



## REVIEW ARTICLE

# ORCHIDS GENETIC DIVERSITY FOR BLOOMING FLORICULTURE INDUSTRY

P. KARUPPAIAH\*

Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar 608 002, Tamil Nadu, India

### ABSTRACT

India is bestowed with different agro-climatic conditions and soil. This makes the country particularly suitable for growing a wide variety of horticulture crops especially flowers. Among the flowers, the orchids represent a fairly young, highly diverse, and successful family of flowering plants, the Orchidaceae. It is still in an active state of speciation. Some of their botanically significant features are presence of intricately fabricated and long-lasting flowers. The numerical strength of orchids, in terms of species have been variously assessed between 17,000 and 35,000. The orchids are in cosmopolitan in distribution. *Rhizanthella gardneri* and *R. slateri* are subterranean in habit and *Corallorrhiza innata* a rootless parasite. The orchids are essentially out breeders, having adapted to insect pollinations. India with a vast geographic expanse and climatic ones ranging from tropical to temperate, supports a rich diversity of flora. The orchids have naturalized here in great profusion; the North Eastern, the Himalayan, and the Peninsular regions (on the main land) and the Andaman and Nicobar region (off shores) are the major orchid habitats in the country, while the occurrence of nearly 1100 species in 157 genera are representing all the major orchid tribes. Efforts have been made to evolve strategies for ensuring the survival and maintenance of genetic diversity that still exists in these plants. In this connection, one need not overstress the importance of orchid breeding. Unfortunately, orchid breeding is still in infancy in the country. Now, there is a need to improve floriculture breeding to reduce the foreign exchange for good quality planting materials. Hence, it is important to explore the orchid wealth of the country. Important floriculture traits, geographical distribution and utility of orchids will also be discussed at length. Further, there is a need to create suitable varieties to different agro-climatic horticultural system and socio-economic condition. Since floriculture trade and consumption are increasing rapidly worldwide, there is a blooming opportunity for India to achieve better growth in its production and export due to presence of high amount of diversity in indigenous orchids flora, thus earning valuable foreign exchange through florist trade, nursery of plant saplings, potted plants, bulb and seed production, micro-propagation and other value added products of orchids.

**Keywords:** Orchids, Orchidaceae, Genetic Resources, Speciation, Genetic Diversity, Orchid breeding, Floriculture

### INTRODUCTION

The orchids are primarily grown as ornamental plants; they are popular with the professionals and hobbyists for their fascinating flowers and botanically interesting features. In fact, it is difficult to escape the magical spell of their mysterious flowers after a visit to an orchidarium during the flowering season. Some of them even enjoy a national flowers status e. g *Cattleya trianaei* (Columbia), *C. skinneri* (Costa Rica); *Peristeria elata* (Panama), *Dendrobium marcenthae* (Srilanka), *Vanda* 'Miss Joaquim' (Singapore), and *Lycaste virginallis* (Guatemala). The orchids are also rich in secondary metabolites [1, 2]. *Vanilla planifolia* and related species, source of 'vanillin', are the spice orchids cultivated as plantation crops.

#### Orchids diversification and speciation

The orchids represent a fairly young (geologically), highly diverse, and successful family of flowering plants, the Orchidaceae, which has outsmarted and outnumbered its counterparts by evolving ingenuity and higher levels of

specialization in both the vegetative and reproductive traits. Some of their botanically significant features are presence of intricately fabricated and long-lasting flowers; suppression of endosperm development; production of numerous and microscopic seeds with undifferentiated embryos; formation of a characteristic organoid, the protocorm, during early stages of seedling development. The numerical strength of orchids, in terms of species have been variously assessed between 17,000 and 35,000 [3,4,2]. Atwood [5], suggests that one in every 15 species of flowering plants is that of an orchid. The orchids are in cosmopolitan in distribution. *Rhizanthella gardneri* and *R. slateri* are subterranean in habit and *Corallorrhiza innata* a rootless parasite. The saxatilis habit, on the other hand, is an extension of both the terrestrial and epiphytic habits [6]. Incidentally the orchids serve as excellent indicators of environmental degradation [2].

