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Role of insect bees in the pollination of *Prosopis cineraria* (L.) Druce (Leguminosae, Subfamily Mimosoideae) in Rajasthan

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ABSTRACT

Prosopis cineraria (L.) Druce is a deep rooted, nitrogen fixing, multipurpose tree endemic to the hot deserts of India. The tree is known locally as Jandi or Khejri (India), Jand (Pakistan), and Ghaf (Arabic). Its synonym is P. spicigera. These trees are the essential component of the agroforestry land use system in these parts of India. It belongs to the family Leguminosae and subfamily Mimosoideae. In this paper we examined bees for pollination biology of Prosopis cineraria flowering at the end of during dry season. The flowers are small, massed into globose heads and function as units of reproduction. The plant is self-incompatible and exhibits synchronous flowering to facilitate cross-pollination. Prosopis cineraria produces small quantities of concentrated nectar, and has abundant pollen resources available to bee pollinators. We recorded some numbers of bee visitors and most fruit set on the tops of trees. Also in wasps and flies were the most numerous visitors and are likely to play a significant role in pollination.The dry season in arid region, Rajasthan State, India.

Key Words: *Prosopis cineraria*, Bees, Khejri, Pollination, Reproduction.

INTRODUCTION

Prosopis cineraria (L.) Druce is the most revered indigenous plant of the arid and semi-arid regions of western India. Very little information is available about the insect-plant associations in *P. cineraria* [1,2,3,4]. This paper describes the insect complex associated with this tree in the western part of the province of Rajasthan, India, divided by the role/influence of the insect on the host plant. *Prosopis cineraria* is locally known as Khejri, is a multipurpose tree for the arid areas. It is a versatile plant species providing fodder, fuel for timber, shade and also helpful in the soil improvement. It is commonly used in dry land agroforestery in India. *P. cineraria* is a large branched shrub or a small tree found commonly in Rajasthan, Delhi, Gujarat, Madhya Pradesh and along with India it is also common in Afghanistan, Persia, Baluchistan and in Pakistan (Sind). Its branches are slender, glabrous and armed with some what compressed, straight and scattered prickles of 3-4 cm length. Flower is in the form of axillary spikes with the length of 7-11 cm, either solitary or in terminal panicles. Flower posses yellow corolla, attracting large number of insects including large number of *Apis florea* and numerous other wild bees in the month of December and April. The flowers are valuable for honey production.

Common Name:	Khejri
Botanical name:	*Prosopis cineraria* (L.) Druce
Latin name:	*Prosopis cineraria*
English name:	*Prosopis cineraria*

Sanskrit:	Khejri
Hindi & Rajasthani:	Khejri, Jant/ Janti
United Arab Emirates:	Ghaf
Punjabi:	Jand
Sind:	Kandi
Gujarat:	Sami, Sumri

Khejri is a medium sized tree, called the king tree of Great Indian Desert because of the role played by it in conserving the ecosystem of arid and semi-arid region of the desert. It is a frost and drought resistant tree which can withstand temperature extremes, ranging from 45-48 degrees Celsius in the summer to less than 10 degrees Celsius in the winter [5]. The tree is worshipped by a large number of people, mostly Bishnois, a great environmentalist community in the Thar Desert. The importance of the medicinal value of this tree has been highlighted in ancient Ayurvedic (medical) literature. Wood is very high in energy value of about 5000 kcal/kg. An unlopped 30-35 years old tree produces about 4-5 kg of air dried pods in normal rainfall year, obtained during May-June months. Pods are brown to chocolate in colour on ripening and have a sweetish pulp. Unripe pods are also used as vegetable and after boiling can be stored for lean periods. Boiled and dried pods are the important constituents of this region's famous dishes "Trikuta" and "Panchkuta" [5].

P. cineraria effectively stabilize the sand dunes and can withstand periodic burial [6]. Because of a deep taproot, trees are not believed to compete for moisture or nutrients with crops grown close to the trunk. During the growing season it casts only light shade and is therefore suitable as an agro forestry species. Farmers in semi-arid regions of India and Pakistan have long believed it to increase soil fertility in crop fields. Yields of sorghum or millet increased when grown under *P. cineraria*, as a result of higher organic matter content, total nitrogen, available phosphorus, soluble calcium, and lower pH [7].

