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Floristic Distribution in Montane Swamps of the Nilgiri Mountains, Southern India

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ABSTRACT

I investigated the distribution of herbaceous species in five montane swamps using fifteen transects which were placed randomly (60 m × 1m) in the western upper Nilgiri Plateau. The aim was to classify swamp species according to the Rabinowitz's forms of rarity. A total of 78 species belonging to 28 families and 61 genera were recorded in five swamps. Eleven families were represented by single species. Twelve species were from the family Poaceae, Cyperaceae had 11 species while Compositae had 6 species. Of all the species, the proportion of swamp species ranged from 0.2 to 17.14% across different sites. Based on Rabinowitz's forms of rarity, 87% species were considered to be rare based on geographical range and habitat specificity. Species that were present in < 2 habitats were classified as restricted, while those with more than two habitats were classified as broad. Forty-eight species had large population size while 19 species had small population sizes. Most of the common species with high frequency and high local abundance belonged to Poaceae, Cyperaceae, Juncaceae and Eriocaulaceae. These four families comprised a total of 85% of the 6260 individuals that were recorded. It is concluded that locally abundant species are restricted to specific habitats and have a narrow geographical distribution, rare forb species are also restricted in habitat and narrow geographical range, and this indicates that rarity decreases through swamp protection and increases due to habitat loss.

Key Words: Commonness, Geographic Range, Habitat Specificity, Montane Swamps, Rarity, Herbaceous.

INTRODUCTION

Identifying common and rare species is important for the conservation of biodiversity in the ecosystem (Rabinotwitz et al. 1986, Gaston 1994, Daniels et al. 1995). Many authors identified and classified both common and rare species of trees and shrubs (Rabinowitz et al. 1986, Hubbell and Foster 1986, Pitman et al. 1999). Although information about herbaceous plant species, both common and rare, is scarce, it has been reported that herbaceous species have smaller geographic ranges than trees (Pitman et al. 1999). Benayas et al. (1999) have reported on both common and rare herbaceous species located in wet montane grassland, in the Sierra de Guadarrama of Central Spain. In the Amazonian forest, the secondary vegetation types comprise 15-26% of species that are restricted to single forest types and this includes swamp forests (Pitman et al. 1999). Daniels et al. (1995) reported that geographical restrictedness (endemism), altitude, vegetation, habitat and microhabitat specialization apparently influence the relative abundance of plant species.

Benayas et al. (1999) explored commonness and rarity by using a new model in Mediterranean montane grasslands. In upper Nilgiris, montane swamps have not been adequately sampled but it contains many endemic and rare species. Endemic species in these ranges are extremely limited in size, being restricted to an ecological region and often, a single mountain range.

For instance, *Eriochrysis rangacharii* Fischer is an endangered species, endemic to the swamps of the western upper Nilgiri plateau and is a habitat specialist. It was considered extinct by the scientific community, and was recently rediscovered (Puyravaud et al. 2003). In the Nilgiri montane swamps, this species is threatened due to agricultural practices, forest plantation, hydroelectric reservoirs and grazing. Swamps are

characterized by saturated with humiferous soils during the growing season and stagnant water during certain times of the year, but with the inevitable streams running through them. The highly organic soils of swamps create a thick, black and nutrient-rich subterranean environment. They have high conservation value as they maintain watersheds, prevent soil erosion and floods, as well as hold valuable biological diversity – like endemic flora and fauna, especially amphibians.

This is the first attempt to classify a swamp species under Rabinowitz's (1981) seven forms of rarity in the montane forest. The study also presents preliminary survey of swamp vegetation and documents swamp species' distribution, and analyses the distribution for three categories. Meher-Homji (1967) and Blasco (1970) have already documented the biogeographical distribution of species in South Indian hills stations. There is no comparable data on the local abundance and habitat restriction of swamp species in the upper plateau of the Nilgiri Mountains. Our aim was to design a conservation strategy of swamp species to include both common and rare species, based on Rabinowitz seven forms of rarity. These results will be used to focus attention upon the conservation of swamp species that are common and rare at different scales.