The Orchids are essentially out breeders, having adapted to insect pollinations. The barriers of reproductive isolation are weakly developed to favour free gene-flow,

Received 11 February 2017; Accepted 28 December 2017

\*Corresponding Author

P. Karuppaiah

Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar 608 002, Tamil Nadu, India

Email: vpkhortic@yahoo.com

©This article is open access and licensed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>) which permits unrestricted, use, distribution and reproduction in any medium, or format for any purpose, even commercially provided the work is properly cited. Attribution – You must give appropriate credit, provide a link to the license, and indicate if changes were made.

across the taxonomy limits, within and between most of the genera. The hybrids (interspecific to plurigeneric) are fertile enough to suggest that speciation (in orchids) has probably been restricted to genic level with chromosomal repatternings being held to a minimum of their number 77,400 [7] far exceeds that of their described species. Their reproductive isolation barriers, however, tend to get variously strengthened, due to highly specific pollination mechanism, in several species belonging to the *genera Catasetum, Cryptochillus, Oncidium, Ophyrus, Oorchis, and Gangora*; accidental pollinations between species are avoided because their flowers excellently mimic females of certain specific insects and lure the male insects to satisfy their pollination requirements through pseudocopulation.

**Rich diversity of orchids flora in India**

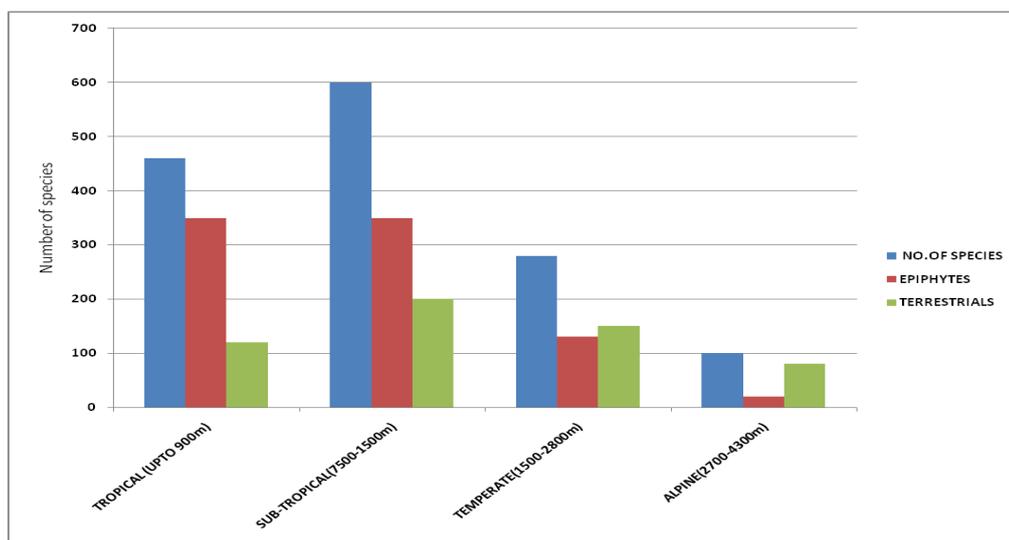
India with a vast geographic expanse and climatic ones ranging from tropical to temperate, supports a rich diversity of flora. The orchids have naturalized here in great profusion; the North Eastern, the Himalayan, and the Peninsular regions (on the main land) and the Andaman and Nicobar region (off shores) are the major orchid habitats in the country (Fig.1). While an exact estimate of the total orchid wealth in the country (in terms of the species and genera) awaits botanical explorations in several virgin forests in the above mentioned regions, the occurrence of nearly 1100 species in 157 genera representing all the major orchid tribes Apostasiaceae, Cypripidiaceae, Neottieae, Orchideae, and Epidendreae have so far been authenticated. A majority of these species (60%) are

