solitary bees have reported to vary from season to season and region to region over the years [8]. The bees of Megachilidae family are favoured by warm climates; however, they are still active in cool days and frequent during the blooming period [3]. Among various species of megachilid bees that had their first activity peak in the month of April (18 species), 11 species namely *M. anthracena*, *M. bicolor*, *M. cephalotes*, *M. chorigaster*, *M. conjuncta*, *M. disjuncta*, *M. hera*, *M. lanata*, *M. rajasthaniensis*, *M. relata* and *M. umbripennis* were found again active in the months of October- November. This indicated that these 11 species have 2-3 generations in a year. *Megachile* bees flies during the warmest parts of the year, with 2-4 generations per year [8], depending on locality and resources. Among these 18 species, *M. cephalotes* and *M. disjuncta* were multivoltine in nature since they were active almost throughout the year. Remaining 8 species studied for biological parameters during present investigation require more elaborate studies on their seasonal activity for determination of their voltinism.

4. Conclusion

This study demonstrated that this region has rich diversity of Megachilid species and there is a need to conduct detailed investigation on various biological parameters for the

conservation and restoration of the diversity of these bees as a whole so that they can be more efficiently utilized as a supplement to other natural pollinating insects including honey bees and as an alternative pollination source in future to have a potential contribution in the pollination of wide range of economic important crops.

5. Acknowledgement

We are grateful to Dr. Rajiv K. Gupta, Professor, Department of Zoology, JNVU, Jodhpur for confirmation of bee species and Dr. D. S. Rawat, Associate Professor, Biological Sciences G.B.P.U.A. & T. Pantnagar for identifying plant species.

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Table 1: Diversity and activity period of megachilid bees at Pantnagar

Megachilid species	Common name	Collection month	Collection substrate	Activity period of megachilid bees in different months												Total activity period observed (months)	
				Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec		
<i>Megachile albifrons</i> Smith	Leaf cutter bee	April	Justicia flower			+	+	+	+								4
<i>Megachile anthracina</i> Smith	Leaf cutter bee	Oct	Pegion pea flower				+	+				+	+	+			5
<i>Megachile bicolor</i> (Fabricius)	Leaf cutter bee	April	Justicia flower			+	+	+					+	+	+		6
<i>M. binghami</i> Meade Waldo	-	April	Blue cary flower				+										1
<i>Megachile cephalotes</i> Smith	Resin/mason bee	Nov	Mung flower			+	+	+	+	+	+	+	+	+	+	+	10
<i>Megachile chlorigaster</i> Cameron	Leaf cutter bee	Nov	Gladium flower	+		+	+							+	+		5
<i>Megachile conjuncta</i> Smith	Leaf cutter bee	Sept	Kachnar leaf			+	+					+	+	+			5
<i>Megachile disjuncta</i> Fabricius	Resin/mason bee	April	White Kachnar flower	+			+	+	+	+	+	+	+	+	+	+	10
<i>Megachile elizabethae</i> Bingham	-	April	Blue cary flower				+	+									2
<i>Megachile femorata</i> Smith	-	April	Blue cary flower				+	+									2
<i>Megachile gathela</i> Cameron	-	April	Blue cary flower				+				+						2
<i>Megachile hera</i> Bingham	-	April	Dalbargia flower				+	+						+	+		4
<i>Megachile inepta</i> Cameron	Resin/mason bee	April	Dalbargia flower				+	+	+								3
<i>Megachile lanata</i> Fabricius	Resin/mason bee	March	Nest in Bee Post			+	+							+	+		4
<i>Megachile rajasthaniensis</i> Gupta	-	March	Nest in Bee Post			+	+							+	+		4
<i>Megachile relata</i> Smith	Leaf cutter bee	Nov	Gladium flower			+	+	+						+	+	+	6
<i>Megachile studiosa</i> Bingham	Leaf cutter bee	April	Chasteberry flower				+	+	+								3
<i>Megachile tetradenta</i> Gupta	-	May	Marigold flower					+									1
<i>Megachile umbripennis</i> Smith	Resin/mason bee	March	Nest in bamboo sticks			+	+							+	+		4
Total (19)		-	-	2	-	11	18	10	5	2	3	4	10	11	5		

