



## Bat Pollination in medicinally important *Cochlospermum religiosum*

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**Abstract:** Detailed studies were carried out on the Phenology, floral biology, pollination and breeding system of *Cochlospermum religiosum* (L) Alston. The main flowering season is between February-April. The flowers were large, yellow, butter cup shaped, growing up to 10cm and with bright orange- yellow shaped stamen. The flowers were opens at night pollen grains were spherical, tricolpate and maximum pollen viability at 20.00hrs. The stigma is dry type and receptive between 16.00hr-24.00hrs. The Indian flying fox *Pteropus giganteus* forages at night as small groups in *C. religiosum*. The maximum foraging activity between 18.00 hrs-20.00hrs. While the flying foxes land on the inflorescence and feed on flower resources, the pollen grains stuck on spur. From this study we found that *P. giganteus* is the most efficient pollinator of *C. religiosum*.

**Keywords:** *Cochlospermum religiosum*, Phenology, Bixaceae

### Introduction

The Megachiropteran bats come under the single family Pteropodidae and almost all of them are phytophagous (feed upon fruits, blossoms, nectar, pollen and leaves). They feed on at least 300 plant species of nearly 200 genera and many of these plants are solely rely on these bats for pollination and seed dispersal (Marshall 1983; Banack 1998; Knudsen and Kiltgaard 1998). Fugita and Tuttle (1991) reported that about 289 plant species of 59 families are dependent on varying degrees on large flying foxes for pollination or seed dispersal.

The *C. religiosum* comes under family bixaceae and is commonly called as 'butter cup' tree due to its flower shape resembles a butter cup. The plant is mainly found in tropical regions of Southeast Asia and Indian subcontinent and known for its medicinal properties. It is small deciduous tree average height of 7.5m. The leaves are palmately lobed. The fruit are brown and oval shaped. The gum of the tree is used as medicine for treatment of cough, diarrhea and dysentery. The dried leaf and flower used as sedative and laxative (Kirtikar and Basu, 1935, 1975).

### Materials and Methods

Phenology is defined as the timing of biological events. Plants in the experimental plot were observed daily to study the flowering phenology; special attention was given to identify the flowering season, flower initiation, development, anthesis, anther dehiscence etc. The floral parts were studied by using hand lens and stereomicroscope (Leica CM, 1100). The measurements of the

floral parts were taken with the help of a plastic scale.

Stigma receptivity was analyzed by  $\alpha$ -naphthyl acetate. In this test excised stigma dipped in 2 drops of  $\alpha$ -naphthyl acetate solution for 30 minutes, after that stigma washed with phosphate buffer and observe the changes.

Foraging behaviour of *Pteropus* was observed by counting echolocation calls. The flying foxes forage as a small group. The foraging activity normally starting from 16.00hr it varies according to sunset. The foraging activities extend up to 24hr after that frequency of visits very less. The echolocation calls were countered every hour and observe foraging activity by using torch light covering with red paper (direct light might be disturbed foraging activity of bat so we using covered torch light by using red paper instead of direct light). Statistical analysis also used for understand the bat visitation frequency (boxspot method was used).

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## Result

**Table.1:** Floral Phenology of *C. religiosum*

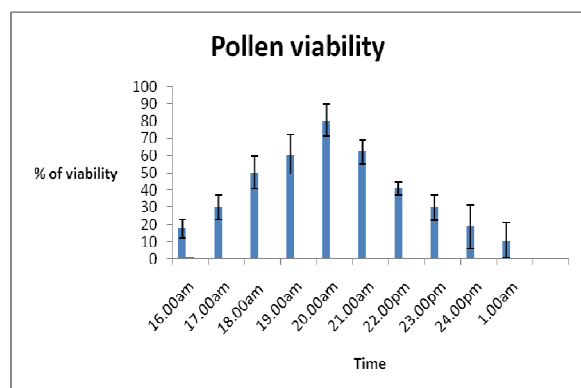
Floral characters	Observation
Flowering period	February-April
Flower type	Regular, Bisexual
Flower colour	Bright, yellow
Odour	Absent
Nectar	Present
Anthesis time	18.00hrs
Anther dehiscence time	18-19. 00hrs
Anther dehiscence mode	Apical pore
Number of anthers per flower	124±2.60
Pollen shape	Spherical
Pollen type	Tricolpate
Sigma type	Dry
Stigma receptivity	16-24.00hrs
Fruit type	Capsule

