CHAPTER – III

PLANT BIODIVERSITY
INTRODUCTION

The concept of diversity is particularly important because it is commonly considered as an attribute of an organized community (Hairston 1964). Generally species diversity is defined as a function of the number of species present in a given area and the evenness with which the individuals are distributed among the species (Tripathy et al. 1989). Tropical forests include the most diverse plant communities on earth with upto 473 tree and liana species in a single hectare (Gentry 1982a, 1988, 1992; Hubbell and Foster 1986; Whitmore 1990; Ashton and Hall 1992; Phillips et al. 1994; Valecia Balslev and Pazy Mino 1994 and Condit et al. 1996). According to Wilson and Francis (1988), historically high extinction rates are associated with human activities. The problem with chronic form of forest disturbance is the plants or ecosystem often does not get time to recover adequately because the human onslaught never stops (Singh 1998). Forest fire is the most common factors, which affect the diversity of the life forms in the forest besides human interference including cutting of wood for timber and charcoal production, grazing etc.

Deciduous forests are not considered species rich (Opter et al. 1976), but have a diversity of life forms (Bullock et al. 1992). Schaik and Van (1986) suggested that deciduous forests are still assume unusual
significance for conservation since they are the most used and threatened ecosystems, especially in India. Besides the agent of disturbance of the forest, such as wind storms and insects and disease outbreaks, forest not cleared for agriculture were influenced by selective cutting and wildfire (Wynn 1981 and Wein 1986). Conservation biologists warn that 25 percent of all the species could become extinct during the next twenty to thirty years (Khera et al. 2001). Khera et al. (2001) suggested that the causes of loss of species are numerous but the most important is the loss and fragmentation of natural habitats. The incidence of deciduous species in the tropics is reported to increase with the increasing seasonality of rainfall (Beard 1955; Walter 1973; Whitmore 1975 and Hall and Swaine 1981). Rajiv et al. (1999) suggested that biodiversity was intact in past but in due course by the pressure of human beings from all corners resulted into fragmentation, loss of vegetation, loss of flora and fauna by leaving some of the hills in isolation. Firing of forest for shifting cultivation is the most important factors, which affect the biodiversity of the forest.

Most of the forests are bounded by extensive human habitation towards lower altitude, especially in the Western Himalayas (Rawat et al. 1999). Regional difference in plant diversity can affect diversity within habitats via mass effects and source sink interactions (Holts 1985, 1992; Shmida and Wilson 1985 and Pullian 1988), in which propagules arriving from elsewhere can sustain local populations showing negative growth. Over longer period of time, accelerated rates of climate change could
increase extinction rates especially in fragmented and simplified landscape (Peter and Darling 1985).

The number of woody species per unit area in relatively uniform samples tends to increase with rainfall and decrease with seasonality in matured lowland forests (Gentry 1982a, 1988; Wright 1992; Specht and Specht 1993; Cline bell et al. 1995 and Aplet Hughis and Vitousek 1998) and decreased with increasing diameter at breast height (dbh) (Whitmore 1975; Gentry 1982a; Condit et al. 1996 and Duivenvoorden 1996).


Recently 25 hot-spot have been identified on the basis of species endemism and degree of threat through habitat loss (Myers 2000). Out of
25 hot-spot, two hot-spot are confined to India sub-continent that is Western Ghat/Srilanka and Indo Burma hot-spot and the present study site fall in the Indo-Burma hot-spot.

An obvious approach to conserving plant biodiversity is to map distributional patterns and look for concentrations of diversity and endemism (Gentry 1992).

This chapter deals with different indices of species diversity and assessment of plant biodiversity in the tropical deciduous forest of Manipur, North Eastern India.

**METHODS AND MATERIALS**

For study of plant biodiversity whole area of selected site has been divided roughly into five parts as per depending on topography and altitude. In each part was sampled using one $250 \times 4m$ transect and in which laid down five quadrate ($10 \times 10m$) randomly, there were collected sample species of tree shrubs and herbs and identified.

