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LEGISLATIONS FOR ORCHID CONSERVATION IN INDIA AND DEVELOPMENT OF NATIONAL RED LIST AS PER IUCN CRITERIA

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Abstract

Present communication describes the threat factors and regulatory mechanism for conservation of Orchids in India. Various issues related to development of national Red List (as per International Union for Conservation of Nature and Natural Resources *i.e.*, IUCN criteria) of the entire Orchid family are also discussed.

Introduction

ORCHIDACEAE IS one of the largest families of flowering plants; there are about 1300 taxa in India of which nearly 400 taxa are endemic to India. The stunningly beautiful flowers, with gorgeous colors, unique shapes, curious ornamentation and prolonged shelf-life have made orchids one of the most sought after flowering plants. These are variously exploited for their high horticultural and medicinal values. They are highly compatible to hybridization in nature as well as in artificial crossing experiments. The resultant hybrid flowers possess enhanced beauty, quality and longevity. Many of the wild species (not much showy of their own) have been used as one of the parents to produce excellent and high demand hybrids. Orchids inhabit fragile ecosystem and are extremely sensitive to their micro-environment and their reproduction largely depend on the availability of suitable pollinators and suitable mycorrhizal associations. Unfortunately, it is the beauty of the orchid flowers, which is endangering their very existence. The human lust and temptation to exploit orchids has pushed a large number of species under various threat categories. Many Global and National legislation like CITES; Negative List of Export; Wildlife Protection Act, 1972, Biological Diversity Act, 2002 *etc.*, exist to impart some regulation in collection and trade of orchids from wild, but a comprehensive document on global or national threat status of individual orchid species is lacking for implementing an effective conservation initiative.

IUCN Red List is the world's most comprehensive information source for extinction risk of species at global level and is based on the best scientific information available. It provides a global context for the establishment of conservation priorities at the national or local level. The entire Orchidaceae family has been regulated through different legislations for its conservation irrespective of the quantum of threat posed against individual species. It has been observed over the years that taxonomic concept of many species has changed; many species have wide range of distribution, quite common locally and do not require immediate conservation measures. Further, many more species which are actually known from a single historic collection are not assigned with the threatened status. The threat level to Indian orchids in above lists is not evaluated with respect to a widely accepted system. Thus, it is the need of the hour to develop a national red list of Indian Orchids by applying the latest guidelines and criteria of IUCN. Present communication deals with the various factors, challenges and methodology involved in red listing of Indian Orchids as per IUCN guidelines and criteria. The threat factors and regulatory mechanism for conservation of orchids in India are also briefly described.

Threat Factors

The various threat factors associated with Indian Orchids are –

- Loss of habitat from urbanization, hydro-electric power projects and construction of roads.
- Development of agricultural land through Jhoom and Terrace cultivation.
- Many highly medicinal terrestrial orchid species like *Dactylorrhiza hatagirea*, *Gymnadenia orchidis*, *Malaxis muscifera*, *Malaxis acuminata*, *Habenaria intermedia*, *Platanthera edgeworthii etc.*, are subjected to live-stock grazing in their natural habitat.
- Natural calamities.
- Non-availability of pollinators.

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- Climate change and shifting of species to alternate habitat condition.
- Smuggling by orchid traders.
- Over-enthusiastic and un-planned collection by students and researchers.

Conservation

During 1980, the International Union for Conservation of Nature and Natural Resources (IUCN) launched the "World Conservation Strategy" (WCS) which defined conservation as "the management of human use of the Biosphere so that it may yield the greatest sustainable benefit to present generation while maintaining its potential to meet the needs and aspiration of the future generation as well." The WCS had three main objectives *i.e.*, : 1) Maintenance of essential ecological process and life support systems; 2) Preservation of genetic diversity; and 3) Sustainable utilization of natural resources and ecosystems.

Conservation efforts in India were streamlined in the last quarter of the Nineteenth Century when several legislations were enacted for the protection of flora and fauna. The Wild-life Protection Act, 1972, the Biological Diversity Act, 2002 and The Biological Diversity Rules, 2004 are the landmark steps towards conservation of our biological resources. Trade on several important species is being regulated through various conventions like Convention on Biological Diversity (CBD), Convention on International Trade of Endangered flora and fauna (CITES) *etc*. Ministry of Environment and Forests, Government of India has notified many important and highly exploited species under Negative list of export and Schedule 38 of Biological Diversity Act, thereby regulating their exploitation from wild. International Union for Conservation of Nature and Natural Resources (IUCN) is engaged in Red Listing of all living organisms in the world by evaluating the associated threat status so that a suitable strategy can be framed for their conservation. A suitable conservation strategy can be framed if we have data on the following aspects.

