International Journal of Research and Review
www.gkpublication.in E-ISSN: 2349-9788; P-ISSN: 2454-2237

Review Article

Orchid's Extravaganza - an Old Wives Tale

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ABSTRACT

Orchids are undoubtedly the most diversified flowering plants. Many of them possess most stunning and elegant blooms that are beyond our imagination. The fascinating intricate beauty of flower in the form of colouration and dramatic shapes rarely matched in the world of flora. Several orchids have adopted different forms of mimicry and baroque pollination strategies. For these they have employed different ingenious and seemingly improbable mechanisms of deception. In this presentation the different types of mimicry adopted by orchids and the smart deceptive beauties are discussed with an aim to generate an interest to all nature lovers about the dizzying diversified world of orchids.

Key words: Orchids, Mimicry, Deception, Pseudocopulation.

INTRODUCTION

Orchidaceae is the fantastically diverse family of flowering plants that employ many fascinating forms of mimicry (i.e., similarity of one species to another) and equally diverse pollination biology. The secret of the astounding diversity of orchids is simply deception (i.e., deliberate employment of trickery aiming to induce misperception). Production of sweet fragrance to attract bees, rancid smell to lure flies, providing stealth, nectar, possessing striking colours are the usual means of orchids for attracting pollinators. But roughly one third of orchid species do not offer conventional food rewards to the pollinators, they evolve themselves with a clever deceit involving visual, aromatic, tactile or all three at once; but perhaps the most interesting of all is offered by those orchids that hold out the promise of sex (really weird sex!). Some of the most specialized orchids through uncanny resemblance with other animals became the center of attraction to researchers for several years.

A sincere approach has been taken to tell an old wives tale of orchid's extravaganza about the deceptive beauty and different types of adopted mimicry along with some amazing examples and brief introductory notes with an aim to revisit the incredible diversified world of orchids and to realize how clever and smart plants the orchids are in reality!

Types of mimicry adopted by different orchids:-

A) Directly for reproductive purpose - where the actions of dupe directly aid in the mimic's reproduction by possessing deceptive flowers that do not provide the reward they would seem to. The flowers falsely advertise the presence of food by its bright colours and sweet scents, thus limiting the ability of pollinator's learning to avoid non-rewarding members.

1) Dodsonian mimicry (After the name of Calaway H. Dodson) - Includes cases where the model belongs to a different species than the mimic. By providing similar sensory signals (like morphology, colour, smell) as the model flower

(rewarding species), it (deceptive species) can lure its pollinators, but no reward (nectar/oil) is provided i.e., the orchids employ the strategy of food deception by taking the advantage of a pollinator's innate sensory biases or tendency to associate a specific perceptual cue with food.

Examples –

(i) The orchid *Epidendrum ibaguense* (do not have any nectar) resembles (Fig.1A) nectar bearing flowers of *Lantana camara* (Fig.1B; Verbenaceae) and *Asclepias curassavica* (Fig.1C; Asclepiadaceae), and thus get pollinated by Monarch Butterflies and perhaps hummingbirds that can't discriminate between the apparently similar flowers. [1]

(ii) The rewardless orchid *Tolumnia guibertiana* resemble (Fig.1D) the oil producing yellow flowers of *Stigmaphyllon diversifolium* (Fig.1E; Malpigiaceae) and *Ouratea agrophylla* (Fig.1F; Ochnaceae) and are pollinated by an oil gathering female bee (*Centris poecila*). [2]

(iii) The food-deceptive orchid *Traunsteinera globosa* resemble (Fig.1I) the rewarding species of *Knautia* (Fig.1G) and *Scabiosa* (Fig.1H) of Dipsacaceae and *Valeriana (*Fig.1J) of Caprifoliaceae family. Jersáková *et al.* [3] showed that both naive and experienced insect species approach the orchids at the same rate as in the other three genera.

(iv) In green-veined or green winged orchid (*Anacamptis morio*) the flower produces a scent that attracts the plants main pollinator queen bumblebee – which associate the odour with nectar; although, in this case the scent profile is different from the rewarding species (*A. coriophora*) and the amount of scent emission was lower than the rewarding species. [4]

In the first three examples the similar signals are in terms of morphology and colour of flower but in the last example it is in terms of smell of flower.

