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## How to Identify Rare and Endangered Ferns and Fern Allies

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### ABSTRACT

Identification of rare and endangered plant species is the first requirement for any conservation programme. The IUCN guideline is the only available method to identify the rare and endangered species and it requires vast data on the wild population of the target species. None of the biological characters, which are playing main role in the survival and distribution of several species, is used in IUCN guideline. In the meantime there are several difficulties in following IUCN guideline, particularly the non availability of complete field data. Moreover, the same guideline can not be used for all the groups of species in equal importance. The vascular cryptogams, pteridophytes, are also an important component of any mountainous flora and they have also to be conserved in nature. As they are the primitive vascular plants on the earth, they are getting depleted in the flora due to various reasons and it is the right time to identify the rare and endangered pteridophytes to conserve them. By considering various difficulties of IUCN method for the identification rare and endangered pteridophytes, a very simple method has been adopted by using just four criteria and this method can be applied to Pteridophytes from any region of the world.

**Keywords:** Conservation, Rare and Endangered ferns, Identification.

*“Ferns in art convey the idea of solitary humility, frankness and sincerity, because they conceal their grace and beauty in forest depth”*

Ferguson

### INTRODUCTION

Plants are the foundation of all life on earth, without which we cannot survive. India is a mega biodiversity country with about 13,000 species of vascular plants including about 1000 species of ferns and fern allies. It is our response to conserve them for the future generations.

To conserve the organism, whether plant or animal, the first step is to identify the rare and endangered organisms in a given geographical area or country. With the aim to conserve the world's flora, the IUCN (International Union for Conservation of Nature) has made special efforts to identify the rare and endangered vascular plants. The information contained in the 1997 IUCN Red List of Threatened plants is useful for conservationists. Worldwide, 12.5 per cent of the world's vascular plants are threatened with extinction, and it has been shown that in areas with more complete coverage, even higher numbers of threatened species (20 percent to over 40 percent on some islands) are being recorded. There are an estimated 270,000 known species of vascular plants, which include ferns, fern allies, gymnosperms and flowering plants. Of the species assessed by IUCN, 33,798 species, or at least 12.5 percent of all known vascular plants, are threatened with extinction on a global level. These plants are found in 369 families, and are scattered throughout 200 countries around the globe. Of these, 91 percent are limited to a single country, which links their potential for extinction to national economic and social conditions. There are certainly other species, as the cases of ferns and fern allies in India, which have not yet been assessed, and which will merit inclusion in future editions of IUCN Red list

IUCN Red List shows the number of threatened vascular plant species recorded for each country. A high figure of threatened species for a particular country, like 29% in USA, generally indicates that inventories and assessments for that country have been particularly thorough, while a low figure for other countries like 7.7 % for India may reflect that similar efforts have not yet been undertaken there. The three countries, USA, Australia and South Africa, which were able to provide complete data sets, have higher percentages of threatened species in the national flora. Coverage of other regions is fragmentary and incomplete. It is necessary to make thorough assessment of flora in Asia, the Caribbean, South America, and the rest of Africa.

According to IUCN Red List, out of 511 families of vascular plants currently recognized, 372 of these contain globally threatened and /or extinct species. Not surprisingly, the largest families also contain the largest numbers of threatened species. Excluding nineteen threatened monotypic families (only one species in the family, and thus 100 percent threatened), there are 20 plant families with at least 50 percent of their species threatened. Of these, eight are gymnosperm families (including cycads and conifers). The prominence of gymnosperms may be due to one or more factors: 1. They are a well known and relatively small group; 2. Many gymnosperm species are widely exploited both for timber and horticultural purposes; 3. Gymnosperms are an ancient group of species, and may not adapt easily to the rapidly changing environment around them. In contrast, the ferns as a group appear to face relatively low levels of threat. This may be due in part to the efficiency with which fern spores are dispersed. At the same time, fern species have not been fully assessed, so their status as a group is not entirely clear. With this background it was planned to assess the Indian Pteridophytes, by selecting the Pteridophytes of the Western Ghats as the first step.

