

ORIGINAL RESEARCH ARTICLE

BIODIVERSITY CONSERVATION WITH SPECIAL REFERENCE TO ORCHIDS

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ABSTRACT:

The success of any conservation programme depends upon meticulous supervision of the protected areas. In India, a large population resides in nearby forests areas which are declared as protected areas by the state forest department. Therefore, it becomes necessary to sensitize the local communities about the need to protect the plant species. This could be achieved by conversing with them about the value of plants in our day to day life. This approach would generate their interest in conservation activities by their active participation

KEYWORDS: Biodiversity conservation, Orchids

Biodiversity is a composite word originated from 'biological diversity'

Biodiversity or 'Biological diversity' refers to the variations existing among living organisms (plants and animals) including terrestrial, epiphytic, marine and other aquatic habitats and the ecological composites to which they belong. These complexes include intra-specific (diversity within a species) and inter-specific (between species) variations [1]. The term 'biodiversity' encloses a wide range of variation in all biological life forms with diverse magnitude. The diversity of fauna and flora differs in various habitats, geographical regions and ecosystems. The variety of life exists at every hierarchical level in an ecosystem for instance genes within populations, populations within species, species within communities, communities within landscapes, landscapes within biomes, and biomes within the biosphere [2].

Broadly, the biodiversity is described by three indices as follows:-

1. Alpha (α) Diversity
2. Beta (β) Diversity
3. Gamma (γ) Diversity

Alpha (α) Diversity:

Alpha diversity refers to the species diversity within a habitat or community. It has two components, (a) species richness and (b) species evenness. Occasionally, the dominance of one vegetation layer may affect the α -diversity of the other strata.

Beta (β) Diversity:

Beta diversity refers to the variety in the inter-community diversity, articulating the rate of species turnover per unit alteration in the habitat.

Gamma (γ) Diversity:

Gamma diversity is the totality of the diversity at landscape level holding both α and β diversities. The relationship between α and β diversity is expressed by the following equation:-

$$g = a + bQ$$

Where,

Q = Total number of communities or habitats

a = Average value of α diversities

b = Average value of β diversities

Levels of Biodiversity: Theoretically there are three levels of biodiversity.

These are:

1. Genetic Diversity;
2. Species Diversity;
3. Ecological diversity

Genetic Diversity:

Variation of genes within the species is referred as genetic diversity. This constitutes distinct population of the same species or genetic variation within population or varieties within a species.

Species Diversity:

Species diversity is the variety of species within a habitat or a region. In other words, the total number of species in a region is known as species diversity. Some habitats, such as rainforests and coral reefs, harbour variety of species. Many others, such as salt flats or a polluted stream, have fewer species. For instance, in Australia, there are more than 80% of animal and plant which are endemic to that region which means that they occur naturally only in Australia. According to shared or common features, a large number of species are clustered together into families. It is not just that individual species are endemic; entire families of plants and animals are endemic. The Australian continent embraces maximum number of families of mammals, four of birds and twelve of flowering plants that are endemic. No other country shows as many endemic flowering plant families as Australia.

Ecological Diversity:

The ecological diversity refers to the interaction among different species present in local ecosystem and the dynamic interplay between them, is known as ecological diversity. An ecosystem consists of numerous species living together in a locality that are linked with each other by flow of energy, nutrients, and matter of different species interact with one another.

THE MEGA-DIVERSITY REGIONS IN THE WORLD:

There are seventeen mega-diversity countries which are recognized by the World Conservation Monitoring Centre including Australia, Brazil, China, Colombia, Democratic Republic of the Congo (DRC), Ecuador, India, Indonesia, Madagascar, Malaysia, Mexico, Papua New Guinea, Peru, the Philippines, South Africa, the United States of America (USA), and Venezuela. These countries have sheltered more than 70 % of the earth's species. To introduce diversification in agriculture (horticulture, floriculture etc.) business world over, valuable "gene pool" from these mega diverse regions are meticulously and judiciously utilized.

