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B. K. Padhi and R. K. Mandal are in the Department of Biochemistry, Bose Institute, Calcutta 700 054, India.

Endemic, rare and threatened flowering plants of South India

R. J. Ranjit Daniels, N. Anil Kumar and M. Jayanthi

Endemism in plants is demonstrated at various geographical scales. A plant species can be restricted to a continent, region or even a locality. Gentry[1], while discussing endemism in neotropical plants, identified four forms, viz. island endemism, relict endemism, neoendemism and anthropogenic endemism. Island endemism is the most common form; as it does not concern us in the present context, we may ignore it. Relict endemism is represented by an ancient taxonomic lineage or distribution restricted in range by specialized habitats which are themselves result of past geological events. Species of plants in the genera *Mahonia* and *Rhododendron* in the hilltops of Western Ghats are good examples of relict endemism. The assumption, nevertheless, is that these plants were widespread in the past when the prevailing environmental conditions were more favourable.

Neoendemics are newly evolved plants which are usually restricted to the site of origin, characterized by the local occurrence of a number of closely related species. The many localized species of *Nilgirianthus* (Acanthaceae) in the hills of south India are examples of neoendemism.

Anthropogenic endemism is more a result of recent human destruction of habitats, exterminating some species locally. There may be a number of species qualifying for inclusion under this category of endemism. At least one example, *Aponogeton appendiculatus*, which is currently endemic to Alapuzha in Kerala, is also known from Madras[2]. The species certainly occurred in many tanks in the intervening area till recently.

Besides the four forms of endemism discussed above, there is in our opinion a unique fifth form, viz. pseudoendemism – plants which are apparently endemic due to an inadequate knowledge of their geographical ranges. It is rather compelling to believe that a large proportion of local endemics, at least in south India, is due to lack of intensive surveys of plant species in their natural habitats. An example supporting this pattern is of *Piper barberi*, listed by Nayar and Sastry[2] as being endemic to Kanyakumari district, which we have discovered in Kulathupuzha (Quilon). A detailed discussion of endemic south Indian flowering plants may be found elsewhere[3].

Though rare plants have been the cause of much concern to conservation biologists, there has not been a single general definition of rarity. Rabinowitz *et al.*[4] have suggested that rarity in plants can be assessed by their geographical range, habitat specificity and population size. A species of plant (e.g. *Terminalia paniculata*) that is most widespread and occurring in all available habitats is not rare. However, on the other extreme, we might find a species (e.g. *Elaeocarpus blascoi*) both localized and restricted by habitat. Such plants can certainly be considered rare. In this spectrum of rarity there are included two other categories, viz. species with wide ranges though with restricted habitat preferences (e.g. *Pinanga dicksoni*) and species with restricted geographical ranges but without any specialized habitat preferences (e.g. *Anaphalis* spp.) If information on the population sizes is also available, we may further divide each of the four categories discussed above into those existing in small populations everywhere and those having a large population somewhere over their ranges. The eight rather discrete forms of rarity which thus emerge can be used while assessing the status of plant species[4].

Studies in the neotropics have indicated that whereas endemism and rarity of species are often independent[1], certain families or genera do have more endemic as well as rare species than others[5]. It is probable that such families or genera diversified locally and recently[1] or they share some common traits that render them rare[6]. It thus becomes apparent that endemism and rarity in plants are a result of (i) biogeography, (ii) phylogeny and (iii) ecology (including anthropogenic influences).

Currently, in India, the M. S. Swaminathan Research Foundation with the cooperation of the Tamil Nadu State Forest Department is making an attempt at outlining a conservation strategy for the endemic, rare and threatened plants of the state. For this purpose, we selected the flowering plants of Tamil Nadu listed in the Red Data Books[2,7,8]. Of the nearly 1500 species of higher plants listed in the Red Data Books, 171 are known from Tamil Nadu. These are flowering plants representing 51 families. Most of these species, as much as is known, are restricted to the southern peninsula (Madras Presidency)[9]; a few, however, extend further south into Sri Lanka. While analysing the factors influencing the status of these species of conservation interest, the following trends have emerged.