## METHODOLOGY

Several methods, including the typical method adopted by IUCN, were tried to identify the rare and endangered Pteridophytes of the Western Ghats. As far as ferns are concerned, influences made by man are less except the destruction of forests. Very few ferns are over collected from the wild for economical use. With so small an area remaining under forest cover and the threat of further deforestation, about half of the pteridophyte species of southern India can be regarded as vulnerable, threatened or endangered (Theuerkauf, 1994). More or less all the ferns are growing in forest depth safely and they are not easy for access. Risk index rating of threatened ferns in Trinidad and Tobago has been done by Baksh-Comeau (1999) considering the number of Herbarium sheets available, date of first collection and last collection, total number of localities, total number of niches and distribution. According to Zajac and Zajac (1995) the endangered to extinction species among the rare vascular plants in Poland are the taxa with limited area of habitats, taxa of an isolated sites by a significant disjunction from their compact ranges and endemics with limited number of specimens in their populations. Most of the existing methods, including the IUCN method, require a vast array of data particularly the field data that are rarely available for any group of plants in any country. Gathering of such data is also very difficult, because different kinds of data are to be collected by different experts. In some methods, with some unknown errors or due to the incorrect method, mistakenly some common species are included in the red list or some rare species are not included in the red list. It is evidenced by Irudayaraj (2003): By considering these difficulties and lacunae in identifying the rare and endangered ferns, the key factors responsible for the rarity of the ferns were identified based on field studies and laboratory studies on south Indian ferns for the last twenty years.

For the successful establishment of a plant species in an ecosystem, the species should reproduce successfully through vegetative or sexual method by producing fertile and viable seeds / spores. It needs specific and suitable ecological niche to establish itself successfully. In the meantime they should have the capacity to colonise a particular ecological niche easily and in general they should have good genetical make up. As far as ferns are concerned the species with erect rhizome could not colonise a place easily when compared to the species with creeping rhizome. In general polyploid species are more tolerable than the diploid species. In evolution polyploidization is usually accomplished with the property of vegetative reproduction (Darlington 1965). and thus polyploid species are usually with creeping rhizome while the diploid species are with erect rhizome. There are also some ferns with some intermediates like diploid with creeping rhizome. In addition, chlorophyllous spores are usually with short viability period when compared to other common brown coloured spores. Usually species with such chlorophyllous spores are rare. For example, all the members of the family Grammitidaceae and Hymenophyllaceae with chlorophyllous spores are usually rare. Majority of ferns are terrestrials and they can grow easily by finding suitable places on the land surface.

Some ferns are epiphytes or lithophytes, which need special hosts to grow. Due to the destruction of forests, several hosts of such epiphytes are vanished and without the host the epiphytes cannot grow. Thus usually diploid, epiphytic ferns with erect rhizome and chlorophyllous spores are very rare in contrast to the common polyploid, terrestrial ferns with creeping rhizome and achlorophyllous spores. There are also several intermediate combination of characters based on which the distribution of the species will vary.

## RESULT AND DISCUSSION

With this context the key factors, particularly biological factors, such as rhizome type (erect or creeping), ploidy level (diploid or polyploid), nature of the spores (chlorophyllous or achlorophyllous) and ecological factor such as habitats, (epiphyte / lithophyte or terrestrial), responsible for the rarity of ferns and fern allies were identified and applied for the assessment of rare and endangered ferns and fern allies of the Western Ghats along with other criteria followed by Perring and Farrell (1977). As far as ferns are concerned each and every species will score equally when we give the threat value for each criterion mentioned by Perring and Farrell like economical value, accessibility of the species etc. Because all the ferns are having at least some economical values and most of the ferns are growing in forest interior and it is very difficult for access. So it is very difficult to differentiate a rare and common fern when they score more or less same range of threat values. The application of the above biological criteria gave meaningful results and when they are applied separately they give more or less the same kind of results. So, for the present analysis only these criteria were used (Fig.1). It is a very simple method based on only five criteria and the successfulness of this method has also been tested for ferns from other geographical regions (Himalayas) and it seems to be a natural, successful, easy method to test and locate a fern or fern ally in the red list category. The list of rare and endangered ferns of the Western Ghats, identified by following this method, is given here (Table.1)

The validity of the present method has also been tested with the Himalayan ferns. In the first volume of "An Illustrated Flora of Western Himalaya" by Khullar (1994) totally 190 species of ferns have been described along with information on cytology, distribution and ecology. By applying the present method, all the 190 species have been categorized into different ranks. Thus the number of species belonging to each rank in the order of first rank to the last rank has been given in table 2. Manickam (1995) has also enumerated 46 rare and endangered ferns of the Western Ghats of South India, based on his own field experience for about thirty years. The species included in that list has also come under any one of the threat category of the present study and thus it is of more value. But the problem is those who want to identify a rare and endangered species for conservation purpose, he may not have such a kind of experience and he has to depend on either the ready made list or the scientific method to identify such species easily.

