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Floral resources and foraging ecology of large carpenter bees (*Xylocopa valga*, *Xylocopa pubescence*, *Xylocopa fenestrata* and *Xylocopa dejeanii*) of Jammu and Kashmir and Ladakh region

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Abstract

The large carpenter bees are the important pollinators and vital component of the mellitofauna. They are cosmopolitan, common in sub-tropical, tropical and thin in temperate and cold arid conditions. The large carpenter bees of Jammu & Kashmir and Ladakh region includes *Xylocopa valga*, *X. dejeanii*, *X. fenestrata* and *X. pubescence*. The species presiding in this region are polylectic with solitary to social behavior. They are univoltine to multivoltine based on the type of region and the availability of flora. The large carpenter bees foraging depends on two different strategies (nectar collection), depending on the morphological characteristics of the flower; legitimate visit: where it feeds while landing on the front parts of the flower and accesses the nectar transferring pollen to the stamens and illegitimate visit: that is accomplished by accessing the flower from behind and cutting the corolla. This paper describes the floral resources and foraging ecology of Large carpenter bees of Jammu & Kashmir and Ladakh so to have a better understanding on their ecological services they provide besides will help in their conservation.

Keywords: Jammu & Kashmir, India, floral resources, foraging ecology, Ladakh and large carpenter bee

Introduction

The pollination service provided by insects are a key component of biodiversity. They form an essential part in ecosystem survival and functioning by their inevitable role that cannot be denied (Garibadli *et al.* 2014) ^[1]. They not only ensure sexual reproduction but helps in stabilizing yield and maintaining genetic variability of crops thus facilitating crop resilience. Nearly 60 to 80 per cent of the flowering plants across the globe depend on animals mostly insects for pollination (Kremen *et al.*, 2007) ^[2]. The annual economic value of insect pollination services to agriculture worldwide worth 235-577 billion USD (FAO, 2018) ^[3].

Large carpenter bees (genus *Xylocopa*) are generalist pollinators of wide geographical distribution. The genus *Xylocopa* Latreille (Xylocopinae: Xylocopini) comprises approximately 470 species of large, robust bees, resembling bumble bees (Apinae: Bombini), that are distributed throughout the world most of them occurring in tropical and subtropical areas of the world (Lucia *et al.*, 2015) ^[4]. The large carpenter bees typically nest in dead wood, stems, or similar cavities but also in soil as in genus *proxycopa* (Michener 2007) ^[5].

Their nesting behaviour and biology varies across species, from solitary to semisocial or primitively eusocial nests where the oldest female (mother or sister) feeds both young females and males via trophallaxis (Lucia *et al.*, 2015) ^[4].

Large carpenter bees are potential pollinators of agricultural and horticultural crops because of their polylectic habits, capability to buzz pollinate, activity throughout the year, hibernation as an adult, foraging under light deficit conditions (nocturnal) and the acceptance of artificial substrates for nesting (Buchmann, 2004; Keasar, 2010) ^[7, 6]. The researchers around the globe concluded that these large carpenter bees are effective pollinators on diverse crops, including on passion fruit, sunflowers, squash, tomato and eggplant, (Gerling *et al.*, 1989; Sihag, 1993; Mardan, 1995; Hogendoorn *et al.*, 2000; Aguiar-Menezes *et al.*, 2002; Sadeh *et al.*, 2007) ^[8, 9, 10, 11, 12, 13]. The paper describes the occurrence of different floral resources utilised by the large carpenter bees of Jammu & Kashmir and Ladakh region with emphasis on the their behaviour whether they are utilised for nectar, pollen or both, besides buzz pollination phenomenon was also verified.

Material and Methods**Study area**

The collection cum survey tours were conducted in various localities/villages/cities situated in different Agro-ecological zones of Northwestern Himalayas of India (Table 1, 2 & 3). The areas were systematically explored (Multistage sampling). Altitude and coordinates of each site were measured with digital altimeter.

Floral rewards (nectar or pollen) by *Xylocopa* spp. during each floral visit was observed. Observations like extending their proboscises to the base of the corolla was visually checked for nectar collection while as during pollen gathering, bees were observed for combing anthers. The different nectar collecting strategies (legitimate & illegitimate type) was also observed

Table 1: Details of locations explored for floral resource of *Xylocopa* spp. from Kashmir valley.