BIODIVERSITY HOTSPOTS IN INDIA:

India is exceptionally rich reservoir of biodiversity. In our country, floral diversity is mainly concentrated in the four major biodiversity hotspots, the Eastern Himalayas, Western Ghats, North-east India and Andaman Islands (Indo-Burma) and Nicobar Islands.

Bio-geographic Zones in India:

In India, there are 10 bio-geographic zones and 26 biotic provinces identified (Table 1)

Table 1. Bio-geographic Zones in India:

Sr. No.	Bio-Geographic Zones	Biotic Provinces
1.	Trans Himalaya	Tibetan Plateau, Ladakh Mountains
2.	Himalaya	North-west, West, Central and Eastern Himalaya
3.	Desert	Thar Kutch
4	Semi arid	Gujarat Rajputana, Punjab Plains
5	Western ghats	Western Ghats, Malabar Plains
6	Deccan- Penninsula	Central highlands, Central plateau, Chotta-Nagpur, Eastern highlands, Deccan south
7	Gangatic plains	Upper and lower gangetic plains
8	Coast	West and East coast, Lakshadweep
9	North east	North-east hills, Brahmaputra valley
10	Islands	Andaman and Nicobar islands

Total number of plant species in India:

India has only 2% total landmass of the world, still it constitutes one of the most significant biodiversity region in the world. Approximately 2,50,000 plant species are found in the world, out of which India harbours a total of approximately 45,000 species (Table: 2)

Table 2. Total number of plant species:

Plant Group	Number of species*[3]
Angiosperms	15,000
Gymnosperms	64
Pteridophytes	1,022
Bryophytes	2,584
Algae	2,500
Fungi	23,000
Bacteria	850
Lichens	1600

Table 3. Some angiosperm families depicting genus and species

Angiosperm family	Number of Genera and species [4]
Poaceae	263 genera / 1291 species
Orchidaceae	184 genera / 1229 species
Leguminosae	173 genera / 1192 species
Asteraceae	167 genera / 950 species
Rubiaceae	113 genera / 616 species
Cyperaceae	38 genera / 545 species
Euphorbiaceae	84 genera / 528 species
Acanthaceae	92 genera / 510 species
Rosaceae and	40 genera / 492 species
Lamiaceae	72 genera / 454 species

In India, angiosperms comprise of 15,000 species including herbs, shrubs, trees, and climbers, trailers etc. which are grouped into monocotyledons and dicotyledons. The family Poaceae (= Gramineae) is the largest in India being represented by 263 genera containing 1291 species, followed by family Orchidaceae comprising (184/1229) and others [4]. Some of the angiosperm families with their genus and species count is represented in Table – 3.

The Eastern Himalayas encases approximately 8000 species of angiosperms of which 40% are endemic. The flora distinctively comprises of *Rhododendron*, *Alnus*, *Betula*, *Magnolia*, etc. Owing to the humid tropical climate, the Western Ghats is also a major biodiversity enriched area of the country. According to an estimate approximately 4,500 angiospermic flowering plants species occur in the Western Ghats. The Botanical Survey of India (BSI) has enlisted 518 endangered species which are endemic to the Peninsular India and most of them occur in the Western Ghats.

Predominantly, the angiosperm families such as Acanthaceae, Compositeae, Graminae, Labiatae, Leguminoseae, Orchidaceae, and Rubiaceae flourish well in the Western Ghats. Over 200 species of rare orchids are found here. Numerous other plants of economic importance such as banana, rice, black pepper, ginger, etc. grow as dense populations in the Western Ghats.



Figure 1A-D Orchids as cut-flowers and pot plants A. *Vanda cristata*, B. *Vanda coerulea* (a famous blue orchid), *Dendrobium* species, *Coelogyne ovalis*.

Among the monocot angiosperms, the family orchidaceae is a highly diverse group of flowering plants. The orchid are habitat specific and still in an active state of speciation. They are popular for their gorgeous and long-lasting flowers. They are amenable to variety improvement and have added tremendously to the expansion of international trade in cut-flowers and potted plants (Figure 1 A-D).