On the 51 families represented, 10 families, viz. Fabaceae (20), Rubiaceae (16), Orchidaceae (14), Asclepiadaceae (10), Commelinaceae (9), Lamiaceae (8), Annonaceae and Apiaceae (6 each) and Capparaceae and Asteraceae (5 each) have the highest number of species listed as endangered in south India. All other families are represented by less than 5 species each.

According to Gamble[9], the total number of species in these 10 families in south India are as follows: Fabaceae 432, Rubiaceae 226, Orchidaceae 199, Asteraceae 189, Lamiaceae 128, Asclepiadiaceae 93, Commelinaceae 49, Annonaceae 47, Apiaceae 28 and Capparaceae 22. Therefore, in order to check whether the observed trend is just a result of the natural distribution of species in these families, we did a χ^2 test. It turned out that the above two distributions are independent ($\chi^2 = 33.86$; $p < 0.01$), suggesting that certain families do have more number of threatened species than the others.

Of the 4500 species of flowering plants known from south India[9], 20% are trees, 16% shrubs, 52% herbs and 11% climbers. Table 1 gives the physiognomic distribution of the 171 species of endangered plants. A comparison of the two distributions indicates that they are also independent ($\chi^2 = 14.80$; $p < 0.01$). Interestingly, there are fewer herbs than expected as against the greater representation of trees and shrubs amongst the selected 171 species.

If we consider the total geographical area covered by these species in the peninsula as that between 8 and 18° N latitudes, then 78 species (45.6%) are extremely localized, i.e., they are not known outside a single locality. Another 75 species (43.8%) are more widespread, though not beyond half the total geographical area. Less than 10% are spread over the entire range (Table 2). We do not have information on the altitudinal distribution of 47 species (27.5%). However, from what we know it is apparent that 42 species (24.5%) are montane specialists restricted to altitudes of more than 1800 m (Table 3). Table 4 suggests that a majority of the species (41.5%) are known from evergreen forests. Though considerably less, the next important vegetation type is the grassland (10%). From the available data on habitat/microhabitat preferences of the 171 species, it is evident that humus, stream banks and tree trunks/branches are very important (Table 5).

The validity of the patterns discussed in Tables 2–5 have not been statistically tested as the data available are limited. Also, the possibility that many local endemics can actually be anthropogenic or pseudoendemics remains to be tested. However, species with specialized habitat/microhabitat requirements are likely to become rare, as the plants in the Red Data Book suggest. For instance, it is noteworthy that in Table 5 at least 6 species are specialists of ecotones. Hubbell and Foster[5] have reported that plants which have an ecotonal 'regeneration niche' are likely to be rarer. Stream banks and swamps are some of the most human-altered habitats in south India. Hubbell and Foster[5] have also reported that on the Barro Colorado Island in Panama, some of the rarest plants occur along stream banks and swamps.

The present data on south Indian flowering plants indicate that epiphytes and those plants growing in humus and organic matter on rocks and forest floors tend to be rare. These include plants in the families Orchidaceae, Commelinaceae and Begoniaceae. Whereas orchids have suffered the over-exploitation of humans,

Table 2. Geographical range of the 171 species of flowering plants

Range	Number of species	Percentage
Restricted to one locality	78	45 6
Laterally spread along the same latitude	10	5 8
Spread across adjacent latitudes but not beyond half the total area	65	38.0
Spread over most of the total area*	12	7.0
Exact range not known	6	3.5

*The total area is that bounded by 8 and 18°N latitude within the peninsular India.

