A Study on Tropical Evergreen Forests in the Kolli Hills

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INTRODUCTION

Liana diversity of the Kolli hills in 8 ha area totaled 26 species ***(2***5 cm gbh) representing 18 families and 24 genera. The range of species in the four 2-ha study plots was 9 to 21, the lowest species richness was that of the disturbed plot KS. The richness of liana taxa above the species-level was also lower in the disturbed plots than in the undisturbed plots. Comparison of liana diversity in the tropical forests is made difficult, since the inventories on lianas vary in their objectives and methodologies adopted.

However, a perusal through the liana literature reveals that across the tropics, liana species richness ranged from 27 species in 0.25 ha to 53 species in 0.5 ha. While for liana stems ***2***10 cm, the species richness of lianas varied from 1 - 20 species with decreasing altitude in La Selva, Costa Rica Lima abundance, across the tropics, also varied considerably between continents and among the study plots of an area. In the Kolli hills, a total of 384 liana individuals with a mean value of 48 individuals hact. and a mean range of 12.5 to 78 individuals per hectare was recorded. Among the other Indian forests, the abundance of lianas *2*5 cm gbh was shown to vary from 93 individuals per hectare. The abundance of lianas ***2***1 cm across the tropical forests ranged from 373 individuals (mean) per hectare .While for the lianas ***2*** 10 cm the abundance ranged from as low as 1 individual per hectare to 133 individuals per hectare. Different tropical forests also have different liana densities. Comparisons of the abundance of lianas greater than 2.5 cm , the girth threshold considered for lianas to be called mature lianas by Hegarty and Caballe, in forests of various regions have been made by Gentry. The Australian sites averaged 40 lianas greater than 2.5 cm per 0.1 ha plot, whereas the African sites averaged 106 lianas and neo-tropical forest sites 69 lianas. This comparison places the Kolli hills under a moderate-density liana forest category.

In summary, the disturbed sites of Kolli hills have lower species richness and density of lianas than the undisturbed sites. This difference is probably due to selective tree felling and cattle browsing in the disturbed sites thus depriving lianas of their hosts. For example, in the disturbed site KS, there was a five-fold decrease in the density of smaller (30-60 cm girth) trees (51.5 stems) as compared with the undisturbed site VS (268 stems hact.) for the same girth as smaller trees were selectively cut. Human disturbance also directly reduces diversity and density of lianas since they are cut for various purposes. In the disturbed sites, thicker lianas were cut together with their support trees. Consequently, decreased species richness and density of thicker (z10 cm) lianas in the disturbed as compared to the undisturbed sites (PS and VS) were notable.

Variations in the family composition of lianas in different tropical forests are evident from several liana studies. The Bignoniaceous is prominent in the neo-tropics and Leguminosae in both the American and Asian tropics. While in the Kohi hills, Rutaceae, Oleaceae and Malpighiaceae are prominent, and in the Karajan hills (the counterpart Kolli hills) in the Eastern Ghats.

Girth class diversity of lianas in the Kolli hills showed almost a uniform species richness (16-19 species) for all the girth classes up to 30 cm gbh. At inter plot level, the liana species richness and density were relatively greater in the 5-10 cm gbh class of the disturbed plots (KS and MS) than those of the undisturbed plots (PS and VS). While for the larger than 10 cm class, the

density was generally less in the disturbed plots and undisturbed plots. The occurrence of smaller lianas in disturbed forests of the Kolli hills is in conformity with the findings of Hearty and Caballe. Further, as shown in studies such as those of Proctor ***el*** *al.,* Putz , Hegarty and Muthuramkurnar and Parthasarathy high proportions of liana stems are found in the smaller size classes. In fact,

these thin lianas make appreciable contribution to species richness. Of the four climbing mechanisms recorded in the Kolli hills, the greatest proportion of both species (14 species, 53.8%) and individuals (271, 70.6%) were twiners. Twining is also reported to be a predominant in other studies in India and in other areas of the tropics.