The orchids are cultivated as a cash crop in various countries. They have carved a niche for themselves among top ten cut-flowers in the floriculture industry in the world. Besides enjoying the status of cut-flowers, the orchids as monocot herbs are also employed as folklore medicine in

different parts of the world, to treat a variety of human ailments. The orchid species are also used as food. They are great ‘nutraceuticals’ since they harbour a variety of phytochemical compounds for instance alkaloids, flavonoids, phenanthrene derivatives, terpenoids, etc. Their bioactive compounds display immune-modulatory, hepatoprotective, anti-carcinogenic, antioxidant and neuroprotective activities. Many orchid species are valuable herbs such as *Angraecum*, *Bulbophyllum*, *Lissochilus*, *Listrostachys*, *Orchis mascula*, *O. maculata*, *Polystachya*, and *Spiranthes* are great aphrodisiacs [5]. Several orchids have been used in local system of medicines to cure nervous (*Cypripedium pubescens*, *Cymbidium elegans*, *Epipactis latifolia*), haematologic (*Habenaria edgeworthii*, *H. intermedia*, *H. pectinata*), dermal disorders (*Dendrobium alpestre*), digestive (*Dendrobium nobile*), reproductive (*Coelogyne cristata*, *Malaxis acuminata*) and rheumatic (*Rhynchostylis retusa*, *Vanda testacea*) ailments and for cooling purposes (*Coelogyne cristata*, *Saccolabium papillosum*) [6],[7]. Their additional uses as restorative drugs, gums, glues, narcotics and poisons are also indicated [5]. *Goodyera pubescens* and *Ansellia humilis* are used as antidote for snakebite and bad dreams respectively. *Vanda parviflora* and *Dendrobium chrysotoxum* have shown positive tests for its anti-cancerous properties and *Epipactis helleborine* and *Liparis ovata* as an antidote to HIV [8],[9]. *Malaxis acuminata* also known as ‘Rishbhak’ possess great therapeutic property.



Figure 2 A – B. Medicinal Orchids

A. Plant of *Epipactis helleborine*, B. Plant *Habenaria edgeworthii*

Its dried pseudobulbs are used as an important ingredient of ‘Ashtavarga’ drugs used in the preparation of an ayurvedic medicine ‘Chyavanprash’. The species is used to cure tuberculosis and is a great aphrodisiac [6]. This medicinally important orchid is faced with extensive collections and habitat destruction. The essence ‘Vanillin’, obtained from unripe pods of *Vanilla planifolia*, is the

most important commercial produce of orchids. Curiously enough, the milch cattle in north-eastern India are fed on dendrobes and other orchids to enhance their milk yield [10]. A kind of tea is prepared from dried flowers of *Dendrobium chrysotoxum* that is effective in treating diabetes and strengthening reproductivity. Figure 2 A-B depicts some of the medicinal orchid species.

In India, the orchids are represented by over 1,300 species, but their commercial cultivation is still in its infancy due mainly to non-availability of proper planting material and cultivation procedures. Being highly versatile, there is progressive loss of orchid diversity due to:

1. Unregulated collections which are made stealthily from their natural habitats
2. Forest destruction pressures.

As a result, they have become rare and figure among other endangered and threatened plant species in the Red Data Book prepared by IUCN.

Biodiversity Hotspots of Orchids in India:

The botanical hotspots of orchid flora in India include:

1. North-East Indian Himalayas
2. Western Himalaya
3. Western Ghats
4. Andaman and Nicobar Islands

These hotspots typically support a substantial ratio of biodiversity and endemic species of orchids. The orchid species diversity has yielded the significant insights into the evolutionary and ecological processes in terms of speciation and extinction. Since the orchids have stringent habitat requirements which adds up to the status of their being rare and endangered.

