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Assessment of tree population and species composition in three forest types of Biligiri Rangaswamy Temple Wildlife Sanctuary, Karnataka, India

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Abstract

Biligiri Rangaswamy Temple Wildlife Sanctuary in Chamarajnagar District of Karnataka State is home for semi-nomadic Soliga Tribe. The species composition and population structure were investigated in three (Shola, Dry deciduous and Moist deciduous) forest types to assess the changes in species composition among them. Random single-scale sampling was adopted with a plot of 2m×2m for regenerated tree species having GBH ≤ 30 cm nested with quadrat of 20m×20m for tree species having GBH ≥ 30cm. A total of 30 species in dry deciduous forest, 36 species in moist deciduous forest and 33 species in shola forest were recorded. The highest diversity in regenerated species was observed in moist deciduous populations followed by shola and dry deciduous forests. The regeneration of NTFP species in moist deciduous forest was found to be high (22 species) and very low in dry deciduous forest (10 species). These types of forests were found to be impacted by disturbance such as canopy opening, weed, grazing fire and lopping. The study is useful to plan conservation strategies for these resources.

Key words

BRT hills, Deciduous forest, Shola forest, Species diversity, Wildlife Sanctuary

Introduction

Forests are the repositories of natural wealth in terms of flora and fauna. They provide a wide range of goods and various ecological services to mankind. They are the chief bio-resources that support the development and economic progress of any country. Forests provide food, fodder, fiber, timber, resin and gums, employment, income and so on. Millions of people worldwide depend on the harvest of non-timber forest products (NTFP) for their livelihoods (Vedeld *et al.*, 2004), and the importance of understanding the complex relationships between harvest and conservation is increasingly recognized (Belcher and Schreckenberg, 2007). The United Nations Food and Agriculture organization approximates that 80% of the developing world relies on NTFPs for nutritional and health needs (FAO, 2008). Chauhan *et al.* (2008a) reported that 50 % of forest revenues and 70 % of forest based export income of the country comes from NTFPs. Thus, NTFPs form one of the mainstays of income and sustenance for many tribal communities.

The Biligiri Rangaswamy Temple (BRT) Wildlife Sanctuary has a rich diversity of vegetation types ranging from scrub to evergreen forest. Dry deciduous and scrub forests are predominant and together constitute almost 90 % of the total area of the sanctuary (Ganesan and Setty, 2004). For hundreds of years, this region has been the home for semi-nomadic Soliga tribe, for whom collection of non-timber forest products (NTFPs) is one of the important sources of income. Exploitation of NTFPs has a significant impact on regeneration of species. Sinha and Bawa (2002) reported that harvesting techniques used by the Soliga's at BRT Wildlife Sanctuary had a negative impact on the trees of *Phyllanthus* species wherein a decline in their growth rate of population was recorded.

In this regard, study of regeneration of forest trees has important applications for the management of natural forests, and is one of the thrust areas of forestry. Research in this field contributes to planning, conservation and decision making in

forest resources management programs (Pokhriyal *et al.,* 2010). In view of above, the present investigation was undertaken to assess the diversity, richness and regeneration status of woody species along with non-timber forest products (NTFP) tree species in three different forest types of BRT Wildlife Sanctuary.

Materials and Methods

Study site : Field exploration was undertaken in Biligiri Rangaswamy Temple (BRT) Wildlife Sanctuary of Chamarajnagar, Karnataka State, India. It is spread in 5,101 sq km with a forest cover of 2620 sq km (51.36%).

BRT Wildlife Sanctuary (Fig. 1) envisages an area of 540 sq km at an elevation of 600 to 1800 m above mean sea level. It extends from 11º 40' to 12º 09' N latitude and 77º 05' to 77º 15' E longitude. The area receives most of its rainfall from June to December. The annual rainfall varies from 600 to 3000 mm at higher elevation. Maximum temperature varies between 20 to 38 ºC, while minimum temperature lies between 9 to 16 ºC.

Data collection : Moist and dry deciduous and shola forests were sampled. In each area, 10 quadrats of 20mx20m with 50m distance between them were established randomly along both sides of the transect line. In each quadrat, all adult trees ≥ 30 cm Girth at Breast Height (GBH) were identified and counted. The GBH was measured for each individual adult tree using a measuring tape. Altogether 40 plots of 2m x 2m were laid down. In each plot, all plant species ≤ 30cm GBH were considered as regenerative seedlings and enumerated separately into following 4 regeneration classes: Class I < 40 cm height, Class II between 40 – 100 cm height, 100 cm height < Class III < 10 cm GBH and 100 cm < Class IV from 10 – 30 cm GBH.