- Inventory of the orchid diversity of the entire country with study on their biology.
- List of horticultural and medicinal species, their natural area of distribution and extent of occurrence.
- Estimation of annual demand and the load on wild population.
- Developed protocol for artificial propagation like seed and tissue culture to conserve the germplasm and fulfill the demand.
- *In situ* conservation.
- *Ex situ* conservation.
- Global and National legislation.

Inventory of Indian orchids are available in various checklists published by Karthikeyan *et al.* (1989); Sathish Kumar and Manilal (1994); Singh *et al.* (2001) and Misra (2007). But clear taxonomic concept of a group can be understood through revisionary studies. Nearly 50% of the Indian Orchid species have been/ are being revised for Flora of India [*Coelogyne* (Das and Jain, 1980); *Oberonia* (Ansari and Balakrishnan, 1990); *Eria* (Agrawala, 2009; Agrawala and Chowdhery, 2009; 2013a,b); Sub-tribe *Goodyerinae* (Bhattacharjee, 2010); *Habenaria* (Chaudhury, 2010); *Dendrobium* (Sabapathy, 2013); *Calanthe* (ongoing at CAL); Sub-families *Apostasioide*, *Cypripedioideae*, Tribe *Nervilieae*, Tribe *Cymbidieae*, Sub-tribe *Habenariinae* (ongoing at BSD)]. Published regional treaties and checklist on orchid flora of various states are available [Andhra Pradesh (Misra *et al.*, 2008); Arunachal Pradesh (Chowdhery, 1998); Andaman and Nicobar Islands (Pandey and Diwakar, 2008); Jharkhand (Kumar *et al.*, 2007); Kerala (Sathish Kumar and Manilal, 2004); Orissa (Misra, 2004); Meghalaya (Kataki, 1986); Tripura (Deb, 1983); Manipur (Sathish Kumar and Suresh Kumar, 2005); Sikkim (King and Pantling, 1898; Lucksom, 2007; Pearce and Cribb, 2002; Shukla *et al.*, 1998); West Bengal (Kumar *et al.*, 2013; Yonzone *et al.*, 2012;) Uttarakhand (Chowdhery and Agrawala, 2013; Jalal *et al.*, 2008); Himachal Pradesh (Vij *et al.*, 2013); Nagaland (Hynniewta *et al.*, 2000); Maharashtra (Santapau and Kapadia, 1966); North-West Himalaya (Deva and Naithani, 1986; Duthie, 1906)]. The highly valuable genera in terms of horticultural importance are *Cymbidium*, *Cypripedium*, *Dendrobium*, *Paphiopedilum*, *Phalaenopsis*, *Vanda*, Jewel Orchids, *Coelogyne etc*. and those with medicinal importance are *Dactylorrhiza*, *Eulophia*, *Gymnadenia*, *Habenaria*, *Malaxis*, *Platanthera etc*. Protocol for artificial propagation has been developed for many important species and being practised in Botanical Survey of India and other organizations. The protected areas like Biosphere Reserves, National Parks, Wildlife Sanctuaries *etc*. and sacred grooves act as *in situ* conservation sites for the inhabitant orchid species. Nearly 300 species are maintained and multiplied *ex situ* in campus gardens and orchidaria of Botanical Survey of India at Shillong, Yercaud and other regional centres. Besides this, several other institutes, and private nurseries are also having good number of orchid

species under their conservatories. Government of India, Ministry of Environment and Forests, has trained many students and stake holders in orchid taxonomy and conservation under the Flora of India programme of BSI and AICOPTAX project on Orchidaceae at BSI and other institutes.

The Legislations

CITES

The Convention on International Trade in Endangered Species of Wild Fauna and Flora is an international agreement between governments, aimed to ensure that international trade in specimens of wild animals and plants does not threaten their survival. The text of the Convention was agreed at a meeting of representatives of 80 countries in Washington, D.C., the United States of America, on 3 March 1973, and on 1 July 1975 CITES entered in force. Appendix I of CITES lists species that are threatened to be extinct and prohibits international trade of these species except when the purpose of the import is not commercial (Article III), for instance for scientific research. In these exceptional cases, trade may take place provided it is authorized by the granting of both an import permit and an export permit (or re-export certificate). Article VII of the Convention provides a number of exemptions to this general prohibition. The orchid species listed under this appendix are *Vanda coerulea* (Blue Vanda), *Renanthera imschootiana* (Red Vanda) and all species under the genus *Paphiopedilum* (Fig.1a-h). Moreover, the entire family Orchidaceae is included under Appendix II which contain species not necessarily now threatened with extinction but that may become so unless trade is closely controlled. It also includes so-called "look-alike species", *i.e.* species whose specimens in trade look like those of species listed for conservation reasons (Article II, paragraph 2 of the Convention). International trade in specimens of Appendix-II species may be authorized by the granting of an export permit or re-export certificate. No import permit is necessary for these species (although a permit is needed in some countries that have taken stricter measures than CITES requires). Permits or certificates should only be granted if the relevant authorities are satisfied that certain conditions are met, above all that trade will not be detrimental to the survival of the species in the wild. (Article IV of the Convention);

