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Honey bee – *Passiflora edulis* Sims. (Passifloraceae) pollination found in the Pachamalai Hills, Eastern Ghats of Tamil Nadu.

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ABSTRACT:

Pollination is the process of fertilization in higher plants. In flowers, pollen is delivered to the stigma through a wide range of mechanisms that insure an appropriate balance in the genetic makeup of the species. For many plants, flowers are vital organs of reproduction containing both male and female gametes. For bees and other nectar-feeding animals, flowers are a source of food. In *Passiflora edulis*, pollen is distributed by bees. The flower is the device by which the plant recruits the bee. The bees and *P. edulis* have evolved an interdependent relationship.

Keywords:
Passiflora edulis, honey bee pollination, Pachamalai Hills, Eastern Ghats.

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INTRODUCTION

The mechanism of pollination among the higher plant groups has been under investigation from very early times and it is highly significant in biological studies. It is particularly important among other aspects of biological studies in ecology, co-evolution, variation, speciation, classical and applied genetics and plant breeding. The knowledge of pollination biology is a prerequisite in plant breeding and for obtaining better yields of crops. Variability is controlled by the breeding system, of which pollination mechanism forms an integral component (Roy and Choudhury, 1981).

Pollination biology has shown a new phase of synthesis and correlation. During its entire flowering period, a plant species needs several flower visitors for its pollination. In the same way, the flower visitors require a number of plant species to provide them continuous nourishment. It is considered that the pollination relationships take place on a community basis (Baker, 1963). Plant– pollinator interactions are crucial in determining community structure and its functioning (Heithaus, 1974; Frankie, 1976).

Pollen productivity of a plant species indicates the biological efficiency of a particular plant. Pollination biology of some angiospermic plants has been studied (Ashoke and Sudhendu, 2000). But an adequate knowledge about the pollination biology of *Passiflora edulis* Sims of the family Passifloraceae is lacking since the plant is economically important on account of its edible fruits, medicinal uses, production of beverages and etc. The present investigation was done with the principal objectives to acquire detailed knowledge about the floral biology, pollen dispersal, pollen-pollinator interaction, pollination mechanism, morphology and receptivity of *P. edulis*.

MATERIALS AND METHODS

The pollination studies were carried out during two seasons (January- May 2007 and 2008). During the peak of flowering season, comparative studies were also carried out on another population growing about 4 km away from this population. To study floral phenology, flower buds that would open the next day were tagged (N=50×2) and were kept under observation (every hour on the first day and every morning, noon and evening on subsequent days until senescence) to record the time of anthesis, anther dehiscence and structural changes associated with ageing of flowers.

A few pollinators were caught using sweeping net, immobilized in ethyl acetate vapours and used to study pollen load on their body. The time and day of their opening were recorded and the samples were kept under observation. Initial observations revealed that honey bee and fly visit the flowers throughout the day from 0600 to 1800 h. The frequency of visits and foraging time were continuously recorded from 0600 to 1800 h for three days (36 hrs of total observation). Pollinators were distinguished from floral visitors based on their landing site, method of foraging,

Figure: Shows various stages of *Passiflora edulis* flowering and Pollination.

their contact with the anthers and stigma, presence of pollen load on their body and their efficiency in transferring pollen to the stigma. For studying the transfer of pollen to the stigma, flowers visited by the insects were excised and observed under the microscope for pollen load on their stigma. An extensive field exploration has been done with a view of finding out the flowering period and floral nature of the selected plant. Flower colour, odour and nectar were observed visually. Anthesis and anther dehiscence were observed using a fluorescent lamp at night and a hand lens, following the standard methods (Reddi and Janaki, 1981; Mathur and Mohan, 1986). Reproductive success was assessed on the basis of fruit and seed set. As the bracts, bracteoles and sepals are persistent and continue to be green until all the flowers in the flowers have opened and the fruits have reached maturity, it was possible to count, from the older flowers, the number of flowers produced and the number of fruits developed from each branch. Plant morphology and floral characters were studied by following standard floras (Matthew, 1983).

RESULTS AND DISCUSSION

The *P. edulis* is a native of southern Brazil through Paraguay to northern Argentina. The yellow form of passion fruit is probably native of the Amazon region of Brazil (Morton 1987). Passion fruit is cultivated today throughout the tropics and subtropics and has naturalized and escaped in many areas (Acevedo-Rodríguez, 1985). In our study *P. edulis* is found as a perennial climber in the riverine ecosystems of mid elevation forests of Pachamalai Hills.

The flower buds of *P. edulis* start to open 7.46±1.17 hrs in the morning after receiving sufficient intensity of the sunlight (Figure 1). At the time of opening the anther facing downwards and the stigma is almost straight (Figure 2). Till the dehiscence of anther, the stigma stands away from them. Later on it bends towards the anther. Even though the bending takes place, the self pollination is not possible because the dehiscence anthers are facing downwards and contains the pollen grains which could not be moved by wind.