**Diversity measured**

The tree species diversity was determined by using Shannon-Wiener information function ($H$) (Shannon-Wiener 1963).

Concentration of dominance was measured by Simpson's index (Simpson 1949).

Similarity index was determined by as per formula given by Sorenson (1941).
RESULTS

A total of 119 species were recorded from the study area, out of these species, 16 species are trees, 38 species are shrubs and 63 species are herbs. Name of the species with their family is listed in Table 4.

In this present study, a total of 119 species belongs to 49 families were recorded. Out of all the families, Fabaceae and Poaceae comprises of maximum speciess, i.e., 16 species each. Then followed by Euphorbiaceae (9 species), Acanthaceae (7 species) Rubiaceae and Papilionaceae have got 5 species each. Dipterocarpaceae and Verbanaceae have 4 species each were recorded and seven families have two species each and the remaining 33 families have 1 species each.

The species diversity, concentration of dominance of different layer of the forest are set in Table 6. The highest concentration of dominance was recorded for tree layer and followed by saplings, seedlings, shrubs and lowest for herbs in site I. In site II, highest concentration was recorded for saplings layers (0.7340) and followed by trees, seedlings, shrubs and lowest for herbs (0.2259). The species diversity (H) was recorded highest for herbs (2.4985) and lowest for tree layers (0.1094) for site I and for site II maximum was recorded for herbs layer (2.2944) and minimum for saplings layers (0.6285). The similarity index between the two site is very high i.e. 50%.
Table 4: Plant Biodiversity of Dipterocarpus forest of Manipur.

<table>
<thead>
<tr>
<th>Plant type</th>
<th>Name of the species</th>
<th>Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees</td>
<td><em>Actephila exelsa</em> Muell.</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td></td>
<td><em>Ardisia penniculata</em> Roxb.</td>
<td>Myrsinaceae</td>
</tr>
<tr>
<td></td>
<td><em>Albizia gamblei</em> Prain</td>
<td>Leguminosae</td>
</tr>
<tr>
<td></td>
<td><em>Antheopelus cadamba</em> Mitz.</td>
<td>Rubiaceae</td>
</tr>
<tr>
<td></td>
<td><em>Croton oblongifolius</em> Roxb.</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td></td>
<td><em>Caryocarya amygdalina</em> Nees</td>
<td>Lauraceae</td>
</tr>
<tr>
<td></td>
<td><em>Dalbergia stipulata</em> Wall.</td>
<td>Fabaceae</td>
</tr>
<tr>
<td></td>
<td><em>Dipterocarpus tuberculatus</em> Roxb.</td>
<td>Dipterocarpaceae</td>
</tr>
<tr>
<td></td>
<td><em>Dipterocarpus turbinatus</em> Gaertn.F.</td>
<td>Dipterocarpaceae</td>
</tr>
<tr>
<td></td>
<td><em>Dysoxylum procernum</em> Hiern</td>
<td>Meliaceae</td>
</tr>
<tr>
<td></td>
<td><em>Ficus cunia</em> Ham.</td>
<td>Moraceae</td>
</tr>
<tr>
<td></td>
<td><em>Lagerstromia villosa</em> Wall.</td>
<td>Lythraceae</td>
</tr>
<tr>
<td></td>
<td><em>Mallotus philippinensis</em> Muell</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td></td>
<td><em>Pithecolobium dulce</em> Benth.</td>
<td>Fabaceae</td>
</tr>
<tr>
<td></td>
<td><em>Shorea robusta</em> Gaertn.</td>
<td>Dipterocarpaceae</td>
</tr>
<tr>
<td></td>
<td><em>Tectona grandis</em> Linn.</td>
<td>Dipterocarpaceae</td>
</tr>
<tr>
<td></td>
<td><em>Wendlandia wallichii</em> W&amp;A</td>
<td>Rubiaceae</td>
</tr>
<tr>
<td>Shrubs</td>
<td><em>Acasia intsia</em> Willd.</td>
<td>Fabaceae</td>
</tr>
<tr>
<td></td>
<td><em>Actiphila exelsa</em> Much.</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td></td>
<td><em>Albizia samman</em></td>
<td>Fabaceae</td>
</tr>
<tr>
<td></td>
<td><em>Antidisma diandrum</em> Linn.</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td></td>
<td><em>Baccaurea sapida</em> Muelarz.</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td></td>
<td><em>Boeica filiformis</em> CBC.</td>
<td>Gesneraceae</td>
</tr>
<tr>
<td></td>
<td><em>Buddleia asiatica</em> Lour.</td>
<td>Longaniaceae</td>
</tr>
<tr>
<td></td>
<td><em>Canavalia ensiformis</em> CD.</td>
<td>Fabaceae</td>
</tr>
<tr>
<td></td>
<td><em>Congea tomentosa</em> Roxb.</td>
<td>Verbanaceae</td>
</tr>
<tr>
<td></td>
<td><em>Clerodendrum serratum</em> Bl.</td>
<td>Verbenaceae</td>
</tr>
<tr>
<td></td>
<td><em>Croton oblongifolius</em> Roxb.</td>
<td>Euphorbiaceae</td>
</tr>
</tbody>
</table>
Grasses