STUDY AREA

This study was conducted in a few montane swamps of Korakundah and Upper Bhavani Reserve Forest - about 60 km southwest of Ootacamund, Nilgiri district. The study sites lie between 11˚13' latitude N and 76˚ 35' longitudes E (Figure 1). The elevation ranges between 2100 – 2400 m above mean sea level. The bedrock is composed of gneisses, charnockites and schists (Lengerke 1977). The soil in the swamps, mostly black in colour, accumulates high content organic matter and contains ferrallitic humiferous soil. The mean annual rainfall recorded at Upper Bhavani Electricity department, during the periods for ten years (1994 - 2003) was 2637 mm (Figure 2). The area receives the southwest monsoon from June-September and later, the northeast retreating monsoon from October-November. The mean annual temperature ranges from below 0˚ C to 23˚ C. The dry season lasts from December to March and hoar frost can occur from December to February

In the upper Nilgiri Mountains, two contrasting physiognomic types are recognized: montane forest and

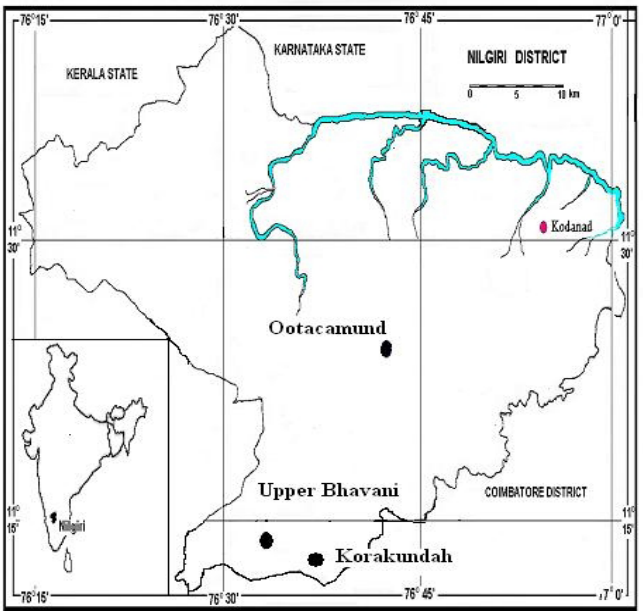

Figure 1. Location of the study sites

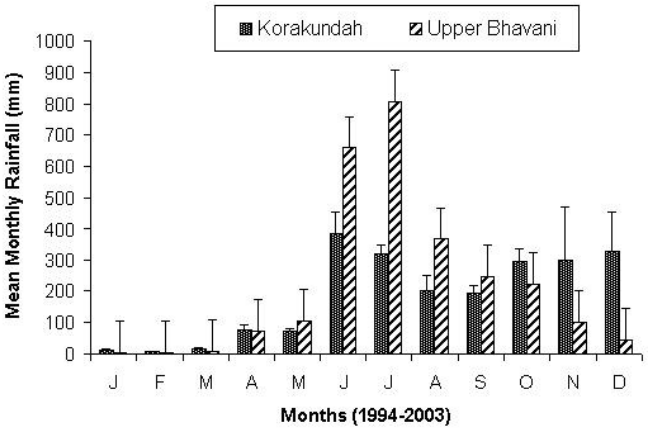

Figure 2. Mean monthly rainfall at the two study sites over a ten year period (1994-2003)

grasslands. The forest, locally called "shola" is almost invariably confined to the sheltered sites such as valleys, glens, hollows and depressions (Meher-Homji 1967). In certain areas however, large stretches of shola forests occur at sites that are protected by a large, westerly-located hill. The swamps mostly occur as flat-tables in depressions between slopes and grasslands. They are discrete and patchy in nature, although large extensive swamps do occur. *Pennisetum clandestinum* was fairly common in grassland. The dominant species in

swamps were *Andropogon polyptychus* and *Rhynchospora rugosa*. The common forbs were *Anaphalis bournei, Eriocaulon nilagirense* and *Neanotis indica var. affinis.*

Jayadev (1954) reported that the Tamil Nadu forest department introduced some exotic species such as *Acacia dealbata, Eucalyptus globosus* and *Pinus patula*. The Forest department has planted exotic tree species like Pinus patula in and around the swamps of the study area. But they have failed to grow *Pinus patula* successfully in this swamp habitat. Thus most indigenous grass and forbs species are disturbed by human interference.

