Chapter 4

PHYTOSOCIOLOGICAL ANALYSIS

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4. Introduction

The study was carried out in the Darjiling hills with elevation ranging from 180 m amsl and above in Darjiling district within the geographical boundary of west Bengal. The plant diversity characterization has been undertaken to understand the vegetation structure of fern and fern allies .The study area comprises of eight administrative blocks representing three sub-division with an area of 2228.13 km^2. The plains of Siliguri sub-division has been excluded in the present work.

The region can be distinguished into four zones on the basis of altitude (Champion and Seth, 1968). The lower hill comprises of tropical vegetation where temperature and rainfall are usually high. As we move along the altitude gradient in the range of 800-1600m amsl the sub-tropical vegetation can be observed. The temperate zone extends from 1600-3000 m and further along the altitude gradient of 3200m amsl a narrow stretch of sub-alpine vegetation occur. The important feature of this region is the descend of temperate species to the tropical zones and at the same time some species tend to ascend towards temperate from the tropical zone. The vegetation characterization for the region included four climatic zone where 80 sample plots were laid covering a total area of 0.8 ha in each climatic zone.

The hills of Darjiling present diverse topographical conditions and offer suitable habitat for the occurrence of wide range of plants (Das ,1995;Acharya & Acharya ,2001; Das, 2004). Though the district is floristically well explored but the occurrence of micro-niche in difficult terrains with negligible accessibility has lead some plants of the region remained undiscovered (Thapa *et al.* 2014).The climatic factor and the geographical feature contribute to the region being floristically diverse. The region is home to numerous species from surrounding region and contributes as different floristic elements which has migrated and successfully

established in Darjiling Hills. Numerous naturalised exotics and high proportion of endemics in the flora has been recorded (Das, 2002;Bhujel and Das, 2002) .

4.1 Result

The raw data collected by ground truth from 80 sample plots (Plate 4.2 and 4.3) in 4 climatic zone recorded a total of 406 species. The Pteridophyte's was represented by 53 species, where 49 species were herb, 2 species were climbers and 2 species were tree ferns (Figure 4.8 & 4.9). The quantitative analysis for each strata was conducted separately i.e. Tree, Shrub and Herb layers. Frequency (F), Density(D), Abundance (A), Relative frequency (RF),Relative density (RD), Relative abundance (RA), Imporatnce value index (IVI) with Diversity indices namely Simpson Index ,Shanon Index and Mehnick index were calculated . In case of tree strata the basal area (BA) with Relative dominance (Rdm) was calculated in place of Abundance(A) and Relative abundance(AB). The picture's of 4 different forest type of darjiling hills has been represented in Plate 4.1.

4.1.1 Tropical Forest

In The tropical forest(Plate 4.1 D) 20 sample plots covering an area of 0.8 ha was laid down. A total of 2541 individual belonging to 109 genus and 117 species has been recorded. 35 species of trees, 38 species of Shrub and 44 species of herb were recorded. In the present study 11 ferns representing 1 climber and 10 herbs were recorded. Rest of 106 species represented the angiosperms. The tree density for this tropical forest was calculated to be 385 individuals/ha and total basal area was 52.07911m^2/ha. The dominance-diversity curve for all strata has been represented in Figure 4.4.

Shannon- Weiner index of diversity in the tropical forest was calculated to be 4.214229. The determined value for species diversity for tree layer was 2.657291, for shrub layer 3.153165 and for herb layer was 3.457137(Table 4.1 & Figure 4.2).

Simpson's index for concentration of dominance for this tropical forest was observed to be 0.020301607.The determined value for concentration of

dominance for tree layer was 0.124304, for shrub layer 0.057628 and for herb layer was 0.040559 (Table 4.1 & 4.3).

Menhinick's index for species richness was calculated to be 2.321045 for this forest. The determined species richness for tree layer was 1.99431, for shrub layer 1.201666 and for herb layer was 1.253058(Table 4.1 & 4.4).

This forest shows good species diversity with low concentration of dominance. The herb layer exhibit good diversity and low dominance than tree and shrub layer. The tree strata exhibited highest species richness in the forest.

4.1.2 Sub-tropical forest

In the sub-tropical forest (Plate 4.1C) 20 sample plots covering an area of 0.8 ha was laid down. A total of 3563 individual belonging to 94 genus and 100 species has been recorded. 26 species of trees, 30 species of Shrub and 43 species of herb were recorded. In the present study 16 ferns representing 1 tree fern i.e. *Cyathea brunoniana* , 1 climber *Lygodium japonicum* and 14 herbs were recorded. Rest 84 species represented the angiosperms and gymnosperm. The tree density for this tropical forest was calculated to be 521.25 individuals/ha and total basal area was 59.05898 m^2/ha. The dominance-diversity curve for all strata has been represented in Figure 4.5.

Shannon- Weiner index of diversity in the Sub-tropical forest was calculated to be 4.308495. The determined value for species diversity for tree layer was 3.150891, for shrub layer 3.289477and for herb layer was 3.50989(Table 4.1 & Figure 4.2).