PHYTOGEOGRAPHY AND DISTRIBUTION OF ORCHIDS IN INDIA:

In India, the orchid-rich spots are confined to North-Eastern region, chiefly the Eastern Himalaya, Meghalaya, Naga Hills and the Mizo or Lushai Hills and Sikkim; the North-Western Himalaya and the Western Ghats (the detached Pulney, Nilgiri and Biligirirangan Hills) [11]. In the Himalaya, Nepal and Bhutan also exhibit very rich orchid diversity. The distribution of orchids is not only restricted to the aforementioned regions but they have also spread in other parts of the country at different altitudes ranging from 150 m. to 2500 m. Most of them dwell extremely well in warm humid weather, preferring dense tropical rain forests, and also preferring temperate forests areas as well. Generally maximum diversity of orchid species is met within tropical region.

The North-Eastern region of India receives an annual rainfall ranging from 700 to 6,500 mm making the climate of the region highly humid. The warm and humid environment favours the growth of dense tropical evergreen rain forests which support luxuriant growth of diverse tropical

orchid species. In the Eastern Himalaya, depending upon the orchid habitat, fundamentally four orchid-rich regions are recognized (Table 4) [12]

Table 4. Orchid rich zones and altitudes:

Orchid-rich Zone	Altitude
Tropical Evergreen rain-forest zone	170 - 900 m
Sub-tropical Forest zone (a) Mixed wet forest belt (b) Mixed or Pine (partially dry) forest belt	900 -1800 m
Temperate forest zone	1,800 - 3,500 m
Alpine forest zone	3,500 -5,000 m

In the tropical evergreen rain-forest area, both epiphytic and terrestrial genera such as *Bulbophyllum*, *Coelogyne*, *Dendrobium*, and *Eria* are commonly found. The *Bulbophyllum* species present in this zone are: *B. capillipes*, *B. clarkeanum*, *B. delitescens*, *B. hirtum*, *B. reptans*, *B. sikkimense*, *Dendrobium* species such as *D. acinaciforme*, *D. aduncum*, *D. anceps*, *D. aphyllum*, *D. cathcartii*, *D. cumulatum*, *D. lituiflorum*, *D. moschatum*, *D. nobile* etc.

The subtropical forest area receives relatively less rainfall. The climate remains cool and humid. Both epiphytic and terrestrial species thrive well in this zone. Besides terrestrial and epiphytes, some saprophytic orchid species, for instance *Cymbidium eburneum* and *Eulophia zollingeri* are also known to occur in mixed wet forest of this area. The mixed wet forest belt of this area is also known to be the home of 'Lost Lady Slipper Orchid' *Paphiopedilum fairieanum* where it thrives sporadically in West Kameng district [12] (Hegde, 1984). Some epiphytic species of *Bulbophyllum*, *Coelogyne*, *Cymbidium* and *Dendrobium* are invariably found in subtropical forest zone. The *Dendrobium* species present here are *D. chrysanthum*, *D. falconeri*, *D. wardianum*. The species grouped under *Bulbophyllum* are *B. acutifolium*, *B. affine*, *B. cauliflorum*, *B. leopardianum* etc. The temperate forest area receives moderate rain-fall with frost forming heavy fog and short-period snowfall. A few of epiphytic and terrestrial orchid species grow in this forest. Among epiphytes, the *Bulbophyllum* species, and terrestrials such as *Calanthe mannii* and *Satyrium nepalense* grow. A saprophytic species *Galeola falconeri* grows very well in this zone.

The alpine area is snow-laden for almost 4-6 months. A few of terrestrial orchids are found growing in this zone. Nearly 700 species have been reported from North-Eastern India [13]. Approximately 18 genera are monotypics, represented by single species [14]. Epiphytic species are found in abundance in Darjeeling and Sikkim area due to high humidity and heavy rainfall as compared to the western Himalaya. The epiphytic orchids that grow at the lower altitudes in Darjeeling and Sikkim area are *Coelogyne cristata*, *C. uniflora*, *Cymbidium devonianum*, *C. elegans*,

Pholidota imbricata, and *Thunia alba*. A survey of literature indicates that nearly 244 species grows in the North-West and Western Himalaya [15]; the genera that prevails in this region are *Bulbophyllum* (11), *Dendrobium* (15), *Eria* (9), *Habenaria* (17 spp.), *Liparis* (10), *Oberonia* (10), and *Peristylus* (10). *Dendrobium* Sw. is considered to be the largest genus containing 104 species and followed by *Bulbophyllum*. Sikkim alone harbours 532 orchid species out of 1229 occur in India [16].