The study area was located and surrounded by the core area of Nilgiri Biosphere Reserve (NBR). In 1980, the government of India declared the Nilgiri Biosphere Reserve (NBR), located in southwest India, north of the Palghat Gap between 10° 45' - 12° 5' N and 76° 10'- 77° 10' E longitude (Daniels 1993) as the first Biosphere reserve. The geographical extent of the reserve is 5520 km^2 (Sukumar et al. 1992). The NBR has all the major vegetation types of peninsular India (Champion and Seth 1968). There are several indigenous tribal communities living in many parts of reserve, they are Kurumbas, Irulas, Todas, Kotas, Paniyas, and Cholanayakans. The Todas are basically pastoralists and vegetarians; the Kurumbas, Irulas, Paniyas and other tribes are hunters and food gatherers (Hockings 1989, 1997). Our study area was located in the typical Toda homeland. All these swamps in this area have specific historical names and sanctity attached to them. Most wetland species are named by them and have specific uses. It is the Toda people who have managed and harvested from these swamps in a manner suitable to their needs since millennia. These traditional management practices are now disallowed by the forest service.

METHODS

I surveyed five swamps of Korakundah and Upper Bhavani Reserve Forest. Samples were collected when most herbaceous plants were in the peak-flowering during September 2001 to February 2002. A preliminary field study was made to ensure that sample size captured >70% of the total species. (Sobero and Llorente 1993, Colwell and Coddington 1994). The size of the quadrats ranged from 1m^2 to 512 m^2 and in each size, the number of species was recorded. In each swamps 60 m x 1 m transects were laid. Further, transects were girded into 1x 1m subplots that were located randomly at three intervals, species were enumerated in subplots. In each swamp, the total transects measured 180 x 1 m. The numbers of rooted individuals were counted in each subplot (1 x 1m). Habitat specificity of each species as a microhabitat function of drainage was recorded as: deep stagnant water, shallow water, humid soil, dry soil and edges of the swamps were recorded.

All plants were recorded and identified at the species level using various regional floras (Fyson 1932, Gamble 1915-1935, Bor 1960, Matthew 1999). Nomenclature of species mostly follows The Flora of Tamilnadu (Nair and Henry 1983, Henry et al. 1987, Henry et al. 1989). Species confirmation was counterchecked with herbaria collections lodged at the Botanical Survey of India, Coimbatore, The French Institute of Pondicherry and The Survey of Medicinal Plants and Collection Unit, Ootacamund. The herbarium specimens were deposited at EBR Herbarium Edhkwehlynawd Botanical Refuge, Ootacamund. Nilgiris.

Identification of common and rare species

I followed Rabinowitz (1981) classification of British flora to assess commonness and rarity among swamp flora. I used the number of species and individuals recorded in transects in the five swamps to assess commonness and rarity, using three criteria: geographical range, habitat specificity and local population size. I classified each species occurring in the plots as per the above-mentioned criteria. I defined abundant species as those with wide geographical range, broad habitat specificity and large population size.

Assessment of Local Population Size, Habitat Specificity and Geographical Range

The assessment of geographic range of each species was recorded through literature survey (Fyson 1932, Gamble 1915-1935, Bor, 1960, Ahmedullah and Nayar, 1986). Narrow geographic ranges were those species distributed in the Nilgiri/Palni hills and adjacent areas of the Western Ghats. Species, which were distributed in the Indian subcontinent, Sri Lanka and extralimital areas, were classified as having wide geographic range.

Whether a species occurs in many habitats or is restricted to a few habitats was assessed using the results from the quadrats. I identified 5 microhabitats related to drainage: dry soil, humid soil, and edges of

swamp, deep stagnant water and shallow water. Species occurring in more than two habitats were classified as habitat: broad and those occurring in less than two habitats, as restricted.