Simpson's index for concentration of dominance for this Sub-tropical forest was observed to be 0.017550023.The determined value for concentration of dominance for tree layer was 0.0531, for shrub layer 0.0526 and for herb layer was 0.0389 (Table 4.1 & 4.3).

Menhinick's index for species richness was calculated to be 1.6752 for this forest. The determined species richness for tree layer was 1.273 , for shrub layer 0.8415 and for herb layer was 1.032(Table 4.1 & 4.4).

This forest shows good species diversity with low concentration of dominance. The herb layer exhibit good diversity and low dominance than tree and shrub layer. The tree strata exhibited highest species richness in the forest.

4.1.3 Temperate Forest

In the Temperate forest(Plate 4.1B) 20 sample plots covering an area of 0.8 ha was laid down. A total of 4304 individual belonging to 104 genus and 115 species has been recorded. 30 species of trees, 36 species of Shrub and 49 species of herb were recorded. In the present study 16 ferns representing 1 tree fern i.e. *Cyathea spinulosa* and 15 herbs were recorded. Rest 99 species represented the angiosperms. The tree density for this temperate forest was calculated to be 576.25 individuals/ha and total basal area was 62.83923m^2/ha. The dominance-diversity curve for all strata has been represented in Figure 4.6.

Shannon- Weiner index of diversity in the temperate forest was calculated to be 3.8122. The determined value for species diversity for tree layer was 3.206, for shrub layer 2.516 and for herb layer was 3.451(Table 4.1 & Figure 4.2).

Simpson's index for concentration of dominance for this Temperate forest was observed to be 0.0588.The determined value for concentration of dominance for tree layer was 0.0449, for shrub layer 0.1642and for herb layer was 0.0434 (Table 4.1 & 4.3).

Menhinick's index for species richness was calculated to be 1.7376for this forest. The determined species richness for tree layer was 1.3972, for shrub layer 0.7249 and for herb layer was 1.3204 (Table 4.1 & 4.4).

This forest shows good species diversity with moderate concentration of dominance. The herb layer exhibit good diversity and low dominance than

tree and shrub layer. The tree strata exhibited highest species richness in the forest.

4.1.4 Sub-alpine Forest

In the Sub-alpine forest (Plate 4.1A) 20 sample plots covering an area of 0.8 ha was laid down. A total of 2237 individual belonging to 64 genus and 74 species has been recorded. 16 species of trees, 14 species of Shrub and 44 species of herb were recorded. In the present study 10 species of ferns and 64 species of angiosperms and gymnosperm has been recorded. The tree density for this temperate forest was calculated to be 685 individuals/ha and total basal area was 47.86782m^2/ha. The dominance-diversity curve for all strata has been represented in Figure 4.7.

Shannon- Weiner index of diversity in the Sub-alpine forest was calculated to be 3.8077. The determined value for species diversity for tree layer was 1.925, for shrub layer 2.493 and for herb layer was 3.35(Table 4.1 & Figure 4.2).

Simpson's index for concentration of dominance for this Sub-alpine forest was observed to be 0.0312.The determined value for concentration of dominance for tree layer was 0.2182, for shrub layer 0.0932for herb layer was 0.0468(Table 4.1 & 4.3).

Menhinick's index for species richness was calculated to be 1.5857 for this forest. The determined species richness for tree layer was 0.6834, for shrub layer 0.536 and for herb layer was 1.3865(Table 4.1 & 4.4).

This forest shows good species diversity with low concentration of dominance. The herb layer exhibit good diversity and low dominance than tree and shrub layer. The highest species richness was observed in herbaceous strata. The tree strata exhibited highest dominance in the sub-alpine forest as well as in all the forest zone of Darjiling hills. The two dominant *Rhododendron sp* in the sub-alpine tract namely *R. arboreum* and *R. falconeri* with highest number of individual and basal area should be accounted for high concentration of dominance in tree strata of sub-alpine forest.

Table 4.1: Diversity indices for different forest type in Darjiling Hills.

Sl. No.	Forest Types	Shannon-Weiner index	Simpson's index	Menhinick's index
1	Tropical forest	4.214	0.023	2.321
2	Sub-Tropical Forest	4.308	0.0176	1.6752
3	Temperate Forest	3.8122	0.0588	1.7376
4	Sub-alpine Forest	3.8077	0.0312	1.5857

