

Review Article

Endangered Ornamental Plant Species in India and Strategy for Their Conservation- A Review

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Abstract

India is bestowed with diverse agroclimatic conditions and is one of the 12 mega-diversity rich centres harbouring a large floristic diversity among which a number of ornamental species are rare, threatened and endangered. Plant collection and identification of the Rare Endangered category Threatened (RET) listed climbing species of the Southern Western Ghats showed 33 species are RET species like *Ceropegia mannarana* Umam, *Gloriosa superba* L., *Celastrus paniculata* Willd., etc. This shows the need for effective conservation of ornamentals. Conservation strategies broadly involve two approaches, namely, *in situ* and *ex situ*, based on the site of implementation. It is now recognized that *ex situ* techniques can be efficiently used to complement *in situ* methods, and they may represent the only option for conserving certain highly endangered and rare species.

The different *ex situ* conservation approaches are Field Gene bank, Seed Gene bank, *and in vitro* Gene bank *etc.* Protected areas, sacred grooves *etc.* are some of the examples of *in situ* conservation method. A coordinated effort of researchers, research institutions, NGOs and communities is the need of hour for the best suitable conservation depending on the available resources.

Keywords: Biodiversity, endangered ornamentals, conservation, RET List

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Introduction

Biodiversity hotspots are areas with a high diversity of locally endemic species, which are species that are confined to particular region and not found or are rarely found outside the hotspot. IUCN (International Union for Conservation of nature and Natural Resources) mainly emphasize on the plants that are endemic (to India) and/or in the rare, endangered and threatened (RET) category. A rare species is one with small population that is not presently endangered but is at risk, an endangered species is one, which is in danger of extinction throughout all or of a significant portion of its range and a threatened species is one, which is likely to become endangered in foreseeable future [1-4]. India is one of the richest nations in the world with respect to floral diversity. There are over 45,500 recorded floral species in India, including 17,527 angiosperms, 67 gymnosperms, 1,200 pteridophytes, 2,500 bryophytes, 2,223 lichens, 14,500 fungi, 7,175 algae and 850 virus/bacteria. 7% of world's documented flowering plants are from India with the major families being Poaceae, Orchidaceae, Leguminosae, Asteraceae, Rubiaceae, Cyperaceae, Euphorbiaceae and Acanthaceae [5]. Among the flowering plants reported from India, one-third is considered endemic in the Western Ghats. Unfortunately because of the rapid urbanization, environmental pollution, habitat fragmentation *etc.* a large number of ornamental plant species are being included in the list of Rare, Endangered and Threatened (RET). Many of these endangered ornamental species including some orchids which possess medicinal properties urgently require to be conserved on priority basis. About 1220 species of orchids have been reported from India among which 300 species are rare, 150 are endangered and ornamental and 37 are of medicinal importance [6]. Leaves of endangered Red vanda (*Renanthera imscootiana*) can be make paste to treat skin diseases. Flower juice of endangered blue vanda (*Vanda coerulea*) generally used as eye drops for controlling glaucoma, cataract and blindness and leaves can be used a expectorant. So in this review attempts were made to create awareness regarding endangered ornamental plant species and methods to conserve them in order to save them from threat of extinction and preserving beauty of "Mother Nature".

Endemism and causes of endangerment

Endemism is the ecological state of a species being unique to a defined geographic location or habitat type. India is home to several endemic ornamental species owing to diverse ecosystems and habitats. Around 33.5 % of Indian flora has been identified as endemic and is distributed predominantly in the Indian Himalayas and Peninsular India. Species

endemism is one of the important criteria for plant biodiversity and setting up priority for conservation. It is estimated that there are 4,000 species of flowering plants known from the Western Ghats and 1,500 (nearly 38%) of these are endemic [7]. A large number of endemic plants are becoming endangered owing to habitat loss and associated fragmentation particularly in the tropics [8]. Collection for the horticultural trade and for private collections is the biggest single threat to the cacti [9] and in many areas, orchids [10] as well as cycads and ornamental species in many other families [11]. Due to rapid urbanization, deforestation and anthropogenic reasons pollution is increasing at an alarming rate and this also posing threat to plants for extinction. The Neelgiri (Blue Mountains) hills of South India are named after *Strobilanthes kunthianus*, locally known as 'Neelakkurinji' those flowers in profusion once in 12 years. This genus is monocarpic in nature and bear extremely beautiful flowers. The dying out of these species subsequent to flowering produces enormous combustible material within and around shola forests which are very susceptible to forest fires, occurrences of fire in these shola forests burn the seeds and hence it may cause extinction of narrow endemics. There are altogether 43 species of *Strobilanthes* known from the state of Kerala. Of these, 38 are endemic to Peninsular India [12].