The highest density reached by a single species defined local abundance. Density was converted into the proportion of individual flora. Species with a maximum local abundance of <0.1% were scored as locally scarce everywhere and those with local abundance of > 0.1% were scored as locally abundant somewhere.

RESULTS

Floristics

I recorded 78 species belonging to 42 families and 61 genera. Of these, eleven families were represented by a single species, six families were represented by two species each, and six families (but this total to 23 families) were represented by three species each. The family Poaceae was the most species' rich (with twelve species) followed by Cyperaceae (eleven species) and Compositae (six species). Density of species ranged from 0.2 to 17.14 % of all species catalogued.

Rabinowitz's Seven Forms of Rarity

Geographic distribution, habitat specificity and local abundance were evaluated for 68 taxa (87%). By using three traits per species, I placed each species into an eight-celled (2x2x2) table. All 68 taxa (87%) were classified into Rabinowitz's seven forms of rarity (Table 1). The most common form of 'rarity' was that of large local population sizes (70%) and broad habitat specificity (70%), while the least common form of rarity range was (28%) (Table 2). Most species had a narrow geographic range and 22% were restricted into a particular habitat and were locally abundant, whereas 4% were not locally abundant in a restricted habitat. Local abundance was high and 35 % were not restricted in habitat. Sixteen percent were not locally abundant and were not restricted in habitat (Table 1). The rarest species, with both restricted ranges and low population densities, were *Satyrium nepalense* D. Don. (Orchidaceae) and *Utricularia graminifolia* Vahl. (Lentibulariaceae) (Table 3).

The commonest species belonging to 17 taxa had both, wide geographic distribution and large population size. Only one species maintained both small population and restricted habitat. The most common species with a wide geographic range were forbs, namely *Commelina clavata* Clarke. (Commelinaceae) *Erigeron karvinskianus* DC. (Compositae) *Juncus prismatocarpus* R. Br. (Juncaceae) *Oxalis corniculata* Linn. (Oxalidaceae) *Polygonum nepalense* Meisner. (Polygonaceae). Twenty two percent were locally abundant species and had a restricted habitat, specifically: *Agrostis pilosa*, *Andropogon lividus* Thw. *Andropogon polyptychus* Steud., *Carex capicelea* Boott., *Coelachne perpusilla* (Arn. ex Steud.) var. *perpusilla*, *Cyrtococcum deccanense* Bor, *Eriocaulon nilagirense* Steud., *Eriocaulon robustum* Steud., *Eriochrysis rangacharii* Fischer, *Fimbristylis quinangularis, Impatiens rufescens* Kunth, *Neanotis indica* (DC.)W.H. Lewis var. *affinis*, *Pleiocraterium verticillare* Wight & Arn., *Potentilla leschenaultiana* Ser., and *Ranunculus reniformis* Wall.

Table 1. Species distribution in montane swamps based on Rabinowitz's system of classifying rare plants

Geographic Distribution		Wide		Narrow	
Habitat specificity		Broad	Restricted	Broad	Restricted
Local abundance	Somewhere Large	12 (8)	1 (1)	35 (24)	22 (15)
	Everywhere Small	7 (5)	1 (1)	16 (11)	4 (3)

Table 2. Summary of Rabinowitz's classification of herbaceous species recorded in montane swamps of the Nilgiri Mountains.

Rabinowitz's classification	Category	Number of species	Proportion, % (n = 68)
Local abundance	Large	49	72
	Small	19	28
Habitat specificity	Broad	49	72
	Narrow	19	28
Geographic range	Narrow	53	78
	Wide	15	22

High density grasses and forbs were *Andropogon polyptychus* Steud.(Poaceae) *Rhynchospora rugosa* (Vahl) Gale. (Cyperaceae) and *Eriochrysis rangacharii* Fischer

Table 3. Commonness and rarity of herbaceous species in montane swamps based on Rabinowitz's categories