Species richness and diversity : Species richness and diversity were analyzed for tree species (overall species and NTFP species) and regenerative seedlings (overall species and NTFP species). Menhinick's richness index (Menhinick, 1964), Simpson (Simpson, 1949), Shannon diversity index (Shannon and Weaver, 1949) and Evenness index (Pielou, 1966) were used to assess the species richness, diversity and distribution range patterns of individuals among the species, respectively. Density and basal area (basal area = g^2/π; where g =girth at breast height, π = 3.14) were calculated.

Disturbance parameters : Four levels of disturbance were given to each parameter namely absent, low, medium and high.

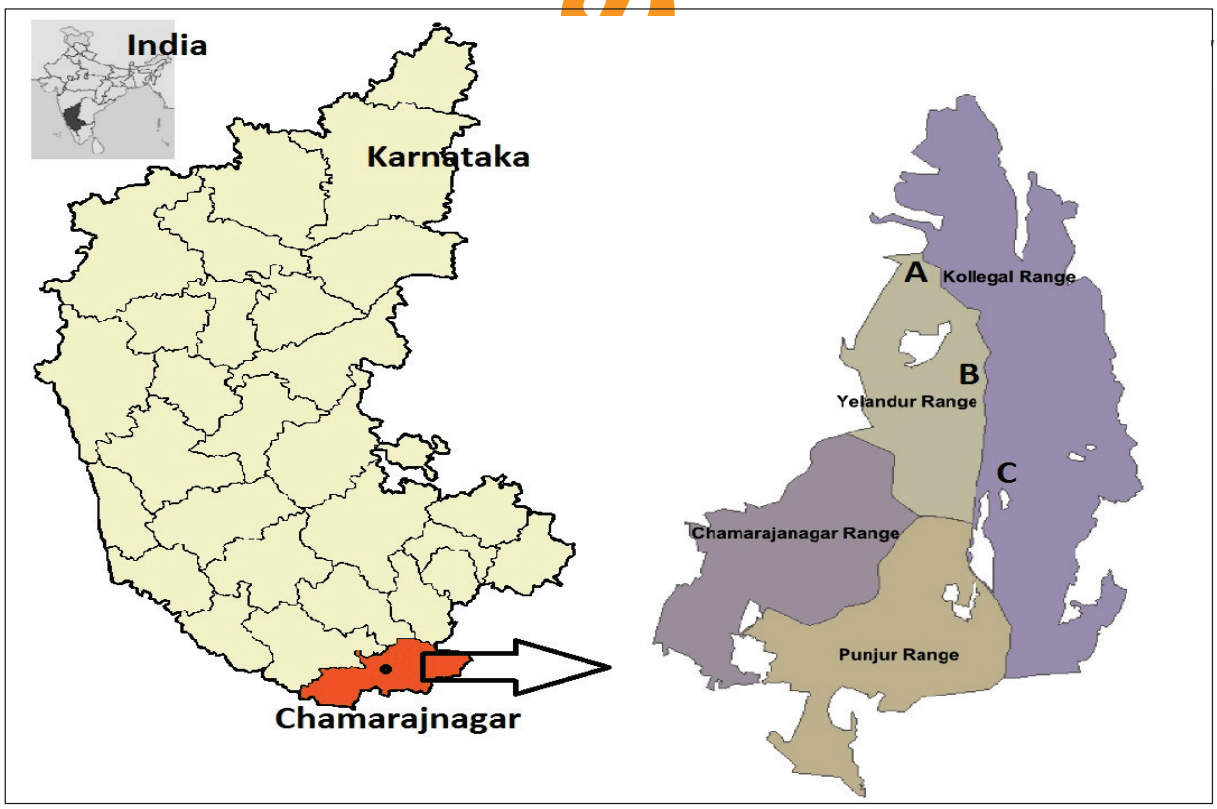

Fig. 1 : Study areas in the three forest types, BRT Wildlife Sanctuary; A – Dry deciduous forest, B – Moist deciduous forest, C – Shola forest

The level of disturbance ranged from 1 to 4. The value of 1 was considered as absence of disturbance, whereas, value of 4 was considered as high disturbance.