Few examples may be cited to test the validity of the present method. The diploid fern *Grammitis medialis* with erect rhizome, chlorophyllous spores and epiphyte/ lithophyte habitat

belonging to the first category has been recorded from only two localities from the Western Ghats. The diploid or tetraploid lithophytic fern *Hypodematum crenatum* with prostrate rhizome and achlorophyllous spores belonging to the first category has been recorded from only three distinct localities from the Western Ghats (Manickam & Irudayaraj 1992).

In contrast, the tetraploid, terrestrial fern *Christella parasitica* with short or long-creeping rhizome, achlorophyllous spores belonging to the last category is the most common fern in South India. It is commonly growing throughout the Western Ghats (Manickam & Irudayaraj 1992). In the same way, the tetraploid, terrestrial bracken fern, *Pteridium aquilinum* with long creeping rhizome and achlorophyllous spores belongs to the last category. Thus it is common colonizer in forest clearings throughout the Western Ghats (Manickam & Irudayaraj 1992)

The diploid epiphytic fern *Ctenopteris subfalcata* with sub-erect rhizome and chlorophyllous spores belonging to the first category has been recorded from only two localities from the Western Himalayas (Khullar 1997). The lithophytic fern, *Woodsia andersonii* with erect rhizome and chlorophyllous spores belonging to the first category is a very rare fern known only from the Western Himalayas. The tetraploid terrestrial fern *Deparia petersenii* with creeping rhizome, achlorophyllous spores belonging to the last category is a common fern throughout the Western Himalayas. (Khullar 1997)

The advantage of the present method is not only the easy one but also a more accurate method to choose the species for conservation among closely related species. On the other hand there are some minor problems which may be solved by taking little more scientific efforts. For example, cytological data may not be available for some species. This can be done if fresh specimens are available. In the present study chromosome number ( $n= 80$ ) for *Tectaria zeilanica* has been reported for the first time from India ( Fig 3-d ) In those cases of species, where only herbarium specimens are available, the ploidy level may be determined based on the size of the spores and (or) stomatal guard cell in comparison with the other related species. The presence of more than one cytotype within a species will result in little more problems to consider the species as a whole or as a diploid one or polyploid one. In such cases the priority should be given to the diploid cytotype of the species.

#### **SUGGESTION OF METHODS FOR CONSERVATION**

As in any conservation strategies, in the cases of ferns also, the best method of conserving the species is by *in situ* conservation by protecting the natural habitats particularly in ever green forests where they grow commonly. Some cases may require *ex situ* conservation either by multiplying species by conventional method or by *in vitro* tissue culture or spore culture method. Such multiplied species may be conserved in the garden. As far as India is concerned the *in situ* conservation has been made by managing several forest areas and sanctuaries or biosphere reserves eg. KMTR, Nilgiri Biosphere reserves. For *ex situ* conservation special efforts are not given much to the cases of ferns when compared to the flowering plants. In majority of the gardens there are very few ferns which are grown mostly as ornamental ferns and not as a rare and endangered ferns. 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. The *ex situ* conservation of rare and endangered ferns may be strengthened by setting up more and more fernaries in different parts of the country particularly near by the sanctuary or biospheres. The *ex situ* conservation through *in vitro* tissue culture or spore culture has to be done at least in the species belonging to the first three ranks.

The purpose of the present paper is to expose the rare and endangered ferns to the conservationists who are interested in conserving the rare and endangered ferns through *in vitro* tissue culture or spore culture. Usually they choose the species, for such conservation measures, without making serious efforts to identify the rare and endangered ferns. Some times they wrongly choose some of the common species even with the availability of the rare species. In India so far, ca out of 45 of species of ferns have been subjected to *in vitro* study with the aim of both academic studies and conservation studies (Khare 1989). Based on the present study it has been observed that 45 of the selected species 31 species have been selected properly and 14 species have been selected wrongly. By following the present guidelines for the identification of rare and endangered ferns the wrong selection may be avoided and the correct species may be identified in future for conservation. Since Pteridologists have not been experienced in tissue culture and the biotechnologists are not aware of the taxonomy, ecology and distribution of the Pteridophytes, the present paper may serve as a link between these two groups of researchers.

