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Research Paper

BIODIVERSITY, CONSERVATION AND BIO-PIRACY IN ORCHIDS-AN OVERVIEW

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Abstract

Region wise bio-diversities of different orchid species of India and its conservation through legislative measures, *ex-situ* and *in-situ* ways and bio-piracy of endangered species have been reviewed.
Key words: Biodiversity, orchid species, conservation, bio-piracy.

INTRODUCTION

Biodiversity especially species diversity indicates the number of species of plants and animals present in a region. Maintaining a wide diversity of species in each ecosystem is necessary to preserve the web of life that sustains all living things

Orchids, believed to have evolved in this region, form a very noticeable feature of the vegetation here. There are about 25,000-35,000 species of orchids estimated to occur in the world. In India, about 1350 species belonging to 186 genera represent about 5.98% of the world orchid flora and 6.83% of the flowering plants in India. The Eastern Himalayas and North Eastern; North West Himalayas; Peninsular India; and Andaman &Nicobar Islands are the major orchid regions of India.

1. Region wise distribution of orchids

1.1. Eastern Himalayas and North-Eastern India

This region includes Darjeeling district of West Bengal and other North-eastern states, i.e., Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. This region is relatively warmer with high humidity and heavier precipitation and endowed with 870 species in 159 genera constituting 72.8% of the total orchid species in this country. A state wise analysis indicates that Arunachal Pradesh has the highest number of orchid species (622) followed by Sikkim (543 species) and Meghalaya with 389 species. Among the other states of this region, Assam accounts for 290, Nagaland for 246, Mizoram for 234, Manipur for 215 and Tripura for 57 species (Hajra and De, 2010).

1.1.1. Endemic orchids

Orchids are distributed from tropical to alpine zones in forest trees, secondary vegetations, river banks, bamboo and palm thickets, forest floor, grassy slopes and rocky areas and are considered as an element in Farming System Research (Chowdhery, 1998, 2001). It is to be noted that there are some orchid species which are endemic not only to this region, but also to the home states in which they are distributed in Sikkim and Arunachal Pradesh Himalayas, the Naga and Manipur hills, the Lusai - Mizo hills and Khasi –Jaintia hills (Nayar, 1996).

These are

- *Dendrobium spatella, Dendrobium parciflorum*and *Luisia macrotis* from Assam.

- *Vanda coerulea* and *Dendrobium palpebrae* from Arunachal Pradesh.
- *Renanthera imschootiana* and *Cymbidium tigrinum* from Nagaland.
- *Anoectochilus crispus, Cymbidium eburneum, Habenaria khasiana, Liparis deliculata, Paphipedilum venustum, Taeniophyllum khasianum and Tainia khasiana* from Meghalaya.
- *Renanthera imschootiana* from Tripura.
- *Dendrobium palpebrae* from Mizoram.
- *Ascocentrum ampullaceum var. auranticum, Epidendrum radicans* and *Vanda stangeana* from Manipur.
- *Calanthe whiteana, Cymbidium whiteae* and *Vanda pumila* from Sikkim (Nayar, 1996)

A state wise distribution of orchid species of North Eastern states of India is listed in Table1.

Table1. Distribution of major orchids in North East States (Chowdhery, 2001, 2009; Nayar and Sastry, 1999, De and Medhi, 2014)

State	Orchid species
Arunachal Pradesh	*Cymbidium ensifolium, C. grandiflorum, Dendrobium aphylla, D. chrysanthum, D. gibsonii, D. nobile, Paphiopedilum fairrieanum, P. venustum, P. spicerianum,Calanthe masuca, Rhyncostylis retusa*
Assam	*Arundina graminifolia, Eulophia mannii, Goodyera procera, Calanthe angusta, Rhyncostylis retusa, Aerides multiflora, Aerides odorata, Acampe papillosa, Cymbidium aloifolium, Dendrobium aphyllum, D. acinaciforme*
Manipur	*Ascocentrum ampullaceum, Paphiopedilum spicerianum, Vanda amsiana, Vanda stangeana, Vanda coerulea*
Meghalaya	*Paphiopedilum insigne, P. venustum, R. retusa, Coelogyne corymbosa, Phaius tankervilliae, Dendrobium devonianum, Cymbidium elegans, Vanda coerulea*
Mizoram	*Vanda coerulea, Renanthera imschootiana, Paphiopedilum hirsutissimum,P. villosum*
Nagaland	*Goodyera viridiflora, Liparis caespitosa, Luisia trichorrhiza, Malaxis latifolia, Oberonia pyrulifera , Spiranthes sinensis*
Sikkim	Alpine zone*(2500-3000m): Orchis, Habenaria,Tipularia, Satyrium, Cypripedium* Temperate & Sub-temperate zone*(1850-3500m): Goodyera, Calanthe, Pleione humilis, Cymbidium hookeranum, C. devonianum, C. longifolium, Coelogyne cristata, Dendribium hookeranum* Subtropical zone*(850-1250m): Anoectichilus, Calanthe, Phaius, Eulophia, Paphiopedilum fairrieanum, P. venustum, Dendrobium, Bulbophyllum, Coelogyne, Arachnis.* Tropical Zone *(250-850m): Phalaenopsis, Dendrobium, Aerides, Vanda, Arundina graminifolia*
Tripura	*Dendrobium (*14 spp.), *Vanda teres, V. coerulea, Renanthera imschootiana*