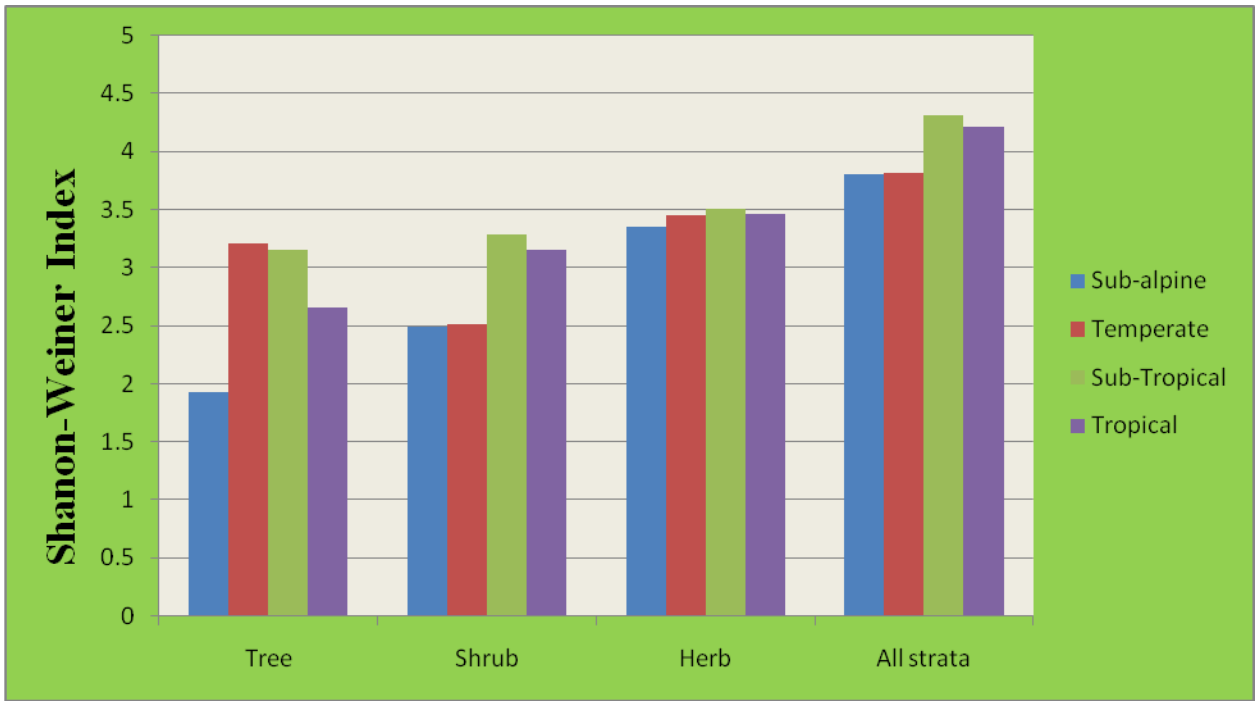

Figure 4.1: Shannon- Weiner Index of species diversity for different forest types in different Strata.

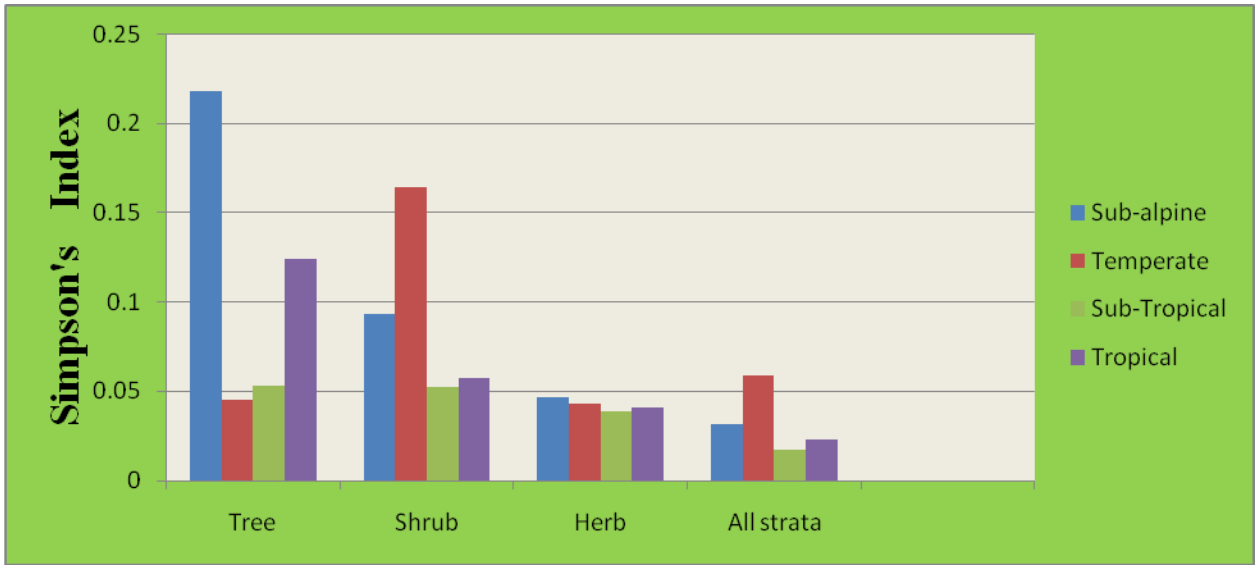

Figure 4.2: Simpson's Index of concentration of dominance for various forest types in different strata.