UT	Districts	Location	Latitude	Longitude	Altitude (m AMSL)
Jammu & Kashmir	Ganderbal	Wakura	34°13'19"N	74°41'41"E	1630
		FoF Benhama	34°16'43"N	74°46'37"E	1757
		Gutlibagh	34°16'33"N	74°49'39"E	1778
		Eco-park Manigam	34°16'40"N	74°48'41"E	1668
		Kijipora	34°16'24"N	74°53'05"E	1770
		Kangan	34°15'56"N	74°54'09"E	1811
	Bandipora	sonamarg	34°18'08"N	75°17'21"E	2669
		Ajas	34°19'56"N	74°40'24"E	1558
		Wullar vintage park	34°21'49"N	74°39'26"E	1599
		Bandipora Nishat park	34°24'51"N	74°38'36"E	1597
		Naidkhai	34°13'54"N	74°34'09"E	1581
		Vijpura	34°16'39"N	74°35'53"E	1583
	Baramulla	FoA wadura	34°20'51"N	74°24'12"E	1585
		Pattan	34°09'25"N	74°33'19"E	1599
		Achabal	34°16'21"N	74°24'11"E	1583
		Delina	34°14'20"N	74°25'22"E	1592
		Hadipora	34°17'31"N	74°24'07"E	1588
		Pinjoora	34°43'47"N	74°51'26"E	1989
	Shopian	Imam sahib	34°44'32"N	74°54'45"E	1882
		Shopian town	33°43'08"N	74°49'54.86"E	2042
		Hirpora	34°41'02"N	74°47'35"E	2269
		Balpura	33°55'37.12.3"N	74°39'15.6"E	2100
		Chogul	34°24'14"N	74°19'31"E	1593
		Vilgam	34°28'21"N	74°08'48"E	1784
	Kupwara	langate	34°18'27"N	74°17'59"E	1710
		Handwara	34°29'55"N	74°17'59"E	1590
		Nutnussa	34°26'50"N	74°17'59"E	1592
		Lal chowk	34°07'26"N	74°81'39"E	1586
		FoH, Shalimar	34°08'54"N	74°52'50"E	1600
		Chhatrahama	34°11'02"N	74°52'02"E	1671
Srinagar	Mujagund	4°08'11"N	74°42'15"E	1589	
	Gulabagh	34°10'52"N	74°49'18"E	1612	

Table 2: Details of locations explored for floral resource of *Xylocopa* spp. from Jammu region.

UT	Districts	Location	Latitude	Longitude	Altitude (m AMSL)
Jammu & Kashmir	Jammu	chattha campus	32°39'13"N	74°48'12"E	267
		R.S. Pura	32°36'35"N	74°44'15"E	273
		Bantalab	32°46'57"N	74°49'35"E	380
		Mansar	2°41'33"N	75°08'55"E	663
		Suransar	32°46'00"N	75°02'39"E	606
	Doda	Main Doda	33°08'33"N	75°33'03"E	1102
		Pul Doda	33°08'06"N	75°33'11"E	1010
		Kvk Doda	2°58'59"N	75°43'03"E	1607
		sartingle	32°56'57"N	75°43'44"E	1765
	Kathua	KVK Kathua	32°22'46"N	75°30'17"E	333
		KK Birla public park	2°23'42"N	75°30'52"E	364
		Barnoti	32°25'22"N	75°26'44"E	346
		Rakh lachipura	32°24'20"N	75°28'06"E	348
	Rajouri	KVK Rajouri	33°22'33"N	4°17'18"E	913
		Budhal	33°22'33"N	4°38'49"E	1785
		Saj thanamandi	33°27'24"N	74°19'49"E	1122
		Badhori, shahdara sharif	33°33'04"N	74°20'23"E	1621
	Poonch	KVK Poonch	33°46'00"N	74°06'40"E	1004
		Lassana	33°41'45"N	74°14'07"E	1248
		Dundak	33°40'55"N	74°14'53"E	1335
		Naka manjheri	33°36'02"N	74°14'47"E	1242

Table 3: Details of locations explored for floral resource of *Xylocopa* spp. from Ladakh region.