Status of rare, endangered and threatened Indian ornamental flora

Some rare and endemic epiphytic orchid species from Western ghats are *Aerides ringens* Fischer, *Bulbophyllum sureum* Hook. f., *Dendrobium aqueum* Lindl., *Liparis elliptica* Weight., *Rhyncostylis retusa* Bl., *Vanda testacea* Lindl., *Xenikophyton seemeanum* Reich, *Eria nana* A. Rich. etc., [13]. A total of 138 tree species belonging to 38 families have been found to be endemic to Wynad district of Kerala [14]. These include *Dillenia bracteata* Wight, *Magnolia nilagirica* (Zenk.), *Goniothalamus cardiopetalus* (Dalz.) Hook. f. and Thoms, *Meiogyne pannosa* (Dalz.) Sinclair, *Miliusa nilagirica* Bedd, *Orophea uniflora* Hook. f. and Thoms, *Polyalthia fragrans* (Dalz.) Bedd, *Casearia rubescens* Dalz, *Calophyllum austroindicum* Kosterm. ex Stevens, *Ixora elongata* Heyne ex G. Don etc. Plant collection and identification of the Rare Endangered Threatened (RET) listed climbing species of the Southern Western Ghats showed 33 species are RET species like *Ceropegia mannarana* Umam, *Gloriosa superba* L., *Celastrus paniculata* Willd., *Aganosma cymosa* G. Don, *Passiflora leschenaultii* DC etc. [15].

Table 1 Endangered ferns of India [16]

List of endangered taxa from the Western Ghats	List of endangered taxa from the Western Ghats
<i>Adiantum lomesam</i> Nayar & Geevar.	<i>Cheilanthes duthiei</i> Baker.
<i>Ampelopteris prolifera</i> (Retz.) Copel.	<i>Adiantum edgeworthii</i> Hooker
<i>Anemia wightiana</i> Gard.	<i>Asplenium anogrammoides</i> Christ.
<i>Anisocampium cumingianum</i> Presl.	<i>Botrychium lanuginosum</i> (L.)
<i>Asplenium affine</i> Sw.	<i>Cheilanthes dubia</i> Hope.
<i>Cheilanthes rufa</i> D.Don.	<i>C. persica</i> (Bory) Mett. ex Kuhn.
<i>Dryopteris approximata</i> Sledge	<i>Osmunda japonica</i> Thunb.
<i>Grammitis attenuata</i> Kze.	<i>O. regalis</i> L.
<i>Helminthostachys zeylanica</i> (L.)Hook.	<i>Woodsia andersonii</i> (Beddome) Christ
<i>Huperzia hamiltonii</i> (Spring)Trev.	<i>Pteris wallichiana</i> Agardh
<i>Hypodematum crenatum</i> (Forssk.)Kuhn	<i>Pellea subfurfuracea</i> (Hooker) Ching
<i>Lycopodium japonicum</i> Thunb.	<i>Loxogramme parallela</i> Copel.
<i>Polystichum subinerme</i> (Kze.) Fras. –Jenk.	<i>Dennstaedtia wilfordii</i> (Moore) Christ.
<i>Tectaria periya</i> Nayar & Geevar	<i>D. scabra</i> Wall. ex Moore.

Table 2 Endangered Rhododendrons of India [17]

Sl. No.	Botanical name	Habit	Status
1	<i>Rhododendron pumilum</i>	Epiphytic shrub	Endangered
2	<i>R. maddenii</i>	Shrub	Rare
3	<i>R. kendrickii</i>	Large shrub/tree	Rare
4	<i>R. neriiflorum</i> ssp. <i>Phaedropum</i>	Large shrub/tree	Threatened
5	<i>R. falconeri</i> ssp. <i>Eximium</i>	Large tree	Endangered
6	<i>R. hookeri</i>	Shrub/small tree	Rare
7	<i>R. megeratum</i>	Dwarf shrub	Rare
8	<i>R. tanastylum</i>	Shrub/small tree	Rare
9	<i>R. keysii</i>	Shrub/small tree	Rare