Statistical analysis : The collected data were subjected to statistical analysis using the Biodiversity software version 2.0 and Microsoft Excel.

Results and Discussion

Species composition : Altogether 77 wood species belonging to 38 families were recorded in three forest types of BRT Wildlife Sanctuary.

A total of 30 species (21 families) in dry deciduous forest, 36 species (17 families) in moist deciduous forest and 33 species (22 families) in shola forest were recorded from the sampling plots covering an area of 4,000 m^2 in each forest type. The family Rubiaceae was represented by maximum number of species (6) followed by Combretaceae, Fabaceae, Lauraceae (4 species each) and Euphorbiaceae (3 species). Among the genera, *Terminalia* was dominated by a maximum of five species.

Of the 26 NTFP tree species belonging to 23 genera and 16 families recorded in the given area, moist deciduous forest showed maximum (22) number of species. Among these, *Acacia concinna, Sapindus laurifolia, Phyllanthus emblica, P. indofischari, Terminalia chebula* and *T. bellarica* were exploited mainly for commercial purpose.

Species diversity and richness : The Shannon-Wiener's Index (H') values for overall tree species ranged from 2.69 (shola forest) to 3.08 (moist deciduous forest), but for NTFP species, dry deciduous forest showed the lowest H' value of 1.4 (Table 1). The lower value for NTFP species could be attributed to the effect of resource extraction and disturbance factors such as grazing, weeds, forest fire and canopy opening in dry deciduous forest. Pausas and Austin (2001) suggested that over any large region, the distribution of species richness is likely to be governed by two or more environmental factors and not by a single factor. The H' values for evergreen forests of Western Ghats ranged from 2.1 to 5.2 (Elouard *et al.,* 1997; Shivaprasad *et al.,* 2002; Vasanthraj *et al.,* 2005), for semi-evergreen forests from 2.3 to 4.3 (Kadavul and Parthasarathy, 1999). However, the present study indicates

Table 1 : Indices for species richness and diversity of growing stock species in different forest types

Indices	Dry deciduous forest		Moist deciduous forest		Shola forest	
	Overall	NTFP	Overall	NTFP	Overall	NTFP
Taxa (No. of species)	29	9	19	11	19	10
Individuals	78	27	43	28	54	32
Density	390	135	215	140	270	160
Basal area (m^2 ha^{-1})	98.92	13.4	159.47	127.13	249.11	155.7
Dominance	0.09	0.42	0.08	0.13	0.08	0.15
Shannon	2.91	1.4	2.72	2.17	2.69	2.03
Simpson	0.91	0.58	0.92	0.86	0.92	0.84
Evenness	0.63	0.45	0.8	0.79	0.78	0.76
Menhinick	3.28	1.73	2.9	2.079	2.59	1.76
Margalef	6.43	2.42	4.79	3.001	4.51	2.59

Table 2 : Indices for species richness and diversity of regenerated species in different forest types.

Indices	Dry deciduous forest		Moist deciduous forest		Shola forest	
	Overall	NTFP	Overall	NTFP	Overall	NTFP
Taxa (No. of species)	27	10	35	22	24	14
Individuals	86	31	179	118	158	77
Density	430	155	895	590	790	385
Dominance	0.09	0.2029	0.06	0.09911	0.07	0.1543
Shannon	2.77	1.869	3.08	2.576	2.84	2.107
Simpson	0.91	0.7971	0.94	0.9009	0.93	0.8457
Evenness	0.59	0.6484	0.62	0.5973	0.71	0.5876
Menhinick	2.91	1.796	2.62	2.025	1.91	1.595
Margalef	5.84	2.621	6.55	4.402	4.54	2.993

moderately low species diversity in the forest types of BRT Wildlife Sanctuary.

Simpson's Index, which varies from 0 to 1, simply states that, higher the index value - lower the diversity of a community. In the present study, values ranged from 0.91 (dry deciduous forest) to 0.94 (moist deciduous forest), which was higher than the values reported in various evergreen forests of Western Ghats (0.78 to 0.95, Elouard *et al.,* 1997; Vasanthraj et al., 2005, Vasanthraj and Chandrashekhar, 2006). UNEP (2001) reported that the disturbance created by habitat destruction, over exploitation, pollution and species introduction determine forest dynamics and tree diversity at the local and regional scale.