Food-deceptive orchids usually bear with low reproductive success than their rewarding counterparts due to limited pollination, [5-6] but absence of competition of pollinators in such orchids, relying on mimicry etc. ensure sufficient pollination rate. Reproductive success of food-deceptive orchids also varies according to the characteristics of rewarding co-flowering species. Early-flowering deceptive orchids get additional benefit from a higher average density of naive pollinators [7] and from lower competition with rewarding co-flowering species. [8] Kindlmann and Jersáková [9] showed that the peak of flowering of deceptive orchids occur earlier compared to that of rewarding orchids. Interestingly starting date of flowering is more relevant than the flowering peak – the most successful individuals usually start to flower before their population's flowering peak. [10]

2) Pouyannian mimicry (After the name of Maurice Alexandre Pouyanne) – In this case a flower mimics a female of a certain insect species, whose males try to copulate with the flower, thus pseudocopulation occurs i.e., the orchids take the strategy of sexual deception. Regardless of this occasional eureka moments the system persists. By this way orchids may account for around 60% of pollinations.

Examples –

(i) The labellum of nearly all of the about 300 species of *Ophrys* flower acts (Fig.1K) as a dummy female of a species of bee or wasp (depending on the species of *Ophrys*), the males visit the flower and try to copulate with the flower; during pseudocopulation (Fig.1M) it acquires the gobbet of pollens and subsequently transmits them to other blossoms. [11-15]

(ii) More than 30 species of the genus *Chiloglottis* are pollinated [16-18] by thynnine wasps of the genus *Neozeleboria* by pseudocopulation (Fig.1N).

(iii) Australian tongue orchid (*Cryptostylis leptochila*) which bears a sufficient resemblance to the female of the ichneumon wasp *Lissopimpla semipunctata* to induce male wasp for pseudocopulation. [19-20]

(iv) The labellum shape and indument of *Mormolyca ringens* are reminiscent of an

insect. Sexually excited drones of *Nannotrigona testaceicornis* and *Scaptotrigona* sp. attempt copulation with the labellum and pollinate the flower in the process. [21]

(v) *Drakaea glyptodont* (Fig.1L), an endangered genus native to Australia being pollinated by pseudocopulation only with the thynnine wasp *Zapilothynnus trilobatus*. The males of this wasp species are sexually attracted to the orchid first by a scent that mimics the female wasp pheromone, [22] then at short range by the visual similarity of the orchid labellum to the female wasp's abdomen. [23]

In all the cases sexual deception is very specific – each orchid attracts only one or very few insect species. [18,24] So in appealing to sex, these orchids limit their potential pollinators, which would seem to be a reproductive disadvantage. Despite the apparent drawback, sexual deception has evolved several times in different orchids. In most of the cases floral scent, which mimics the sex pheromones of female insect, has been suggested to be the main attractant of pollinators. [22,25-28] Bower and Brown [18] were of opinion that in both *Ophrys* and *Chiloglottis*, floral scent composition is driven towards their pollinators' preferences in both quantity and quality. In few cases the odour of the flower is a more potent attractant for the male than that of the appropriate female. [29]

Advantage of orchids to avoid a simple nectar reward mechanism and rely on elaborate pollination mechanism –

Firstly, the sexual frustration of a deluded bee resulting from pseudocopulation turns out to be an essential part of the orchid's reproduction strategy. [19] After pseudocopulation, the bee determined not to do the same mistake again and travel a distance and then a ways off may involve in pseudocopulation again (!) with an orchid that may have 'subtle variation' in appearance as well as in smell. Thus the bee cannot learn not to fall over a flower again and the orchid ends up with success in trickery deception.

