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STUDIES ON THE DIVERSITY OF CLIMBERS AND LIANAS OF ALAGAR HILLS IN MADURAI

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ABSTRACT

To study the forest resource conservation is to sustain the economic development of local communities and nation in which they occur. Predictions regarding the possible implications of increased liana density of forest development and succession depend, in part, on an understanding of liana growth, reproduction, and lifespan. Liana species richness and density varied considerably across the three Alagar hills, M. Compared to other tropical forest sites, the liana diversity in India was low, especially in our wet evergreen forest sites. The fact that majority of lianas in evergreen forests have animal dispersal that reveals their faunal dependence and emphasizes the need for a holistic approach in conservation to protect forest sites with all biota, particularly the tree communities which provide physical support for lianas and fauna for seed dispersal. Keeping in this view, and as lianas are reported to play a key role in the ecology and dynamics of forests. Further research on the role of lianas in forest structure, stand dynamics and functioning particularly, the use by fauna communities deserve the investigation in our study sites. Such data are expected to be useful for forest conservation and management.

KEYWORDS: Lianas, Bio diversity, Climbers, deciduous forest, anthropogenic pressure.

INTRODUCTION

India has a rich and varied heritage of biodiversity covering ten bio geographical zones, the Trans-Himalayan, the Himalayan, the Indian desert, the semi-arid-zone(s), the Western Ghats, the Deccan Peninsula, the Gangetic Plain, North-East India, and the islands and coasts (Rodgers et al., 2000). India is rich at all levels of biodiversity and is one of the 12 mega diversity countries in the world. India's wide range of climate and topographical features has resulted in a high level of ecosystem diversity encompassing forests, wetlands, grasslands, deserts coastal and marine ecosystems, each with a unique assemblage of species.

Surveys conducted so far in India have over 47,000 species of plants and 89,000 species of animals over just 70% of the country's total area (MOEF, 1999). The National Bureau of Plant Genetic Resources has over 1,59,080 varieties and 1,07,018 germplasm collections. Genetic diversity comprising native species and land races in concentrated areas of the Western Ghats, Northern Himalayas, Southern plateau, Central India and North-western Himalayas. Domesticated livestock and poultry include 27 breed of cattle, 8 breed of buffalo, over 42 breeds of sheep, 20 breeds of goats, 7 breeds of camel, 8 breeds of horses and a few types of pigs. Among 20,000 species comprising the fish genetic resources of the world, nearly 11 per cent (or 2118 fish species) have been reported in India, including the fin fishes from the Western and Eastern Ghats (MOEF, 2001 and Muthuchelian, 2004). The forests consist of many other elements that not only play a large role at the forest level, but also have an impact at an ecosystem scale. For instance, shrubs, herbs, epiphytes, and lianas compose the vast majority of the plant species diversity in most tropical forests (Schnitzler & Carson, 2000), but are not well studies when compared to trees. Lianas, in particular have been overlooked in most forest studies. Recent evidence, however, suggests that lianas play an extremely important role in many aspects of forest diversity, regeneration and dynamics (schnitzel and Bongers, 2002).

Lianas are a taxonomically diverse group; anatomically, liana stems range from round with successive cambia producing concentric rings of xylem to highly irregular shapes with furrowed or segmented arrangements of vascular tissue (Carquest, 1991). Liana climbing habits range from species that simply arrange over their hosts to those that use multiply branched tendrils or adhesive adventitious roots to secure themselves (Darwin, 1867; Hegarty, 1991). Finally, although tropical lianas are generally thought to be light demanding, there are some shade-tolerant species that reproduce in the forest under story (Putz. 1984).

There is, however, evidence that the relative abundance of lianas using different climbing mechanisms varies among forest succession phases. The biomechanics of climbing growth shows that tendril climbings are limited using smaller diameter supports than twining lianas (Putz; Putz and Chai, 1987; Putz and Holbrook, 1991).