epiphytic/saxatilis in habit and as many as 35 saprophytic in nature. Dendrobium (106 species) and Habenaria (75 species) respectively are the largest genera with epiphytic and terrestrial habits. Besides them, *Aerides, Arachnis Bulbophyllum, Calanthe, Coelogyne, Cymbidium, Cypripedium, Dactylorhiza, Papiopedilum, Papilionanthe, Phalaenopsis, Pleione, Renanthera, Rhynchostylis, Thunia, Vanda* and *Vanilla* are among the important genera represented in the country. Interestingly as many as 12 monotypic genera are also met with in the country. Moreover, nearly 300 species in 75 genera including the monotypic *Didicea, Proteroceras, and Risleya* are endemic to India [8, 3, 4, 2]. Such a high degree of endemism suggests that the country has been an active centre of orchid speciation. In this connection, it is worthwhile to mention that most of the endemics are actually incipient species which do not get time to spread due to a high rate of evolution. The number of total and endemic species, in the major orchid habitats, is given in table 1. and it appears the richness of species diversity has been at its maximum in the North-Eastern and the Himalayan regions whereas the endemism has been most pronounced in the Peninsular region. The qualitative abundance of orchids, in these regions, may be attributed to large scale mutations (resulting through frequent seismic activity), successful wide matings (promoted due to the proximity of several immigrant taxa from the adjoining regions of Bhutan, Burma, China, Nepal, Sri Lanka, Tibet etc.), and congenial growth conditions (thick vegetation, high humidity) as has already been suggested by Joseph [9] and Rao [8].

**Table 1: The number of total, endemic, threatened and extinct species in major Indian orchid habitats**

Orchid habitat(region)	Number of species			
	Total	Endemic	Extinct	Endangered
Andaman and Nicobar islands	87	15	2	2
Central India and Gangetic plains	35	-	-	-
Eastern India	120	5	-	8
North-Eastern India	650	86*	18	54
Eastern Himalayas	625	105*	14	36
Western India	5	-	-	-
Peninsular India	250	113	5	38
Total	1076	302	30	147

\*Some of species overlap in these regions.



**Fig. 1: Distribution pattern of orchids in India (climate wise)**

**Native orchids with proven floriculturl traits**

The rich diversity of Indian orchids is being increasingly realized [10,11,12,2]. A large number of species, particularly in the genera *Arachnis*, *Ascocentrum*, *Cymbidium*, *Dendrobium*, *Paphiopedilum*, *Phalaenopsis*, *Phaius*, *Renanthera*, *Rhynchostylis*, *Vanda*, etc., are source of incalculable aesthetic pleasure (table 2).

Many of orchids, e. g., *Aerides multiflorum*, *A. odoratum*, *Ascocentrum ampullaceum*, *Cymbidium dayanum*, *C.*

*devonianum*, *C. eburneum*, *C. elegans*, *C. grandiflorum*, *C. lowianum*, *C. tracyanum*, *Dendrobium aggregatum*, *D. chrysotoxum*, *D. formosum*, *D. nobile*, *D. primulinum*, *Doritis pulchherinum*, *Paphiopedilum fairrianum*, *P. insigne*, *P. venustum*, *Papilionanthe teres*, *Phalaenopsis manni*, *P. perishii*, *Renanthera imschootiana*, *Rhynchostylis retusa*, *Vanda amesiana*, *V. coerulea*, *V. coerulescens*, *V. parviflora*, and *V. tessalata* have been extensively used as progenitors of high-profile and internationally acclaimed hybrids [11, 13, 4, 2].

**Table 2: Some floriculturally important species and their floral characters**

Species	Flowers		Diameter (cm)	Longevity (weeks)
	Period	Color		
<i>Aerides multiflorum</i>	Apr	White flushed purple	2	4
<i>A. odoratum</i>	May-Jun	White with purple blotches	2	4
<i>Arachnanthe cathcartii</i>	Mar-Apr	Pale yellow with brown bands	10	4
<i>Ascocentrum ampullaceum</i>	Mar-May	Pink	5-7	4
<i>Calanthe tricarinata</i>	Apr-Jun	White with purple lip	2.5	1-2
<i>Cymbidium eburneum</i>	Mar-Apr	Ivory white	3	3
<i>C. elegans</i>	Oct-Nov	Straw yellow	5	4
<i>Dendrobium chrysanthum</i>	Jul-Oct	Bright yellow	2.5	1-2
<i>D. chrysotoxum</i>	Apr-May	Golden yellow	5	3
<i>D. densiflorum</i>	Mar-May	Butter yellow	5	1
<i>D. fimbriatum</i>	Mar-May	Orange yellow	7.5	1
<i>D. heterocarpum</i>	Apr	White	5	2
<i>D. nobile</i>	Apr-May	White tinted with amethyst	10	4-8
<i>D. regium</i>	Apr-Jun	Rosy red	7.5	3.4
<i>D. wardianum</i>	Feb-Mar	White tipped with magenta	10	4-8
<i>Paphiopedilum fairieanum</i>	Oct-Jan	Greenish-violet	12.5	8-10
<i>P. hirsutissimum</i>	Feb-Mar	Deep purple with Green	12.5	7
<i>P. villosum</i>	Nov-Feb	Brownish yellow	15	18
<i>Phaius tankervilliae</i>	Mar-Apr	White shaded with red	12	4-5
<i>Phalaenopsis manni</i>	May	Yellow with brown markings	4	9
<i>P. speciosa</i>	Feb-Apr	Amethyst purple with pale margin	5	8-10
<i>Renanthera imschootiana</i>	May-Jul	Red	6	4
<i>Rhynchostylis retusa</i>	Jun-Jul	White with purple spots	1.5	4
<i>Vanda coerulea</i>	Oct-Feb	Pale lavender blue	10	4-6
<i>V. teres</i>	May-Jun	Rose	10	4