### Pollen viability:

Pollen viability was tested by using tetrazolium solution. They test revealed that, only 10% and 20% of pollen grains were viable soon after anthesis 80% pollen grains were viable at 20.00hrs. At 20.00hrs viability gradually decreases (Table 2).

**Table.2:** Pollen viability

Sl. No	Time	<i>C. religiosum</i>
1	16.00am	17.67 ± 5.38
2	17.00am	30.19 ± 7.20
3	18.00am	50.32 ± 9.50
4	19.00am	60.59 ± 11.35
5	20.00am	80.45 ± 9.32
6	21.00am	62.16 ± 6.78
7	22.00pm	40.97 ± 3.31
8	23.00pm	30.02 ± 7.49
9	24.00pm	18.59 ± 12.66
10	1.00am	10.86 ± 10.51



### Stigma receptivity:

Receptivity of stigma was analysed by  $\alpha$ -Naphthyl acetate. If the stigma was more receptive, the stigma was stained pink in colour. In *C. religiosum* the stigma was more receptive at 22-24hrs; receptivity is gradually decreases (Table 3).

**Table.3:** Stigma receptivity of flower on  $\alpha$ -naphthaline acetate

Sl. No.	Time	Frequency of colour <i>C. religiosum</i>
1	16-18.00hrs	Orange-yellow
2	18-20.00hrs	Tip become pink
3	20-22.00hrs	Purple- pink
4	22-24.00hrs	Pink
5	24-2.am	Yellow

### Breeding analysis:

Open pollination in natural conditions resulted in 95% fruit set. Apomixis, Flower bud bagged by removing stamens and stigma results no fruit set. Autogamy was carried out around 20 flowers but no fruit set observed. Manual pollinations using pollen from other flowers of the same plant resulted in 80% fruit set. Manual cross pollinations using pollen from flowers of different plant resulted in 90% fruit set (Table 4).

**Table.4:** Breeding analysis

S. No.	Breeding system analysis	No.of flowers pollinated	No.of flowers fruit set	Percentage of fruit set
1	Openpollination	20	19	95
2	Apomixis	20	0	0
3	Autogamy	20	0	0
4	Geitonogamy	20	16	80
5	Xenogamy	20	18	90

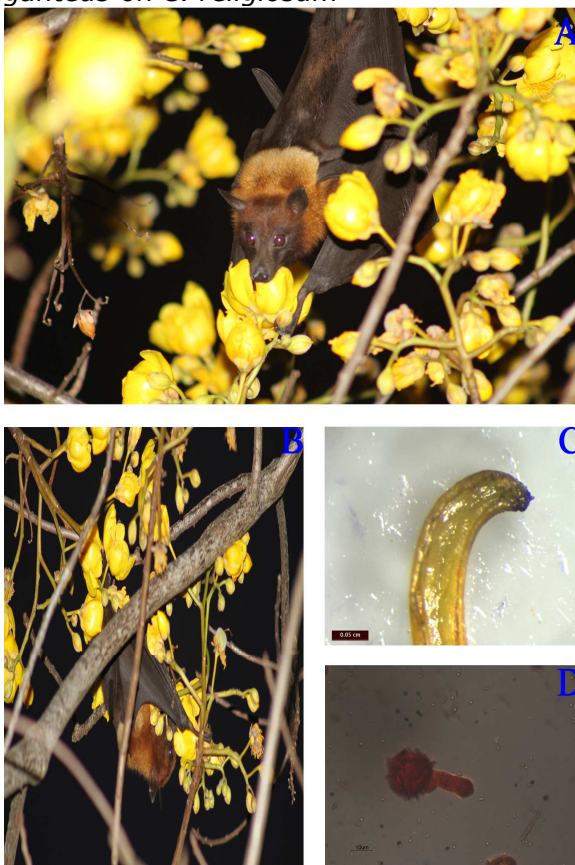
### Plant-Bat interaction:

At night, flying foxes navigate principally by sight. Their excellent sense of smell helps to locate food. They normally feed on blossoms, fruits, nectar, pollen and leaves. In *C. religiosum* flying foxes forages as a small group (3-6 individuals at a time). They were very noisy produce sounds at regular intervals. The flying foxes are communicated by producing sounds. The bat calls were counted and observed the foraging behaviour.

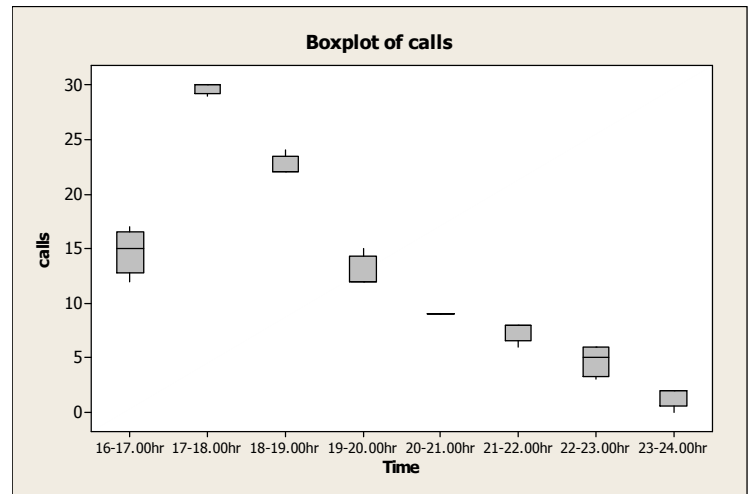
They were feed pollen and nectar from *C. religiosum*. The flying foxes normally lands on flowering branches and select the fully opened flower as a meal. The foraging strategy of this bat is highly interesting they have inserted its mouth parts in to flower and lick the pollen. While doing so the hairy face stuck with pollen grains.



**Plate.1:** A & B, Foraging behavior of *P. giganteus* on *C. religiosum*



**Plate.2:** A & B, Foraging strategy of *P. giganteus* on *C. religiosum*. C & D, Viable pollen showing germination and receptive stigma



Bat visitation frequency is calculated by using call count method. The flying fox is more active during 17-18.00 hrs in *C. religiosum*

### Discussion

The amount of food supply, the kind of available food plants, location of the food plants and the duration of availability are the four main concerns for the plant visiting bats (Fleming 1982). Other than fruits they also visit flowers for nectar and so they are helpful for the long distance transport for the seeds and pollen (Nathan *et al.*, 2005). The food choice and foraging behaviour of bats could be constrained by extrinsic factors such as location and renewable rate of food, feeding behaviour of competitors and risk of predation. Group foraging probably increases the rate of patch discovery, but also increases the potential for feeding interference among individuals.

Besides good smell, the flying foxes have also developed vision by having large eyes which might further help them to fruits at night (Marshall 1983). The large bright yellow cup shaped flower of *C. religiosum* is very easy to locate from long distance even in dark that might be the reason for flying foxes regularly visits in the flowering season. Flying foxes visit flowers for nectar and so they are helpful for the long distance transport for the seeds and pollen (Nathan *et al.* 2005).

After sunset smaller groups like 3-6 individuals forages at a time. Flying foxes used its forearm to retrieve the inflorescence to its mouth and lap the nectar from them. In that process, the pollen gets dusted on the muzzle on these bats. This might be the first fully documented data about bat pollination on *C. religiosum*.

### Conclusion

Bats are mobile pollinators, especially fragmented landscapes. The pollination study of bats already studied by several biologists before but this is the first fully documented report on *C. religiosum*. The flying foxes pollinating *C. religiosum* medicinally important in India and abroad.

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**Conflict of interest:** None Declared