ENDANGERED SPECIES: PROBLEMS OF ASSESSMENT AND CONSERVATION

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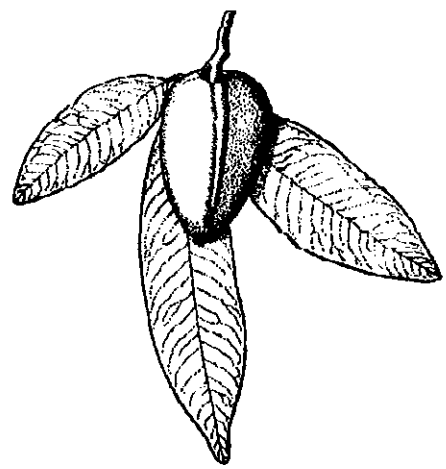
Human activities in the last quarter of the 20th century are reducing the biological diversity at a rate that may be unprecedented in the history of life on earth. It is difficult to assess, with our limited knowledge, the consequence of the disappearance of the species for the stability of Earth's environment or the economic value lost because of extinctions. The best available estimates indicate that if the current trends continue, some 15-20% of the estimated 10 million to 30 million species of plants and animals alive today may become extinct by 2000 AD (Wolf, 1987). Human activity is greatly accelerating the extinction rates; several hundred species a day may become extinct over the next 20-30 years. The reduction of wildland habitats to less than the critical amount necessary for the survival of a species is by far the greatest cause of modern extinctions.



***Myristica malabarica*, a tree species found highly scattered from Kanyakumari to Dakshina Kannada. Declared Vulnerable by the FRLHT Medicial Plants CAMP, 1995.**

India has ca 45,000 species of plants of which 35% are vascular plant species. It is feared that 15-20 % of total vascular flora, that is over 2,500 species may now fall in one or the other category of threatened species (Jain, 1987). Identification and inventorisation of such rare, endangered and endemic plant species, therefore should find first priority on the agenda items of any conservation biology programmes.

What are Endangered Species ?

The endangered species are those which are under threat of extinction and whose survival is unlikely, if the causal factors continue operating. Under this category are included those species whose numbers have been reduced to a critical level, or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction.

The concept of rarity of species requires proper scientific definition. Many workers have given different attributes as per their perceptions. According to Drury (1974) - "A rare species is the one that occurs in widely separated small sub populations so that interbreeding between sub populations is seriously reduced, or is restricted to a single population".

According to Wayne King (1984) endangered species are recognised thus "If the decline has just started or is slow the species may be vulnerable. If it has been ongoing for some time the species already may be depleted. If the decline is rapid the species is endangered".

Categories of Threatened Plants

The rare plants are categorised under various groups as indicated below. But clear cut circumscription may not be possible to provide for these categories in any given situation.

Also, virtually every state/country has produced a list of their own endangered, threatened and rare plants but all these show some variation in their criteria for determining endangered status of taxa. For example, the endangered plants are recognised by the following different criteria.

a. Wisconsin (Read, 1976): Native plants with three or fewer stations.
b. Oregon (Siddall *et. al.*, 1979): Known only from one population.
c. California (Smith *et. al.*, 1980): Follows REVD Code to store Californian species.
d. Florida (Ward, 1979): Circumstances which cause change in frequency and distribution of species.

The World Conservation Union (IUCN 1994) has recognised the following categories of threatened plants and animals

Extinct (EX): A taxon is Extinct when there is no reasonable doubt that the last individual has died.
Extinct in the Wild (EW): A taxon is Extinct in the wild when it is known only to survive in cultivation.
Critically Endangered (CR): A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (EN): A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.
Vulnerable (VL): A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.
Lower Risk (LR): A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable.
a. **Conservation Dependent (cd).** Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation programme targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.
b. **Near Threatened (nt)**. taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable.
c. **Least Concern (lc)**. Taxa which do not qualify for Conservation Dependent or Near Threatened.
Data Efficient (DD): A taxon is Data Deficient when there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or

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population status.
Not Evaluated (NE): A taxon is Not Evaluated when it is has not yet been assessed against the criteria.

Endemic Species

Endemic species by virtue of their narrow distribution also qualify for conservation. Endemic species may be restricted in their distribution to a country (broad endemic) or to a small biogeographic zone (narrow endemics). Again, endemics may be 'relict' when a genus with many species in the past is presently surviving as a solitary species; or may be 'neoendemics' when the species has just evolved and has not yet been able to spread. The narrow endemics and the relict endemics naturally should find a priority in the conservation programmes.