UT	Districts	Location	Latitude	Longitude	Altitude (m AMSL)
Ladakh	Kargil	Research station kargil	34°32'19"N	76° 09'04"E	2700
		KVK Kargil	34°31'13"N	76° 08'35"E	2670
		Minjee	34°29'10"N	76° 06'06"E	2676
		Sankoo	34°17'31"N	75° 57'39"E	2630
	Leh	HMAARI	33°58'30"N	77°41'56"E	3304
		Leh park	34°08'47"N	77°34'51"E	3385
		Kuzey chuchot	34°05'37"N	77°35'19"E	3224
	Shey	34°04'08"N	77°37'56"E	3237	

Results and Discussion

The study revealed the presence of *Xylocopa valga* from Kashmir and Ladakh region and *X. fenestrata*, *X. pubescence* and *X. dejeanii* from Jammu region. The *Xylocopa* spp. earlier recorded in temperate conditions so far are *X. valga*, *X. fenestrata* and *X. violacea* (Raj and Mattu, 2014; Ara *et al.*, 2019; Farook *et al.*, 2021) [17, 15, 14]. While in sub-tropical conditions *X. collaris*, *X. latipes* and *X. pubescence* (Abrol *et al.*, 2012; Tara *et al.*, 2014) [16, 18] were reported. The *X. valga* is the largest among all the species recorded and is present under temperate conditions only. All the *Xylocopa* spp. females collect nectar and pollen as it is used for making pollen paste for the mass provisioning of the broods. The males only feed on nectar for their survival.

The large carpenter bees prefer white coloured flowers

however yellow is also preferred besides size and odour also plays an important role in foraging behaviour. The *Xylocopa valga*, *X. fenestrata*, *X. pubescence* and *X. dejeanii* prefer flowers which are usually medium-sized, but also use large flowers (open type). Plants like *Plectranthus* spp. with small flowers are not appropriate for visitation by *Xylocopa* bees, but the latter still use them as nectar source opportunistically. A total of fifty-three species of flowering plants belonging to 10 families were recorded as associated with these carpenter bees including Asteraceae (11 spp.), Cucurbitaceae (3 spp.), Fabaceae (4 spp.), Lamiaceae (11 spp.), Rosaceae (10 spp.), Solanaceae (4 spp.), Oleraceae (1 sp), Bignoniaceae (2 spp.), Rutaceae (3 spp.), Malvaceae (4 spp.) as shown in Table 4.

Table 4: List of floral resources associated with carpenter bees of J&K & Ladakh

Family	Plant species	Common name	Floral Reward N=Nectar, P=Pollen	<i>Xylocopa</i> spp. visited
Malvaceae	<i>Alcea rosea</i>	Common hollyhock	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Abelmoschus esculentus</i>	Lady's-finger	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Hibiscus rosa-sinensis</i>	China rose	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Lavatera cashmiriana</i>	Kashmir Mallow	NP	<i>X. valga</i>
Cucurbitaceae	<i>Cucumis sativus</i>	cucumber	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Cucurbita maxima</i>	Common squash	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Citrullus lanatus</i>	watermelon	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
Rutaceae	<i>Citrus limmetoides</i>	Palestinian sweet lime	NP	<i>X. fenestrata</i> , <i>X. pubescence</i>
	<i>Citrus limon</i>	lemon	NP	<i>X. fenestrata</i> , <i>X. pubescence</i>
	<i>Citrus reticulata</i>	Mandarin orange	NP	<i>X. fenestrata</i> , <i>X. pubescence</i>
Fabaceae	<i>Phaseolus vulgaris</i>	Common bean	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Pisum sativum</i>	pea	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Trifolium pratense</i>	Red Clover	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Trifolium repens</i>	White Clover	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
Bignoniaceae	<i>Cercis siliquastrum</i>	Judas tree	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
Oleraceae	<i>Catalpa bignonioides</i>	Indian bean tree	NP	<i>X. valga</i>
Asteraceae	<i>Forsythia viridissima</i>	Chinese golden bell tree	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Ageratum houstonianum</i>	Bluemink	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Arctium lappa</i>	Greater burdock	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Calendula officinalis</i>	Pot marigold	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Carduus edelbergii</i>	Cotton thistle	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Chrysanthemum coronarium</i>	Crown daisy	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Cirsium arvense</i>	Creeping thistle	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Cirsium falconeri</i>	Falconer's thistle	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Cirsium vulgare</i>	Spear thistle	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Taraxacum officinale</i>	common dandelion	NP	<i>X. valga</i> , <i>x. dejeanii</i>
Solanaceae	<i>Helianthus annuus</i>	sunflower	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Zinnia elegans</i>	common zinnia	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Hyoscyamus niger</i>	stinking nightshade	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Lycopersicon esculentum</i>	Tomato	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
Lamiaceae	<i>Solanum nigrum</i>	Black nightshade	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Solanum tuberosum</i>	Potato	NP	<i>X. valga</i>
	<i>Hyssopus officinalis</i>	Hyssop	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Marrubium vulgare</i>	White horehound	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
Lamiaceae	<i>Mentha longifolia</i>	Mint	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>
	<i>Mentha arvensis</i>	Field mint/wild	NP	<i>X. valga</i> , <i>X. fenestrata</i> , <i>x. dejeanii</i> , <i>X. pubescence</i>