The biomechanical difference among climbing mechanisms may explain the high relative abundance of tendril climbers along forest edges (Putz, 1984; Laurance et al., 2001) and in early succession forests (Dewalt et al., 2000) where small diameter supports, in the form of sapling trees, are abundant. There are also examples of differences in reproductive strategies among species of lianas. At the global level, the report shows that increases in tropical forest turnover rates, possibly linked to global climate change, and have been paralleled by increases in liana density (Phillips and Gentry, 1994; Phillips et al., 2002). Predictions regarding the possible implications of increased liana density on forest development and succession depend, in part, on an understanding of liana growth, reproduction, and lifespan.
To the extent that having long lived gene is characteristic shared by many species of lianas across forest types, increases in liana density are likely to result in persistent changes to forest structure. This works compares life history traits among three co-occurring species of lianas in an old-growth forest in the Eastern Ghats of Alagar hills, Madurai.

OBJECTIVES

The objectives of the present study are

- To study the woody biodiversity in Alagar Hills of Eastern Ghats, Tamilnadu, India.
- To evaluate the impact of human disturbance on woody plant biodiversity in the tropical dry deciduous forest of Alagar hills.
- To study the impact of anthropogenic pressure on the forest.

Table 1: Details of the four study sites of Liana inventories.

S.No.	Location Eastern Ghats	Latitude and Longitude	Altitude (m)	Mean rainfall (mm per year)	Length of dry season (months)	Forest stature (m)
1	Plot 1	11*38’-12*01’N and 78*37’-78*51’E	680	971	5	Moist deciduous Forest
2	Plot 2	11*48’-12*41’N and 78*34’-78*55’E	760	971	7	Moist deciduous Forest
3	Plot 3	11*28’-12*51’N and 78*37’-78*41’E	550	971	7	Dry deciduous Forest

Table 2: Complete list of Liana species enumerated in the four study sites, along with their abundance, arranged in the increasing order of site elevation.

Species	Family	Alt (m)	200	600	950
		Plot 1	Plot 1	Plot 1	Total of species
Chilocarpus atrovirens (G.Don) Bl	Apocynaceae	13		8	21
Strychnos Dennst	Loganiacea			22	22
Artabotrys zeylanicus J.D.Hook and Thoms.	Annonaceae	6		11	17
Kunstleria Keralense Mohanan and Nair	Papilionaceae		12	7	19
Combretum alibidum G.Don	Combretaceae	3	7	1	11
Combretum latifolium B1	Combretaceae	2		2	4
Alangium salvijolium (L.F) Wang.	Alangiaceae	7	22	15	44
Jasminum augustifolium (L) Wild.	Oleaceae	22		5	27
Derris ovalifolia (Wight and Arn.) Benth	Papilionaceae	8	3		11
Ventilago bombaiensis Dalz.	Rhamnaceae		9	5	14
Derris benthamii (Thw.) Thw.	Papilionaceae	12	6		18
Cayratia pedata (Lam.)Juss. Ex Gagnep.	Vitaceae	17		15	32
Canthium angustifolium Roxb.	Rubiaceae	23	11		34
Ziziphus oenoplia (L.) Mill.	Rhamnaceae	13		15	28
Derris brevipes (Benth) Baker	Papilionaceae		5	13	18
Gymnema sylvestre (Retz.) R. Br. ex Scheltes	Apocynaceae	17	14	25	56
Sacostigma kleinii Wight and Am.	Icacinaceae		21		21
Cappar is brevispina DC.	Capparaceae	12		2	14

MATERIALS AND METHODS

Alagar hill forms a discontinuous minor range in the Deccan plain and appears as an extension of Eastern Ghats. It is located 22 kms north east of Madurai city (Lat. 12 18 N; Long 76 42 E; Alti. 600 m above mean see level). Table 1) & (Plate 1 1a and 1b). The dry deciduous forest of Alagar hill is composed of both highly disturbed and protected vegetation, which varies with topography of the area and degree of anthropogenic pressure. The vegetation and soil characteristics of this forest has three different altitudes viz., 275 m, (foot-hill – Silambar Valley), 350 m (mid-hill-Palamutheer solai – middle of Silambar Valley) and 550 m (top – hill –above- Nupuragangai towards Bison Valley) were selected to study the disturbances to this dry deciduous forest. The present study was carried out during post monsoon (October-November) seasons Both summer and monsoon seasons were considered for sampling to reduce the confounding effect of seasons on selected measures of disturbance. Lianas density at selected three altitudes was estimated by two measures viz., number of lianas with multiple stems and number of crossing branches. To estimate the former, all lianas occurring in 5 m *5m randomly placed quadrates were tagged with fluorescent stacked to differentiate them from others. Numbers of lianas with multiple stems