Table 3 Endangered ornamental plants of Jammu & Kashmir Region, North-West Himalaya [18]

Name of the species	Family	Characteristics	Cause of threat
<i>Habenaria intermedia</i>	Orchidaceae	A handsome orchid found in temperate forest fringes and grassy meadows. Tuberos roots are harvested for medicine	Habitat Loss
<i>Meconopsis aculeata</i>	Papaveraceae	Queen of Himalayan Flowers, It is locally called Gul-Neelmi because of its sky blue flowers	Degradation of soil due to over grazing, deforestation
<i>Eremostachys superba</i>	Lamiaceae	Ornamental herb of Nandni Wildlife Sanctuary, Sunderbani	Anthropogenic pressure due to soil erosion, soil compaction and loss of moisture
<i>Gentiana kurroo</i>	Gentianaceae	Handsome gentian of temperate Chir pine and oak forests which flowers during Sep-Oct	Habitat loss, dam building, over-exploitation, forest fires and illegal trade

Table 4 Some Plants of High Conservation Significance in Uttarakhand Himalaya [19]

Name of the species	Family	Characteristics	Cause of threat
<i>Phaius tankervilleae</i>	Orchidaceae	A ground orchid, large showy inflorescence	Heavy exploitation in the past for ornamental purposes
<i>Wallichia densiflora</i>	Arecaceae	A dwarf palm, high ornamental value	Exploitation for ornamental purpose
<i>Trachycarpus takil</i>	Arecaceae	Ornamental Palm	Use of leaves for thatching, brooms and ornamental purposes and also due to fires
<i>Cyathea spinulosa</i>	Cyatheaceae	Only tree fern found in the Himalayan region	Population on a stream across Gopeswar-Tangsa Road was washed off in a landslide in 2007

Table 5 Some Threatened and Endemic orchids of Sikkim and their altitudinal distribution [20]

Sl.No.	Species	Habitat	Altitude Range
1	<i>Bulbophyllum trichocephalum</i> var. <i>capitatum</i> S.Z. Lucksom	Lithophytic	800 – 1000 m
2	<i>Calanthe anjanii</i> S.Z.Lucksom	Terrestrial	2000 – 2500 m
3	<i>Calanthe keshabii</i> S.Z.Lucksom	Terrestrial	2000 – 2600 m
4	<i>Coelogyne pantlingii</i> S.Z. Lucksom	Epiphyte	2100 – 2500 m
5	<i>Malaxis saprophyta</i> (K&P) Tang & F.T.Wang	Terrestrial	1200 m
6	<i>Cymbidium whiteae</i> King & Pantling	Epiphyte	800 – 2000 m
7	<i>Goodyera dongchenii</i> S.Z.Lucksom	Epiphyte	2000 – 2300 m
8	<i>Gastrochilus sonamii</i> S.Z.Lucksom	Epiphyte	2300 – 2700 m
9	<i>Liparis chungthangensis</i> S.Z.Lucksom	Lithophyte	1800 – 2000 m
10	<i>Liparis lydiaii</i> S.Z.Lucksom	Epiphyte	1000 – 1300 m
11	<i>Liparis pygmaea</i> King & Pantling	Lithophyte	4350 m
12	<i>Oberonia kingii</i> S.Z. Lucksom	Epiphyte	1000 m

Conservation strategies

Germplasm conservation is defined as the management and use of biosphere resources which may yield the sustainable benefit to present generations while maintaining its potential to meet the needs of future generations [21]. Conservation of plant biodiversity is an integral part of biodiversity conservation and is a need of the hour. Conservation strategies broadly involve two approaches, namely, *in situ* and *ex situ*, based on the site of implementation. *In situ* conservation is the management of species within their natural ecosystems and habitats. This is traditionally used / mostly used traditional conservation approach in case of wild species. However, it is now recognized that *ex situ* techniques can be efficiently used to complement *in situ* methods, and they may represent the only option for conserving certain highly endangered and rare species [22]. The different *ex situ* conservation approaches are Field Gene bank, Seed Gene bank, *in vitro* gene bank, Cryo-Genes bank, Pollen bank and DNA Bank.

With widespread awareness on conservation of plant biodiversity in recent days, many organizations have started working towards conservation and management of endemic and threatened plant species. NBPGR, New Delhi is one of the organizations which is equipped and enriched with the essential conservation facilities including seed gene bank, *in vitro* repository, cryobank, field gene bank, etc.