	<i>Nepeta cataria</i>	Cat mint	NP	<i>X.valga, X.fenestrata, x. dejeanii, X. pubescence</i>
	<i>Nepeta discolor</i>	catnip	NP	<i>X.valga, X.fenestrata, x. dejeanii, X. pubescence</i>
	<i>Prunella vulgaris</i>	Carpenter's herb	NP	<i>X.valga, X.fenestrata, x. dejeanii, X. pubescence</i>
	<i>Salvia hians</i>	Himalayan Blue Sage	NP	<i>X.valga, x. dejeanii,</i>
	<i>Stachys sericea</i>	Melissa-Leaf Woundwort	NP	<i>X.valga</i>
	<i>Thymus serpyllum</i>	creeping thyme	NP	<i>X.valga, X.fenestrata, x. dejeanii, X. pubescence</i>
	<i>Thymus linearis</i>	Himalayan Thyme	NP	<i>X.valga</i>
Rosaceae	<i>Agrimonia pilosa</i>	hairy agrimony	NP	<i>X.valga, X.fenestrata, x. dejeanii, X. pubescence</i>
	<i>Cydonia oblonga</i>	Quince	NP	<i>X.valga, x. dejeanii,</i>
	<i>Eriobotrya japonica</i>	Loquat	NP	<i>X.valga, x. dejeanii,</i>
	<i>Fragaria ananassa</i>	strawberry	NP	<i>X.valga, x. dejeanii,</i>
	<i>Malus domestica</i>	apple	NP	<i>X.valga, x. dejeanii, X.valga, x. dejeanii,</i>
	<i>Prunus armeniaca</i>	Apricot	NP	<i>X.valga, x. dejeanii,</i>
	<i>Prunus domestica</i>	plum	NP	<i>X.valga, x. dejeanii,</i>
	<i>Prunus persica</i>	peach	NP	<i>X.valga, x. dejeanii,</i>
	<i>Pyrus communis</i>	pear	NP	<i>X.valga, x. dejeanii,</i>
	<i>Rosa brunonii</i>	Himalayan musk rose	NP	<i>X.valga, X.fenestrata, x. dejeanii, X. pubescence</i>

There are few cases of illegitimate type of nectar foraging observed in *Xylocopa* spp. on hollyhock flowers where flower is accessed not from above but from behind and cutting and piercing corolla leading to inefficient pollination service.

The *X. valga* do have the buzz pollination ability where pollen from poricidal anthers are liberated *via*, the sonication mechanism particularly in solanaceous crops like tomato, potato, brinjal. The results obtained from the current study is very much important when evaluating this species as potential manageable pollinator and will also promote the use of wild bees for crop pollination, especially those crops of particular interest commonly cultivated by small-scale farmers in the studied area, such as Capsicum, *Solanum lycopersicum* (tomatoes) and *Solanum melongena* (Brinjal).