*Derris elliptica* Hk.f.
*Dioscorea sativa* Linn.
*D. wallichii* Hk.f.
*Desmos deemosa* Roxb.
*Desmodium pulchellum* Benth.
*Ficus drupacea* Thunb.
*Flemingia congeta* Roxb.
*Gynocardia odoviata* R.Br.
*Glycomis cyanocarpa* Spring.
*Jasminum coarctatum* Roxb.
*Manglietia insignis* (Wall)Bl.
*Murraya koenigii* Spreng.
*Meliosma simplicitalia* Bl.
*Machilus puthii* Roxb.
*Phlogacanthus tubiflorus* Nees.
*Pithecellobium montatum* Benth.
*Puerarea thunbergiana* Benth.
*Psychotria curviflora* Thew.
*Randia malabarica* Wall.
*Mallotus philippinensis* Muell.
*Trewia nudiflora* Linn.
*Quercus incana* Roxb.
*Vitex penuncularis* Wall.
*Eleocarpus chinensis* Linn.
*Viteus crispa* Bl.
*Smilex roxburghinia* Benth.
*Erythroxylon kuntiasia* H.k.f

*Arundinella setosa* Trin..
*Alocasia farnicata* Roxb.Scott.
*Arundinella mutica* Nus.ex. Stued
*Alocasia ocuminata* Scott.
Alternenthera sessilis Roxb.
Andrographis paniculata Nus.
Andrographis weghliaana Arn.
Bambusa affinis
Bryophytom sansitivum
Calanthe wallichii Hook.f.
Clerodendron nutans Wall.
Costus speciosus Smith.
Crotalaria incana Linn.
Cyanolis barbata Linn.
Cyperus distans Linn.
Desmodium psuedotriguitrum DC
Desmodium pulchellum Benth.
Desmodium concenum DC
Dusticia simplex Don.
Eulalia fastigiata Hainis
Eupatorium odoratum Linn.
Eleusine indica Gaertn.
Eranthemum scabrum Wallex &. T. And
Eragrostis nigra
Euphorbia hirta Linn.
Flemingia invocrata Benth.
F. strobilifera R.Br.
Globba orixinsis
Heteropogon contortus
Inula coppa DC
Holboellia latifolia Wall.
Iodes ovalis Bl.
Ipomea linifolia,Wall.
Justisia simplex Don.
Knoxia lancialata Benth.
Leucas aspera Wall.