Species	Family	Total No. Individuals	Density (%)	Population size	Habitat Specialisation	Geographic Range
Andropogon polyptychus Steud.	Poaceae	1074	17.14	Large	Broad	Narrow
Rhynchospora rugosa (Vahl) Gale.	Cyperaceae	1000	15.96	Large	Broad	Narrow
Eriochrysis rangacharii Fischer.	Poaceae	761	12.14	Large	Restricted	Narrow
Juncus effusus L.	Juncaceae	438	6.99	Large	Broad	Narrow
Cyrtococcum deccanense Bor.	Poaceae	423	6.75	Large	Restricted	Narrow
Eriocaulon nilagirense Steud.	Eriocaulaceae	393	6.27	Large	Restricted	Narrow
Carex lindleyana Nees var. *lindleyana*	Cyperaceae	228	3.64	Large	Broad	Narrow
Cyperus flavidus Retz.	Cyperaceae	180	2.87	Large	Broad	Wide
Carex capicelea Boott.	Cyperaceae	173	2.76	Large	Restricted	Narrow
Ischaemum commutatum Hack.	Poaceae	139	2.22	Large	Broad	Narrow
Neanotis indica (DC.)W.H. Lewis var. *affinis*	Rubiaceae	115	1.84	Large	Restricted	Narrow
Fragaria nilgerrensis Schlecht.ex Gay.	Rosaceae	110	1.76	Large	Broad	Narrow
Ranunculus reniformis Wall.	Ranunculaceae	82	1.31	Large	Restricted	Narrow
Potentilla leschenaultiana Ser.	Rosaceae	79	1.26	Large	Restricted	Narrow
Impatiens rufescens Kunth.	Balsamineae	65	1.04	Large	Restricted	Narrow
Juncus prismatocarpus R. Br.	Juncaceae	63	1.01	Large	Broad	Wide
Chrysopogon zeylanicus (Nees ex Steud.) Thw.	Poaceae	59	0.94	Large	Broad	Narrow
Scirpus mucronatus L.	Cyperaceae	57	0.91	Large	Broad	Narrow
Anaphalis bournei Fyson.	Compositae	53	0.85	Large	Broad	Narrow
Andropogon lividus Thw.	Poaceae	41	0.65	Large	Restricted	Narrow
Gentiana pedicillata Griseb. var. *wightii*	Gentianaceae	39	0.62	Large	Broad	Narrow
Agrostis pilosula Trin. var *filifolia* Bor	Poaceae	38	0.61	Large	Restricted	Narrow
Isachne kunthiana W. & A.	Poaceae	38	0.61	Large	Broad	Narrow
Xyris capensis Marl.	Xyridaceae	37	0.59	Large	Restricted	Narrow
Fimbristylis quinquangularis (Vahl) Kunth	Cyperaceae	34	0.54	Large	Restricted	Narrow
Ischaemum indicum (Houtt.)	Poaceae	34	0.54	Large	Broad	Narrow
*Laurembergia coccinea (*Blume) Kan.	Haloragaceae	33	0.53	Large	Broad	Narrow
Pleiocraterium verticillare Wight & Arn..	Rubiaceae	31	0.49	Large	Restricted	Narrow
Pinus patula L.	Pinaceae	31	0.49	Large	Broad	Wide
Cyperus melanospermus (Nees) Valcken subsp. *melanospermus*	Cyperaceae	30	0.48	Large	Broad	Narrow
Polygonum nepalense Meisner.	Polygonaceae	26	0.41	Large	Broad	Wide
Leucas suffruticosa Benth.	Lamiaceae	24	0.38	Large	Broad	Narrow
Oxalis corniculata Linn.	Oxalidaceae	24	0.38	Large	Broad	Wide
Hydrocotyle sibthorpioides Lam.	Umbelliferae	23	0.37	Large	Broad	Narrow
Eriocaulon robustum Steud.	Eriocaulaceae	21	0.34	Large	Restricted	Narrow
Hypochoeris glabra Linn.	Compositae	19	0.30	Large	Broad	Narrow
Lipocarpha chinensis (Osbeck) Kern.	Cyperaceae	19	0.30	Large	Broad	Narrow
Eleocharis congesta Don.	Cyperaceae	18	0.29	Large	Broad	Narrow
Coelachne perpusilla (Arn.ex Steud.)v. *perpusilla*	Poaceae	17	0.27	Large	Restricted	Narrow
Viola pilosa Blume.	Violaceae	17	0.27	Large	Broad	Narrow
Erigeron karvinskianus DC.	Compositae	16	0.26	Large	Broad	Wide
Impatiens chinensis L.	Balsamineae	16	0.26	Large	Restricted	Wide
Plantago erosa Wall.	Polyagonaceae	15	0.24	Large	Broad	Narrow
Geranium nepalense Sweet.	Geraniaceae	13	0.21	Large	Broad	Narrow
Pteridium aqualinum (L.) Kuhn.	Denstaedtiaceae	13	0.21	Large	Broad	Wide
Senecio wightii Benth.	Compositae	13	0.21	Large	Broad	Narrow
Commelina clavata Clarke.	Commelinaceae	12	0.19	Large	Broad	Wide
Carex nubigena Don.	Cyperaceae	10	0.16	Large	Broad	Narrow
Carex phacota Spreng.	Cyperaceae	6	0.10	Small	Broad	Narrow
Centella asiatica (L.) Urban	Umbelliferae	6	0.10	Small	Broad	Wide

