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Orchid Pollination: An Observation on Pollination-Pollinator Interaction in *Cymbidium pendulum* (Sw.) Roxb.

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Abstract

The path of pollination in *Cymbidium pendulum* (Sw.) Roxb. has been traced in the present studies. The honey been identified as *Apis mellifera* was found to act as main pollinator and this bee is the only insects, among others, who succeeded in performing pollination because probably due to its structural compatibility with the plant species. Pollination by *Apis mellifera* bees was suggested to occur in a number of families but rare phenomenon in orchids and it is first time that the species was observed to pollinate the *Cymbidium pendulum* flowers. Bee moved around the flowers for some times, entered the flower and carried on pollinia along with on the back during its journey. It revisited the different flower and deposited its pollinia on to it and the act of pollination was accomplished. SEM study showed an intricate network on the back of bee thus clearly indicates its role in firm attachment to pollinia.

Key Words: Bees, insect, pollination, pollinator, SEM

Introduction

Orchidaceae, one of the largest families of flowering plants (up to 30 000 species, and contributing nearly 10% of all flowering plant species in the world [1-3], is characterized by its floral structure generally specialized to avoid spontaneous self-fertilization and promote insect-mediated outcrossing [4, 5]). Pollination ecology is crucial, as orchids are known to exhibit higher degree of specialization with pollinators. In evolutionary and ecological terms, specialization may lead to higher levels of species endangerment [6].

Ever since, this startling observation was made [7], the saga of exploring the plant-pollinator interaction appears to be a never-ending endeavour [8].

The levels of fruit production are frequently reported in orchid species and fruit set consistency is the most widely used estimate of reproductive success [9]. It has been generally accepted that the evolutionary diversification of orchids is closely related to their complex pollination systems [10-11]. More than in other plant families, the precision of pollinaria transfer in most Orchidaceae requires tighter morphological correspondence between the flower and pollinator. Orchids offer their visitors (insects and birds) a variety of rewards such as oil in *Disperis* [12], floral fragrances in *Catasetum* [13, 14] and, more frequently, floral nectar [15, 16].

About 60% of the Orchidaceae are considered to be adapted to bee or wasp pollination. Some groups of bees have particular importance in orchid pollination, specially the tribe *Euglossini* (faro. *Apidae),* the carpenter bees (faro. *Anthophoridae,* genus *Xylocopa),* the bumblebees (fam. *Apidae,* genus *Bombus)* and some oil-gathering *Anthophoridae* (genera *Centris, Paratetrapedia* and others. There are records of halictid pollination in *Spiranthes* [17]. In this context, the pollination mechanism of the *Cymbium pendulum* (Sw.) Roxb. has been traced (Fig. 1). The aims of our research were of immense importance because of (i) its taxonomic utility (ii) to determine the adaptation of plant [collected from the natural habitats (North-East India)] with one of the insects present in the locality (iii) to evaluate the influence of pollinators on reproductive success; and (iv) to assess the extent of fruit production by bee pollination.

Materials and Methods

Present studies were carried out with *Cymbidium pendulum* in the Green house, Department of Botany, Panjab University, Chandigarh, in the presence of other orchid species. We have collected the plants of *Cymbidium pendulum* from their natural habitat and maintained in the orchid house, Department of Botany, Panjab University, Chandigarh, India. We have purposely confined our study in the green house to check the co-adaptability of the orchid plant with pollinators for reproductive success.

It was laborious and difficult task to photograph the bees visiting flowers who carry pollinia on back and finally revisit the other flowers, we used to spent 3-4 hours daily in the month of March and April during year 2005-2007, then we were able to complete the story. The pollinator was then captured, identified and then fix for SEM studies. SEM studies were done to understand the complexities of its back on which the pollens were seen to deposit. Thereafter, we followed the flowers till the seed set, in order to establish the reproductive success. The pollination process and relationship with pollinator was established in the field in a total of 25-28 hours in the month of March during 2005-2007.

Most bees were identified at the Zoology Department, Panjab University, Chandigarh

Results and Discussion

Pollination, though appear to be as simple as transfer of a pollen onto a conspecific stigma, is a complex phenomenon and irreplaceable by any tool or technique. Coherence of ecological events such as timing of flowering/blooming and the availability of a suitable/legitimate pollinator is the essential prerequisite. For an in-depth knowledge of species biology, species specific pollination strategy and pollinator behaviour are necessary in acquiring better understanding of processes that generate enormous morphological and genetic variation [18], as shown by Orchids.