In the tropical Sikkim Himalaya, epiphytic species thrives best. These are *Bulbophyllum cornucervi*, *B. leptanthum*, *B. roxburghii*, *B. tortuosum*; *Dendrobium aphyllum*, *D. farmerii*, *D. formosum*, *D. jenkinsii*, *D. moschatum* [16] (Luckson, 2007); are also distributed in this zone. In subtropical Sikkim Himalaya some epiphytic species such as *Bulbophyllum reptans*, *B. guttulatum*, *B. hirtum*, *Dendrobium chrysanthum*, *D. densiflorum*, *D. moschatum* are distributed.

The orchids have also adapted well in the tropical rain forests of Western Ghats. Due to heavy rainfall, the climate of western coastal plains has high moisture content besides high temperature that promotes the lush growth of epiphytic orchid species namely *Acampae praemorsa*; *Bulbophyllum acutiflorum*, *B. aureum*, *B. elegantulum*, *B. fimbriatum*, *B. fuscopurpureum*. *B. neilgherense*, *B. keralense*, *B. mysorensis*, *B. nodosum*, *B. orezii*, *B. proudlockii*, *B. rheedei*, *B. rosemarianum*, *B. silentvalliensis*, *B. tremulum*; *Cymbidium aloifolium*; *Dendrobium macrostachyum*; *Luisia zeylanica*; *Pholidota pallida*; and a terrestrial orchid, *Eulophia epidendrea* [17]. As we get nearer to the mountain ranges there is an increase in density of orchid population. In the Western Ghats, the altitude of 300-600 m supports the growth of *Aerides ringens*, *Dendrobium ovatum*, *Oberonia brunoniana* and *Polystachya flavescens*. Going higher at an elevation of 600-1300 m in the rain forests does not allow enough light penetration in the dense canopy of trees, as a consequence, a few epiphytes and terrestrial orchids such as *Acanthephippium bicolor*, *Calanthe masuca* and *Eulophia macrostachya* grow in this zone. At the elevations of 1700-2300 m., the weather is quiet cold and dry; the terrestrial orchid *Habenaria* spp. thrives well. The orchid species above 2300 m gradually disappears [17].

Apart from the hotspots of orchid biodiversity in our country, some orchid species are also found dwelling in the Eastern Ghats. Although, the Eastern Ghats are not among the hotspots, they, as well, indicate the occurrence of orchids. The orchids growing here are *Bulbophyllum albidum*, *B. fusco-purpureum*, *B. neilgherense*, *B. putidum*, *B. tremulum*; *Dendrobium aqueum*, *D. herbaceum*, *D. heyneanum*, *D. graminifolium*, *D. macrostachyum*, *D. microbulbon*, *D. ovatum*, etc.

The Indian peninsular region is endorsed with a high degree of endemism. The angiospermic flora of India is mostly endemic, which is next to Australia. It is considered to be the second richest endemic centre after the Himalaya [18]. The genus *Bulbophyllum* (15 species) and *Dendrobium* (11 species), *Habenaria* (25 species) *Oberonia* (17 species) are endemics to this region. The Peninsular

region supports the highest degree of endemism as compared to the Western Ghats and even less in Eastern Ghats of India [19]. It has been reported that 19 orchid species are endemic to the Himalayan region whereas 63 species are extensively distributed in the adjacent countries such as Bhutan, Nepal, Tibet, Pakistan and Afghanistan [15].