Table 3. Continued.

Species	Family	Total No. Individuals	Density (%)	Population size	Habitat Specialisation	Geographic Range
Cnicus wallichii DC.	Compositae	6	0.10	Small	Broad	Narrow
Satyrium nepalense D.Don.	Orchidaceae	6	0.10	Small	Broad	Narrow
Juncus inflexus L.	Juncaceae	5	0.08	Small	Broad	Narrow
Drosera burmanni Vahl.	Lentibulariaceae	4	0.06	Small	Restricted	Wide
Themeda tremula (Nees ex Steud.) Hack.	Poaceae	4	0.06	Small	Restricted	Narrow
Eulalia phaeothrix (Hack.) Kuntze	Poaceae	3	0.05	Small	Broad	Wide
Fragaria vesca L.	Rosaceae	3	0.05	Small	Broad	Wide
Parnassia mysorensis Heyne ex Wight & Arn.	Parnassiaceae	3	0.05	Small	Broad	Narrow
Ranunculus diffusus DC.	Ranunculaceae	3	0.05	Small	Broad	Narrow
Utricularia graminifolia Vahl.	Lentibulariaceae	3	0.05	Small	Restricted	Narrow
Ranunculus wallichianus Wight & Arn.	Ranunculaceae	2	0.03	Small	Broad	Narrow
Bulpleurum distichophyllum W. & A.	Umbelliferae	2	0.03	Small	Broad	Narrow
Osbeckia brachystemon Naudin.	Melastomaceae	2	0.03	Small	Broad	Narrow
Rubus racemosus Roxb.	Rosaceae	2	0.03	Small	Broad	Narrow
Wahlenbergia marginata (Thunb.) A. DC.	Campanulaceae	2	0.03	Small	Broad	Narrow
Eriocaulon collinum Hook.f.	Eriocaulaceae	2	0.03	Small	Restricted	Narrow
Conyza bonariensis (L.) Cronquist	Compositae	1	0.02	Small	Broad	Wide
Commelina clavata Clarke.	Commelinaceae	1	0.02	Small	Broad	Wide

(Poaceae). The most common species of grasses and forbs that combined high frequency with high local abundance were concentrated in the families Poaceae (42% of all individuals), Cyperaceae (28%), Juncaceae (8%) and Eriocaulaceae (7%). These four families comprised a total of 85% of the 6260 individuals that were enumerated.