The reproductive features including specialization of floral parts, dispersal of pollen grains in units (pollinaria), constancy for specialized pollinators and the refined cues (mostly scent) for attraction to one group or a type of pollinator [15], make natural study of Orchids a challenging task in terms of prolonged and repeated monitoring in the field. Although cosmopolitan in distribution, most of the orchids have restricted distribution to specialized habitats and require extraordinary efforts along with suitable equipment to unravel their survival strategies.

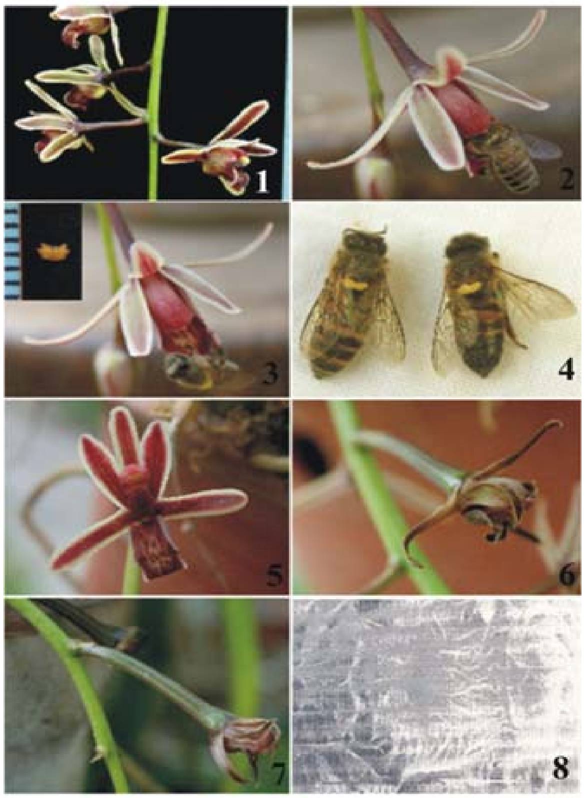
Yellow wasp, *Apis melifera,* and other small insects were seen to fly around but *Apis melifra* has been succeeded in pollination due probably to its morphological compatibility with flowers. Bee pollination was recorded in Goodyeriinae orchids: the protandrous *Erythrodes arietina* and the non-protandrous *Aspidogyne longicornu* [19]. Mixed moth and crane-fly (Tipulidae) pollination was documented in *Habenaria parviflora* (Habenariinae) [20]. Protandry was traditionally associated with Bumble-bee pollination. All the species in Orchidaceae may not have a specialized relation with pollinators. For example in a study comprising ~550 species of orchids, it was found that ~34% species had more than one species of bee pollinator and they carried out pollination with almost equal efficacy. In a terrestrial orchid *Epipactis palustris*, 103 pollinators have been identified.

In present study, bee activity at flowers was observed between 6.00 a. m and 6.30 p. m. in the months of March and April during 2005 and 2007. but with much higher frequency between 11.00 a.m and 1.00p.m, when consecutive insect visits were observed in 1 to 8 min intervals. Bees enter the flowers from their upper side (Fig. 2), and since the flowers are large sized therefore allow bee to enter its body straight in the flower tube (Fig. 3). The insects visit 2-4 flowers in sequence, spending about 15-30 seconds in each inflorescence. Bees visited 1-2 inflorescences each time, then left the plant

The honey bees (Fig. 4) prime commercial value is as a pollinator of crops. Orchards and fields have grown larger; at the same time wild pollinators have dwindle. In several areas of the world, the pollinator shortage is compensated by migratory beekeeping, with beekeepers supplying the hives during the crop bloom and moving them after bloom is complete. In many higher latitude locations, it is difficult or impossible in winter to have enough bees, or at least to have them ready for early blooming plants, so much of the migration is seasonal, with many hives wintering in warmer climates and moving to follow the bloom to higher latitudes.

The bee attracts at the pinkish colour/pattern of labellum of the flowers. Floral traits covering scent, colour display is the major cues for attraction and each of these traits may contribute in different proportion to the reproductive success of orchids. On the basis of the reward offered, two types of bee pollination in orchids have been reported so far namely (a) pollination by the nectar collecting bees [21, 22] in *C. nitida* (Wall. ex. D. Don) Lindl. and *C. corymbosa* Lindl. by the Indian honey bees *Apis indica* who forage these flowers for the nectar and (b) Orchid flowers pollination by oil – collecting bees- this is a rare phenomenon in plants, occurs in at least 55 South African Orchids in the genera *Disperis, Pterigodium, Corycium, Ceratandra, Evotella, Satyrium* and *Pachites.*