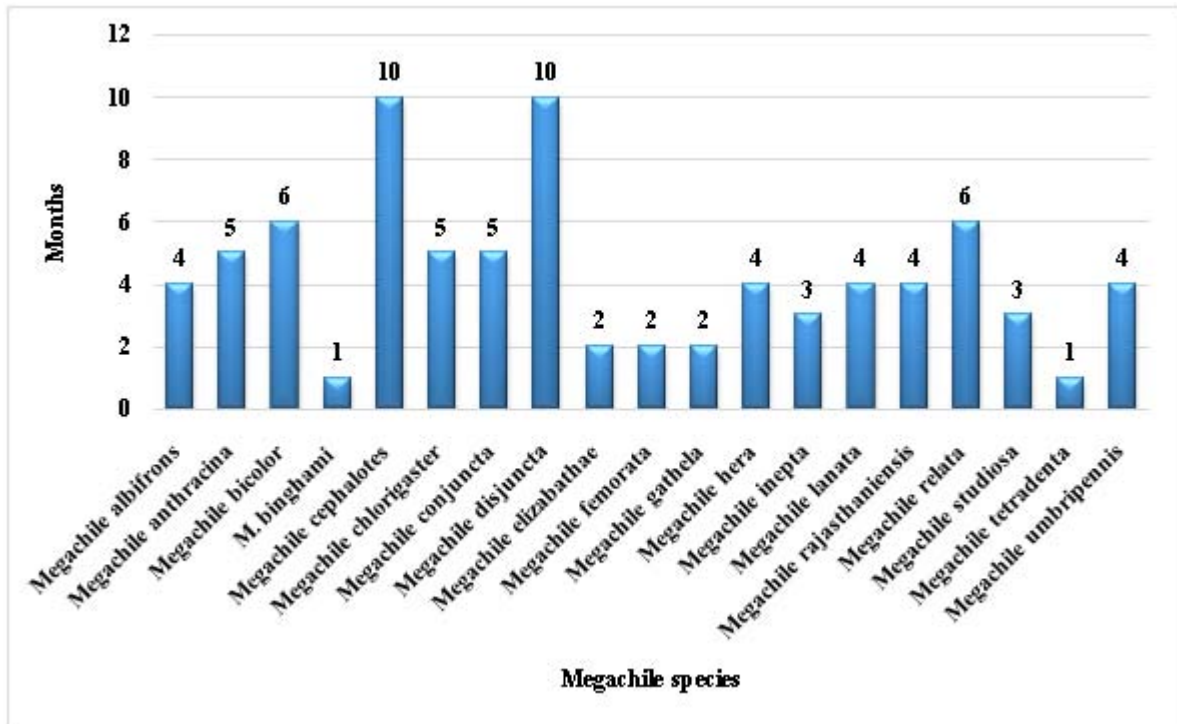


Figure 1: Activity period (in months) of different *Megachile* species at Pantnagar