It may not be out of place to mention that majority of Indian orchids flower during, March-May and September-November, but there is hardly a time when one or the other of their species is not in bloom [2,4]. Jain [14]

prepared a flowering calendar of some of the more common genera with ornamental species (table 3), whereas Kataki and Abbas [15] presented similar details for some ornamental species from North-East India.

**Table 3: Flowering calendar of some commercially important Indian genera of orchids**

Month	Genus
January	<i>Arachnanthe</i> , <i>Cymbidium</i> , <i>Paphiopedilum</i>
February	<i>Dendrobium</i> , <i>Eulophia</i>
March	<i>Coelogyne</i> , <i>Phaius</i> , <i>Eulophia</i>
April	<i>Rhynchostylis</i> , <i>Vanda</i> , <i>Paphiopedilum</i> , <i>Coelogyne</i>
May	<i>Aerides</i> , <i>Dendrobium</i>
June	<i>Dendrobium</i> , <i>Renanthera</i> , <i>Phaius</i>
July	<i>Arundina</i> , <i>Dendrobium</i> , <i>Calanthe</i>
August	<i>Arundina</i> , <i>Dendrobium</i> , <i>Calanthe</i>
September	<i>Vanda</i> , <i>Paphiopedilum</i>
October	<i>Vanda</i> , <i>Cymbidium</i> , <i>Coelogyne</i>
November	<i>Cymbidium</i> , <i>Paphiopedilum</i> , <i>Pleione</i>
December	<i>Paphiopedilum</i>

### Conservation of native orchids

Ever since suggestions were made to vigorously protect and preserve the orchids and their habitats [16,17,11,13,4,2], the problem of orchid conservation has been discussed at various national and international fora. Efforts have been made to evolve strategies for ensuring the survival and maintenance of genetic diversity that still exists in these plants. However, keeping in view a reasonable land use policy for agriculture and forestry, the orchid conservation needs to be considered as a by-product and rational use-cum-conservation of forests. Conforming to some of these strategies, the Government of India has already banned the export of orchids collected in wild, and has taken steps to protect orchid-rich habitats by creating Biosphere Reserves/National Parks in certain selected areas in Assam, Arunachal Pradesh, Uttar Pradesh, Kerala, etc. The efforts have, however, not been commensurate with the dimensions of the problem. The Botanical Survey of India, the apex organization concerned with the plant resources and their conservation, has brought a large number of rare and threatened species under cultivation at the three national orchidaria, at Howrah, Shillong, and Yercaud. Such efforts are also being made at orchidaria/botanical gardens attached to some Universities and Research Institutes. It is, however, distressing to note that most of the sanctuaries and orchidaria, at present, are the consumers rather than the multiplication centers of native species. At present, orchids are collected characterized, evaluated, documented and maintained at National Research Centre for Orchids, ICAR, Pahyong, Sikkim.

Consequently, mass propagation, through conventional and tissue culture techniques, is expected to emerge as an important strategy to save their natural populations from commercial collection pressures. In this connection, one need not overstress the importance of orchid breeding. Almost all the orchids sold as cut-flowers and potted-plants are hybrids. Moreover, the hybrids are much easier to cultivate than the wild species from which they are derived and can release pressures on the increasingly endangered natural species by satisfying the commercial demands for orchids [2,318-21]. Unfortunately, orchid breeding is still in infancy in the country.