The lowest values of species richness indices were recorded in the shola forest (4.51 – Margalef's Index, 1.91 – Menhinick's Index). Margalef's Index values in the present study ranged from 4.51 (shola forest) to 6.55 (moist deciduous forest). Chauhan *et al.* (2008b) reported a range of Margalef's index value of 14. 11 to 17.30 for tropical dry deciduous forests, and Sharma *et al.* (2009), reported a range of 2 to 9 for moist tropical forests. Our study indicated moderately low species richness of study area. Larpkern *et al.* (2009) reported that the variations in species richness and diversity at a local scale are affected by both natural environmental factors and human- made changes to the local environment.

Density and basal area : The highest density was observed in dry deciduous forest with lowest basal area, while, moist deciduous and shola forests represented the lowest density with highest basal area/girth class (Table 2). This could be attributed to the fact that tree species such as *Dalbergia latifoila, Vibernum punctatum, Mallotus philippensis, Persea macrantha* and *Syzygium cumini* with higher girth class are abundant in shola and moist deciduous forests. Similar observations on decrease in density have been made in various forests of India (Pascal and Pelisseir 1996; Parthasarathy and Karthikeyan 1997, Ashalatha *et al.,* 2005) Malaysia (Newbery *et al.,* 1992) and Costa Rica (Nadkarni *et al.*, 1995).

Regeneration studies : A total of 179 regenerated individuals belonging to 35 species were recorded in moist deciduous forest which is relatively higher than dry deciduous (86 individuals belonging to 27 species) and shola forests (158 individuals belonging to 24 species) (Table 2). The richness of moist deciduous forest could be related to the fact that this forest is located in medium altitude and received intermediate disturbance as compared to dry deciduous and shola forests. Of the 179 individuals, 118 were NTFP species that showed regeneration in

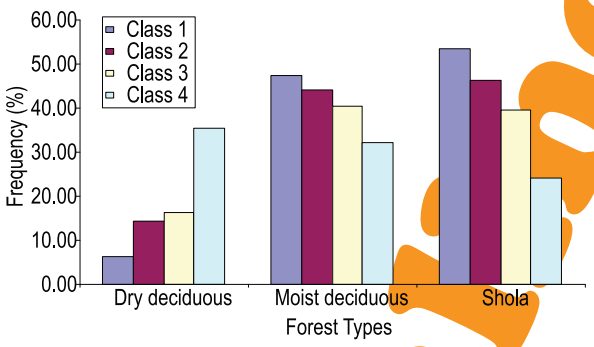

Fig. 2 : Distribution of regeneration classes of species in different forest types

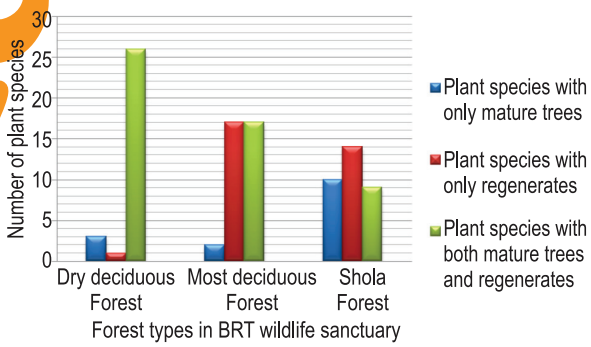

Fig. 3 : Regeneration status of tree species enumerated in different forest types