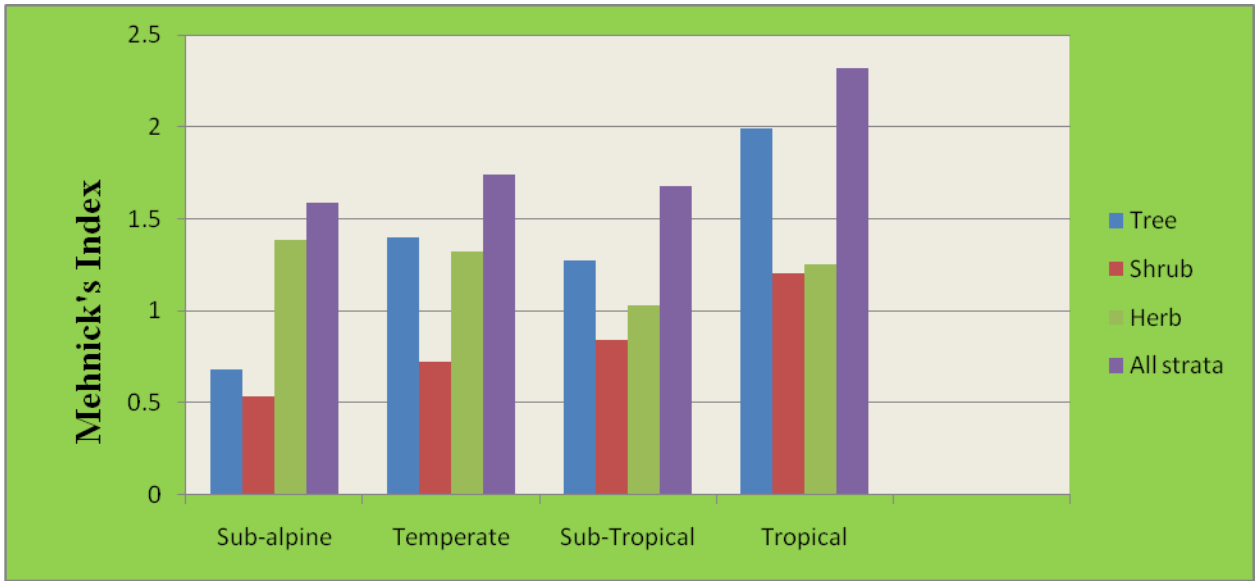

Figure 4.3: Menhinick's Index of species richness for various forest types in different strata.

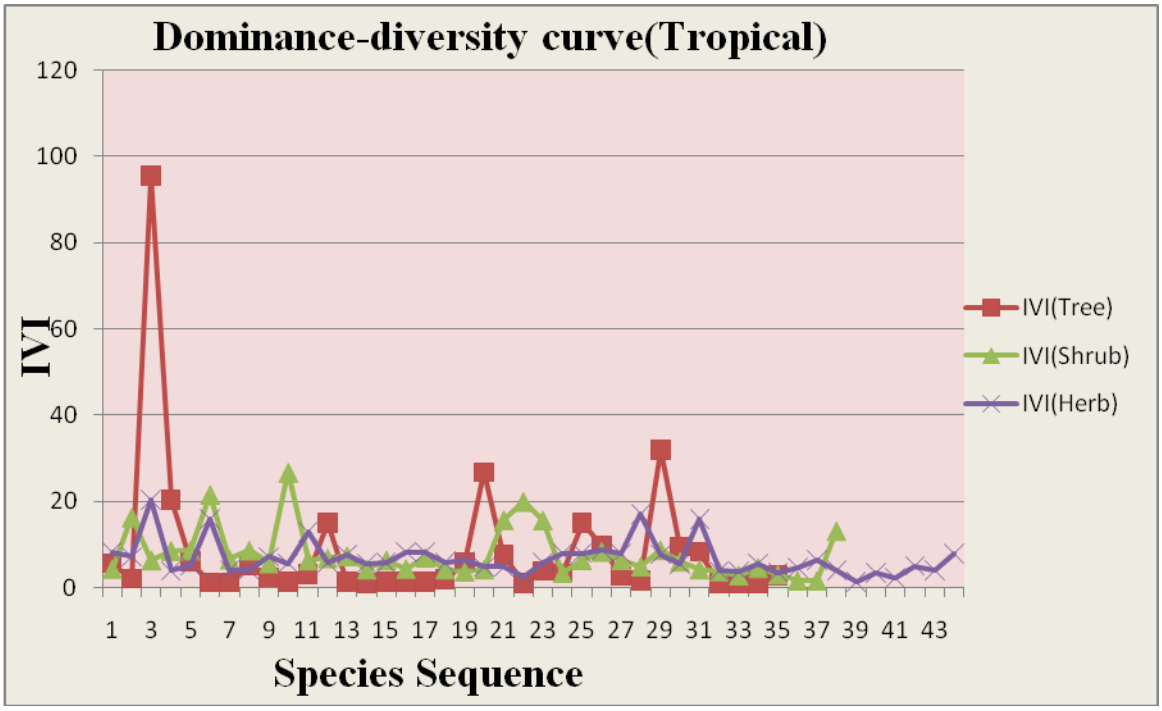

Figure 4.4: Dominance-diversity curve for different strata in Tropical Forest.