1.2. North- Western Himalayas

This region covers the states of Jammu & Kashmir, Himachal Pradesh, and Uttarakhand. The Western Himalayan region is blessed with larger size, higher elevations, cooler drier climate and the wider mountain mass. The pre-dominant forest flora are pine, deodar, far etc. In all, 288 species under 75 genera are found to occur in this region constituting 24.1% of the total Indian orchids.

Four species of ground orchids found mainly in this region, *viz.*, *Platanthera edgeworthii, Habenaria intermedia,Crepidium acuminatum* and *Malaxismuscifera* form important constituents of *Astavarga* (a group of eight herbs used in preparation of *Chyavanprash*).

Among the epiphytes, *Dendrobium* Sw. and *Bulbophyllum* Thouars.are the largest genera comprising of 16 and 12 species, respectively whereas, among the terrestrial orchids, *Habenaria* Willd. is the largest group with 13 species. 34 species of Orchids are represented by single species in western Himalaya. Eleven species are found to be endemic to this region namely, *Dendrobiumnormale*, *Eriaoccidentalis*, *Flickingeriahesperis*, *Gastrochilus garhwalensis*,

Herminiumkumaunensis, *Neottiamackinnonii*, *Neottia nandadeviensis*, *Peristylusduthiei*, *Peristyluskumaunensis*, *Peristylus fallax* and *Ponerorchisrenzii* (Jalal*et al*, 2009a 2009b, 2010a, 2010 b).

1.3. Peninsular India

This region comprises Madhya Pradesh, parts of Orissa, Andhra Pradesh, Gujrat, extra peninsular region of Central India and Gangetic plains along with Eastern and Western Ghats. Western Ghats harbour dense forests with high humidity and rainfall and the vegetation is rich in scrub jungles, moist and dry deciduous forests, tropical evergreen forests and montane grasslands containing huge number of orchid species. Eastern Ghats consist of broken hills. Orchid diversity in Eastern Ghat is poor as compared to that in Western Ghats. The region is enriched with 379 species belonging to 89 genera constituting 31.72 % of the total Indian orchid flora.

Predominant terrestrial orchid species available in Western Ghats are *Acanthephippium bicolor* Lindl., *Aenhanhreya rotundifolia* Blatt., *Anoectochillus elatus* Lindl., *Calanthe masuca* Lindl., *Calanthe triplicata* Willemet, *Eulophia epidendrea* Koenig., *Epipogium roseum* D.Don, *Geodorum densiflorum* Lamk., *Habenaria longicorniculata* Grah., *H. longicornu* Lindl., *H. multicaudata* Sedgw., *H. roxburghii* Nicolson, *Liparis atropurpurea* Lindl., *Malaxis versicolor* Lindl., *Nervilia aragona* Gaud., *Paphiopedilum* d*ruryii* Bedd., *Tainia bicornis* Lindl., *Vanilla walkeriae* Wight., *Zeuxine gracilis* Breda. and*Z. longilabris* Lindl (Sharief, 2011). Some rare and endemic epiphytic species from Western Ghats are *Aerides ringens* Fischer, *Bulbophyllum aureum* Hook.f., *B. fuscopurpureum* Wight, *B. fimbriatum* Lindl., *B. fischeri* Seid, *B. tremulum* Wight., *B. neilgherrense* Wight., *Coelogyne breviscapa* Lindl., *C. nervosa* A. Rich., *Cottonia peduncularis* Lindl., *Cymbidium bicolor* Lindl., *Dendrobium aqueum* Lindl., *D. crepidatum* Lindl., *D. herbaceum* Lindl., *D. microbulbon* A. Rich, *D. ovatum* Lindl., *Diplocentrum recurvum* Lindl., *Eria nana* A. Rich, *E. pseudoclavicaulis* Blatt., *Flickingeria nodosa* Daiz., *Liparis elliptica* Wight., *L. viridiflora* Bl., *Luisia zeylanica* Lindl., *Oberonia brunoniana* Wight., *Papilionanthe subulata* J. Koen., *Pholidota imbricata* Hook., *Rhyncostylis retusa* Bl., *Sirhookeria lanceolata* Wight., *Taeniophyllum alwisii* Lindl., *Trias stocksii* Benth., *Vanda testacea* Lindl. and*Xenikophyton smeeanum* Reich. Orchids distributed in Eastern Ghats are given in Table.2.