Prosopis cineraria is one of the most common plant species growing on sand through out the area of Jodhpur district and often forming gregarious patches. Cross pollination with the help of bee's results in the formation of Pods of 10-20 cm which are eaten as vegetable and valued as fodder. Thus in Jodhpur regions, green pods called *Sangri* are boiled, dried and are eaten as a vegetable in the human diet. Its leaves are locally known as 'loong' and are much valued as a fodder for goats. The bark is powdered and mixed with flour during the scarcity of food and famine [8]. *P. cineraria* provide excellent firewood and charcoal. Its wood is favored for cooking and domestic heating [9]. Hard and reasonably durable, the wood has a variety of uses for house building, posts, tool handles, and boat frames, although poor tree form limits its usefulness as timber.

Table: 1. General native pollinator habitat requirements

No.	Pollinator	Food	Shelter
1	Solitary bees	Nectar and pollen	Most nest in bare or partially vegetated, well-drained soil; many others nest in narrow tunnels in dead standing trees, or excavate nests within the pith of stems and twigs; some construct domed nests of mud, plant resins, saps, or gums on the surface of rocks or trees
2	Bumble bees	Nectar and pollen	Most nest in small cavities (approx. softball size), often underground in abandoned rodent nests or under clumps of grass, but can be in hollow trees, bird nests, or walls
3	Butterflies and Moths – Egg	Non-feeding stage	Usually on or near larval host plant
4	Butterflies and Moths – Caterpillar	Leaves of larval host plants	Larval host plants
5	Butterflies and Moths - Pupa	Non-feeding stage	Protected site such as a bush, tall grass, a pile of leaves or sticks or, in the case of some moths, underground
6	Butterflies and Moths – Adult	Nectar; some males obtain nutrients, minerals, and salt from rotting fruit, tree sap, animal dung and urine, carrion, clay deposits, and mud puddles	Protected site such as a tree, bush, tall grass, or a pile of leaves, sticks or rocks
7	Hummingbirds	Nectar, insects, tree sap, spiders, caterpillars, aphids, insect eggs, and willow catkins Typically need red, deep-throated flowers, such as cardinal flower, or penstemons	Trees, shrubs, and vines

[Source: Native Pollinators. Feb. 2006. Fish and Wildlife Habitat Management Leaflet. No. 34.

MATERIALS AND METHODS

Selection of field survey sites:

Rajasthan was selected as one the survey site state on *Prosopis cineraria*. The widely distributed site was selected on *Prosopis cineraria* of their provinces located in adjacent Jodhpur, arid zone, Rajasthan state, India. As per Global Positioning System (GPS), Jodhpur is situated at 26^{o}18.381' N Latitude and 73^{o}04.514' E Longitude. The soils are supporting the particular for leguminosae plant species. Climatic condition of Jodhpur is of an extreme type, with the variations in temperature range being very high. Weather in Jodhpur, Rajasthan is dry and hot, a typical desert weather whereas the average annual rainfall is approximately 32 cm. In summer, the maximum temperature remains around 42°C and the minimum temperature is around 37°C. In winters, the maximum temperature is around 27.5°C and the minimum temperature is around 15.5°C. Jodhpur is bright and sunny throughout the year. Regular and periodical field surveys were conducted, from various localities of Jodhpur and collection of sample during July, 2007 to September, 2009. Extensive collection was made during the months of March to May in each year.

Flowering biology of *Prosopis cineraria:*

The open, accessible structure of P. cineraria flower heads makes them accessible to a wide diversity of visitors, and in general visitor assemblages associated with mimosoid flowers are more diverse than those associated with more structurally complex legume flowers, such as the papilionoids [10]. There is also evidence that interpopulation variation in floral dimensions may be correlated with differences in the pollinators recruited [11]. We examined the availability of *Prosopis cineraria* pollen and nectar as floral rewards, according to the methods described [12]. Analyses were carried out for trees that were unprotected and therefore accessible to all potential in bees pollinators. Inflorescences sampled ranged from 1 m to 5 m above ground. Insect bees visitor to the inflorescences were classified to order level, or family where possible. Visits were simply recorded rather than timed, as described [12]. The *Prosopis cineraria* trees examined were scattered throughout the study area, < 80 m from other flowering *Prosopis cineraria*, and there were not more than five other flowering trees within a 250 m radius of each focal tree [13].