Amaranthaceae
Acanthaceae
Acanthaceae
Poaceae
Oxalidaceae
Orchidaceae
Verbenaceae
Scilaminace
Fabaceae
Commelinaceae
Cyperaceae
Papilionaceae
Papilionaceae
Acanthaceae
Poaceae
Asteraceae
Poaceae
Acanthaceae
Poaceae
Fabaceae
Fabaceae
Zingeberaceae
Poaceae
Asteraceae
Berberaceae
Icacinaceae
Convolvulaceae
Acanthaceae
Rubiaceae
Ampelidaceae
Melodinus khasianus Hk.f. Apocynaceae
Melodinus monogynus Roxb. Apocynaceae
Mikania scandens wild. Asteraceae
Mucuna pruriens DC Fabaceae
Murdavia simplex Vohl. Commelinaceae
Oplismenus compositus (L) Poaceae
Ophiopogon griffithii W.A Haemodaraceae
Panicum brevifolium Linn. Poaceae
Paraya macrocarpa Br. Brassicaceae
Paspallum chinensis Hk.f. Poaceae
Pavetta indica Gaertn. Poaceae
Polygola leptolia DC Polygonaceae
Pueraria thunbergiana Benth. Fabaceae
Phragmites karka Trin. Poaceae
Polygonum chinensis Linn. Polygonaceae
Rungia racemosa Linn. Acanthaceae
Scalloria bicolour Linn. Lamiaceae
Scoparia dulcis Linn. Scrophulariaceae
Sesamum indicum DC Pedalineae
Setaria compacta Schur. Poaceae
Seigesbeckia orientalis Linn. Asteraceae
Smilax milalaciana Hk.f. Smilaceae
Smithis sensitive Ait. Fabaceae
Sporobulus indicus Br. Poaceae
Stelleria vagans Linn. Caryophylaceae
Themeda gigantean Cav. Poaceae
Thladiantha calcara C.B.C Cucurbitaceae
Vernonia cinerea Less. Asteraceae
Thysolina maxima Poaceae
Table 5: Plant biodiversity in Dipterocarpus forests.

<table>
<thead>
<tr>
<th>Name of the family</th>
<th>Number of species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabaceae</td>
<td>16</td>
</tr>
<tr>
<td>Poaceae</td>
<td>16</td>
</tr>
<tr>
<td>Euphorbiaceae</td>
<td>9</td>
</tr>
<tr>
<td>Acanthaceae</td>
<td>7</td>
</tr>
<tr>
<td>Rubiaceae</td>
<td>6</td>
</tr>
<tr>
<td>Asteraceae</td>
<td>5</td>
</tr>
<tr>
<td>Papilionaceae</td>
<td>5</td>
</tr>
<tr>
<td>Dipterocarpaceae</td>
<td>4</td>
</tr>
<tr>
<td>Verbenaceae</td>
<td>4</td>
</tr>
<tr>
<td>Apocynaceae</td>
<td>2</td>
</tr>
<tr>
<td>Araceae</td>
<td>2</td>
</tr>
<tr>
<td>Commelinaceae</td>
<td>2</td>
</tr>
<tr>
<td>Deoscoreaceae</td>
<td>2</td>
</tr>
<tr>
<td>Lauraceae</td>
<td>2</td>
</tr>
<tr>
<td>Rutaceae</td>
<td>2</td>
</tr>
<tr>
<td>Polygonaceae</td>
<td>2</td>
</tr>
<tr>
<td>Others (33)</td>
<td>1 each.</td>
</tr>
</tbody>
</table>

Table 6: Species diversity in different forest sites in different layers of plants communities.