In Situ Conservation

In situ conservation is the management of species within their natural ecosystems and habitats. Viable populations of the target species are maintained in their natural surroundings with minimal human intervention [23].

Protected Areas (PAs) in India

The term 'protected area' is defined in the Convention on Biological Diversity (Article 2) as 'a geographically defined area, which is designated or regulated and managed to achieve specific conservation objectives'. They include national parks and nature reserves, sustainable use reserves, wilderness areas and heritage sites [24]. For the effective conservation in PAs, IUCN has categorized them according to management objectives. In India, a network of 668 PAs has been established comprising of 102 national parks, 515 wildlife sanctuaries, 47 conservation reserves and 4 community reserves [25]. In addition, sanctuaries in Tura range in Garo Hills of Meghalaya for the conservation of *Rhododendrons* and orchids in Sikkim have been established. With an objective of an ecosystem-level conservation, the government of India has established 18 biosphere reserves [26] which protect large land and/or coastal environments and often include several protected areas within. Sacred grove is another form of *in situ* conservation which refers to the small patches of native vegetation traditionally protected and managed by local communities. Himachal Pradesh, Karnataka, Kerala, Maharashtra, Andhra Pradesh, West Bengal and Chhattisgarh are very prominent states for sacred grooves. About 13,928 sacred grooves presently exist in India [27]. A large number of official and NGO's are working for conservation of plant biodiversity, some of them includes Convention on International Trade in Endangered Species of wild fauna and flora (CITES), the Convention on Biodiversity (CBD), the International Union for Conservation of Nature (IUCN), the Ramsar Convention on Wetlands, the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Convention to Combat Desertification (UNCCD), the United Nations Commission on Sustainable Development (UNCSD), the International Treaty on Plant Genetic Resources (ITPGR), *in situ* conservation of medicinal plants by the NGO Foundation for Revitalisation of Local Health Traditions (FRLHT) in medicinal plant conservation areas established in the South Indian states [28]

Ex Situ Conservation

Botanical Gardens

In India, there are over 140 botanical gardens, including those attached to university botany departments, public parks and agri-horticultural gardens [29]. Over 38 botanical gardens conserve around 246 rare and threatened plants of India as living plant collections, and among these, 32 species are catalogued in the Indian Red Data Books [30]. Several plants species of botanical interest such as *Rafflesia*, several orchids, Bromeliads, *Nepenthes* and other insectivorous taxa and aquatic species including *Victoria amazonica*, *Nymphaea gigantea*, *Nelumbo nucifera* and *Euryale ferox* which can only be protected in botanical gardens under *ex situ* conditions. In India there are very few fernaries to conserve the rare and endangered ferns eg. Kodaikanal Botanic Garden, Gurukula Botanic Garden, Nadugani Gene pool forests and National Botanical Garden.

Arboreta

Arboreta are special spaces set apart for the cultivation and display of a wide variety of different kinds of trees and shrubs. For example, in India, the Ooty arboretum has both indigenous and exotic tree species such as *Hypericum hookerianum* and *Alnus nepalensis*. In addition, the Regional Plant Resource Centre (RPRC), Bhubaneswar, Odisha, has an arboretum with 1,430 species of trees [31].

In Vitro Conservation

In vitro techniques are important tools for the conservation of plant biodiversity especially for crop species having Non- orthodox seeds (where seeds are desiccation/freezing sensitive), vegetatively propagated crop species and rare and endangered plant species. *In vitro* culture techniques ensure the production and rapid multiplication of disease-

free quality planting material. For long-term conservation, cryopreservation (storage in liquid nitrogen at $-196\text{ }^{\circ}\text{C}$) is the best option which allows the storage of germplasm by ceasing the complete metabolic activity, for extended periods. Botanical survey of India (BSI) is pioneer in collecting and conserving important rare and endangered ornamental plants and their large scale mass propagation using biotechnological tools.