### CONCLUSION

Orchids, owing to its breath taking beauty, an array of size and shape beyond human imagination, share 10-15% of world floriculture trade. Awareness about the beauty and utility of orchids though increasing, the commercial exploitation is still far from its potential. Though India is the center of origin for many orchids and has rich genetic diversity, the research contribution to orchids improvement is very meagre when compared to developed countries. The reason being, much importance was not given for floriculture crops in India. Now, there is a need to improve floriculture breeding to reduce the foreign exchange for good quality planting materials. Hence, it is important to explore the orchid wealth of the country. Important floriculture traits, geographical distribution and utility of orchids will also be discussed at length in different fora. Further, there is a need to create suitable varieties to different agro-climatic horti-silvi system and socio-economic condition. It is also important to generate awareness among the growers, traders and the consumers

on the orchid resources. Innovative breeding programmes to cater the need of cut flowers, high value potted plants, species trade and other floriculture needs are very much essential for the benefit of Indian floriculture.

### REFERENCES

1. Arditti, J. 1992. Fundamentals of Orchid Biology. John Wiley and Sons, Inc., New York.
2. Rajeevan, P. K., P. K. Valsalakumari, C. K. Geetha and P. K. Sudhadevi. 2006. Reflections in Indian Floriculture. Department of Pomology and Floriculture. KAU. Thriuvananthapuram.
3. Chadha, K. L. 1992. The Indian orchid scenario. *J. Orchid Soc. India*, 6: 1-4.
4. Bhattacharjee, S. K. and L. S. De. 2003. Advanced Commercial Floriculture. Aavishkar Publishers and Distributors, Jaipur.
5. Atwood, J. T. 1986. The size of Orchidaceae and the systematic distribution of epiphytic Orchids. *Selbyana* 9: 171-86.
6. Vij, S. P., Shekhar, N., Kashyap, S. K and Garg, A. K. 1983. Observations on the Orchids of Nainital and adjacent hills in the central Himalayas (ecology and distribution). *Res. Bull. (Sci.) Panj. Univ.*, 34:63-76.
7. Freed, H. D. 1979. New Horizons in Orchid Breeding. Day Printing Corporation, Pomona, California.
8. Rao, A. N. 1991. Post-independence additions to the orchid flora of India with a particular reference to Arunachal Pradesh. *J. Orchid Soc. India*, 5(1,2): 29-41.
9. Joseph, J. 1986. Orchids of North-East India and their conservation. In *Biology, conservation and culture of Orchids* (Vij. S. P., Ed.). Affiliated East-West Press, New Delhi.
10. Abraham, A. and Vatsala, P. 1981. Introduction to Orchids. Tropical Botanic Garden and Research Institute, Trivandrum.
11. Bose, T. K. and Bhattacharjee, S. K. 1980. Orchids of India. Naya Prokash, Calcutta.
12. Kaushik, P. 1985. Glimpses of Medical Botany in Atharvaveda (Kand IV). *The Vedic Path*, 48:64-67.
13. Mukherjee, S. K. 1996. Orchids ICAR. New Delhi.
14. Jain, S. K. 1987. Orchids: Gems of mountain flora of India. *J. Orchid Soc. India*, 1 (1,2): 45-49.
15. Katak, S. K. and Abbas, S. L. 1992. Flowering calendar of the North-East Indian Orchids with a special reference to ornamental species. *J. Orchid Soc. India*, 6 (1,2): 109-13.
16. Baade, F. 1960. Gedanken zum Schutze nuserer heimischen orchideen. *Orchidee*, 11:41-44. [Reprint from 'Natur und Landchaft' 34:179-80 (1959)].
17. Warnar, H. H. 1952. Orchid destruction. *Amer. Orchid. Soc. Bull.* 21:97.
18. Hey, G. L. and Hey, M. G. 1966. Raising rare Orchids from seeds. In *Proc. Fifth World Orchid Conf.*, (de Garmo, L. R., Ed.). Long Beach, California (1965).
19. Stewart, J. 1989. Orchid propagation by tissue culture techniques—Past, present and future. In *Modern Methods in Orchid Conservation* (Pritchard, H. W., Ed.). Cambridge University Press, Cambridge.
20. Vij, S. P. 1992. Orchid conservation through tissue culture: Possibilities and achievements. *Proc. Fourth Asia Pacific Orchid Conference*, Chiang Mai, Thailand.
21. Raghava, S. P. S. 2001. Floriculture—a viable diversification option in agri-business. *Indian Hort.*, 44:41-45.