RESULTS

Its yellow flowers in globose inflorescence attracted few bees including honey bees. The pollinators started to visit around 8:00 AM (IST) and their number was highest in between 12:00 noon to 2:00 PM (IST). During specified collection periods, following bee species were collected on *Prosopis cineraria* crop.

Table: 2. List of bee species found in *Prosopis cineraria* in arid and semi arid region in Rajasthan

Sl. No.	Order	Family	Subfamily	Tribe	Genus & Species	No. of Bees
1.	Hymenoptera	Apidae	Apinae	Apini	*Apis dorsata* Fabricius	08
2.	Hymenoptera	Apidae	Apinae	Apini	*Apis florea* Fabricius	16
3.	Hymenoptera	Megachilidae	Megachilinae	Anthidiini	*Icteranthidium sinapinum* Cockerell	12
4.	Hymenoptera	Megachilidae	Megachilinae	Anthidiini	*Eoanthidium punjabensis* Gupta & Sharma	08
5.	Hymenoptera	Halictidae	Halictinae	-	*Halictus constrictus* Smith	06
6.	Hymenoptera	Halictidae	Halictinae	-	*Halictus lucidipennis* Smith	05
7.	Hymenoptera	Halictidae	Halictinae	-	*Halictus torridus* Smith	07
8.	Hymenoptera	Megachilidae	Megachilinae	Megachilini	*Megachile gathela* Cameron	08
9.	Hymenoptera	Megachilidae	Megachilinae	Megachilini	*Megachile suavida* Cameron	06
10.	Hymenoptera	Halictidae	Nomiinae	-	*Nomia elliotii* Smith	04
11.	Hymenoptera	Halictidae	Nomiinae	-	*Nomia oxybeloides* Smith	08
12.	Hymenoptera	Halictidae	Nomioidinae	-	*Nomioides comberi* Cameron	05
13.	Hymenoptera	Halictidae	Nomioidinae	-	*Nomoides sp.1*	13
14.	Hymenoptera	Halictidae	Nomioidinae	-	*Nomoides sp.2*	12
15.	Hymenoptera	Apidae	Apinae	Apini Meliponini	*Trigona iridipennis* Smith	25

Visitors to *Prosopis cineraria* flowers:

A diverse array of insect bee's visitors was caught on and around flowering *P. cineraria*. In addition, there were numerous invertebrate visitors. Fifteen species of bee were recorded visiting trees in bloom during observations. Maximum number of visitors of bee in *Trigona iridipennis* Smith, followed by *Apis florea* Fabricius and minimum time visitor bees are *Nomia elliotii* Smith *and followed by Halictus lucidipennis* Smith and *Nomioides comberi* Cameron.

DISCUSSION

The flowers of *P. cineraria* are entomophilous and depend on insects for seed setting. Table 2 presents the insect species that were collected from *P. cineraria* inflorescences from a wide range of locations in Rajasthan, India. Flowering occurs during the driest months of the year, and therefore the insect visitors would be those that are adapted to aridity. Fifteen species belonging to the Hymenoptera were recorded visiting *P. cineraria* flowers. Insect bees are likely to play a significant role in the pollination of *P. cineraria*, as has been demonstrated in closely related species [11]. *P. cineraria* flowers produce highly concentrated nectar. Nectar concentration and volume clearly reflected the effect of evaporation (and possibly nectar harvesting) during the day. Available nectar volumes seem too small to attract birds, and nectar feeding by birds was never obvious. The most frequent insect visitors were flies (which show limited movement between trees) and wasps. Solitary bees are thought to be important pollinators of *Prosopis* species 'wherever their pollination has been studied in depth'. Honeybees were more common visitors to trees close to water, although bees may in fact fly considerable distances to obtain water (for example, honeybee species have been recorded foraging 10–20 km from their nest [14,15]. In contrast, other bees, wasps and flies were actually more common visitors to trees far from water, and the total number of insect visitors was higher for trees away from surface water compared with those near water.

So far no studies concerned to bee spices composition on *Prosopis cineraria* has been done. As *Prosopis cineraria is* one of the major plant of the western Rajasthan, a serious need was felt to study the native Apoidean pollinators of this crop for its pollination requirement. *Trigona iridipennis* Smith exclusively use this plant for its nesting purpose and several important plant sites have been discovered where this bee construct its nest. During collection period following bee species were collected from this crop:

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