Table 2. Orchid flora of Eastern Ghats of India (De *et al*, 2014)

Name of species	**Habit**	**Flowering time**	**Remarks**
Acampe carinata	Epiphyte	October – January	Flowers light yellow with maroon blotches on sub-umbellate raceme
A. ochracea	Epiphyte	December – Feb	Flowers light yellow with maroon markings on lax panicle
A. praemorsa	Epiphyte		Flowers small creamy yellow with maroon transverse bands clustered on compact corymbose cyme
A . rigida	Epiphyte	August – September	Flowers pale yellow on sub-corymbose raceme
Acanthephippium bicolor	Terrestrial	May	Flowers yellow specked with red
Aerides maculosa	Epiphyte	June	Flowers mild violet on axillary spreading racme
A .multiflora	Epiphyte	June-July	Flowers purple on long axillary pendulus floral axis
A . odorata	Epiphyte	June-july	Flowers white, lemon scented on extra axillary, deflexed

			raceme
A . ringens	Epiphyte	June -August	Flowers white on axillary, sub-erect second raceme
Bulbophyllum crassipes	Tropical epiphyte	Octo –Nov.	Flowers small, yellow maroon, densely spirally arranged in catkin like raceme
B. umbellatum	Epiphyte	April –May	Flowers pale yellow with purple spots on umbellate raceme
Calanthe sylvatica	Terrestrial	July	Flowers large, purple coloured
Cleisostoma appendiculatum	Epiphyte	August-October	Flowers pale yellow on recurved raceme
Coelogyne breviscopa	Epiphyte	April	Flowers white raceme with scarious bract, lip 3-lobed
Cottonia peduncularis	Tropical epiphyte	March –June	Flowers dark purple on long and branched raceme with a bee like lip.
Cymbidium aloifolium	Epiphyte	April-June	Flowers pale yellow with purple centre on long pendulus raceme
C. bicolor	Epiphyte	Feb –April	Flowers pale yellow at base and maroon towards top borne on lax raceme
Dendrobium aphyllum	Tropical epiphyte	Feb –April	Flowers pale purple, translucent with sub-panduriform, fenely dendate lip
D. aqueum	Epiphyte	Sept –Nov	Flowers showy white. Lip faintly yellowish
D. bicameratum	Epiphyte	August	Flowers pale yellow, crowded on sub-terminal capitate raceme.
D. cathcartii	Tropical epiphyte	March – April	Flowers yellow-ochre on leaf opposed fascicles of 2-3 flowers.
D. crepidatum	Tropical epiphyte	Feb –April	Flowers white with a large yellow spot on the lip, 1-3 on very short bracteate peduncle from the swollen nodes of the leafless stems.
D. fimbriatum	Epiphyte	April	Flowers golden yellow. Lip orbicular, fimbriate.
D. formosum	Tropical epiphyte	May-June	Flowers white with bright yellow patch on lip, on subterminal racme.
D. herbaceum	Epiphyte	Feb –March	Flowers greenish white on subterminal condensed racemes.
D. macrostachyum	Tropical epiphyte	May-July	Flowers lemon green, 1-4 in cymes.
D. moschatum	Epiphyte	May –June	Flowers large, spreading, peach coloured, musk scented on a spreading raceme from a

			node near to apex.
D. regium	Tropical epiphyte	April –June	Flowers magenta coloured with yellow throat on sub-terminal raceme.
Diplocentrum recurvum	Epiphyte	April – August	Flowers small in long racemes, pink to rose or pink or brownish tinged with pink. Lip sessile.
Eria bambusifolia	Epiphyte	Dec –Jan	Flowers pale brown on axillary lax raceme
E . lasiopetala	Tropical epiphyte	March-April	Flowers greenish yellow, lip light maroon, on axillary racemes.
E. pauciflora	Epiphyte	Aug –Sept	1-2 white flowered inflorescence
E. reticosa	Epiphyte		Single flowered
Eulophia epidendraea	Terrestrial	Dec –Jan	Scape laxly many flowered. Flowers green white purple.
E. graminea	Terrestrial	Jan –May	Inflorescence 1-3 per plant, lax flowered produced from the nodes. Flowers inodorous, leaf-green with maroon veins.
E. pulchera	Terrestrial	May –July	Flowers in few-many flowered raceme, greenish purple.
E. spectabilis	Tropical terrestrial	May -June	Flowers greenish white or purple, lax racemes; lip crenate and crisped.
Flickingeria macraei	Epiphyte	July –Sept	Flowers cream with a pale yellow lip, solitary on top of the pseudobulb.
Gastrochilus acaulis	Epiphyte	March – April	Flowers pale yellow, lip white with violet blotch, on axillary corymb; hypochile cup-shaped
Gastrochilus inconspicuum	Tropical epiphyte	June –Sept	Flowers greenish purple on a condensed spike, hypochile cup-shaped
Geodorum densiflorum	Terrestrial	July –Aug	Flowers pinkish white on decurved racemes, lip sub-panduriform.
G. recurvum	Tropical terrestrial	May –June	Flowers white, inodorous on long slender decurved corymbose raceme.
Goodyera procera	Terrestrial	March –May	Flowers minute, white; lip saccate at base.
Habenaria commelinifolia	Terrestrial	Aug –oct	Flowers greenish white, inodorous on long dense spike with a long curved spur.
H. digitata	Terrestrial	July	Flowers greenish white with sickle-shaped flower petals.
H. furcifera	Terrestrial	Aug –Sept	Flowers green on long and stout peduncle
H. gibsoni var. foetida	Terrestrial	July –Aug	Flowers green, foul scented, on lax raceme