In the Kolli hills, of the four diaspore types, zootomy was the most common dispersal type with 19 species (73.1%) and 297 individuals (77.3%). This indicates the dependence of lianas on the fauna for their dispersal. A similar situation prevails in the evergreen forests of Vargalaiar in Anamalais, Western Ghats, India . The prevalence of zoochory suggests that a holistic approach in conservation strategies is needed to maintain liana diversity.

Lianas are important structural parasites of trees. In the entire 8-ha plots inventoried in the evergreen forests of Kolli hills, 39 (50%) out of the total of 78 of tree species hosted the 26 liana species. These species consist of 336 individuals and belong to 34 general families.

With increasing tree girth class, the number of trees hosting gradually decreased at all four sites. However, the trend with trellis height class varied between sites. ; the number of trees hosting lianas increased progressively up to 4- or 6-m height:, and then it decreased. The *x2* lest demonstrated that the number of host trees of particular and trellis height differed significantly from what was expected. Lianas frequently infested trees of 120-150 cm class and 4-6 m trellis height class in the Kohi hills.

Discussions on the patterns and trends of tree diversity in six continents and a review on the tropical forest diversity and processes attributed to it are available. Gentry remarked that the highest alpha-diversity of trees in the world occurs in upper Arnazonia with record diversities of 275 - 283 tree species per hectare at Yanamono and Mishana near Iquitos, Peru. Inventories in upper Amazonian Ecuador corroborate Gentry's remark.

However, a strikingly high tree species richness of 473 species for tees and 307 species for tees greater than 10 cm in Amazonian Ecuador was reported by Valencia et al. (2004). The gaiter's finding is world's highest record of tree species richness per hectare for trees greater than 10 cm.

A wide range of sampling methods have been employed in tree diversity inventories over the years; especially the number, size and shape of the plots besides the girth threshold of trees. While most of the studies adopt plot method, prior-less methods, such as point-centered-quarter method are also used. The plots of different shapes are in vogue. For example, 100 m x 100 m square plot to 5O m x 120 m rectangular plot to 10 m x 100 m long belt transect can be found from this literature survey. The sample plot area in various studies ranged from as small as 0.1 ha, as in the case of Gentry to a maximum of 52 hact. as in the Limber National Park, Malaysia. It is notable that plot size and plot shape have great influence on plant diversity assessment.

From small-scale 1 hact. Plots, which are frequently, used sample method all over the world for tree inventories, through medium-side 2 to 8 hact. Plots, to large-scale 10 to 50 ha permanent

plots are used in plant diversity inventories. A number of large-scale plots were established for long-term studies. Large-scale 50 hact. Permanent plot of Barro Colorado in Panama was the first of its kind. This was followed by the other large-scale plots of La Silva in Costa Rica, Paracou in French Guiana, Pasoh in Malaysia, and major tropical forest formations of the world and Anamalais in the Western Ghats of India. The data derived from such large-scale plots help in establishing computer database, from which it would be possible to prepare models of the forest dynamics.

REVIEW OF LITERATURE:

The tree species richness of 78 species in the 8 ha of the Kolli hills, Eastern Ghats reflects the low diversity status of this forest. As the four study sites in the Kolli hills are 1 - 7 km apart, the extent of human-impacts differs among the plots, and the disturbed category plots are proximal to human settlements. Thus, attributed to human-impacts and small-scale altitudinal differences between them. The species richness varied from 26 species ha.' of the highly disturbed site MS to 54 species hact. in the undisturbed site PS. The notable two-fold decrease between the study sites clearly demonstrates the reduction in tree species diversity in human-impacted sites of Kolli hills in the Indian tropical evergreen forest. The diminishing tree diversity along *an* elevational gradient (between 1000 m and 1250 m in the Kolli hills) is in conformity with Lieberman and Heaney and Proctor.

The study sites of Kolli hills, compared to the semi-evergreen forests of Indian Eastern Ghats, i.e., the Shervarayan hills harboring 70 tree species in 4 hact. and the Kalarayan hills with 73 species in Karakul and Parthasarathy have more similar species richness. Also within peninsular India, species richness for the same tree girth threshold in various sites of the Western Ghats ranged from 30 species ha-' in Nelliampathy to 57 species hact. in Mylodai area of Courtallum reserve forest , 64 to 82 species ha-' in the medium-elevation forest of Kalakad , to 80 to 85 species ha-' in high elevation evergreen forests.