The Wildlife Protection Act, 1972

It is an Act of the Parliament of India enacted for protection of plants and animal species in their natural habitats. Several Protected Areas were designated under this act to protect collection of specimens from wild. A Wild-life Sanctuary has been named as Orchid Sanctuary at Sessa, West Kameng district of Arunachal Pradesh and another at Deorali, Sikkim to indicate the rarity and conservation dependence of Orchids. Blue Vanda, Red Vanda and all Lady's Slipper Orchids are protected under Schedule VI, Section-2 of Wildlife Protection Act, 1972.

Negative List of Export

In 1992, Ministry of Environment and Forests, Government of India has prepared a Negative List of plants for export which figures entire Orchidaceae in general and Blue Vanda, Red Vanda, All Lady's Slipper Orchids and *Dactylorhiza hatagirea* in particular. The species listed in this negative list are banned from export. The items which are restricted can be imported with a license (with its conditions) issued by Directorate General of Foreign Trade. The decisions regarding license for import/export of restricted items are taken in consultation with the various ministries/departments depending on the product. All such licenses are subject to the FTDR Act, 1992 and Foreign Trade Policies/ HBP 2009-14.

The Biological Diversity Act, 2002

It is an Act of the Parliament of India for preservation of biological diversity in India, and provides mechanism for equitable sharing of benefits arising out of the use of traditional biological resources and knowledge. The Act was enacted to meet the obligations under Convention on Biological Diversity (CBD), to which India is a party. Under Schedule-38 of Biological Diversity Act, several states have proposed many plant species (including large number of Orchids) to be declared as threatened and thereby regulate their collection from wild. 12 orchid species have been notified as threatened under this schedule and another 8 have been proposed (Table 1).

Certificate of Cultivation or Legal Procurement Certificate

Export of the following endangered and vulnerable orchid species requires *Certificate of Cultivation* or *Legal Procurement Certificate* from the designated authorities of the forest department as per Ministry of Environment and Forests, Government of India circular dated 04/10/2000.

- *Vanda coerulea* Griff. ex Lindl. [Blue Vanda]
- *Renanthera imschootiana* Rolfe [Red Vanda]
- *Eulophia cullenii* (Wight) Blume
- *Eulophia ramentacea* (Roxb.) Lindl. [= *E. dabia* (D.Don) Hochr.]

Fig. 1.a-h. Orchids included in APPENDIX-I of CITES: a, *Paphiopedilum hirsutissimum* (Hook.) Stein; b, *Paphiopedilum venustum* (Wall.) Stein; c, *Paphiopedilum fairrieanum* (Lindl.) Stein; d, *Paphiopedilum insigne* (Lindl.) Pfitz.; e, *Paphiopedilum spicerianum* (Rchb.f.) Pfitz.; f, *Paphiopedilum villosum* (Lindl.) Stein; g, *Renanthera imschootiana* Rolfe; h, *Vanda coerulea* Griff. ex Lindl.

- Lady's Slipper Orchids
- All Orchidaceae species

Why Red Listing is Required ?

It has been observed that all Indian orchids are included under various legislations for their conservation irrespective of the quantum of threat associated with individual species. But the assigned threat level is not evaluated as per a widely accepted system and not based on the best scientific data available on their taxonomy, population size, threat factors and rate of population decline, range of distribution *etc*. Many orchid species are not exploited in high scale; they are widely distributed and do not require immediate conservation measures. The taxonomic concept of many species is being changed with amplification of knowledge and new distribution areas are being discovered for many species. Additional information with respect to exploitation, threat, population size *etc*. are being accumulated. Therefore, all orchid species are required to be evaluated for possible exclusion/ inclusion in the red list and for setting conservation priorities.

The IUCN Red Listing

The IUCN Red List is world's most comprehensive information source for extinction risk of species. It is not just a list, but a compilation of the conservation status of species at the global level based on the best scientific information available. It is widely used to inform and influence biodiversity conservation and also to provide information and analyses on the status, trends and threats to species in order to inform and catalyze action for biodiversity conservation. It can be used both at regional and national level.