Table 6 Endemic and threatened species stored in National Gene Bank showing orthodox seed storage behaviour [32]

Sl. No.	Family	Scientific name
1	Acanthaceae	<i>Barleria prionitis</i>
2	Apocynaceae	<i>Tabernaemontana haeyneana</i>
3	Asteraceae	<i>Saussurea costus</i>
4	Calophyllaceae	<i>Calophyllum inophyllum</i>
5	Cycadaceae	<i>Cycas bedomi</i>
6	Fabaceae	<i>Dalbergia latifolia</i>
7	Lythraceae	<i>Woodfordia fruticosa</i>
8	Ranunculaceae	<i>Aconitum ferox</i>
9	Santalaceae	<i>Santalum album</i>
10	Flacourtiaceae	<i>Flacourtea indica</i>

Table 7 *In vitro* techniques available in endemic and threatened ornamentals [33]

Explants used	Botanical name
Axillary Bud	<i>Gerbera aurantiaca</i> , <i>Rumex acetosella</i> , <i>Wrightia tomentosa</i> , <i>Valeriana wallichii</i>
Corm	<i>Gloriosa superba</i>
Hypocotyl, cotyledon	<i>Meconopsis simplicifolia</i>
Seedling	<i>Oncidium cathariensis</i>
Shoot tips, nodes	<i>Vanda coerulea</i> , <i>Gentiana kurroo</i>
Shoot tips, axillary buds and segment of young leaves	<i>Renanthera imschootiana</i>
Nodal shoot	<i>Aconitum napellus</i> , <i>Aconitum noveboracense</i>
Node, internode, leaf	<i>Rotula aquatic</i>
Stem	<i>Celastrus paniculatus</i> , <i>Dendrobium moschatum</i>
Nodal segment/axillary bud	<i>Ceropegia fantastica</i> , <i>Daphne cneorum</i> , <i>Coronopus navastii</i> , <i>Frerea indica</i> , <i>Huernia hystrix</i>

Achievements of Botanical Survey of India

About 2,865 saplings, seeds, propagules belonging to 376 taxa of rare, threatened, endemic and economic plant species, including wild relatives of cultivated plants, aquatic plants, orchids, palms, canes, bamboos, ferns and fern-allies etc., were collected for introduction in AJC Bose Indian Botanic Garden, Howrah and associated botanic gardens of different Regional Centre. Artificially pollinated, an IUCN red listed endangered species, Experiment on Micropropagation of following mentioned threatened species has been initiated – *Ilex khasiana*, *Cymbidium tigrinum*, *Armadorum senapatianum*, *Rhododendron coxianum*, *Paphilpedilum hirsutissimum*. Successfully transferred 40 plantlets of *Cymbidium tigrinum* to greenhouse. 219 plantlets of *Armadorum senapatianum* were planted in sphagnum, wood chips in different ratio and maintained in greenhouse. Five plantlets of *Rhododendron coxianum* were transferred to greenhouse and maintained. Seed germination experiment was conducted in *Indopiptadenia oudhensis* but all the seeds failed to germinate. Screening of plant growth regulators for the induction of multiple shoots, callus induction in *Indopiptadenia oudhensis* was done. Micropropagation protocol has been standardized for *Pittosporum eriocarpon* [34].

Measures for 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 [35].

Legislative Measures

According to The Convention of International Trade on Endangered Species (CITES) orchids are treated as protected species. In India, 3 genera and 11 species are being treated as protected under Schedule VI of Wild Life Protection Act 1972 and under CITES Appendix-I. Those species are *Paphiopedilum charlesworthii*, *P. fairrieanum*, *P. hirsutissimum*, *P. spicerianum*, *P. insigne*, *P. venustum*, *P. wardii*, *P. druryi*, *Renanthera imschootiana* and *Vanda coerulea*. However, except *P. druryi* which is reported from Kerala, all other species of *Paphiopedilum* belong to Northeast India. Appendix-I includes threatened and extinct species. Species which may be threatened unless trade is strictly regulated listed in Appendix-II of CITES. Trade in wild and propagated specimen is allowed subject to licensing

In situ conservation

Biosphere Reserve

India has 18 biosphere reserves, namely, Achanakmar-Amarkantak, Agasthyimalai, Cold Desert, Dihang-Dibang, Dibru Saikhowa, Great Nicobar, Gulf of Mannar, Kachchh, Khangchendzonga, Manas, Nanda Devi, Nilgiri, Nokrek, Pachmarhi, Seshachalam Hills, Simlipal, Panna and Sunderbans, for conservation of endemic, endangered and vulnerable orchid species.

National Parks

Presently, there are 98 national parks in India. About 96 different species of orchids are found in Simlipal National Park of Orissa. About 150 different species of orchids are conserved in Buxa Tiger Reserve of West Bengal.