Across the tropics, richness of woody species *2*10 cm ranges from a low value of 20 species hact. in flooded Varzea forest of Rio Xingu, Brazil through a medium-value of 137 to 168 species hact. for the four 1-ha plots of terra forest, Central Amazonia to a very high 307 species hact. Amazonian. Such a comparison places the present study site in low-diversity forest category like the adjacent Shervarayan and Karajan hills of the Indian Eastern Ghats. The occurrence of low diversity in tropical forests is not uncommon. In some cases, most of the trees in the canopy layer are a single species. This results in a low diversity. Connell and Lowman reported that the low diversity single-species dominant forests in the major world regions of rain forest in Africa, the Americas, and Asia might be due to the possible tree species association with mycorrhiza.

The trend of decreasing diversity and density with increasing girth class is in conformity with the studies of Hara et *al.* , Jeffre and Veillon , Kadavul and Parthasarathy , Newbery et *al* and Caimans. Sites PS and VS had typical reverse shaped structure for girth frequency . As exemplified by undisturbed site PS, mature stands with good regeneration were reported from Jhanga forest reserve, Malaysia Costa Rica, Brazilian Amazon , Sungei Manila in Malaysia. Lieberman reported the occurrence of a species over the entire range of altitude, plot altitude ranging from 30 m at the base to 2600 m near the summit in Volcano Brava, Costa Rica, was possible due to its greatest amplitude Spatial patterns of tree species were studied in the study plots of Kolli hills. Out of 29 mature tree species occurring with greater than 10 individuals per hectare in the undisturbed plots, 80% (23 species) scale had clumped distribution and 20% uniform. No tree species in any plot displayed random pattern, while, 58% of the trees in the disturbed plots, was clumped. This trend of reduction in clumped pattern and two-fold increase (42%) in uniform pattern of tree distribution in human-impacted sites of Kolli hills is notable. As resource patchiness is reduced very much in disturbed sites, clumped pattern decreases in the Kolli hills. This has been reported by several workers. However, the absence of random pattern in the Kolli hills contradicts their finding. The probable reason for this could be greater human disturbance and maximum slope observed in disturbed plot KS. Basinet stated that the distribution pattern of trees is affected by numerous biotic and biotic factors and their interactions. Slope and anthropogenic disturbances are the major factors which affect the composition, growth, and distribution of tropical forests.

RESERCH METHODOLOGY:

Climatologically data of Salem , the nearest station and 50 km from the study area, available for a 30-year period reveals a mean annual temperature of 28.3" C and the mean annual rainfall 1014 mm. The mean monthly temperature ranged from *250* C during December-January to 310 C in April-May for the same period. The mean maximum temperature was 37.20 C in April, while the mean minimum temperature was 19.20 C in January for the above period.

To summarize and comprehend the human-impact on plant diversity, the plots PS and VS are graded as relatively undisturbed while the sites KS and MS are human-impacted sites. It may be noted that the study plots of the Kolli hills are referred throughout the thesis as PS, VS, KS, and MS, after their respective study sites.

One plot of (100 m x 200 m) of largely mature phase forest in each of the four forest sites in the Kolli hills was investigated. Each plot was sub-divided into two hundred 10 m x 10 m quadrates to facilitate quantitative plant diversity inventory of trees and lianas, and within the quadrates, 2 m x 2 m sub-quadrats were regularly laid for sampling understory plants (Fig. 4). The elevation of the plot was determined by using an altimeter. The slope of the study plot was calculated by using the following formula:

Slope = d. h where, h' is the vertical distance on the meter stick between the eye height and the line of sight; and d' the horizontal distance from the eye to the meter stick .