Any known taxa (at or below the species level) in this universe can be categorized under the 9 red list categories [Extinct (Ex), Extinct in the wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concerned (LC), Data Deficient (DD), and Not Evaluated (NE)] of IUCN. The IUCN has framed five Red Listing Criteria (A, Population size reduction; B, Geographic range; C, Small population size and decline; D, Very small and restricted population; and E, Quantitative analysis) to evaluate the threat status of any organism. Any one or all of these criteria can be used to assign the threat category. The tools and reference materials [IUCN Red List Categories and Criteria version 3.1, (2012a, second edition); Guidelines as per IUCN, 2013; Documentation standards and consistency checks for IUCN Red List assessments and species accounts, Version 1.1; Guidelines for application of IUCN (2012b) Red List Criteria at Regional and National Levels, version 4.0 *etc*.] for red listing can be found at the official website of IUCN *i.e.* www.iucnredlist.org. Data required for an effective red listing procedure can be summarized as follows:

- Solid and widely accepted taxonomic concept of the taxa to be assessed.
- Complete distribution range and geo-coordinates to plot the distribution maps for calculation of Extent of Occurrence (EOO) and Area of Occupancy (AOO).

Table 1. Notified and proposed orchid species under Schedule 38 of Biological Diversity Act, 2002.

Orchid Species			
Sr. No.	Notified		Proposed
1.	*Calanthe whiteana* King & Pantl.	1.	*Aphyllorchis alpina* King & Pantl.
2.	*Cymbidium whiteae* King & Pantl.	2.	*Corybas himalaicus* (King & Pantl.) Schltr.
3.	*Paphiopedilum fairrieanum* (Lindl.) Stein	3.	*Crepidium aphyllum* (King & Pantl.) A.N. Rao
4.	*P. wardii* Summerh.	4.	*Diplomeris hirsuta* (Lindl.) Lindl.
5.	*P.spicerianum* (Rchb.f.) Pfitz.	5.	*Flickingeria fugax* (Rchb.f.) Hawkes
6.	*P.druryi* (Bedd.) Stein	6.	*Paphiopedilum venustum* (Wall.) Stein
7.	*P.villosum* (Lindl.) Stein	7.	*Renanthera imschootiana* Rolfe
8.	*Pecteilis triflora* (D. Don) Tang & Wang	8.	*Vanda coerulea* Griff. ex Lindl.
9.	*Pleione hookeriana* (Lindl.) B.S. Williams		
10.	*P. maculata* (Lindl.) Lindl.		
11.	*Vanda thwaitesii* Hook.f.		
12.	*V. wightii* Rchb.f.		

- Population size and rate of decline (if any).
- Generation length of the taxa to be evaluated.
- Observed and plausible threats for the habitat or the taxa to be assessed.
- Any quantitative analytical data on rate of population reduction over past 10 years or three generations.

Role of a Red List Assessor

1. Compile all currently available data on population status, distribution, ecology, use/trade, threats & conservation measures:

- Across the species entire global range
- Data may come from published studies, unpublished reports, grey literature, personal knowledge, *etc.*

2. Assign a Red List category and criteria based on the available information.

3. Justify the assessment following the documentation requirements.

4. Prepare a range map following the mapping standards.

5. Know who to submit the assessment for review and submission to the IUCN Red List Unit.

How can Red List Assessors Ensure that assessments are Rigorous and Defensible?

- Understand the Categories & Criteria and apply them properly.
- Justify the assessments with thorough supporting data.
- Follow the documentation standards.
- Provide relevant references.
- Submit a good map.
- Double check for consistency and errors.
- Work with other relevant groups doing Red List assessments.

The Red List Document

The Red List document as per IUCN standards should contain following information on each taxa evaluated.

- Taxonomy including authority details.
- Common names
- Red List Category and Criteria
- Countries of occurrence
- Map of distribution
- Rationale for the assessment (supporting the criteria used)
- Habitat preferences (text and codes)
- Major Threats (text and codes)
- Conservation Measures in place & needed (text and codes)
- Citations list
- Reasons for any category changes
- Names of assessors