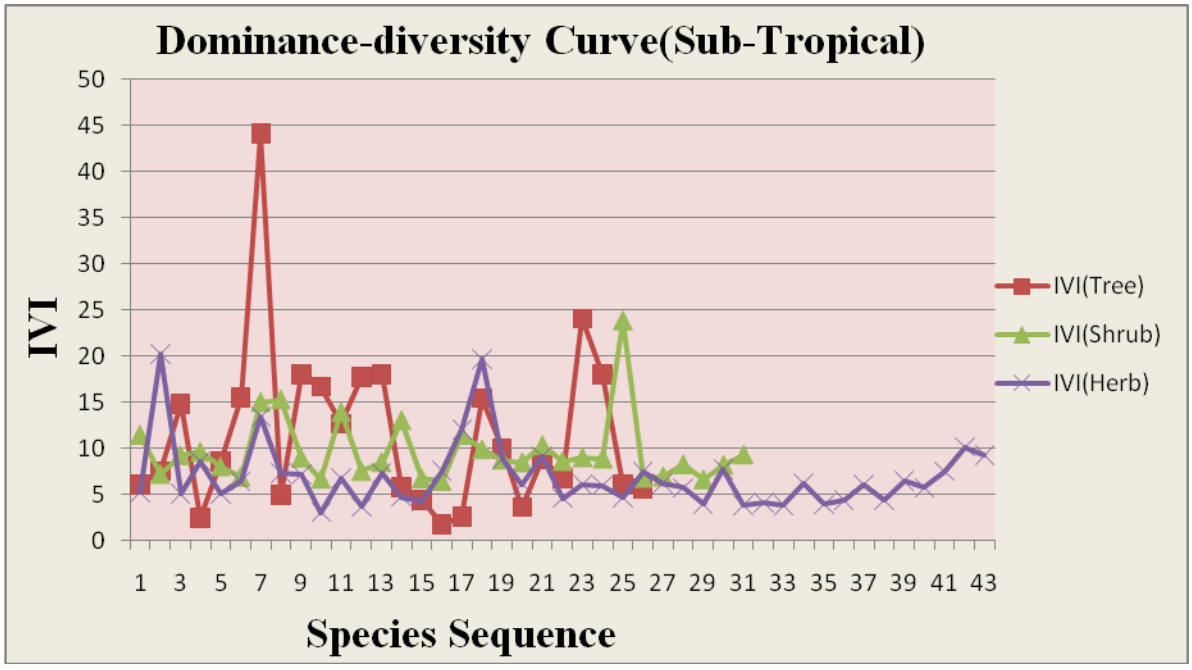

Figure 4.5: Dominance-diversity curve for different strata in Sub-Tropical Forest.

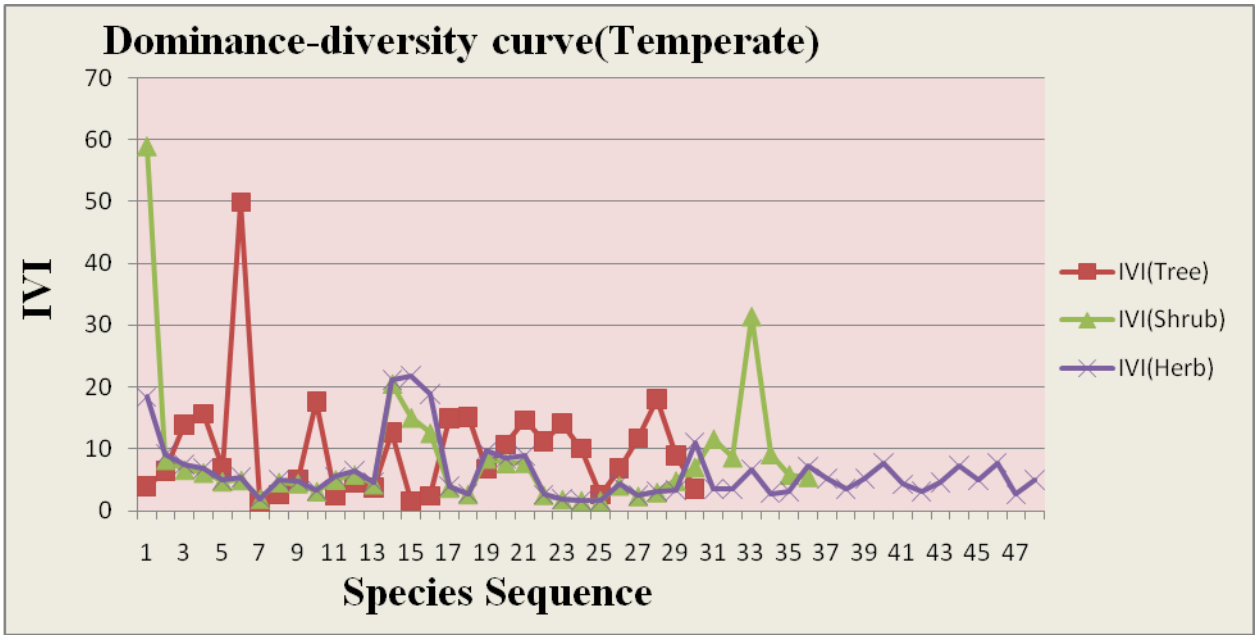

Figure 4.6: Dominance-diversity curve for different strata in Temperate Forest.