H. longicorniculata	Terrestrial	August	Flowers greenish white faintly scented on long peduncled raceme.
H. longicornu	Terrestrial	Aug –Sept	Flowers white, about 8 on lax raceme
H. marginata		Sept –oct	Flowers yellow on many flowered lax raceme
H. ovalifolia	Terrestrial	Aug-Oct	Flowers green. Side lobes of lip linear-lanceolate, midlobe inflexed, ovate-oblong
H. panigrahiana	Terrestrial	Oct –Dec	Flowers green on lax racemes, sweet scented at night
H. rariflora	Terrestrial	Aug –Sept	Flowers white with bipartite petals
H. reniformis	Terrestrial	July –Sept	Flowers green on lax spike
H. roxburghii	Terrestrial	August	Flowers white, mildly fragrant on densely many flowered spike
H. stenopetala	Terrestrial	Oct –Dec	Flowers grayish green with brown lip on densely many flowered raceme.
H. virens	Terrestrial	July –Oct	Flowers white, lip scabrid-pilose, 3-furcate
Kingidium deliciosum	Epiphyte	May –Sept	Flowers pale yellow and purple
Liparis nervosa	Terrestrial	May –Aug	Flowers purple or green tinged with pink on long spikes.
L. paradoxa	Terrestrial	July	Flowers small, pale yellow to maroon in terminal raceme
L. viridiflora	Epiphyte	Nov –Dec	Flowers pale yellow on slightly recurved, dense flowered raceme
Luisia abrahami	Epiphyte	March –May	Flowers pale green flushed with pale purple
L. birchea	Epiphyte	Throughout the year	Flowers stray coloured, thick. Lip sessile, dark purple.
L. trichorhiza	Epiphyte	March –July	Flowers maroon on extra axillary, condensed raceme
L. zeylanica	Epiphyte	Feb –March	Flowers green and dark purple on extra-axillary condensed raceme
Micropera pallida	Epiphyte	June –Sept	Flowers light yellow on leaf opposed decurved raceme
Nervilia aragoana	Terrestrial	May –July	Flowers many in lax, slightly drooping, nodding, light green in colour
N. crociformis	Terrestrial	May-July	Flowers greenish white, single on top of the peduncle
N. infundibulifolia	Terrestrial	June	Flowers maroon green on one solitary flowered, pale maroon peduncle
N. plicata	Terrestrial	May –June	Flowers two on top of the peduncle, dull brownish green and white

Oberonia brunoniana	Epiphyte	Sept –Oct and Feb-March	Flowers large, brown
O. ensiformis	Epiphyte	Oct –Nov	Flowers minute, greenish-yellow on sigmoid curved spiciform raceme
O. falconeri	Epiphyte	Sept –Oct	Flowers minute; in whorls, greenish yellow on densely flowered curved raceme
O. mucronata	Epiphyte	Sept-Nov	Flowers are minute, greenish yellow at decurved, spiciform raceme
O. proudlockii	Epiphyte	February	Flowers yellowish, partly sunk in pits of the rachis
Odisha cleistantha	Terrestrial	October	Flowers verdant green, inodorous
Papilionanthe cylindrica	Epiphyte	Feb –June	Flowers showy, fragrant, white. Lip 3-lobed yellow at the tip, pink with white spot below.
Pecteilis gigantea	Terrestrial	August – Sept	Flowers are large, snow white, fragrant in terminal raceme
Pelatantheria insectifera	Epiphyte	Oct –Dec	Flowers greenish yellow with deep brown streaks lip purple on extra-axillary corymb
Peristylus constrictus	Terrestrial	June- July	Flowers white, fragrant, dense flowered on long terminal spikes
P. goodyeroides	Terrestrial	July	Flowers greenish white, sub-secund on dense flowered spike
P. lawii	Terrestrial	June –July	Flowers minute, white on slender, terete peduncle
P. plantagineus	Terrestrial	Sept	Flowers greenish white on many flowered spike
Phaius tankervilleae	Terrestrial	Feb –March	Flowers large, downwardly faced, mildly scented, yellow brown within white without.
Pholidota imbricata	Epiphyte	July –Sept	Flowers small, cream or pale yellow on drooping racemes arising from the base of the petiole
Polystachya concreta	Epiphyte	July	Flowers pale greenish yellow, on terminal raceme
Pomatocalpa decipiens	Tropical epiphyte	Jan –march	Flowers yellow with reddish blotches on extra-axillary spikes
Robiquetia josephiana	Epiphyte	Aug –Dec	Inflorescence pendulous of few flowered raceme. Flowers inodorous, white, small
Seidenfia versicolor	Terrestrial or Lithophyte	July –Aug	Flowers minute, light yellow or maroon
Smitinandia micrantha	Epiphyte	April -June	Flowers minute, waxy