Extinct Species

Declaring a species as extinct is neither a pleasant task nor easy. Before a species is declared extinct it is necessary that all known habitats within the distribution range of the species are thoroughly explored at different times of the year and more than once. Sometimes a species declared as extinct is rediscovered from some remote botanic gardens. Such species should be provided immediate measures for conservation and multiplication. Some species supposed to the extinct from India are the following:

Carum villosum Haines - Endemic to Bihar, Deccan peninsula
Ligusticum albo alatum Haines - Endemic to M.P.
Pimpinella evoluta (Cl.) Mukh. - Naga hills, Northeast India
Pimpinella pulneyensis Gamble - Endemic to Western Ghats
Ceropegia fantastica Sedgw. - Endemic to Western Ghats
Carex repanda Cl. - Endemic to Meghalaya
Dipcadi concanense (Dalz.) Bak. - Endemic to Western Ghats
D. Reidii - Western Ghats
Urginea polyphylla Hk.f. - Endemic to Deccan Peninsula
Coelogyne treutleri Hk.f. - Endemic to Sikkim Himalaya
Pleione lagenaria Lindl. - Endemic to Northeast India
Vanda wightii Reich.f. - Endemic to Western Ghats
Deyexia simlensis Bor - Endemic to Simla Hills
Hubbardia heptaneuron Bor - Endemic to Western Ghats
Hedyotis hirsutissima Bedd. - Endemic to Western Ghats
Ophiorhiza bamesii Fisch. - Endemic to Western Ghats
O. brunonis W. & A. - Endemic to Western Ghats
O. pykarensis Gamble - Endemic to Western Ghats
O. caudata - Kerala
O. radicans - Kerala & Sri Lanka
Psychotria tylophora Kurz - Endemic to Nicobar Island
Isoetes sampathkumarnii - Karnataka
Lastreopsis wattii - Manipur
Wendlandia angustifolia - Tamil Nadu
Trochetia parviflora - Meghalaya
Sterculia khasiana - Meghalaya
Eragrostis rottleri - Tamil Nadu
E. rangacharii - Tamil Nadu
Corypha taliera
Hedychium marginatum - Nagaland
Calanthe whiteana - Sikkim
Prasophyllum colemaniae - Meghalaya

Why Species Become Rare

The main cause behind any species to become endangered is that its reproductive capacity falls far below its rate of elimination from the habitat, thereby leading to a decline in number and size of populations. The factors leading to rarity of species rate is about 1 per year. The factors leading to rarity of species can be broadly categorised into (a) Systematic pressures (b) Stochastic perturbations.

The systematic pressures (Anthropogenic factors) are those that are affected by man made causes such as building of dams, power plants, various land development activities, commercial exploitation, overgrazing, etc., all at the cost of original forests. These man made imbalances in the ecosystem lead to anthropogenic rarity of species. Rarity of a large number of orchid species in India is primarily due to the destruction of their habitats. Besides, the selective but large scale removal of certain medicinal plants such as *Podophyllum hexandrum*, *Coptis teeta*, *Dioscorea* sop.. *Allium strachyei*, *Nordostachys grandiflora*, *Rheum emodi*, *Aconitum* spp., *Picrorhiza kurrooa* and *Saussurea lappa* is also an instance of such systematic pressures leading to endangerment of species. It is no wonder that many of these valuable species are not found in large populations in their natural habitats. (Table - ???).

The stochastic perturbations may be placed under the following categories

Demographic Stochasticity which arise from chance events in the survival and reproductive success of finite number of individuals. Demographic stochasticity is more significant in populations of 50 or less individuals (Pollard, 1966: Rao and Garg, 1994).

Several examples can be cited for this from our local flora, *Eremostachys superba*, a species of Labiatae has been reduced to below the minimum viable population size (MVP) that is required for any species to survive. Such a thin homozygous population cannot withstand any more perturbations (Rao and Garg, 1994).

Environmental Stochasticity: Due to temporal variations in the population's operational environment of habitat parameters and the populations of competitors or predators, parasites and diseases.

Natural Catastrophes: Such as fire, floods, disease outbreaks, drought, wind storms, earthquakes and ice storms etc. which may occur at random intervals through time.