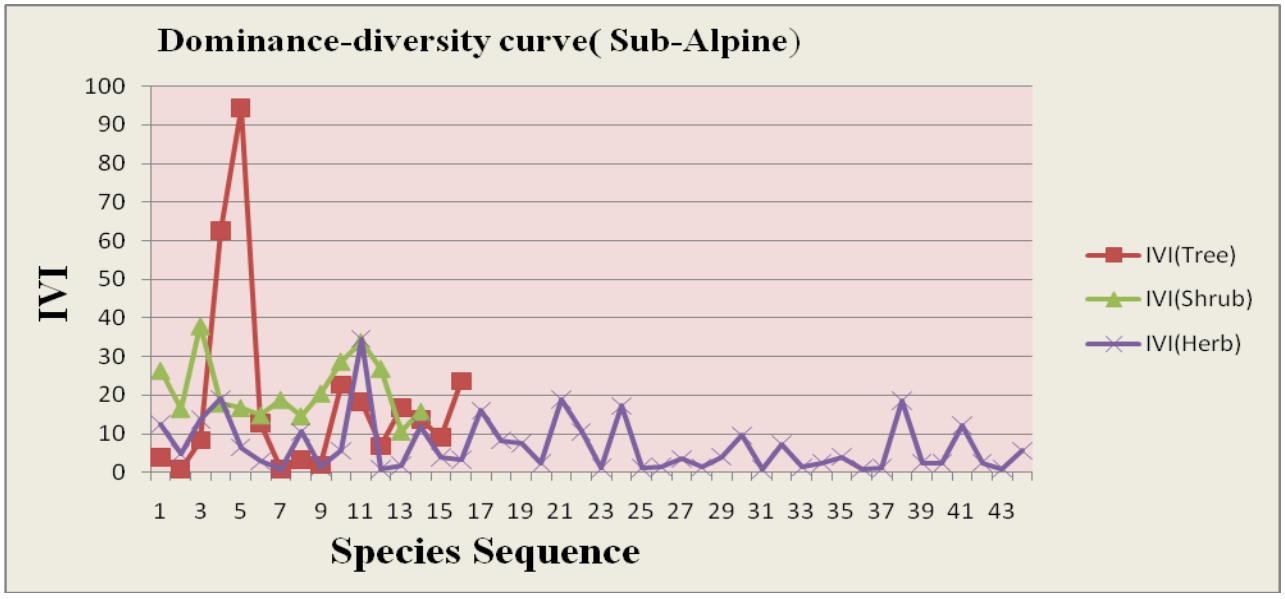

Figure 4.7: Dominance-diversity curve for different strata in Sub-alpine Forest.

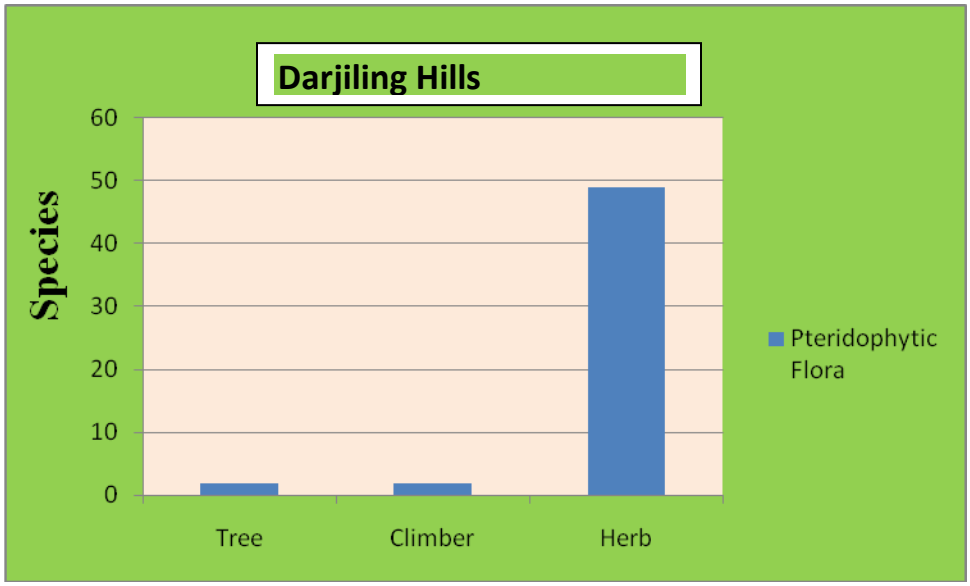

Figure 4.8: Species Distribution of Pteridophytes in Darjiling Hills.