DISCUSSION

I focused on the prevalence of local abundance and geographical distribution that characterize species with high conservation priority in montane swamps of the western upper Nilgiris. In general, species with large geographic ranges have greater local abundances than do geographically restricted species (reviewed in Gaston and Lawton, 1990). In the study, most swamp species had large local abundance and narrow geographical distribution, which was not surprising, because this montane stage has many endemic species. Pitman *et al.* (1999) reported that the higher proportion of narrow endemics in the British data set, and by the inclusion of herbaceous species, which tend to have smaller geographic ranges than trees.

In all five swamps, only the families Poaceae and Cyperaceae combined had high frequency coupled with high local abundance. Seventy eight percent of species have narrow, geographically distribution in n montane swamps, further 24% of these were restricted in their microhabitat. Only small proportions of common and rare species have a wide geographical distribution and are non-dominant species in the swamp community. A large proportion of common species are dominant in the grasslands. Most species had narrow geographic ranges and least microhabitat specificity, partly because of deep stagnant water and shallow water in the montane swamps of upper Nilgiri plateau. The majority of swamp grass species at the sample sites are susceptible to environmental heterogeneity, while few forb species are common on edges. In swamps edges, species are mostly accumulated by colonization from nearby grassland as they might have become colonized into adjacent swamps by anthropogenic factors. Examples of such fringe species are: *Erigeron karvinskianus, Centella asiatica, Commelina clavata.* .

In the Amazon basin, among thousands of species each of which is locally rare, restricted to a single habitat, and confined to a small geographic area (Pitman et al. 1999). In the study, some large population size of grass species in restricted habitat had a narrow geographical distribution based on Rabinowitz classification table. Interestingly, *Eriochrysis rangacharii* a perennial grass endemic to the western upper Nilgiri

plateau and the only representative in India of an otherwise African genus (Puyravaud et al. 2003). According to the Red Data Book of Indian Plants (Nayar and Sastry 1987) this was presumed extinct and was collected only once in 1900. Recently, *Eriochrysis rangacharri* was rediscovered (Puyravaud et al. 2003) and it grows in high density in restricted habitat, its rank places it in the third category (Table 3). However, this species is harvested routinely by the indigenous Toda people to thatch their temples and traditional houses. Based on Rabinowitz table, *Eriochrysis rangacharii*, has a large population size, restricted habitat and narrow geographical distribution whereas *Andropogon polyptychus* also had large population size, narrow geographical distribution but habitat generalist his a perennial swamp grass endemic in Western Ghats (Sreekumar and Nayar 1991). *Coelachne perpusilla* var. *perpusilla* is a grass endemic and rare in Nilgiris (Nayar and Henry 1983). Rabinowitz table describes that *Coelachne perpusilla* var. *perpusilla* is restricted in swamp habitat, narrow geographic range and large population size.

Floristic information on the altitudinal distribution was less, though it is apparent that 42 species (24.5%) are montane specialists restricted to altitudes of more than 1800 m (Daniels et al. 1995). Compared to that, according to the Rabinowitz table, swamp grass and forb species are restricted in habitat and exhibit 19 species (27%). Rarity includes swamp forb species that are also restricted to a narrow geographical range, but without any habitat specialist (e.g. *Anaphalis bournei*). Annual forb *Impatiens rufescens* endemic to upper Nilgiri swamps have a restricted wetland habitat and narrow geographical range. It seems that such annual species are very sensitive and once their habitat is lost or altered, they are usually unable to recover.

The grasses are highly resilient compared to forbs and it helps to maintain the diversity of forbs. Nearby and within the swamp, some exotic species have been planted, especially *Pinus patula*, and this is found to devastate the growth of indigenous common and rare herbs in the swamp community. Whalley et al. (1978), and Prober and Thiele (1995) suggested that native species diversity is heavily impacted by exotic species. This study points out that the swamp habitat should be protected from exotic tree plantations and other anthropogenic activities.

In conclusion, the herbaceous swamp species are rich in biodiversity, with marked heterogeneity in species composition, even within a single habitat type. According to our results, most of the narrow geographically distributed species are locally abundant and restricted in habitat. Further, the Rabinowitz table clarifies that small population ranges occur in broad habitat, and this could be due to recent human disturbances. Eventually, swamp restoration may be possible through protection of common and rare species.

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