In *Ophyris* also, the lablellum and the lateral tepals are believed to have greater role in attracting the male wasp pollinators than the scent alone [23]. In the labellar micromorphological studies of the *Ophrys*, the author had opined that the epidermal cell types and other structural complexity might influence the optical properties and might play an important role in directing male insects [24, 25]. Many studies have shown that an increase in the number and/or the size of the inflorescence renders the plant more attractive results in increasing the frequency of pollinator visitations [26, 27] and leading to an increase in fruit set [28, 29], the plant in present studies probably have this advantage. As bee lands on the flower, it reaches the labellum and stabilizes itself on it. At the time of landing, some intelligent bees visit here and there near the flowerpots and may trying to differentiate fresh (just open) and old flowers (2-3 days old). When we were observing the pollination process, honeybee becomes aggressive and made every effort to sting us. Sometimes, bee directly lands on the labellum. After stabilizing itself on the labellum, it moves towards the centre of flower where its thorax (or scutellum ?) comes in contact with the anther many times which is present opposite to the labellum. Then bee stars forward and backward movement and on the backward movement, it put pressure on the labellum which causes it to slightly shifts downward. This downward movement of labellum press column to downward towards thorax of bee and ultimately the thorax come in contact with anther with every backward movement. The overall process help in the pollinarium unit detaches from the anther and adhered it to the thorax of bee with the help of sticky viscidium. This viscidium ruptures when dorsally pressed, exposing the glue that fixes the pollinarium to the ventral surface of the bee's labrum (Fig. 4), have also been reported earlier. After the attachment of pollinarium unit, bee flew away within a few seconds. Now bee either leaves that place or visit other flower. If it visits other flower, it repeats the process of landing and stabilising on the labellum of that flower. Due to pressure on the labellum, the upper part of column of flower comes in contact with the thorax of bee, which contains the anther and stigma. Now the pollinarium unit from the thorax of bee adhered to the sticky surface of stigma. Finally, the flower gets pollinated. Further, it has been observed that the process of pollination is successful in only freshly opened flowers (Fig. 5). Although, some bees also visit 2-3 days old flowers. Here, it reaches the labellum, moves towards the centre of flower. Here, now it moves forward and backward. Due to this, although pollinarium unit removed from the anther, however, it does not attaches with the thorax of bee, which may be possibly due to drying of viscidium which otherwise help in attachment when it is fresh (freshly anthesized flower). Similarily, pollinarium unit do not attaches in such flowers (anthesized before 2-3 days) which may be also due to drying of stigmatic fluid. Therefore, pollination is failed in such flowers. In those flowers, where lip is slightly broken (in those area, where it is in contact with the column) due to some mechanical injury or any injury made by the authors (us), pollination is also failed. In such case, bee visits the flower, reaches the broken labellum, but unable to stabilize itself and flew away. The bee pollinated flowers were followed to see the reproductive success and it was evident by perianth senescence and ovary growth (Figs. 6, 7), which ultimately set seeds. The bee was traped and SEM was done; an interesting intricate network (Fig. 8) was fabricated on the back of bee indicated thereby that this web might play significant role in deposition and firm attachment of pollinia on the back of bee. The process of pollination is same in *C. aloifolium* as that of *C. pendulum*. However, only about 25% flowers get pollinated in *C. aloifolium* due to firm attachment of the pollinarium unit with the anther as compared to *C. pendulum*, where it is loosely attached and therefore easily removed by the bee.



Figs. (1-8). Bee Pollination in *Cymbidium pendulum* (Sw.) roxb. 1. Flowers, 2. *Apis melifera* enters to flowers, 3. Bee enter deep which bend column hard to its back, 4. bee loaded with pollinia on the back after coming out, 5. Visit to other flower leads to pollination shown by swelling of column, 6-7. Pollination success evident from crumpled perianth and ovary growth, 8. SEM of Scutellum (back), showing network on back which help the pollinia to attached firmly.

Orchids, in general, suffer from pollinator limitation [30-32]. Thus, knowledge of limitation on reproductive success is important in conservation planning and management of orchids. Finding the difference between supplementary pollinations and natural fecundity is the useful conventional method to establish if there is any pollination limitation in the species. Nevertheless, the pollination requirement, pattern and processes vary among rewarding and non-rewarding (~10,000) orchids in different regions [33].

Conclusion

Pollination success is absolutely the result of plant-pollinator interactions. Study under discussion concluded that the plants can well adapted to the pollinator to complete the act of pollination. The structure of flower plays an important role in pollination process. The pollinators are very intelligent and visit only those flowers where they speculate to get some reward. The little change in structure (colour fade, wilting etc.) in flower can intelligently sensed by pollinator and they prefer to keep away from these flower.

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