Data collection

All mature trees *2*30 cm high in the four 2 hact. Plots, were permanently marked with sequentially numbered aluminium tags attached to the trunk by iron nails placed approximately at breast height. The girth of each mature tree was measured at the level of the nail attaching its numbered tag. For those trees with buttresses, the girth was measured above the latter. In the case of trees with multiple stems, each stem was measured separately. In addition to measuring its height, the following features were recorded:

(a) The height of each tree (measured for trees up to 5 m tall and others were estimated);

For the regeneration tree inventory, eight 10 m x 50 m subplots distributed one each approximately in the center of every 100 m x 100 m (I-ha) area of all the four 2 ha (100 m x 200 m) plots, were established. Each one of these subplots was gridded into five 10 m x 10 m quadrates, thus making 10 sample quadrates (0.1 ha) per plot. All the tree seedlings (3-10 cm girth) and saplings (10-30 cm girth) were enumerated, and measured for their girth.

All lianas ***2***5 cm gbh in the four 2 ha plots were individually censuses. The following series of observations and measurements were taken for the lianas:

a) stem girth at breast height, 1.3 m above the ground (gbh);

b) climbing mechanism;

c) diaspore type; and

d) number of hosts used as support.

In the case of host trees, which were already enumerated in the mature tree inventory, the following additional observations were recorded:

a) estimated height at the first branch (trellis); and

b) number of lianas supported by each host tree.

Four climbing mechanisms (Chalmers and Turner, 1994) were recognized for the lianas in the Kolli hills. They include:

a) tendril climbers - wherein modified leaves, leaflets, inflorescence or stipules twine around a support;

b) root climbers - which are attached to the support with glandular secretions or by growing into crevices;

c) twiners - whose apical portion of the shoo^, the branches or petioles twine around the support;

d) scramblers - which lean on but do not become closely attached to the support

The fruit types of lianas were ascertained to find out the proportion of species adopting zootomy, anemochory, autochory and hydrochloric modes for dispersal.

Understory plant diversity was investigated in 4-m2 (2 m x 2 m) quadrant regularly laid within the two hundred 10 m **x** 10 m grids of each 2 hact. plot. All the understory plants were enumerated in the total 800 sample quadrates, besides noting their life-form and fruit types. Life-forms constituting the understory plants in this study are the following:

(a) herbs (non-woody small plants < 1 m tall);

(b) under shrubs (small plants of 1 to 1.5 m tall with moderate stem thickness);

(c) shrubs (>1.5 m to 3 m tall with thick stems and branching at ground level without a distinct trunk);

(d) herbaceous climbers.

Grasses, sedges, aroids, root parasites and pteri-dophytes, in this study, are treated separately under the synusia of herbs. This investigation excluded the tree-lets and facultative herbs, the latter are those which are generally epiphytic and are occasionally encountered on the forest floor.

CONCLUSION:

Plant diversity is fundamental to total forest biodiversity, especially the trees which provide resources and habitat structure for almost all other forest species. The plant diversity and forest composition strongly correlate with geographical location, soil type and disturbance. As human activities keep escalating with ever-increasing population, ecosystems near human settlements become fragile. Hence documenting plant diversity of disturbed forest sites and thereby emphasizing the need for site conservation arise.

The tropical evergreen forests in the Kolli hills are unique and are found in secluded patches, locally called 'shoals', rather fragmented due to anthropogenic pressure. The greater human impacts are observed in plots KS and MS, resulting in reduction of diversity and density of plants. For instance, reduction of species richness in disturbed plot MS by 52% (26 species as against 54 species of relatively undisturbed PS) and basal area by 56% is notable. Tree density was also reduced to 58% in the disturbed plot KS (266 as against 632 trees of the other undisturbed plot VS). The present study offers a baseline data on total plant diversity excluding herbaceous epiphytes and the human impacts on them. The real patterns of forest changes will emerge only after long-term monitoring of permanent sample plots, as opined by Andel.

Future research can be directed towards species biology of dominant species and reproduction strategies of rare tree species to answer the questions regarding the conservation strategy to be made. The need for conservation arises from the multiple benefits offered by biodiversity. Hence proper and stringent forest conservation measures would rescue species loss in the tropical evergreen forests of the Kolli hills.

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