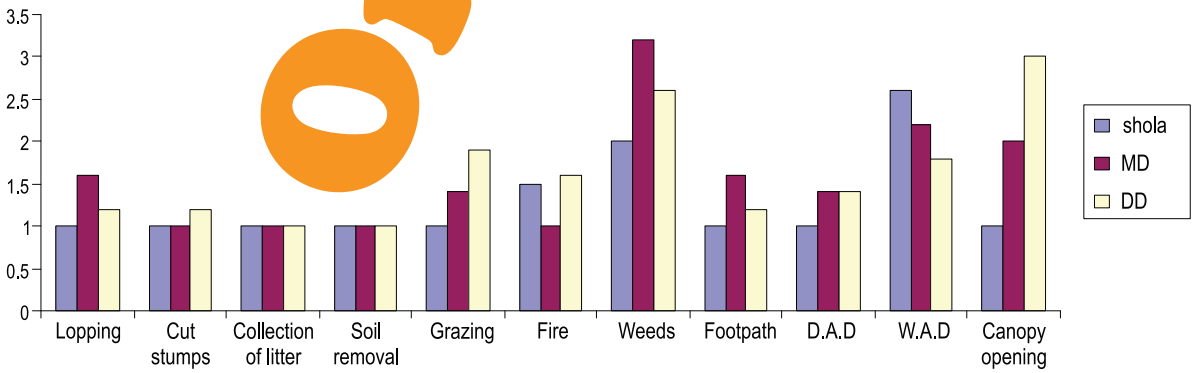

Fig. 4 : Disturbance values of natural and anthropogenic factors; Shola: Shola forest, MD: Moist deciduous forest, DD: Dry deciduous forest.

moist deciduous forest, 77 among 158 individuals in shola forest and 31 among 86 individuals in dry deciduous forest.

Distribution of regeneration classes and their frequency percentage is shown in Fig. 2. As shola and moist deciduous forests showed a reverse-J shaped graph, it can be inferred that there is a continuous process of multiplication and healthy regeneration status in these forests. Sharita *et al.,* (2011) reported a reverse J-shaped curve for diameter distribution of *Shorea robusta* trees, which is an indication of sustainable regeneration (Vetaas, 2000). Distribution curves that drop exponentially with increasing GBH (reverse J-shaped curves) are characteristic for species with continuous regeneration (Khamyong *et al.,* 2004). A J-shaped graph obtained for dry deciduous forest indicates a poor status of regeneration of species. Inadequate regeneration of the constituent species is a general phenomenon in Indian forests because of grazing, fire extraction of timber and fuel wood and cultivation (Uma Shankar *et al.,* 1998; Uma Shankar, 2001). It is reported that fairly large number of species had good regeneration where light intensity was low, soil moisture level was high and intensity of disturbance was low (Tripathi *et al.,* 2010). In the present investigation, similar results have been obtained in shola and moist deciduous forests but poor regeneration was observed in dry deciduous forest.

However, when regeneration status of species were enumerated, it was observed that greater regenerates were recorded by the existing species in dry deciduous forest as compared to moist deciduous and shola forests where regenerates were from both existing and newly established species (Fig. 3). Maximum number of plants species [26 out of 30 (86%)] were represented by both mature trees and their regenerates in dry deciduous forest and only three species didn't show any regeneration. In shola forest, only 27% (9 out of 33) of plant species had both mature trees and their regenerates. No regeneration was observed among the ten species of the area, but regenerates were recorded from 14 new arrivals. In moist deciduous forest, regenerates was observed in both existing plant species as well as new arrivals (17 species each) of the area.

No regeneration of plant species in the study area could be attributed to poor seed set and seed germination, high mortality at seed/seedling stage because of grazing due to which regeneration of such species may become periodic (Ashalatha Devi *et al.,* 2005). Existence of maximum number of new arrivals in shola and moist deciduous forests could be due to the presence of favorable micro-environmental conditions such as higher moisture level, canopy cover and less grazing, for the germination and establishment of seeds dispersed from nearby forests.

Disturbance analysis : It was observed that lopping, grazing, footpath, forest fire and weeds were the main natural and anthropogenic activities in the forests (Fig. 4). A good canopy cover was observed in shola forest followed by moist deciduous forest and a high canopy opening was observed in dry deciduous forest. Anthropogenic disturbances are generally accompanied by an opening up of the forest canopy and a reduction in soil moisture and humus content which in turn affects tree growth and forest cover (Peh *et al.,* 2005; Lee *et al.,* 2005; Shahabuddin and Kumar, 2006). Shola forest was found to have less disturbing activities as compared to dry deciduous forest which has the highest disturbing activities. The disturbance led to thinning of woody layer and change in the forest micro-climate which in turn might have impaired regeneration process of tree species (Pooja *et al.,* 2010).

It is evident from the results that species richness was more in dry deciduous forest which could be due to open canopy, grazing and forest fire. At the same time, these disturbance factors influenced the regeneration status in dry, moist deciduous and shola forests. Presence of lesser regenerated NTFP species in dry deciduous and shola forests indicates that extraction of non-timber forest products might have a negative impact on regeneration of those species.

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