Genetic Stochasticity: Resulting from changes in gene frequencies due to founder effect, random fixation, and/or interbreeding.

Kinds of Rarity in Plants

There are two kinds of rarity exhibited by species (a) Anthropogenic rarity (b) Natural rarity. Kruckeberg and Rabinowitz (1985) have pointed out that rarity is influenced by three aspects of spatial distribution. Whether species have wide or narrow geographical range, whether they have wide or narrow ecological ranges and whether the population always exist in low effective density throughout the geographical range or in con-

centration of high density with scattered individuals in between. Schoener (1987) called these last two alternatives 'suffusive' and 'diffusive' rarity.

As stated above, some species are by nature rare. These species have narrow ecological ranges such as the plants of Cold Desert Regions in the Himalaya (*Acantholimon lycopodioides, Arenaria bryophylla, Astragalus gracilipes, Corydalis tibetica, Euphrasia kashmiriana, E. paucifolia, Saussurea bracteata, Waldhemia glabra* and a few others); Some alpine species with ephemeral nature and parasitic plants and so on. On the contrary, some plants are rendered rare by man by destroying the natural habitats for a variety of developmental activities or by selective removal for short term economic gains. The chances of survival of these "anthropogenic rare species" are doubtful if the threats operating on them are not removed.

Populations may be small for a variety of reasons. According to Harper (1977), the following are important.

i. The available sites are few and separated by distances beyond a species' normal dispersal ability.
ii. The carrying capacity of the site is low.
iii. The habitability of the site is of short duration because of successional displacement.
iv. Colonization is in its early stages, and full exploitation of the site has not occured.

The distribution and amount of genetic diversity within and among populations of rare plants are likely to depend on whether a species has always been rare or whether it has recently become so as a result of human influences. Species that occur naturally in sparsely distributed, small populations may possess genetic system adjusted to close inbreeding. In contrast, species that have experienced severe reduction in population numbers owing to habitat destruction or grazing may be more susceptible to genetic stresses imposed by small population size. These considerations highlight the importance or considering the ecology of rare species and the diverse ways that rarity can arise.

Problems in Assessment of Rare Species

Identifying a rare species is by no means easy. The qualitative assessment of rare species is generally based on field observations, a visual decline of species, lesser frequencies of collections, long spaced collections and such other reasons. All these studies have their own drawbacks or limitations as a source for assessment of rare species.

Herbarium as a source for identification of rare species

Herbaria, both regional and national form the important tool for identification of rare and endemic species. Scrutiny of specimens in a Herbarium provides useful clause to the status of a species. For example a scrutiny of *Berberis* specimens in various Indian Herbaria revealed that about 50% species are not or poorly collected during the past several decades (Rao *et. al.*, 1994). Some of the species are not collected after their type collections. Thus, Herbarium study gives preliminary idea about the species which are rare or endemic in distribution. Customarily, if a species is not represented by more collections in a herbarium, it is determined as a rare species, and this may not always be correct. While partly it could be true, certain ephemeral plants such as species of *Gentiana, Primula, Saxifraga,* etc. complete, their life cycle in a short span of time, often within weeks; and such species are likely to be missed by field botanists. Also, the species might have been originally described on a stray collection from a spot not visited by botanists frequently. Hence, poor representation of a species in a herbarium may not necessarily conclude a species rare or endangered. Whereas such analysis could be considered as better than no data at all, these have serious limitations or handicaps.

Literature

A review of literature records in Floras, Checklists, Monographs, Revisions and other taxonomic accounts provide the distribution status of species. Several species are marked in the literature as rare with very few populations. Such data are very important for identification of rare plants. Further, a comparison of old floras and recent ones also gives the present status of several species. For eg. Mukherjee (1983) gave a list of 25 rare Umbellifers in India based on analysis of literature and Herbarium. He stated that some of the species like *Acronema, Pimpinella* and *Heracleum* have not been collected since the last 100 years or so.