GEOGRAPHICAL AFFINITIES:

The orchid flora of India show geographical affinities with other regions of the world. Literature study indicates that the Western Himalaya orchid flora shows similarity with the Eurasian and Mediterranean species whereas Eastern-Himalayas also show prevalence of Indo-Malayan species. Alternatively, orchids of southern India show resemblance with the African as well as South-East Asian species. Some orchids of Southern India, such as *Cottonia peduncularis*, *Diplocentrum recurvum*, *Ipsea malabarica*, *Seidenfadeniella chrysantha*, *Sirhookera lanceolata*, and *S. latifolia* etc., also grow in Sri Lanka [20]. There are some orchids very common in India as well as other parts of Asian countries. The Burmese-Thai orchids for instance *Bulbophyllum crassipes*, *B. rufinum*, *Cleisostoma elegans* and *Coelogyne quadratiloba* also grow in the Andamans. Likewise, the orchids such as *Appendicula reflexa*, *Dendrobium pensile*, *Phalaenopsis tetrapsis* and *Schoenorchis minutifolia* growing in Malaysian region are also reported to be growing in Nicobar islands. The *Bulbophyllum* and *Dendrobium* are reported from both Andaman and Nicobar islands and Papua New Guinea.

THREATS TO BIODIVERSITY:

The major threat to biodiversity is the population explosion leading to the development of pressures such as construction of residential areas and setting up of industries, irrigation / hydel projects, clearing forests for agriculture purposes, firewood collection and unsustainable use of natural resources consecutively leads to severe habitat. The International Union for Conservation of Nature and Natural Resources (IUCN) has contributed immensely in converging the world wide attention towards the extinction of species and has introduced the first Red Data Book in 1966 listing rare, endangered and threatened plant species by recognizing three threatened categories which are as follows:-

Critically Endangered (CR):

Those species having high risk of extinction in their natural habitat are categorized as critically endangered. It is the highest risk category assigned by the IUCN Red List for wild growing species.

Endangered (EN):

The taxa whose number has been reduced to a critical level or whose habitats have been so drastically reduced that they seemed to be in immediate danger of extinction.

Vulnerable (VU):

Species can be placed into endangered category in a condition when conservation measures are not followed.

Threatened:

Those species that are categorized under any one of the above categories is designated as “threatened.”

Rare:

Those species which exists as a small population in restricted area and presently are not endangered or vulnerable but are at risk, are said to be rare.

The IUCN Red list is revised on annual basis. In India, for the first time, a list of threats to orchid species was prepared [21],[22],[23]. The first red data sheet on Indian orchids was prepared which supplemented the IUCN Plants Red Data Book [24,25,26]. A list of nearly 58 threatened species was also produced [27],[28],[29].

Under IUCN in 1984, the orchid conservation groups, such as the Orchid Specialist Group (OSG) was established. Since then, there are many regional groups like ‘ISROSG’ —‘Indian Subcontinent Regional Orchid Specialist Group’ which have been established that embraces the Indian sub-continent region and gathers the information about the status and conservation of orchid species. Apart from IUCN, at the international level, several other treaties, have been established for the protection of biodiversity as a whole, encompassing the protection of wild orchids as well. The Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES), ratified by India, places whole family Orchidaceae under the Appendix II, meaning thereby that their trade will be only through export permits and few endangered species of orchids in Appendix I. The Appendix - 1 orchid species are represented in Table 6.