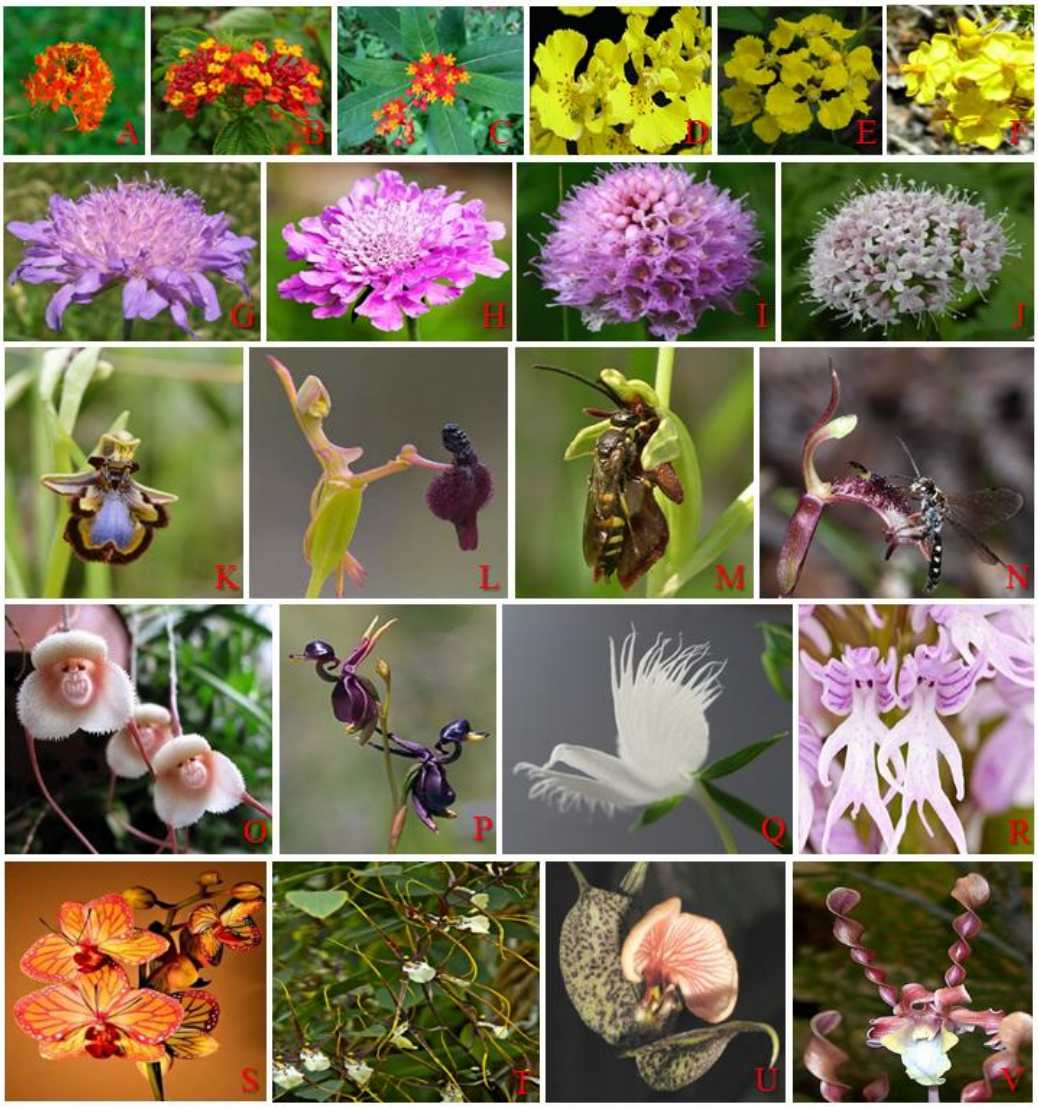
Secondly, nectar besides being metabolically expensive for the flower to produce is liked by so many different animals which comes to flower for the nectar and may often cause a loss of pollen by not delivering it to a right target. Producing floral odour with only a little variation, orchids develop relationship with a single, highly devoted pollinator which can insure more precise delivery to the actual target. [19] Specializing with one pollinator and appealing to it with sex, lead to less precious pollen lost in the transport process and the orchid may avoid clogging of stigmas with other non-compatible pollen and subsequently show high pollination efficiency. [30]

Variation in floral traits in deceptive orchids may be adaptive for the plants, as it may delay the avoidance learning of the pollinators. [7] Moreover, variation in the chemistry of floral scent can function as much as geographic isolation does in the creation of new species.[19] Pollinator shift through changes in floral scent can provide a mechanism for pollinator driven speciation in orchids. [31]

For the tongue orchid (*Cryptostylis sp.*) the sexual deception is beyond the pseudocopulation. The wasp, in the throes of its misguided sexual exertions, actually ejaculates onto the flower and thus waste copious sperm – the height of maladaptive behavior. [19] Gaskett *et al.* [32] showed that this orchid species provoking such extreme pollination behavior have the highest pollination success. It is found that the wasp is a haplodiploid species – it can reproduce with or without sperm. With sperm, they produce usual ratio of male and female offspring, without sperm they produce only male offspring. By inducing wasp to waste sperm on flowers, tongue orchid results in more male population than female, thus increases the competition in male for females, which leads the desperate wasps less picky in their choice of mates and thus much more likely to fall for a flower. [19,32]

B) For defensive purpose (some indirectly aid in reproduction) – In this type orchids

are able to avoid encounters that would be harmful to them by deceiving enemies into treating them as something else.