As the plant *P. edulis* produces sticky and heavy pollens without any aids to fly in the wind, this plant is in the need of a vector for the pollen transfer from the anther to stigma. In this case, honey bees are playing an important role as the pollen transferring devices. Honey bees are one of the members of the insect family Apidae. They are having very specific body structures with feather-like hairs called setae. Flowers are the main support for the survival of honey bees. The nectar secreted in the flowers give carbohydrates, which gives energy to fly and their activities like hive making and reproduction. The Pollen grains are the main source of proteins, fats, vitamins and minerals to build their body and for growth. A worker bees foraging for pollen grains over the flower and store it in their legs specialized for pollen collection (Figure 3). The bees have three pairs of

TABLE: Vegetative and Flowering characteristics of *P. edulis*.

S. NO	PARAMETER	OBSERVATIONS
1.	Height of the Plant	According to the supporting plants
2.	Number of Branches in an Individual	8 ± 2.77
3.	Number of Branch initiating flowers	Almost all
4.	Number of flower in a branch	7 ± 3.34
5.	Number of flowers opens	Almost all
6.	Time of opening	7.46 ± 1.17 hrs
7.	Time of closing	15.2 ± 1.48 hrs
8.	Foraging time	Between 8.06 ± 1.11 hrs and 14 ± 1.22 hrs
9.	Foraging duration	9.8 ± 4.14 seconds
10.	Number of fruits Produced Per branch	6 ± 1.81
11.	Number of seeds per fruit	37 ± 6.38

legs, which are evolved to comb pollen from the bee hairs and pack it into the pollen basket for transport to the hive.

The forelegs are equipped to clean their antenna and brush pollen from the antennae. With the mid legs, the bee clears the pollen from its head, thorax and forelegs. And then the pollen grains are brushes and packed into the baskets like structures in the hind legs.

The petals of the flower attracting them to the flower with their colourful markings, act as landing pad for the bees and guiding them to the nectarines and anthers. The bee drives their head very deep into the flower to get the sweet nectar. At this time, pollen grains are entrapped in its body hairs and then brushes against the anthers and stigma.

As bees move one plant to another, the pollens are also carried from anther to stigma and perform the pollination. Some pollen grains are deposited on the sticky surface of each stigma and germinate in to a pollen tube through the style of the ovule to complete fertilization. After the 50 ± 14.28^{th} hours of fertilization, petals fall down and the pistil stars to develop into a fruit and the seeds develop inside. The vegetative, reproductive and pollination details are given in the table.

It is also noted that some flies come to the flowers to collect nectar only. As they are comparatively small in size, they could not get contact with the anther during the collection of nectar from the inner part of the flower. And usually they are not having the habit to collect the pollen grains. Thus the flies are not involved in the pollination of *P. edulis* and they get the nectar only from the flower, in this case it may be considered as nectar robbers (Figure 4).

The fruit of the *P. edulis* is used to make delicious juice. It is also collected by local people in the forests. The fruit pulp contains protein, fat, carbohydrates. The fruit stands as food for numerous wild birds and mammals.

Plants were once the main source of all medicines in the world and they continue to provide mankind with new remedies. Natural compounds found in plants and their derivatives make up more than 50% of all drugs in clinical use in the world (Marius Hedimbi *et al*., 2012 and Igoli *et al*., 2005). The *P. edulis* is also used as a diuretic to treat urinary infections. The earlier reports focused on the antibacterial properties of *Passiflora* species by different methods. The crude materials of *Passiflora* were separated into several fractions; passicol was obtained, which had antimicrobial activity (Birner and Nicolls, 1973). On the other hand, the antibacterial activity of *Pseudomonas tetrandra*, which has got activity against *E. coli*, *B. subtilis* and *P. aeruginosa*, the potential plant derived antibiotic (Perry *et al*., 1991).

The type of fragrant produced by the flower determines the type of pollinators. *P. edulis* produces pleasant fragrance and it attracts honeybee. In the case of *Caralluma umbellata* a fleshy odour is produced during the peak flowering season. This odouring attracts the house fly towards the flowers and the pollination also performed by the house fly only (Anburaja *et al.,* 2011).

In the other hand, like *P. edulis,* most flowering plants depend on animals for effective pollination and sexual reproduction (Buchmann and Nabham, 1996). Although animal vectors improve pollen transfer to stigmas such evolutionary dependence on mutualists for reproduction has increased plant susceptibility to fragmentation and other forms of habitat disturbance (Aizen *et al*., 2002). The majority of studies conducted so far indicate that insect pollinator guilds are particularly sensitive to habitat fragmentation (Aizen and Feinsinger, 2002).

CONCLUSION

The *Passiflora edulis* is found as a perennial climber in the riverine ecosystems of mid elevation forests of Pachamalai Hills. The opening of the flower

starts after receiving sufficient intensity of the sunlight. At the time of opening the anther facing downwards and the stigma is almost straight. Later on stigmas bend towards the anther. Even though, the bending of stigma does not facilitate the self pollination. In this case, honey bees are playing an important role as the pollen transferring devices. The petals of the flower attract them towards the flower with their colourful markings. It is also noted that some flying insects come to the flowers to collect nectar only. As they are comparatively small in size, they could not successfully transfer the pollen from anther to stigma. And usually they are not having the habit to collect the pollen grains. Thus the flies are not involved in the pollination of *P. edulis* and they get the nectar only from the flower, in this case it may be considered as nectar robbers.

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