			white,faintly scented, small on densely flowered raceme
Spathoglotis plicata	Terrestrial	Throughout the year	Flowers racemed, reddish violet, pink or rarely white
Staurochilus ramosus	Epiphyte	April –May	Flowers pale yellow, mildly scented on paniculate raceme
Taprobanea spathulata	Epiphyte	March – September	Flowers large, golden yellow in raceme
Thunia bracteata	Epiphyte	August	Flowers nodding, large pinkish white on compressed racemes
Tropidia angulosa	Terrestrial	July	Inflorescence terminal, very short, slender with a few crowded small white flowers
Vanda tessellata	Epiphyte	March –May & Sept-Dec	Flowers greenish yellow with brownish tessellations, on axillary, zigzag racme, lip purple
Vanda testacea	Epiphyte	April	Flowers light yellow on axillary raceme
Zeuxine longilabris	Terrestrial	Jan –Feb	Flowers small, brownish and white

1.4. Andaman &Nicobar Islands

The A & N islands are a group of about 319 islands and islets in the Bay of Bengal. The South East monsoon governs the climate of these islands. Heavy mist over the forests in morning, high rainfall from May to November and constant sea currents keep the forest moist throughout the year. These types of climate provide congenial habitats for luxuriant growth of unique orchid flora in the area. This region is home of 115 species belonging to 53 genera. Genera like *Grosourdya*, *Plocoglottis* and *Vrydagzynea* are confined only to this region (Singh *et al,* 2001).

Some orchid genera of Andaman and Nicobar islands are listed in Table 3.

Table 3. Orchid genera of Andaman and Nicobar islands

Name of species	**Habit**	**Categories**
Bulbophyllum protractum	Epiphyte	Rare
Dendrobium tenuicaule	Epiphyte	Endangered
Habenaria andamanica	Terrestrial	Rare
Malaxis andamanica	Terrestrial	Endangered
Malleola andamanica	Epiphyte	Rare
Phalaenopsis speciosa	Epiphyte	Rare
Taeniophyllum scaberulum	Epiphyte	Vulnerable
Zeuxine andamanica	Terrestrial	Rare

2. Conservation of Orchid Genetic Resources

There are three prominent methods of conservation of genetic resources of orchid species namely

- Legislative measures
- *In -situ* conservation in Sanctuaries /Reserves
- *Ex-situ* conservation in Orchidaria /Botanic gardens by cultivation (Hedge, 2012).

2.1. Legislative Measures

Vanda coerulea (Blue Vanda) and *Renanthera imschootiana* (Red Vanda) are now included in schedule VI of Wild Life Protection Act 1972 of Government of India as amended in 1992. As a result, all orchids are protected plants under Wild life (Protection) Act.

The International Union for Conservation of Nature (IUCN) has a Species Survival Commission (SSC) with a well defined preservation program for the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). Under this provision, orchids are treated as protected species. In India, three genera and eleven species are being treated as protected under Schedule-VI of Wild Life Protection Act 1972 and simultaneously under CITES Appendix-I. All other species of India have been included in Appendix –II of CITES. The following species have been kept under CITES Appendix -1 and Schedule –VI of Wild Life Protection Act of Govt. of India.
Paphiopedilum charlesworthii, P. fairrieanum, P. hirsuitissimum, P. spicerianum, P. insigne, P. venustum, P. wardii, P druryii, Renanthera imschootiana and *Vanda coerulea.* However, Excepting *P. druryii* which is reported from Kerala all other species of Paphiopedilum belong to North East India.

As per laws, no wild orchids can be traded with and so, plants listed above can not be allowed for export. However, under CITES rules and regulations, whenever CITES Appendix-I species are cultivated then, these can be allowed for export subject to condition that proper permit for possessing and growing these scheduled plants is obtained from the concerned State, provided the nursery is registered under Wild Life Preservation Office, Government of India.