Figs. 1 (A-V). Flowers of: A- *Epidendrum ibaguense*, B- *Lantana camara*, C- *Asclepias curassavica*, D- *Tolumnia guibertiana*, E- *Stigmaphyllon diversifolium*, F- *Ouratea agrophylla*, G- *Knautia arvensis*, H- *Scabiosa columbaria*, I- *Traunsteinera globosa*, J- *Valeriana montana*, K- *Ophrys speculum*, L- *Drakaea glyptodon*; pseudocopulation of: M- *Ophrys insectifera* and male *Argogorytes mystaceus*, N- *Chiloglottis trilabra* and male *Neozeleboria proxima*; O- *Dracula simia*, P- *Caleana major*, Q- *Habenaria radiata*, R- *Orchis angusticruris*, S- *Phalaenopsis nivacolor*, T- *Bratonia toscana*, U- *Dracula chesterotonii*, V- *Dendrobium helix*.
(All the photos are taken from www.google.co.in)

1) Batesian mimicry (After the name of Henry Walter Bates) – Here mimic poses themselves as something else (stranger or stronger or dangerous) than they actually are.

Examples –

(i) *Dracula simia* – commonly known as Monkey faced orchid as the flower looks (Fig.1O) like a face of monkey. The plant smells like a ripe orange when fully blossomed. Small monkeys sometimes try to copulate with this orchid.

(ii) *Caleana major* - commonly known as flying Duck orchid as the flower looks (Fig.1P) like a flying duck. It is a small orchid and pollinated via male saw flies. When the insect touches the labellum, it quickly snaps shut trapping the saw fly; upon release it carries the picked up pollen to the next orchid it visit.

(iii) *Habenaria radiata* – commonly known as flying Bird orchid. The flower resembles (Fig.1Q) to the white garnet, spreading its

fluffy white wings and is ready to take off. It is pollinated by moth and butterfly.

(iv) *Phalaenopsis nivacolor* – commonly known as Moth orchid as the flowers resemble (Fig.1S) moths in flight. They might attract insect or other animals that look out for moth and get pollinated by them or through male moth itself by pseudocopulation.

(v) *Bratonia toscana* – commonly known as Spider orchid – the spiky leaves resemble (Fig.1T) a spider to attract spider eating wasps which then end up pollinating the orchid.

(vi) *Orchis angusticruris* – commonly known as Man orchid – It is a hybrid orchid (*O. purpurea* × *O. simia*). The petals look (Fig.1R) like a man.

(vii) *Dracula chesterotonii* – commonly known as Mushroom orchid as the labellum resemble (Fig.1U) the gilled surface of an agaric mushroom. The physical likeness is paralleled by mushroom like scents. The small fly genus *Zygothrica*, which accomplish their mating by elaborate courtship dances on mushroom, are attracted by this orchid, where pollen rubs onto the thorax. Travelling to another flower complete the pollen transfer.

(viii) *Dendrobium helix* - A large to giant sized, hot growing epiphyte. The flowers are variable in colour from green to pink but all have very strange flowers (Fig.1V) with petals and sepals that are heavily curled and twisting carried on flower spikes up to 2 feet long, which provide a landing place for pollinators.

There are many more Orchid genus that looks like different other entities.

CONCLUSION

The remarkable diversity of orchid species with spectacular floral forms showing mimicry is a wonder of nature and it opens up a huge area of research.

ACKNOWLEDGEMENT

The author has no pretension to expertise in this vast field, nor do claim an exhaustive treatment of the topic. It is an attempt from the keen interest to compile the information available in various resources according to author's own thinking. So, the author is grateful to all the scientists referred in this article.

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How to cite this article: Paul R. Orchid's extravaganza - an old wives tale. International Journal of Research and Review. 2017; 4(1):1-6.

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