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Mini Review

Orchids and Pollination- A Mini Review

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Abstract

The orchids are primarily insect pollinated species, yet a variety of pollinators are reported. The pollinators have a considerable role in the evolution of species biodiversity. They exhibit a mutualistic behaviour with orchid species. The orchids have evolved unique floral architecture to accomplish pollination successfully. The morphological diversity of orchid flowers reflects several adaptations to a wide range of pollinators. In this communication, pollination system in orchids is discussed.

Keywords: Pollination; euglosine bees; insect pollination; orchids; resupination

Introduction

The highly evolved group of flowering plants i.e. angiosperms (87.5% approx.) is predominantly pollinated by animals [1]. Amongst them, the monocotyledonous family - Orchidaceae, displays special connection with pollinators due to the structural design of their flowers. Orchid flowers show bilateral symmetry and have perianth. The tepals of the outer whorl has three sepals which are symmetrically arranged in an alternating fashion with three inner whorl of petals. Among these whorls, the posterior petal of the inner whorl, gets modified into a variety of shapes and called as lip or labellum. It bears fringed, wavy structures or sometimes covered with some hairy outgrowths. Architecturally, being highly attractive, the labellum fascinates insect pollinators by providing a landing surface to them [2]. In orchid species, the pollinia which remain agglutinated are packed into a waxy mass which remain attached to the tiny tacky thread like structure known as viscidium. The pollinators clutch the viscidium to collect pollen. The orchid flowers also possess column [3]. These flowers have set limits for cross – pollination to occur by developing a tissue called rostellum in between pollinia and stigma. The family orchidaceae proves itself as one of the excellent examples of analyzing such evolutionary behaviour.

To facilitate pollination, the orchid species of diverse habit and habitats have evolved a special mechanism to accomplish pollination which is resupination. In this phenomenon twists the 'lip' below the other two petals of inner whorl twists to 180o, thus, providing a platform for a pollinator to land on the flower. The phenomenon of resupination is the most characteristic of family orchidaceae. The orchids species are pollinated by many other members of diverse families of ants, bees, moths, wasps, butterflies, nectar-drinking flies, sphinx, humming birds, and African sunbirds.

Economic importance of orchids

The orchids, besides being famous for their medicinal value, are floriculturally important as well. In world's floriculture industry, they occupy top position among the other cut-flowers and fetch substantial amount of revenue in the floriculture business. The floriculturally important orchids are *Aerides odoratum, Arundina graminifolia, Cymbidium aloifolium, Dendrobium species, Dendrobium chrysanthum, Paphiopedilum venustum, Paphiopedilum spicerianum,Paphiopedilum insingne, Renanthera imschootiana, Rhyncostylis retusa, Rhyncostylis gigantea, Thunia alba, Blue Vanda, Vanda cristata* etc. Apart from being floriculturally important, the orchids also possess medicinal value. There are evidences in Indian

and Chinese literature which mention the medicinal importance of orchid species. The orchid herbs for instance *Malaxis muscifera, M. acuminata, Habenaria intermedia* and *H. edgeworthi* are used as ingredients to prepare ayurvedic tonic 'chyavanprash' [4]. Orchids also synthesize certain biochemically active chemical compounds which show anti-inflammmatory, analgesic and astringent activity.

These are collected ruthlessly from their wild habitats. Their regeneration is extremely low in their wild habitats. As a consequence, they have become rare, endangered, and threatened and been enlisted in the category of RET plant species prepared by Convention on International trade in Endangered Species if Wild Fauna and Flora CITES [5] along with other plant species. Several other factors also integrate up to the unremitting decline in their wild inhabitants. One of the factors appear to be clearing of forests which are shelter to a variety of insects and bees pollinators. Loss of their pollinators, particularly bees, has direct effect in reducing their population in natural habitats. Therefore, for continuous survival of orchid species in nature, the availability of pollinators is necessary to accomplish pollination.