Appendix-I includes threatened and extinct species. In fact, no trade in wild plants is allowed. Trade is allowed in cultivated and artificially propagated plants subject to licensing.
Appendix-II covers species which may be threatened unless trade is strictly regulated. Orchidaceae is listed on Appendix-II. Trade in wild and propagated specimen is allowed subject to licensing. Further, all cultured orchid seedlings in flasks or aseptically cultured from seeds and tissues are now exempt from CITES control w.e.f. 16th April, 1993.

These legislations have helped in checking illegal collection of orchids from the wild as no importing countries also accept plants of wild origin. In this regard, the Proceedings of the Seminar on CITES Implementation for Plants (1997), illustrates the method of recognizing the wild plants at the port and the procedure to deal with the same.

2.2. *In Situ* Conservation

It refers to the maintenance of the germplasm in its natural habitat allowing continual adaptation to the environment without any human interference.

2.2.1. Biosphere Reserve

These are versatile protected areas to preserve the genetic diversity in the representative ecosystem which are internationally recognized. The proposal for development of biosphere reserve was initiated by UNESCO in 1971 under the 'Man & Biosphere' (MAB) programme. The first biosphere reserve of the world was established in 1979. Presently, 564 biosphere reserves have been developed in 109 countries across the world. India has 17 biosphere reserves namely, Achanakamar-Amarkantak, Agasthymalai, Cold Desert, Dihang-Dibang, Dibru Saikhowa, Great Nicobar, Gulf of Mannar, Kachchh, Khangchendzonga, Manas, Nanda Devi, Nilgiri, Nokrek, Pachmarhi, Seshachalam Hills, Simlipal and Sunderbans for conservation of endemic, endangered and vulnerable orchid species.

2.2.2. National Parks

This is an area of adequate natural biological and geomorphological interest owned by a sovereign state having one or several ecosystems where conservation of wild life (both flora and fauna) is practiced along with educative and recreative interest, designated, created and

protected by legislation. HaileyNational Park, presently known as JimCorbettNational Park is the first developed National Park in India in 1936. Presently, there are 98 National Parks in India. 96 different species of orchids are found in Simlipal National Park of Orissa. 150 different species of orchids are conserved in Buxa Tiger Reserve of West Bengal.

2.2.3. Sacred Groves

A secret groove is a special type of area where all forms of life particularly the secred tree species related to any particular culture and protected by a particular human community, race or tribe in the name of their respective deity. Himachal Pradesh, Karnataka, Kerala, Maharashtra, Andhra Pradesh, West Bengal and Chhattishgarh are very prominent states for sacred grooves. About 13928 sacred grooves are presently existing in India. This may be an important area for in situ conservation of orchids of that particular locality.

2.2.4. Gene Sanctuary

Gene sanctuary is a protected area where broad spectrum of genetic variability is conserved to act as a reserve for future use and crop improvement. At present, India has 480 wildlife gene sanctuaries. Sessa Orchid Sanctuary of Arunachal Pradesh with 100 Sq. kilometer area conserves about 200 species of orchids. Similar type of sanctuaries have also been created in Sikkim at Deorali and Singtam.

2.2.5. Individual Trees

The epiphytic orchid species are conserved on tree species in its natural habitat. In their natural habitat, they attach themselves to the bark of trees, or the surface of other plants. Some of host trees of orchid species are*Lyonia ovalifolia, Benthamidia capitata, Quercus leucotricha*, *Diploknema butyracea,Berberis asiatica,Myrica esculenta,Castanopsis indica,Persea odoratissima, Pinus roxburghii,Rhododendron arboretum, Berberis cristata,Engelhardia spicata, Pyrus pashia, Shorea robusta, Mioromeles rhamnoides,Alnus nepalensis*and *Prunus cerasus* (De *et al*, 2013).
Their thick, white roots are specially adapted to absorb moisture and dissolved nutrients. Because these tropical orchids usually grow high in the trees, rather than on the forest floor, they are accustomed to good air circulation and plenty of light.

3. *Ex-situ* Conservation

It refers the preservation of germplasm outside the natural habitat. In India, Botanical Survey of India is maintaining three National Orchidaria andExperimentalGardens one each at Yercaud (Tamil Nadu), Howrah (West Bengal), and Shillong (Meghalya) where representative species of the region are cultivated. Similarly, Arunachal Pradesh State Forest Research Institute in maintaining large number of orchid species at Orchid Research Centre, Tipi, Itanagar, Sessa, Dirrang, Jenging and Roing as a measure of ex-situ conservation of orchids. In Karnataka, three ex-situ conservation Centers have been established one in Kodagu, another in Kudremukh and the third in Dhandeli (Rao and Sridhar, 2007). A natural Orchidarium for the conservation of orchid germplasm has also been planned in Bangalore within Lal Bagh Botanical Garden.