Present Status of Documentation and Challenges to Meet the IUCN Criteria

Red Data Book of Indian Plants (Nayar and Sastry, 1987-1990) published by Botanical Survey of India includes 65 orchid species in 3 volumes and the IUCN 1997 Red List include 105 Indian orchid taxa. All these assessments require revision because of the additional information available on the taxonomic concept, distribution range and threat factors. Perusal of all available literature on Indian Orchidaceae reveals very little or no information on the population size and rate of population decline of Indian Orchid species. Apart from few scattered literature available, no comprehensive document available with species specific information on any of the required data mentioned above. No statistical data available on population/ rate of decline of Indian Orchids (during past several years) for applying Criteria E (quantitative analysis). Thus, it is a challenging task to assess Indian Orchidaceae for assigning threat status as per IUCN Criteria in near future. First and most important challenge is to assign clear taxonomic identity to all *ca* 1300 taxa recorded so far from India. The revisionary work on Indian orchids done/being done has been detailed in previous paragraphs. It is an uphill task to count the number of mature individuals to evaluate population size and rate of population decline of individual taxa by visiting their natural habitat in appropriate season in a short time period. The geographical range of distribution (Criteria B) can be assessed by considering the known distribution data available in literature and by compiling the label data of all herbarium specimens of Indian orchids available

Table 2. Methodology and deliverable for the Red List Assessment Document.

Sr. No.	Deliverable	Methodology
1. 2. 3. 4.	Name of the taxa Taxonomic position Synonyms Taxonomic history (citations)	This will be done based on the revisionary studies available (work for 50% species has been done/ being done in different centres of BSI) and own judgment in consultation with the latest code for Botanical Nomenclature and available literature.
5.	Diagnostic characters, supplemented with photographs and/ or illustration	Based on study of live as well as herbarium specimens, and in consideration of protologues and available literature.
6.	Distribution, Extent of Occurrence (EOO) and Area of Occupancy (AOO), supplemented with range map in India (Criteria B of IUCN)	• Data on distribution will be presented for within India and outside India based on direct observation of specimens (label data in the herbarium sheets) and available literature. Only those specimens will be considered whose identity will be found as correct and only those literatures will be considered where information provided is supported with authentic voucher specimens. • Range map will be plotted by finding geo-coordinates of the locality mentioned in the label of all specimens and those observed in the field. • Maps will be prepared with the help of Arc GIS mapping software and the Extent of Occurrence (EOO) and Area of Occupancy (AOO) will be calculated for application of Criteria B of IUCN.
7.	Population status including population size, rate of population reduction, extremely small population (Criteria A, C and D of IUCN).	• As there is very little or no data available on the population size and rate of population decline of Indian Orchids, and in view of the vast geographical area and large number of taxa included in this study, it may not be possible to visit all the known/ expected habitats of all taxa during the project tenure. Thus, only endemics and taxa known from a single locality will be visited in their natural habitats to confirm their occurrence, study the number of surviving individuals and possible threat factors associated with those taxa. In this process, other species distributed in the visited area can also be studied and new localities for many species can be traced. • Literature available in this regard will also be considered.
8.	Observed, inferred, documented or plausible threat associated	This will be done based on own field observations and documented literature available.
9.	Economic importance/ potential value	
10.	Conservation measure available for the species	
11.	Threat status (as per IUCN criteria as assessed during the present study)	By application of all available information in fitting with Criteria A to E of IUCN
12.	References assessed.	All the reference will be provided at the end of each taxa

(the number of specimen is estimated over 30000 for the 1300 Indian orchid taxa) across the country and globe.

Challenge in Applying Criteria-A of IUCN

- Little or no data available on population size of Indian Orchids.
- Field visit to all known localities in proper season required to access the population size.
- Difficulties in counting number of matured individuals in hilly terrain.
- Defining the mature individual in case of epiphytic orchids where numerous sympodia (capable of independent reproduction) are organically connected through their rhizome.

- To apply Criteria A, trend of population decline has to be recorded for 3 generation or 10 years whichever is earlier.

Challenge in Applying Criteria-B of IUCN

- To find the geographical range of taxa, all available data in the literature and herbarium specimens are to be considered.
- Geo-coordinates are to be determined from the localities mentioned in the herbarium label and literature.
- More than 30,000 herbarium specimens are available for all known taxa of Indian Orchids.
- Distribution maps are to be plotted using a standard mapping software to calculate EOO and AOO

Challenge in Applying Criteria-C, D, E of IUCN

- Available data on Indian Orchids do not quantify to apply Criteria C, D, and E of IUCN.
- Several field visits required over 10 – 100 years to access the population size, trend of population decline and to generate data for quantitative analysis.

Developing the National Red List: Deliverable and Methodology

Botanical Survey of India has started developing the National Red List for Orchidaceae as per IUCN guidelines and Criteria. Table 2 depicts the methodology and deliverable of the red list assessment document for each taxa.

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