(two or more) among these tagged lianas were counted, five for each season. To estimate the second parameter, the estimator walked along transect of 3 m length towards the double-storey vegetation AL growth in the interior areas of the forest and counted the branches of lianas, trees and shrubs crossed above his chest and resisted his entry into the forest. No distinction was made either on the thickness or species of the counted branches. Total ten transects were walked at each altitude, five for each season. All lianas 1 cm depth (diameter at breast height), rooted within the study plots were systematically enumerated in the 30 has plot of Nupuragangai, Palamutheer solai and Slumber valley in Eastern Ghats. In, all lianas 1.6 cm depth (5 cm gbh, girls at breast height) were enumerated and identified. To facilities a valid comparison of the liana diversity and identified. To facilitate a valid comparison of the liana diversity and density, we used only lianas 1.6 cm dbh from the liana data sets. Liana diameters were measured at 1.3 m from their base. Fisher's a, an index of species diversity which is relatively unbiased by samples size, was computed for all the sites.

The deciduous forests of Alagar hill is composed of both disturbed and protected vegetation, which varies due to change in topography of the area.

The data set on lianas used in this work is bases on the liana inventories carried out in three sites of Fig.1. Map showing location of all the three study sites in Alagar hills.

RESULTS AND DISCUSSION

The liana inventory in the total sample of 47 ha distributed in three sites of Alagar hills forests yielded 9,255 liana individuals and 48 species in 34 genera and 23 families (Table. 3) and (Table 4). In the total species pool, 26% of species occurred in Nupuragangai area, 27% in Palamutheer solai area; and 47% of the species, respectively, in the Silambar valley area. The most diverse genera include Derris, Capris, Jasmine, Cisssus and Caryatid. The per site species richness of liana 1.6 cm dbh ranged from 26 to 65 species, in the three study areas, while the species richness ranged between 2 and 36 species at the 1 ha scale across these forests. The density of lianas 1.6 cm dbh ranged from as high 702 individuals ha 1 in site (Table 2) and (Plate 2). The density contribution of each site to the total density revealed that the Nupuragangai are contributed the most (47%) whereas the Palamutheer solai sites contributed just 32% of density. The log density of species revealed that majority of species occurred in low density. About 57% of species had 30 individuals, while 22.3% of species had > 127 individuals, whereas just two species had > 1024 individuals. About 69% of species occurred in only one of the three forest sites, 24% of species were present in one

forest sites, while 5% of species were present in two forest sites, just 2% of species were recorded in three study sites, and no species was common in all the three forest sites. The computed Fisher's a value was as high as 7.9 for Nupuragangai. The values ranged from 7.06 in the Palamutheer solai, 3.65 in the two Slumber valleys (Table 20 & (Plates 3 & 4).

Predominant liana taxa

The four most species families, Papilionaceae, Vitaceae, Mimosaceae and Capparaceae contributed 23% of the total species richness, whereas a total of 9 families were represented by single species (Table. 3). In Nupuragangai sites, Capparaceae, Vitaceae, Papilionaceae, Asclepiadaceous and Apocynaceae were well represented. The Palamutheer solai contained Rhamnaceae, Asclepiadaceous and Apocynaceae as prominent families. While in the Silambar valley, Vitaceae, Oleaceae, Mimosaceae, Rutaceae and Rubiaceae were the most species families. With respect to liana density among the Indian forest sites, Piperaceae, Apocynaceae, Oleaceae, Papilionaceae, Papilionaceae and Arecaceae were the most important families. In the Nupuragangai area, Loganiaceous, Combretaceae and Papilionaceae contributed 41% of its total density, whereas in Palamutheer solai area 32%. Of the densities were contributed by Arecaceae, Rubiaceae and Papilionaceae, whereas the Silambar valley 27% of density was contributed by Piperaceae, Oleaceae and Apocynaceae.