2.3.1. Field Gene Banks

In this areas, germplasm are collected from natural habitat or from other sources including commercial houses and nurseries and maintenance in field or protected structures. The Centre for Orchid Gene Conservation of the Eastern Himalayan region at Hengbung of Senapati district of Manipur the country's first orchid gene bank has already been established to conserve orchids as well as to facilitate research work.
In the field gene banks of TBGRI, Trivandrum, 600 different species and 150 hybrids of orchids are maintained. Orchids of 90 different genera and a number of hybrids of commercial orchids are also maintained at NRC for Orchids, Pakyong, Sikkim.

2.3.2. Botanical Gardens

These are protected areas where living plant specimen are conserved in fields or in protected structures provide significant information regarding mode of perpetuation, reproductive biology, taxonomical characters and propagation technique. At present, there are 13 botanical gardens in India maintaining a number of orchid species. About 43 species of orchids are collected and displayed in the orchid house of LloydBotanical garden, Darjeeling, West Bengal.

2.3.3. Herbal Gardens

In these areas, medicinal plant genetic resources are reared in a protected area for maintaining them generation after generation. Government of India, sanctioned funds for development of herbal gardens in 16 SAU's and research institutions in different agro-climatic regions of the country to conserve and maintain regional medicinal plants and endangered species (Gupta, 1993). In India, a networking among the herbal gardens is already developed at DMAPR where 83 such gardens with details of their species are registered.

2.3.4. Orchid Seed Gene Bank

Million of seeds are produced in a single capsule of orchid. However, they lack the functional endosperm and require specific mycorrhizal association for germination under natural conditions and consequently, the percentage of germination is low. Many of orchids have been germinated through asymbiotic technique where germination is found as high as 90%. The seeds of orchids are orthodox in nature and provide a great scope for long term storage through low temperature.

2.3.5. *In- vitro* Conservation

This technique can be used for revitalization of orchid germplasm affected by virus and virus-like diseases through apical meristem culture. As a matter of fact, orchids are first plants to be tissue cultured (Pritchard, 1989). There is need for studies on genetic stability to avoid the soma-clonal variants and slow growth cultures for longer storage duration to avoid frequent transfers.

2.3.6. Cryo-preservation

Cryo-preservation means long term storage or conservation of plant parts and reproductive materials at a very low temperature in the laboratory condition either in liquid nitrogen (-196^{o}C) or in vapour phase (-150^{o}C). Tissues/ explants of orchids can be cryo-preserved in liquid nitrogen cylinders as a long term storage procedure after proper treatment of cryo-protectants and Plant Vitrification Solutions. In our country, NBPGR has created the facility of cryobank where 2.5 lakhs of germplasm lines can be stored (Singh, 2005).

3. Bio-piracy

Bio Piracy defines the gaining of exclusive monopoly rights, over the biological material of one country by individuals, institutions or companies of other countries that ultimately leads to the denial of the rights, of the country of origin. Few objectives of the bio piracy are as follows (Akurugoda, 2013):

- Introduction of new plant varieties
- Introduction of new living organisms
- Production of pharmaceuticals
- Privatization of traditional knowledge

Further, bio- piracy is also called as the stealing of knowledge from traditional and indigenous communities or individuals. The term also means to suggest a breach of a contractual agreement on the access and use of traditional knowledge to the detriment of the provider and bio- prospecting without the consent of the local communities. Accordingly, it can be suggested that the bio piracy is a twofold phenomenon which includes traditional knowledge bio -piracy and genetic resources bio piracy. As such 'bio piracy' has described as a term to describe the

ways that corporations from the developed world claim ownership of, free ride on, or otherwise take unfair advantage of, the genetic resources and traditional knowledge and technologies of developing countries.

As a result of bio- piracy there are many negative effects on bio diversity such as extinction of endemic genotypes, genetic erosion of bio diversity, and privatization of bio treasures of the country. Further, this practice impairs the economy of the country as well. Bio- piracy is an extremely lucrative business and as a result most racketeers tend to exploit bio resources of developing countries and obtain patent for those. The emergence of monopoly over seeds and medicines through patents is becoming a major threat to farmers, livelihoods and public health.

3.1. Legal Regime Pertaining to Biodiversity and Bio-piracy

3. 1.1. International Law

Before 1994, the legalities of obtaining samples of plant, microbes and animals were straightforward. Anyone including researches, scientists, tourists, could simply reach a field site, collect samples and take them home because living species were regarded as the common heritage of mankind. On that basis, as common resources, private companies and individuals could take and use the resources without stating valid justifications or giving compensation. But, after the implementation of Convention on Bio Diversity (CBD), principles have been set in order to strengthen the national protection against bio- piracy.