Field survey

Field studies are very important and crucial for identification of rare species. Field studies provide not only first hand information about the population size, number and frequency of a particular species but also help in monitoring the size of population over the years. Actual field work for assessment of specific taxa can also provide information on their specialised ecological requirement, life forms and such other details which help in evaluating the rarity of a species. In fact, what is now urgently needed is the critical field evaluation of all "tentatively decided" rare species following elaborate species specific surveys as has been done in the case of *Eremostachys superba*, a highly endangered taxon of Doon valley (Rao and Garg, 1994). This species was listed as a rare species in the 'Red Data Book of Indian Plants' based on information partly from literature, partly from field and Herbarium. Our own surveys for assessment of this species have shown that not only the populations of this species at Jammu and Himachal Pradesh have become extinct but also provided actual data on the status of the only population at Doon Valley. No doubt, such detail species specific surveys on all rare species may not be feasible, considering the time and financial constraints.

Conservation of Endangered Species

Conservation of endangered species is a great challenge to biologists. Assessing the correct status of endangered species is itself no easy task. Once such a species is identified, integrated approaches are necessary to effectively conserve and monitor the populations of endangered species. The various *in situ* and *ex situ* methods of conservation are well known and do not deserve any discussion here.

Two issues are however important. It is certainly not possible to save all the 2,500 threatened species in India. Prioritization of endangered species for conservation purposes is a must. Among the anthropogenic rare plants, endangered family (monogenetic and monospecific), endangered genera and

other unique species of economic value must find priority over others for conservation.

No conservation programme becomes successful until and unless the bottlenecks in the reproductive biology of rare species are identified and overcome. Our own study on the reproductive biology of *Eremostachys superba* has shown that (a) its population has drastically collapsed to hardly 25 plants at Mohand (b) the species is adapted for outbreeding but forced to inbreed (c) refuse to inbreed but when hand pollinated show high seed set (44.5 %) (d) low plant population effect the pollinator population and (e) failure of seed germination under natural conditions and (f) poor sexual reproduction and failure of seed germination has resulted in the development of thick root stock system to serve as buffer from environmental stochasticiy.

From this study it is clear that preservation of the habitat alone may not assure the long term conservation of the species. The loss of diversity, both genetic and phenetic reduces the ability of populations to adapt to changing environments and increase their succeptability to pests and diseases. Such plants therefore, need to be protected on top priority.

Genetics and demography, i.e., population dynamics are crucial to success in long term conservation and management of any species. In case of *Eremostachys superba*, the population of which is small and isolated, a strong genetic drift operates. Population in which drift operates loose variation more readily than do populations in which drift is not a factor. Another consequence of low population structure is the occurrence of inbreeding resulting in loss of fitness (inbreeding depression). Therefore, we have to think of strategies that increase the genetic diversity in rare species - say bringing together geographically isolated populations, which again is not an easy task.

Monitoring of populations of endangered species is another area of work which is not given due attention. Monitoring of species involves the study of the population dynamics during different seasons over a period of time. This gives us an idea about the adaptive ability of a particular endangered species to its natural habitat. Where required overgrowth of other surrounding species (alien weeds) also need to be controlled to keep the populations of the endangered species to a level that it can sustain itself.

Conclusions

Study of endangered species and their conservation is a great challenge to biologists. Just declaring certain areas as "protected" may not ensure the long term protection of endangered species. Even if so, the populations are threatened by obnoxious weeds, herbivores or demographic or environmental stochasticity. Co-ordinated multidisciplinary approaches to work out strategies that increase the genetic diversity in them is highly warranted. Future studies should highlight the correct status of threatened and endemic plants, at least at a state level based on extensive field surveys. Some aspects which need immediate attention with regard to rare and endangered species are (a) extensive and if possible, species - specific surveys of endangered species, (b) assessment and monitoring of number and size of populations of rare taxa, (c) preparation of distribution maps for all endangered and endemic species, (d) District wise/state wise assessment and inventorisation of rare and endangered species and preparation of Red Data Books for each State, (e) Identification Manual for endangered species of each state/district. Conservation biologists in different States could concentration few selected highly rare and endemic species in their own region and assess - (a) which taxa endemic to India, occur in their region, state or district ? (b) what is the general distribution of these species in the country ? (c) whether any of the species are endemic only to their area of work, (d) whether any of these species are of commercial importance and are in trade, (e) Detailed data on their distribution in the area of work and type of rarity (f) Data on their past distribution and trends of shrinkage of populations or extinction, (g) Causes of threat, (h) Detailed data on the reproductive biology of those species, (i) Suggested measures for conservation, (j) Information of the species concerning its sustained utilization, (k) Suggestions for its inclusion or deletion from the national Red Data |Books.

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