Ex Situ Conservation

In India, Botanical Survey of India is maintaining three National Orchidaria and Experimental Gardens, one each at Yercaud (Tamil Nadu), Howrah (West Bengal) and Shillong (Meghalaya) where representative species of the region are cultivated. Similarly, Arunachal Pradesh State Forest Research Institute is maintaining a 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 centres have been established (1- Kodagu, 2- Kudremukh and 3-Dandeli) [36]. A natural orchidarium for the conservation of orchid germplasm has also been planned in Bangalore within Lal Bagh Botanical Garden.

Field Gene Banks

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.

Botanical Gardens

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 Lloyd Botanical garden, Darjeeling, West Bengal.

Conclusion

As the time is goes by intervention of the man with nature is increasing. The uncontrollable increase in population which demands the space and other needs is aggravating this problem. On the other hand increased pollution, natural calamities etc. bringing threat to biodiversity and causing endangerment to several wild species which are also useful. Addition of the new species into RET list time by time is proving this fact. Plants with ornamental value are not exceptional for this. As the part of biosphere it is our responsibility to protect its diversity which in turn helps us to be benefited from them and sustain on this earth. The conservation of such endangered species falls mainly into two categories *viz. in situ* and *ex situ*. In this regard Indian government has been taken the efforts by establishing several

national parks, natural sanctuaries, biosphere reserves etc. Several public and private research institutions and NGOs are also working in this area. The future challenges for the conservation of such rare and threatened species are scientific, technical, socio-economical, legal and political including public awareness. A coordinated effort of researchers, research institutions, NGOs and communities is the need of the hour that can jointly make an effort for the best suitable conservation depending on the available resources and also in creating the awareness among public.

References

- [1] IUCN Plant Red Data Book, (Royal Botanic Garden, Kew, England). 1978.
- [2] Bryde, M.B. (1979). Information needed to use the endangered species Act for plant conservation, Geographical Data Organization, Rare plant conservation, New York.
- [3] Smith, E.V. (1980). Laws and information needs for listing plants. *Rhodora*, 1980, 82, 193.
- [4] Nayar, M.P., Sastry, A.R.K. (1990). Red Data Book of Indian Plants, Botanical Survey of India, Howrah (Calcutta), India.
- [5] Goyal, A.K., Arora, S. (2009). India's fourth national report to the convention on biological diversity. Ministry of Environment and Forests, Government of India, New Delhi.
- [6] De, L. C., Medhi, R. P. (2014). Diversity and Conservation of Rare and Endemic Orchids of North East India - A Review. *Indian Journal of Hill Farming*, 27: 138-153.
- [7] Nair, N.C., Daniel, P. (1986). The floristic diversity of the Western Ghats and its conservation: A review. *Proceedings of the Indian Academy of Sciences (Animal Science/Plant Science) Supplement*, pp. 127-63.
- [8] Ter Steege H., Pitman, N.C.A. Killeen, T.J. (2015) Estimating the global conservation status of more than 15,000 Amazonian tree species. *Sci. Adv.* 1, e1500936.
- [9] Goettsch, B., Hilton-Taylor, C., Cruz-Piñon, G. (2015). High proportion of cactus species threatened with extinction. *Nat. Plants*, 1, 15142.
- [10] Phelps, J., Webb, E.L., (2015). Invisible wildlife trades: southeast Asia's undocumented illegal trade in wild ornamental plants. *Biol. Conserv.* 186, 296-305.
- [11] Sharrock, S., Oldfield, S., Wilson, O. (2014). Plant Conservation Report 2014: a Review of Progress in Implementation of the Global Strategy for Plant Conservation, Secretariat of the Convention on Biological Diversity and Botanic Gardens Conservation International, Richmond, U.K.
- [12] Sasidharan N. (2000). In: M. Sivadasan & K.V. Mohanan (eds.) *Biodiversity and Ecology: Concepts and Facts*, 33-37.
- [13] De, L.C. and Singh, D.R. (2015). Biodiversity, Conservation and bio-piracy in Orchids – an overview. *Journal of Global Biosciences*, 4(4): 2030-43.
- [14] Volga, V.R., Ratheesh, M.K., Narayanan, N. and Kumar, A. (2013). Endemic trees of western ghats—a check list from wayanad district, Kerala, India. *International Journal of Plant, Animal and Environmental Sciences*, 3(2): 197-202.
- [15] Sarvalingam, A., Rajendran, Arumugam. (2016). Rare, Endangered and Threatened (RET) climbers of Southern Western Ghats, India *Revista Chilena de Historia Natural*, 89(9): 2-5.
- [16] Benniamin, A. Irudayaraj, V., Manickam, V.S. (2008). How to Identify Rare and Endangered Ferns and Fern Allies. *Ethnobotanical Leaflets* 12: 108-117.
- [17] Shaily Menon, Mohamed Latif Khan, Ashish Paul, A. (2012). Townsend Peterson., *Rhododendron Species in the Indian Eastern Himalayas: New Approaches to Understanding Rare Plant Species Distributions*. Peer Reviewed Publications., pp 38.
- [18] Sharma, O.P. (2008). Threatened Plants of Jammu Region, North-West Himalaya and Strategies for Their Conservation. *Special Habitats and Threatened Plants*, 11, 37-40.
- [19] Manoj Chandran. (2008). Some Plants of Taxonomic and High Conservation Significance in Uttarakhand Himalaya. *Special Habitats and Threatened Plants*, 11, 45-50.
- [20] Lucksom. S.Z. (2008). Endemic and Threatened Orchids of Sikkim and Their Conservation. *Special Habitats and Threatened Plants*, 11, 63-68.
- [21] IUCN/UNEP/WWF. (1980). *World conservation strategy: living resources conservation for sustainable development*. IUCN, Gland.
- [22] Ramsay, M.M., Jackson, A.D., Porley, R.D. (2000). In: BGCI (ed) *Proceedings of the II European Botanic Gardens Congress EuroGard 2000*. Las Palmas de Gran Canaria, Spain, pp 52-57.
- [23] UNEP, (1992). *Convention biological diversity*. United Nations Environment Programme, Nairobi,