**Table 1: List of endangered taxa from the Western Ghats (Fig. 2 & 3)**

1. *Adiantum lomesam* Nayar & Geevar.
2. *Alsophilla nilgirensis* Holttum var. *lobatus* Manick. & Irud.
3. *Ampelopteris prolifera* (Retz.) Copel.
4. *Anemia wightiana* Gard.
5. *Anisocampium cumingianum* Presl.
6. *Asplenium affine* Sw.
7. *Athyrium solenopteris* var. *pusillum* (Kunze) Moore
8. *Cheilanthes rufa* D. Don.
9. *Ctenopteris subfalcata* (Bl.) Kunze.
10. *Dicranopteris taiwanensis* Ching et Chiou
11. *Dryopteris approximata* Sledge
12. *Grammitis attenuata* Kze.
13. *Grammitis medialis* (Baker.) Sledge
14. *Helminthostachys zeylanica* (L.) Hook.
15. *Huperzia hamiltonii* (Spring) Trev.
16. *Huperzia hilliana* (Nessel) Holub.
17. *Huperzia squarrosa* (G. Forst.) Trev.

18. *Hypodematium crenatum* (Forssk.)Kuhn
19. *Lindsaea malabarica* (Bedd.)Bak.
20. *Lycopodium japonicum* Thunb.
21. *Phanerophlebia caryotideia* var. *caryotideia* (Wall.ex.Hook & Grev.) Copel.
22. *Phymatosorus malabaricus* (Nayar & Geevar.) Geevar.ex Nampy ex Madhus.
23. *Polystichum subinerme* (Kze.) Fras. –Jenk.
24. *Polystichum tacticopterum* (Kunze) T.Moore
25. *Prosaptia obliquata* (Bl.)Mett.
26. *Pteris wallichiana* Agardh.
27. *Selaginella microdendron* Bak.
28. *Tectaria periya* Nayar & Geevar.
29. *Tectaria zeilanica* (Holtt.) Sledge.
30. *Trichomanes vamana* Hameed & Madhus.

Table : 2 List of Endangered taxa from East Himalaya

1. *A. bullatum* Wall. ex Mett.
2. *A. lingtaulensis* Ching
3. *A. nesii* Christ.
4. *A. tenuicaule* Hayata.
5. *A. tenuifolium* D.Don.
6. *A. wallichiana* (Spreng.) Ching
7. *Adiantum edgeworthii* Hooker.
8. *Arthromeris lehmanii* (Mett.) Ching.
9. *Asplenium anogrammoides* Christ.
10. *Botrychium lanuginosum* (L.) Swartz. var. *onondagense* (underwood) House
11. *B. multifidum* (Gmelin) Ruprecht.
12. *B. ternatum* (Thunb.) Swartz.
13. *B. lunaria* (L.) Swartz.
14. *Cheilanthes dubia* Hope.
15. *C. duthiei* Baker.
16. *C. persica* (Bory) Mett. ex Kuhn.
17. *C. chrysophylla* Hooker.
18. *C. anceps* Blanford.
19. *Colysis pothifolia* (Ham. ex D. Don) H. Ito.
20. *Cryptogramma brunoniana* Wall. ex Hooker et Greville.
21. *Dennstaedtia wilfordii* (Moore) Christ.
22. *D. scabra* Wall. ex Moore.
23. *Dicranopteris linearis* var. *subferruginea* (Hieron.) Nakai.

24. *Drynaria tibetica* Ching *et* Wu.
25. *Lepisorus clathratus* (Clarke) Ching.
26. *L. contortus* (Christ) Ching.
27. *L. oligolepidus* (Baker) Ching.
28. *L. bicolor* Ching
29. *Loxogramme parallela* Copel.
30. *Osmunda japonica* Thunb.
31. *O. regalis* L.
32. *O. claytoniana* L.
33. *Pellea subfurfuracea* (Hooker) Ching.
34. *P. hastata* (Thunb.) Prantl.
35. *Phymatopteris erythrocarpa* (Mett. *ex* Kuhn) Pichi -Sermolli
36. *Pteris wallichiana* Agardh
37. *Pyrrosia costata* (Wall. *ex* Presl) Tagawa *et* Iwatsuki.
38. *Woodsia andersonii* (Beddome) Christ