3.1.2. Convention on Biological Diversity (1994)

Under Article 038 of the CBD, sovereign has national rights over biological resources. This principle favours developing countries to get better benefits from their biological resources and traditional knowledge pertaining to them. Further, according to Article 01 of the CDB the main objectives of the convention are, conservation of bio diversity, the sustainable use of its components and the equitable sharing of the benefits arising out of the utilization of genetic resources. Under Article 8(j), CBD needs each state party to respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity. CBD commits member countries to conserve and develop biological resources for sustainable use. Sustainable use of biological resources includes finding new drugs, crops and industrial products, while conserving the resources for future generation. Since CBD establishes the concept of bio- prospecting under article 15(5) which can be read with 15(7) and 19 of the CBD. According to article 15(5), access to genetic resources shall be subject to prior informed consent of the contracting party providing such resources, unless otherwise determined by that party.

Further, article 15(7) provides that each contracting party shall take legislative, administrative or policy measures, as appropriate, and in accordance with Articles 16 and 19 and, where necessary, through the financial mechanism established by Articles 20 and 21 with the aim of sharing in a fair and equitable way, the results of research and development and the benefits arising from the commercial and other utilization of genetic resources with the Contracting Party providing such resources. Such sharing shall be upon mutually agreed terms. Further, under CBD, it is expected that developing countries should receive a share in the benefits from biotechnology. Hence, state parties must take all practicable measures to promote and advance priority access on a fair and equitable basis to the results and benefits arising from biotechnologies based upon genetic resources. It can be argued that under the CBD prior informed consent is the standard for ensuring a fair and equitable access and benefit sharing agreement.

3.1.3. Cartagena Protocol (2003)

The *Cartagena Protocol on Bio- safety to the Convention on Biological Diversity* is an international agreement which aims to ensure the safe handling, transport and use of living modified organisms (LMOs) resulting from modern biotechnology that may cause adverse effects on biological diversity, taking also into account of human health hazards. It was adopted on 29 January 2000 and entered into force on 11 September 2003. The Protocol contains reference to

a precautionary approach and reaffirms the precaution language in Principle 15 of the Rio Declaration on Environment and Development.

3.1. 4. Nagoya Protocol (2010)

The *Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity* is an international agreement which aims at sharing the benefits arising from the utilization of genetic resources in a fair and equitable way, by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding, thereby contributing to the conservation of biological diversity and the sustainable use of its components.

3.1.5. Cites 1972

The Convention on International Trade in Endangered Species of Wild Fauna and Flora is an international agreement between governments. It ensures that international trade in specimens of wild animals and plants does not threaten their survival.

3.4.Measures of Bio-piracy in Some Orchids

The species of *Paphiopedilum*, a genus first described by E. Pfitzer in 1886 (Chowdhery, 1998), are commonly called as 'Lady's or Venus's Slipper' orchids. The plants are characterized by their luxuriant and multi-coloured flowers with shoe-shaped labellum or synsepalum, a structure unique to orchids that is formed by the fusion of two lateral sepals. The flowers have long vase life, and they remain on the plant for 60–90 days (Rao, 2006). The beautiful and long-lasting flowers of *Paphiopedilum*species are among the most expensive and horticulturally important among orchid flowers (Rao, 2006). The genus is native to south-east Asia, northern India, southern China, Myanmar, Thailand and New Guinea, with 80 species distributed worldwide (Chung *et al*, 2006). Out of the nine species of *Paphiopedilum*occurring in India, one (*P. druryii*) is endemic to South India, and the remaining eight species are found in different parts of north-east India, viz. Sikkim, Meghalaya, Manipur and Arunachal Pradesh (Chowdhery, 1998). All species of *Paphiopedilum*are highly endangered and are currently listed in Appendix I of CITES (Sun *et al*, 2011). Consequently, the international trade of these naturally occurring wild species is strictly prohibited. Many hybrids of *Paphiopedilum*with complex parentage exist in the international orchid markets (Sun *et al*, 2011). It is fairly easy to identify these species at flowering stage but very difficult in vegetative stage or as fragments. Moreover, it is difficult to differentiate their inter-species hybrids from the endangered *Paphiopedilum*species morphologically, especially in their vegetative stage. Hence, the illicit trade of the endangered species cannot be checked very easily.

The efficacy of DNA barcoding with matK as the signature sequence for the identification of closely related endangered species of Indian Paphiopedilums and also in elucidating the parentage of their inter-specific hybrids. The uniqueness of the generated matK sequences of the investigated species as evidenced by the BLAST results further confirmed their species discrimination capability. This approach could be used for generating DNA barcoding for all other endangered *Paphiopedilum* species. These barcodes once developed could become potent tools in the hands of enforcement agencies entrusted with the responsibility of checking their illicit trade. An effective check on their collection from wild, in turn, would help in their conservation *in -situ*.

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