Table 1. Physiognomic breakup of the 171 species of flowering plants

Physiognomy	Number of species	Percentage
Tree	42	24.5
Shrub	43	25.1
Herb	70	40.9
Climber	16	9.4
Not described	2	1.2

Table 3. Altitudinal distribution of the 171 flowering plant species

Altitude (m)	Number of species	Percentage
Low (0–650)	18	10.5
Medium (650–1400)	36	21.0
High (1400–1800)	16	9.4
Montane (1800)	42	24.5
Widespread	12	7.0
Not known	47	27.5

Table 4. Vegetationwise distribution of the 171 species of flowering plants

Vegetation type	Number of species	Percentage
Evergreen forest	71	41.5
Deciduous forest	9	5.2
Scrub	12	7.0
Grassland	17	10.0
Cultivation/man-made	4	2.3
Aquatic	3	1.75
Not specified	55	32.2

Table 5. Habitat/microhabitat distribution of the 171 species of flowering plants

Type	Number of species	Percentage
Epiphytic	13	7 6
Stream banks	16	9 4
Rock crevices with humus	17	10.0
Humus on forest floors	10	6.0
Ecotones	6	3.5
Not specified	109	63.7

at least during the recent history, a general impact on these plants can also be the dessication brought about by canopy opening in the humid forests, where they occur.

The above analysis based on the available data on endemic, rare and endangered plants of south India has highlighted a few important issues. First, certain families tend to have more number of rare and endangered plants than the others (phylogeny). Second, physiognomic categories such as trees and shrubs (woody plants) tend to be more vulnerable to extinction than the other forms. Third, although the data are limited, geographical restrictedness (endemism), altitude, vegetation, habitat and microhabitat specialization apparently have an influence on the status of plant species. Further information on the distribution and status would be of great value while outlining conservation strategies for flowering plants.

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The authors are in the M. S. Swaminathan Research Foundation, 3rd Cross Street, Taramani Institutional Area, Madras 600 113, India

COMMENTARY

Marine pollution in India: An emerging problem

G. P. Glasby and G. S. Roonwal

With a population growth rate of about 2% p.a. and an economic growth rate of about 4% p.a., India is likely to face increasing environmental problems and chemical pollution in the future. The seas are the ultimate receptacle for land-based pollution and it is interesting to assess the stress on coastal seas caused by this pollution. A number of scientific papers have been published on this topic[1–9] and this article attempts to summarize some of the major findings

India has a coastline of about 7500 km with about 25% of its population living in coastal areas. Many major cities are located along the coast, including Calcutta, Madras and Bombay. In all, there are 11 major, 16 intermediate and 78 minor ports in India. India is one of the wettest countries in the world, with an annual rainfall of 1000 km^3. There are 14 major, 44 medium and 162 small rivers in India, with a mean annual runoff of 1645 km^3, although not all these rivers discharge into the sea. About 500 million tonnes of sediment are discharged into the seas each year from India. A unique feature of the Indian Ocean is the monsoons. In the Arabian Sea, the SW monsoon results in intense upwelling along the west coast of India and this accounts for the high productivity and fisheries potential in this area. The Arabian Sea and the Bay of Bengal are subject to large semi-diurnal tides with amplitudes of 1–8 m and are also influenced by the biannual reversal of the monsoon winds. These two factors result in the flushing of Indian coastal areas which helps in dispersing pollutants. The study of coastal ocean monitoring and prediction system by the Department of Ocean Development is useful to monitor coastal marine pollution. This study shows that the open oceans around India are pollution-free[10]. Nevertheless, coastal pollution is an increasing problem in India and we therefore record some of the major sources of pollution.

Domestic sewage

Domestic sewage is perhaps the major pollutant in coastal areas of India. Some 4.4 km^3 of such wastes are discharged into the seas off India each year. For example, Bombay discharges 365 million tonnes of sewage effluent to the sea annually and Calcutta about 396 million tonnes. Perhaps the major problem in India is that only a small proportion of this sewage is treated before discharge The situation could improve when the