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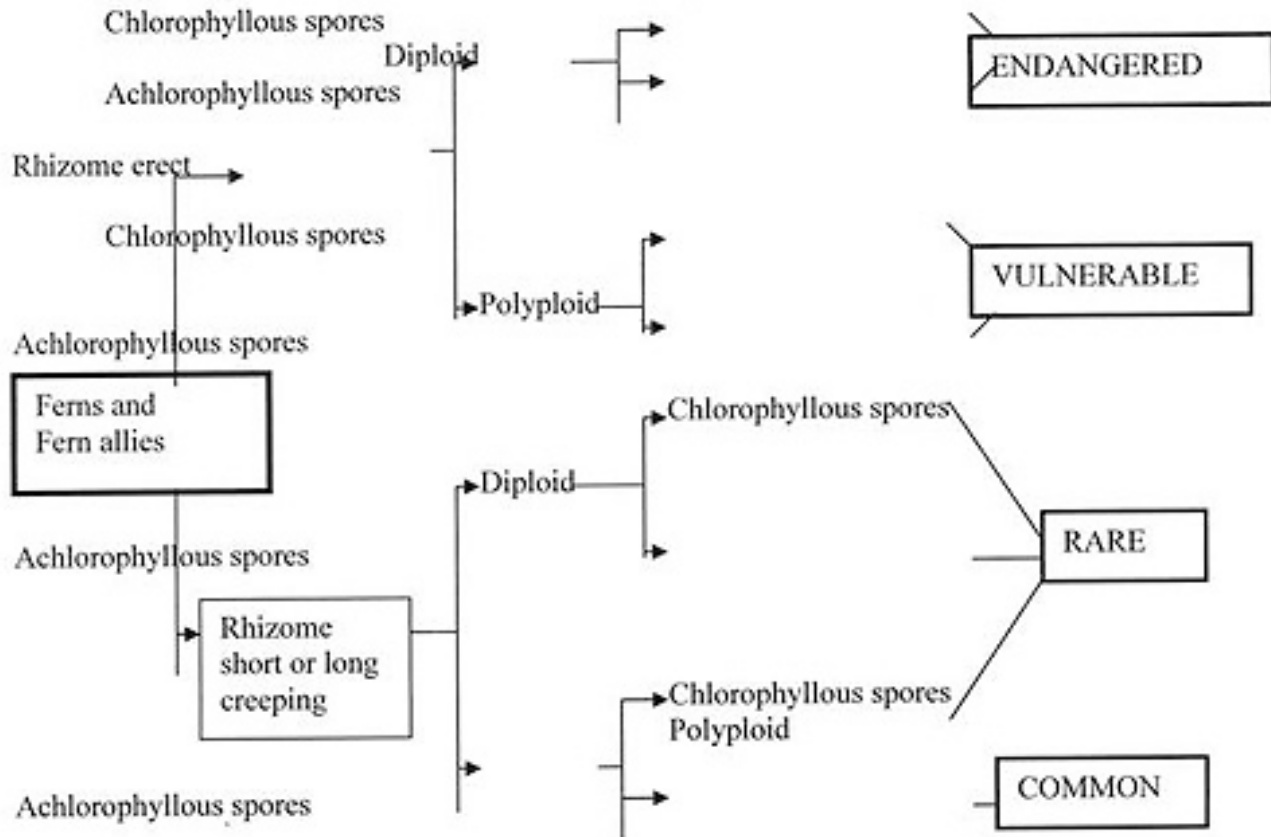


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**Fig. 1. Key for the identification of rare and endangered ferns and fern allies**



**Fig. 3**  
**Endangered ferns from the Western Ghats.**



- a. *Grammitis medialis* (Baker ) Sledge,  
 b. *Hypodematium crenatum* ( Forssk. )Kuhn.,  
 c. *Tectaria zeilanica* (Holttt.) Sledge,  
 d. Cytology of *Tectaria zeilanica*  
 e. *Helminthostachys zeylanica* (L.) Hook,  
 f. *Pteris wallichiana* Agardh.,  
 g. *Huperzia hilliana* (Nessel) Holub.,  
 h. *Alsophilla nilgirensis* Holttum

**Plate - 2**  
**Endangered ferns from the Western Ghats.**