Table 6. Orchid Genus and species categorized in Appendix I of CITES* (2017):

Sr. No.	Orchid species
1	<i>Aerangis ellisii</i>
2	<i>Dendrobium cruentum</i>
3	<i>Laelia jongheana</i>
4	<i>Laelia lobata</i>
5	<i>Paphiopedilum spp</i>
6	<i>Peristeria elata</i>
7	<i>Phragmipedium spp</i>
8	<i>Renanthera imschootiana</i>
* (https://cites.org/eng/app/E-Apr27.pdf)	

STRATEGIES TO CONSERVE BIODIVERSITY:

Conservation refers to preservation and utilization of the species. In broader term, the conservation is to protect wild plant and animal species in their natural habitat. Biodiversity conservation can be successfully accomplished following the proper scientific approach and society involvement. Basically, the conservation of plant genetic diversity is achieved by the following:-

1. *In-situ* conservation
2. *Ex-situ* conservation

***In-situ* conservation:**

In situ conservation is exclusively concerned with the conservation of wild growing plant species. The conservation is achieved through protection of the species in nature. A species that is conserved in its natural habitat or native place where it thrives naturally is known as *in-situ* conservation. It includes Biosphere reserves, cultural landscapes, national parks, sacred sites, sacred grooves, wild-life sanctuaries, gene banks and forest protected areas etc. In nature, plant diversity, can be conserved on long-term basis at the genetic, species and ecosystem level. The establishment of protected area network has become central in all policy decision processes that are related to the biodiversity conservation at national and international level.

Conservation strategies are also adopted for orchids. The orchid sanctuaries, biosphere reserves, National Orchid and Biodiversity Park are established (Table 7).

Table 7. Sites of *in situ* conservation of orchids:

Sr. No.	Sites	State
1.	Kaziranga National Orchid and Biodiversity Park	Golaghat & Nagaon district, Durgapur, Assam
2.	Sessa orchid sanctuary	West Kameng District, Arunachal Pradesh
3.	Deorali orchid sanctuary	Gangtok, Sikkim
4.	Nilgiri Biosphere Reserve*	Western Ghats & Nilgiri Hills, South India.
5.	Pachmarhi Biosphere Reserve	Madhya Pradesh

*An [International Biosphere Reserve](#). 175 species of orchids are found in the Nilgiri Biosphere Reserve of which eight are endemic. These include endemic and endangered species of *Bulbophyllum*, *Liparis*, *Thrixspermum* and *Vanda*.

The success of any conservation programme depends upon meticulous supervision of the protected areas. In India, a large population resides in nearby forests areas which are declared as protected areas by the state forest department. Therefore, it becomes necessary to sensitize the local communities about the need to protect the plant species. This could be achieved by conversing

with them about the value of plants in our day to day life. This approach would generate their interest in conservation activities by their active participation

Ex-Situ Conservation:

Ex-situ conservation refers to the conservation external to the natural habitat. It is accomplished, by cultivating and maintaining endangered plants in the botanic gardens, parks, farmer's field, R&D research centres, universities, Botanical Survey of India etc. and through long term *in vitro* conservation of plant germplasm in the gene banks, seed banks, and pollen banks, DNA libraries, and also through cryopreservation and plant tissue culture techniques (Figs.3A-C).



Figure 3A-B. A. *In vitro* asymbiotic seed germination of *Dendrobium* species; B. Protocorm and leaf stage; C. Seedlings maintained in liquid medium

Some of the laboratories/centres of national repute are actively engaged in *ex situ* conservation of orchid research in the country are:-

- Centre for Orchid Gene Conservation of eastern Himalayan Region, Manipur
- Department of Plant Breeding and Genetics, Assam Agricultural University, Jorhat, Assam
- National Research Centre for Orchids, Pakyong, Sikkim
- National Bureau of Plant Genetic Resources, New Delhi
- Orchid Laboratory, Department of Botany, Panjab University, Chandigarh
- Orchid Laboratory, Department of Botany, Karnatak University, Dharwad, Karnataka
- Orchid Biology and Conservation Unit, Jawaharlal Nehru Tropical Botanic Garden and Research Institute Palode, Kerala

Botanical gardens support *ex situ* conservation of plants, especially those facing extreme threat of extinction. Several gardens in the world are specialised in orchid cultivation such as:-

- National Orchid Garden, Singapore, Chicago Botanic Garden, USA
- Missouri Botanic Garden, USA
- Soroa Orchid Botanical Garden, Havana
- Botanical Garden, Panjab University, Chandigarh, India

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