References

- Garibaldi LA, Aizen MA, Klein AM, Cunningham SA, Harder LD. Global from research to action: enhancing crop yield through wild pollinators. *Frontiers in Ecology and Environment*. 2014 Oct;12(8):439-447.
- Kremen C, Williams NM, Aizen MA, Gemmill-Herren B, LeBuhn G, Minckley R, *et al.* Pollination and other ecosystem services produced by mobile organisms: a conceptual framework for the effects of land-use change. *Ecology Letters*. 2007;10(4):299-314.
- FAO. The Beeconomy: Economics and insect pollination. *Biodiversity*; c2018 April 27. <https://modernag.org/biodiversity/beeconomy-economic-value-pollination/>
- Lucia M, Gonzalez VH, Abrahamovich AH. Systematics and biology of *Xylocopa* subgenus *Schonnherria* (Hymenoptera, Apidae) in Argentina. *ZooKeys*. 2015;543:129-167.
- Michener CD. *The Bees of the World* [2nd Edition]. Johns Hopkins University Press, Baltimore. 2007;16(1):953.
- Keasar T. Large carpenter bees as agricultural pollinators. *Psyche*; c2010. p. 1-7.
- Buchmann SL. Aspects of Centridine biology (*Centris* spp.) importance for pollination, and use of *Xylocopa* spp. as greenhouse pollinator of tomatoes and other crops. *Solitary Bees. Conservation, Rearing and Management for Pollination* (ed. by B. M. Freitas and J. O. P. Pereira), Imprensa Universitária, Brazil; c2004. p. 203-211.
- Gerling DW, Velthuis HD, Hefetz A. Bionomics of the large carpenter bee of the genus *Xylocopa*. *Annual Review of Entomology*. 1989;34(1):163-190.
- Sihag RC. Behaviour and ecology of the subtropical carpenter bee, *Xylocopa fenestrata*. Nest preferences and response to nest translocation. *Journal of Apicultural Research*. 1993;32(2):102-108.
- Mardan M. Varied pollinators for sub-tropical Asian crops. *Pollination of Cultivated Plants in the Tropics* (ed. by D. W. Roubik). FAO (UN), Italy; c1995. p. 142-148.
- Hogendoorn K, Steen Z, Schwarz MP. Native Australian carpenter bees as a potential alternative to introducing bumblebees for tomato pollination in greenhouses. *Journal of Apicultural Research*. 2000;39(1-2):67-74.
- Aguiar-Menezes EL, Menezes EB, Cassino PCR, Soares MA. Passion fruit. *Passion Fruit in Tropical Fruit, Pests and Pollinators* (ed. by J. E. Peña, J. L. Sharp and M. Wisoki). CAB International, Orlando, Florida; c2002. p. 361-390.
- Sadeh A, Shmida A, Keasar T. The carpenter bee *Xylocopa pubescens* as an agricultural pollinator in greenhouses. *Apidologie*. 2007;38(6):508-517.
- Farook UB, Yaqoob M, Gani M, Verheyde F. First record of *Xylocopa valga* Gerstaecker, 1872 from the cold and arid conditions of Ladakh in India (Hymenoptera: Apidae: Xylocopini). *OSMIA, Observatoire des Abeilles*. 2021;9:59-64.
- Ara S, Rather ZA, Paray MA, Khurshid R, Yaqoob M. Bee flora of Kashmir: The Himalayan biodiversity hotspot. *Journal of pharmacognosy and photochemistry*. 2019;8(2):2172-2182
- Abrol DP, Shankar U, Chatterjee D, Ramamurthy VV. Exploratory studies on diversity of bees with special emphasis on non-Apis pollinators in some natural and agricultural plants of Jammu division, India. *Current Science*. 2012;103(7):780-783.
- Raj H, Mattu VK. Diversity and distribution of insect pollinators on various temperate fruit crops in Himachal Himalayas, India. *International journal of science and nature*. 2014;5(4):626-631.
- Tara JS, Zaffar N, Gupta M, Bala A. Hymenopteran insect pollinators on apple bloom in district Rajouri, Jammu (J&K), India. *International journal of interdisciplinary and multidisciplinary studies*. 2014;1(8):168-171.