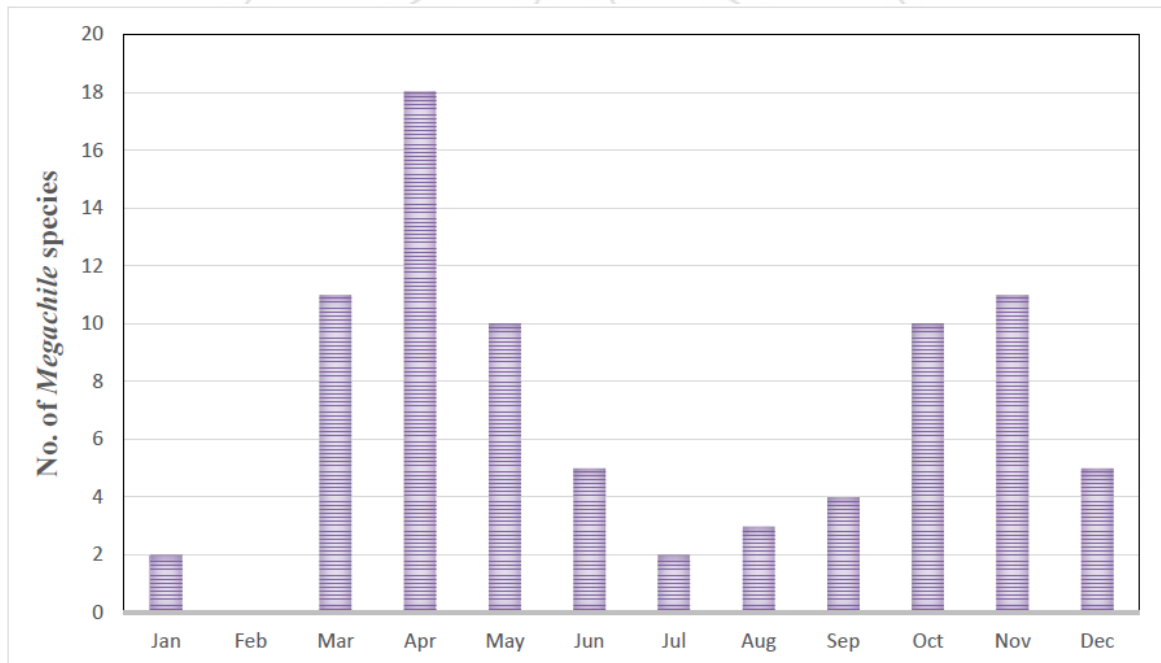


Figure 2: Species richness of *Megachile* bees during different months

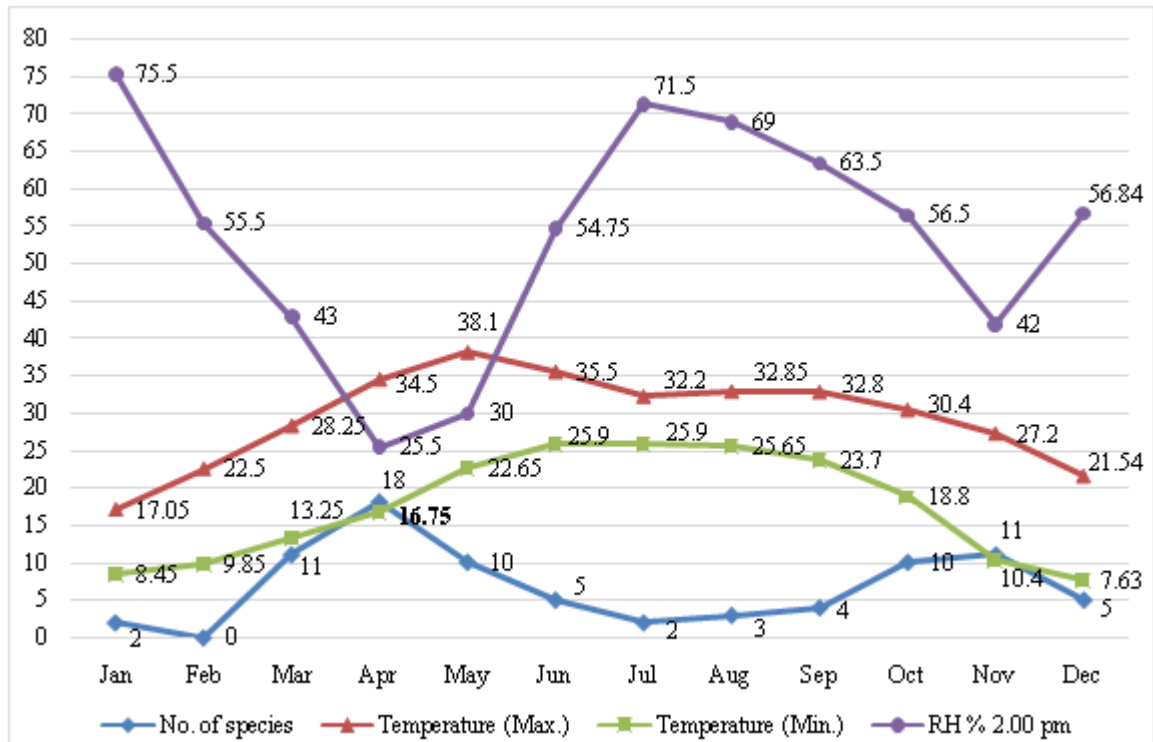


Figure 3: Species richness of *Megachile* species and their relation with abiotic factors during different months