- [24] Chape, S., Spalding, M., Jenkins, M. (2008). The world's protected areas: status, values and prospects in the 21st century. UNEP-WCMC, University of California Press, Berkeley.
- [25] MoEF. c2014a, Protected area network in India. In: Public Information. Ministry of Environment and Forests. Government of India. <http://envfor.nic.in/public-information/protected-area-network>.
- [26] MoEF c2014b, List of biosphere reserves, their area, date of designation and its location. In: Ministry of environment and forests. Government of India. <http://www.moef.nic.in/sites/default/files/brs-list.pdf>.
- [27] De, L.C., Rao, A.N., Singh, D.R. (2016). Endangered Orchids and Their Conservation in North East India. Springer Science+Business Media Singapore, J. Purkayastha (ed.), Bioprospecting of Indigenous Bioresources of North-East India.
- [28] FRLHT. (2006). Conservation and adaptive management of medicinal plants – a participatory model: medicinal plants conservation areas and medicinal plants development areas.
- [29] Chakraverty, R.K., Mukhopadhyay, D.P. (1990). A directory of botanical gardens and parks in India. Botanical survey of India, Calcutta.
- [30] Chakraverty, R.K., Pandey, D.S. Mukhopadhyay, D.P. (2003). Directory of plants in the botanic gardens of India. Botanical Survey of India, Kolkata.
- [31] Jalli, R., Aravind, J., Pandey, A. (2015). Conservation and Management of Endemic and Threatened Plant Species in India: An Overview. Plant Biology and Biotechnology: Volume II: Plant Genomics 461 and Biotechnology, DOI 10.1007/978-81-322-2283-5_24, © Springer India, p 461-486.
- [32] NBPGR. PGR portal. (2012). In: National Bureau of Plant Genetic Resources. <http://www.nbgr.ernet.in/PGRPortal>.
- [33] Sarasan V, Cripps R, Ramsay MM, Atherton C, McMichen M, Prendergast G, Rowntree JK. (2006). Conservation in vitro of threatened plants—progress in the past decade. *In Vitro Cell Dev Biol Plant* 42:206
- [34] Report, Ministry of Environment, Forest and Climate change, 2014-2015, pp-2-6
- [35] Hegde SN. (2012). Ex-situ and in situ conservation of orchids in India. *J Orchid Soc India* 26(1-2):1-4
- [36] Rao, T.A., Sridhar S. (2007). Wild Orchids of Karnataka-a pictorial compendium. INCERT, Bangalore.

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