Table 2: Summarized results of liana inventories of the four Alagar Temple hills sites.

Location	Sampled area (ha)					Fisher's a	Number of climbing mechanism	Liana species/(tree species liana species	Liana density/(tree density liana density)
		>_ 1 cm dbh	>_1 6 cm dbh	>_ 1 cm dbh	>_1.6 cm dbh				
Plot 1	1	-	16	-	55	7.9	4	0.23	0.09
Plot 2	1	-	15	-	58	7.06	3	0.25	0.11
Plot 3	1	-	12	-	95	3.65	3	0.26	0.16

Table 3: Distribution of liana species diversity (S) and abundance (A) percentage of individuals) under various climbing mechanisms in the Alagar hills.

S.No.	Climbing Mechanism	Total number of species and percentage of individuals in		
		Nupuragangai	Palamutheer solai	Silambar Valley
1	Twines	8	11	12
2	Scrambles	7	8	15
3	Root climbers	0	1	1
4	Hook climbers	1	0	0
5	Tendril climbers	4	5	8
6	Grapnel-Like climbers	0	3	2

Table 4: Mean number and percentage of species under various dispersal modes in the three sites.

Study sites	Mean number and percentage of species under various dispersal modes				X2
	Zoochory	Autochory	Anemochory	hydrochory	
Nupuragangai	19.0(69.7)	3.0(11.0)	5.3(19.3)	-	X2=16.5,d.f.=2.p<0.01
Palamutheer solai	15.0(76.1)	2.0(10.2)	2.0(10.2)		X2=45.4,d.f.=3.p<0.01
Slumber valley	14.5(61.7)	0.5(4.4)	1.5(13.2)	0.4(3.5)	X2=17.9.d.f.=3,p<0.01

Liana diversity and density in relation to forest stature and altitude

The three forest sites that are located along an altitudinal gradient varied significantly in the mean density of lianas (1.6 cm dbh) and forest stature (Tables 1 and 2). The density and richness of lianas were strongly correlated with geographical location as density decreased with increasing site. Altitude (r2 ¼ 0:72, P<0:05 and r2 ¼ 0:54, P < 0:05; Fig. 5a and b, respectively). The mean liana density ranged from as high as 585 individuals ha 1 in the Nupuragangai to as low as 49 individuals ha 1 in the Palamutheer solai (900 m a.s.1) of Alagar hills. The mean liana density across the forest sites showed a weak negative correlation with forest stature (r2 ¼ 0:13, P < 0:05). The tall-statured (35 m) Silambar valley area contained mean density of 175.6 lianas (1.6 cm dbh).

Climbing mechanism

The total liana species enumerated in the Alagar hill can be categorized into six climber types: twines, tendril climbers, scramblers, root climbers, hook climbers and grapnel-like climbers. Twining was the chief climbing mechanism both in terms of species richness (55%) and density (49%) when all the sites together, and when the individual forests were considered. The highest density of tendril climbers (24%) was found in Nupuragangai. The rattan Calamus (Arecaceae) with a grapnel like climbing mechanism was found in both Silambar valley and Palamutheer solai areas (Plate 5).

Liana dispersal ecology

The mean number of liana species in each dispersal mode within the area varied significantly. Among the two areas showed the minimum variation, while Silambar showed maximum variation. There was no variation in dispersal modes across the five study sites (w2 ¼ 7:9, d:f: ¼ 12, P< 0:01). Dispersal mode analysis of the five peninsular Indian sites revealed that animal dispersal species were prevalent in all the three sites. Among the two sites, a high per cent of species with animal dispersal guild were found in the Nupuragangai and Palamutheer

solai (78%). Wind dispersal mode was more common in the Silambar valley (22%) than the other sites. Entada pursaetha, found in Palamutheer solai was the only species dispersed by water (Plate 6).