Pollinators, deceptive mechanisms and reproductive success

Orchids are mainly entomophyllous species and exhibit exclusive relationship and deceptive mechanisms with their pollinators. Almost, 700 species of orchids develop optic and olfactory adaptations to fascinate male bees. Various other characteristic features such as colour, phenology and floral scent are extremely advantageous to accomplish pollination [6]. The orchids are cross-pollinated by bees, flies, moths, butterflies, wasps and ants. Among these pollinators, the most common pollinator of orchids are euglossine bees of tribe euglossini. These are also known as orchid bees or corbiculate bees. They belong to sub-family Apinae. These euglossine bees are solitary creatures, but some of them are communal and exist in advanced form of animal sociality. The tribe euglossini has genera such as, *Euglossa, Eulaema, Exaerete,* and *Aglae*. *Eulaema* are also called as carpenter bees or bumblebee queen bees. Phenotypically, these bumblebee queens are dark coloured and bear dense hairs, with thick yellow, orange or greenish stripes on their abdomen part. All other species of this tribe except *Eulaema* show distinctive luminous metallic green, blue or gold coloration (https://en.wikipedia.org/wiki/Euglossini). The labellum of the genus *Ophrys* flower imitate the body of a female bee which have glistering hairs on their body that attracts its pollinator bee. When male bee lands on labellum of the flower, it intends to copulate with the visited flower. During this process, the pollinia, automatically, gets placed over the head of the insect. Now, the gathered pollinia gets deposited on to the next flower when bee visits for it again and accomplishes pollination. *Oncidium henekenii* resembles with female bee to attract male bee as a pollinator. A variety of orchid species are pollinated by flies or carrion flies. *Bulbophyllum* species emits a characteristic odour simulating rotting meat that attracts male *Bactrocera* species. This smell is due to a secretion of a chemical compound- methyl eugenol. The orchid species pollinated by bees and flies have short floral spur with globose viscidia. These viscidia are present in terminal rostellum. When a bee pollinator visits an orchid flower, these viscidial threads stick to the eyes, face and thorax of the pollinator bee. A few orchids for instance *Ophrys holoserica* and *Ophrys insectifera* possessing a long floral spur with plate-like viscidia are exclusively pollinated by lepidoptera species and birds [7]. The viscidia threads gets attached to the probosis of pollinator bees taken to the next flower when bee visits it. Certain orchid species imitates the oviposition sites of pollinators like carrion, and deceits the insects, who are in want of place to lay their eggs. This type of deception mechanism is only found in the orchid species of the tropical and subtropical areas and it is entirely absent in European species [8]. Certain reports are available in literature which reveals that orchids mimic fruiting bodies of basidiomycetes as well. For instance, the genus *Dracula* possesses fungus-shaped lip with fishy scent [9]. However, the majority of the orchid flowers are non-rewarding to their visitor bees because they do not contain nectar, yet they are able to deceive their insect pollinators [8]. The orchid species, which are non-rewarding to their pollinators, successfully develops various mechanisms such as food, sexual deception, and specifically mimicing the pollinating bees to attract their specific pollinators [10]. Out of these reported deceptive pollination mechanisms, the food and sexual deception are usual. Some of the species such as Polystachya develops deceptive morphological markers like false anthers or pseudopollens to attract their specific pollinators [11], *Eria maxillary* [12] and *Dendrobium* species, *Glosssodia, Elythranthera* [13]. Another deceptive morphological marker such as brightly coloured tuft of hairs is also developed by Arethusa bulbosa, Calopogon tuberosus, Cephalanthera longifolia, and Pogonia ophioglossoides (snake mouth orchid) to attract hunter bees. The pollinators also visit orchid flowers to gather protein and starch from rich labellar papillae and trichomes [14]. The orchid blossoms also mimic female insects and emanate mating signals like pheromones in sexual

deception [15]. These chemical signals are detected by the antennae on their head, which have diverse shapes and sizes in different species, and they also distinguish between male and female insects [16,17]. Insects use chemo-receptors (olfactory sensilla) on their antenna to receive and recognize pheromonal signals.

Advantage of floral deception

The advantage of floral deception appears to be maximizing pollination in orchid species without giving any incentive to its pollinator. Most of deceptive orchid species magnetize their specific pollinators through imitating sex pheromone of receptive female bee species. The male bees get attracted to copulate the flower by landing on labellum / lip. This floral deception provides fitness advantages to orchids. As an evidence to floral deception two hypotheses are indicated. First is the resource-limitation hypothesis, which helps in reallocation of the resources [18] and second hypothesis is out-crossing hypothesis, according to which, floral deception promotes out-crossing due to large number of flowers [19].

Conclusion

The species of family Orchidaceae show exceptional behaviour towards its pollinators due to non-rewarding nature of many orchid flowers. They display sexual and food deception to attract their pollinators. To achieve such deception, the orchid flowers have evolved a number of special structural features. Such morphological modifications and pheromone secretion in orchid flowers help them to attain success in pollination. These floral characteristics represent strong evidences towards evolution. Thus, for the conservation of medicinally and floriculturally significant orchid species, there is urgency to conserve our ecosystem, the orchid species and their specific pollinators in nature.

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