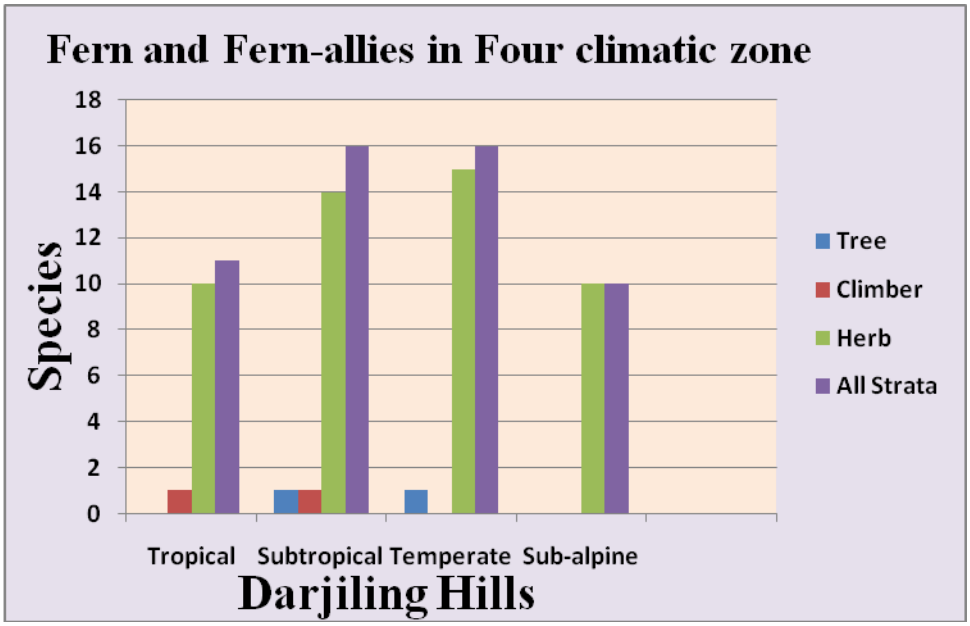

Figure 4.9: Species distribution of Pteridophytes in different strata.