Liana diversity vs Tree diversity ratio

Among the three sites the ratio of the Liana species richness to the woody species richness ranged from a low of 0.23 for the Silambar to a high value of 0.55 in Nupuragangai (Table 2). The ratio of liana stem density to woody stem density was as low as 0.08 in the Palamutheer solai. The vast majority of the species in our sites was site-specific and occurred in low density (Fig. 2). This trend conforms to the observation of Ibarra-Marquez and Martinez-Ramos (2002) in Mexican rain forest. In our sites, only four species, Chilocarpus atrovirens (G.Don) BI. Kunstleria Keralense Monahan and Nair, Derris ovalfolia (Wight and Arn.) Benth. And Gymnema Sylvester (Retz) R. Br. Ex Schulte's, showed wide ecological amplitude and occurred in three, but all had considerable variation in their population density.

The fact that species of the same family or same genus tended to dominate different habitats supports the hypothesis that evolutionary niche differentiation has occurred within some liana phylogenetic lineages (Ibarra-Marquez and Martinez-Ramos, 2002. Gentry, 1991 a; Dewalt et al., 2000). In Alagar hill, various general of Papilionaceae dominated in different sites (Derris ovalifolia in Nupuragangai, Capparis brevispina). In Palamutheer solai and Silambar valley and Derris scndens (Roxb.) Benth. The dominance of some species may also be due to disturbance. For example, site Nupuragangai (plot 2) Toddalia astatic (L.) Lam. was abundant, probably due to disturbance such as selective losing. Liana composition likely is a function of both stand age and geographical location (Dewalt et al., 2000) and disturbance (Laurance et al., 2001).

Gentry (1991 a) reported that liana diversity decreased with increasing altitude. A similar trend was noticeable in Alagar hills too (r2 ¼ 0:54, P< 0:05), but the diversity was higher in 600-700 m altitude. Our results are also in accordance with Lieberman et al. (1996), who found greatest species diversity (10 cm dbh) in 300 m altitude when compared to <300 and >300 m altitude on the Atlantic slope of Costra Rica. Ibarra – Marquez – Ramos (2002) also obtained similar results. The highest liana density of the Silambar valley, which experience 6-8 months of dry period, is also in conformity with the above reports. One of the lowland evergreen forest plots (plot 2) in Nupuragangai had density very close to Palamutheer solai, even though its length of dry period is short. This higher density of lianas in plot 2 was

assigned to disturbance such as selective logging of the Toddalia astatic (L.) Lam. (Pataki and Parthasarathy, 2000).

The appropriateness of a climbing method appears to vary with the type of support available and the structure of the forest canopy (Whitmore, 1974, Kelly, 1985). Twining was the chief climbing mechanism, both in terms of species diversity and density, in all our five study sites. In Mexican forests, Solórzano et al. (2002) reported that maximum number of liana species are wind dispersed and the single largest factor governing diasporas type of taxonomy and the predominance of certain families and genera that are predominantly wind dispersed. The Nupuragangai and Palamutheer comprised high prevalence of Toddalia Asiatic (L.) Lam. Indicating the faunal dependence of lianas for dispersal as also suggested by Gentry (1982, 1991 b) that liana species are mostly wind dispersed, although he noted that the species number decreased as rainfall increased, changing the prevalence to animal – dispersed species in wetter localities.

CONCLUSION

The present study intend to evaluate the impact of the structure and species composition in moist deciduous forest in Alagar Temple hills of Eastern Ghats, Madurai. Liana species richness and density varied considerably across the three Alagar hill. Compared to other tropical forest sites, the liana diversity in India was low, especially in our wet evergreen forest sites. The fact that majority lianas in evergreen forests have animal dispersal guilds reveals their faunal dependence and emphasizes the need for a holistic approach in conservation to protect forest sites with all biota, particularly the tree communities which provide physical support for lianas and fauna for seed dispersal. Overall, it is becoming clear that lianas are important players in many aspects of forest dynamics, far more important than was realized a decade ago. Keeping in this view, lianas are reported to play a key role in the ecology and dynamics of forests. Further research on the role of lianas in forest structure, stand dynamics and functioning particularly, liana reproduction ecology and resource use by fauna communities deserve investigation in our study sites. Such data are expected to be useful for forest conservation and management.

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