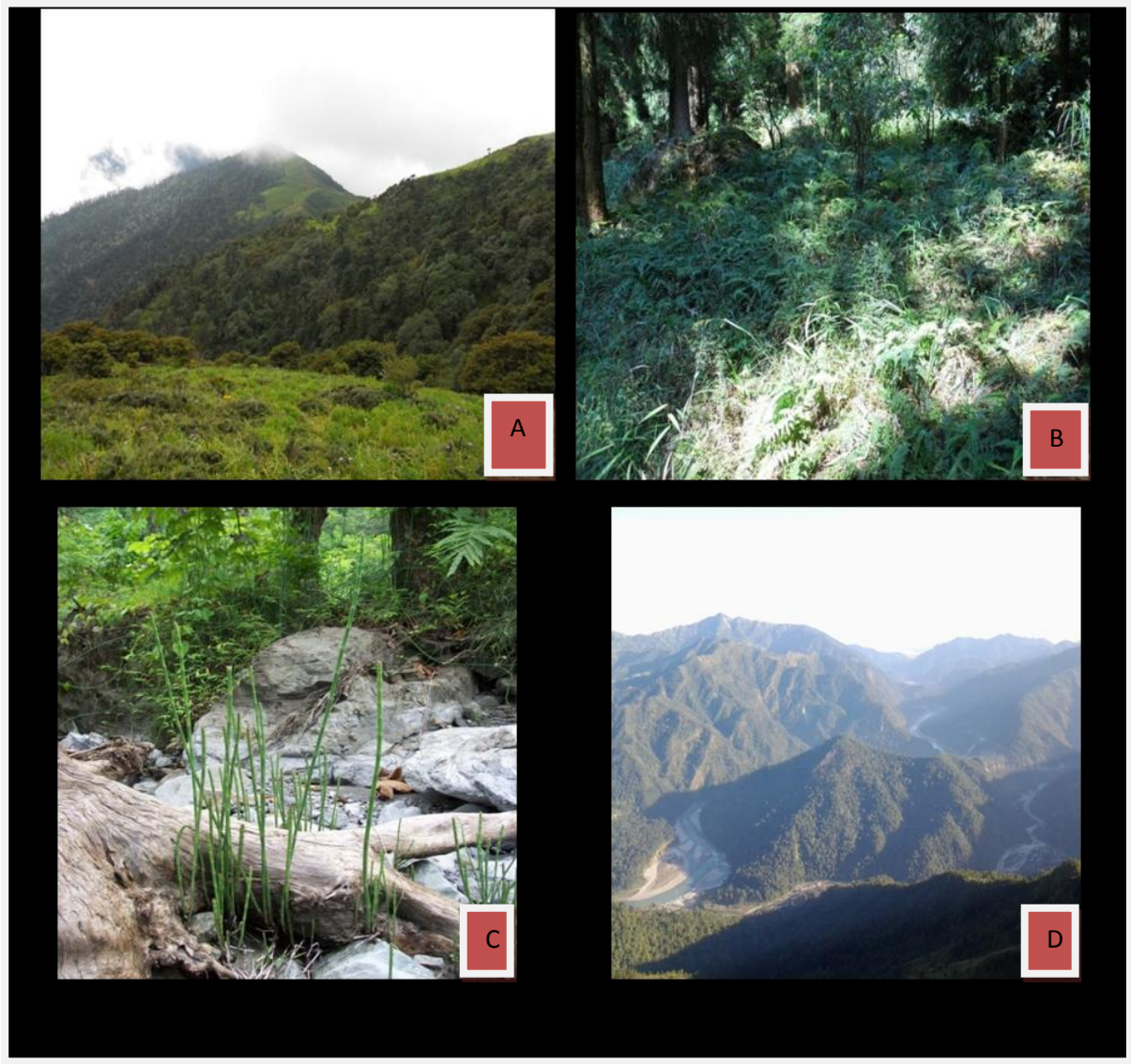

Plate 4.1: A. Sub-Alpine Forest; B. Temperate Forest; C. Sub-Tropical Forest; D. Tropical Forest.

Plate 4.2: A. Watch Tower at Neora Valley National Park; B. Biggest Girth *Rhododendron arboreum* Smith in Park;C. Field study; D. Sub-Alpine Vegetation; E. *Polystichum perscotianum* (Wallich ex Mettenius)T.Moore; F. Taking GPS reading on field .

Plate 4.3: A. Collecting Raw data; B. Field survey; C. Tagging for Quadrat study; D. Invasiveness of *Arundinaria sp* in the field; E. Measurement of girth; F. Tropical vegetation.

4.2 Discussion

The Phyto-sociological analysis with respect to fern and fern allies is the first of its kind studied in the region. Fragmentary work with respect to this group of Pteridophyte without proper identification and nomenclature update has been adopted in the previous work(Rai,2006). Floristic analysis with respect to angiosperms and gymnosperms has been conducted from time to time and numerous base line data can be cited (Das 1995,2004;Bhujel 1996; Lama ,2004; Rai,2006). In the post independence work (Mehra & Bir,1964) tried to classify the Pteridophytes on the basis of observation into epiphytes, climbers, ravine ferns etc. without creating a sampling plot neither ground truthing to assess the different parameter like Density, Frequency, Abundance,IVI etc. Different workers who studied the pteridophytes of the region just enumerated the species distribution but failed to study their ecology (Hara,1974;Matthews ,1971;Fraser-Jenkins,2008). Therefore this study is an attempt to observe and infer the ecology of Pteridophytes. 49 species of herbs, 2 species of climber and 2 species of tree fern has been recorded from Fern and fern allies in the study area. The highest importance value index was 19.62 for *Nephrolepis cordifolia* with respect to Pteridophytes in the study area. However it was found that Pteridophytes form a small portion of the vegetation in all the forest type studied. They are not a dominant partner in any forest type as their over all representation in our ecological studies contribute to be around 13.05%

4.3 Conclusion

The ground truth data from 80 sampling plot in four different forest types revealed 406 species of Plants. The Pteridophyte were represented by 53 species, angiosperm and gymnosperm constitute 353 species. 49 species of herbs, 2 species of climber and 2 species of tree fern has been recorded from Fern and fern allies in the study area. The sub-tropical forest showed the highest species diversity of 4.308 and least concentration of dominance .0176 .The species richness was Maximum in case of Tropical forest i.e. 2.321.And in case of Fern and fern- allies the subtropical and temperate forest showed the highest diversity of 16 species each and highest Importance value index was 19.62 of *Nephrolepis cordifolia*.

4.3 Summary

The present study was conducted in Darjiling hills to assess the Phytosociological analysis of Fern and Fern-allies in different forest tract. The ground truth raw data from the 20 sampling plot covering 0.8 ha under each forest type was collected and analyzed. The quantitative analysis was carried out where density, frequency, abundance Relative density, Relative frequency, relative abundance and importance value index was calculated for shrub and herb Strata. In case of tree strata basal area and relative dominance were calculated in place of abundance and relative abundance. The overall idea of vegetation of each forest type was computed on the basis of diversity-dominance curve , *Shannon-Weiner Index, Simpson's Index* and *Menhinick's Index*. The raw data collected by ground truth from 80 sample plots in 4 climatic zone recorded a total of 406 species. The Pteridophyte's was represented by 53 species, where 49 species were herb, 2 species were climbers and 2 species were tree ferns. The tropical forest shows good species diversity with low concentration of dominance. The herb layer exhibit good diversity and low dominance than tree and shrub layer. The tree strata exhibited highest species richness in the forest. *Shannon- Weiner index* of diversity was 4.214229, Simpson Index was 0.020301607 and *Menhinick's index* was 2.321045 for the vegetation.

The sub-tropical forest 3563 individual was recorded belonging to 94 genus and 100 species of which 26 species was trees, 30 species was Shrub and 43 species was herb . In the present study 16 ferns representing 1 tree fern i.e. *Cyathea brunoniana* , 1 climber *Lygodium japonicum* and 14 herbs were recorded. *Shannon- Weiner index* of diversity was 4.308495, *Simpson's index* for concentration of dominance was 0.017550023 and *Menhinick's index* was 1.6752 for this forest.

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