<table>
<thead>
<tr>
<th></th>
<th>Site I</th>
<th></th>
<th>Site II</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>cd</td>
<td>H</td>
<td>cd</td>
<td>H'</td>
</tr>
<tr>
<td>Trees</td>
<td>0.9712</td>
<td>0.1094</td>
<td>0.5554</td>
<td>1.1782</td>
</tr>
<tr>
<td>Saplings</td>
<td>0.7106</td>
<td>0.7595</td>
<td>0.7340</td>
<td>0.6285</td>
</tr>
<tr>
<td>Seedlings</td>
<td>0.4581</td>
<td>1.3323</td>
<td>0.4486</td>
<td>1.3180</td>
</tr>
<tr>
<td>Shrubs</td>
<td>0.2574</td>
<td>2.4544</td>
<td>0.3467</td>
<td>1.6432</td>
</tr>
<tr>
<td>Herbs</td>
<td>0.2304</td>
<td>2.4985</td>
<td>0.2259</td>
<td>2.2944</td>
</tr>
</tbody>
</table>
DISCUSSION

A total of 119 species belongs to 49 families were recorded, out of which 16 species are trees, 38 species are shrubs and 63 species are herbs. The number of species recorded in the present study was found to be higher than the number of species reported by Fox et al. (1997); Pande (1999); Kadavul and Parthsarathy (1999); Chowdhury et al. (2000); Uma Shanker (2001) and Khera et al. (2001). And lower than the value reported by Mekail et al. (1997) in different forest types.

The highest concentration of dominance was recorded for tree layer in site I and in site II, highest concentration was recorded for saplings layers and lowest was recorded for herbs in both the sites. The species diversity ($H'$) was recorded highest for herbs in both the site and lowest was recorded for trees in site I and sapling in site II.

The Shannon-Wiener index is used as a diversity index because it is dimensionless and combines the variety and equitability components. The index increased with an increased in number of species. In this present study sites, number of species in the entire layer, i.e. tree, saplings, seedlings, shrubs and herbs are in a sequence, Tree = Saplings = Seedlings < Shrubs < Herbs. So the index increased in sequence, Tree < Saplings < Seedlings < Shrubs < Herbs. Although, same number of species is recorded in tree, saplings and seedling, the index is higher in saplings and seedlings than that of trees, this may be due to presence of large number of individuals in saplings and seedlings that tree layer.
The diversity index is generally higher in tropical forests, which reported as 5.06 and 5.40 for young and old stand respectively (Knight 1975), whereas for Indian forests the same has been ranged between 0.83 to 4.1 (Singh et al. 1984; Parthasarathy et al. 1992 and Visalakshi 1995). These values are reported between 1.16 to 3.40 for temperate forest (Braun 1950; Monk 1967; Rice 1971; Singhal et al. 1986 and Pande et al. 1996, 1998). The value of diversity index of the present study are well lies within the range reported for tropical forests of Indian sub-continent.

According to Whittaker and Niering (1965); Resser Rice (1971); Singhal et al. (1996) and Pande et al. (1996, 1998), reported that the value of concentration of dominance (cd) for temperate forests falls within the range of 0.10 to 0.99, however, for tropical forests the average value is 0.06 as reported by Knight (1975). The range of cd reported by Bisth (1989); Parthasarthy et al. (1992) and Visalakshi (1995) for tropical forest of India varies from 0.21 to 0.92. However the value of present study lie near the reported range.

The similarity index between the two site is very high i.e. 50 %. This indicates that the two forest forms are the parts of same forest formation of the region.

Species diversity was minimum at lower elevation and maximum at higher elevation across aspects (Tripathy et al. 1989). Single dominant forest communities have been frequently found in the tropics (Beard
1946; Richard 1952; Anderson 1961; Swaine and Hall 1981; Whitmore 1984; Rai and Proctor 1986; Hart et al. 1989 and Connell and Lowman 1989). It is generally believed that their species diversity is lower than mixed rain forest (Hart et al. 1989 and Connell and Howman 1989). Simpson (1949) and Margalef (1958) suggested that, as a simple measure of number and/or distribution of abundance of species, diversity has long been used to characterized the taxonomic structure of communities. Despite the potential ambiguity of indices that consider rare and common taxa equally or that weight species relative to their abundance diversity remains on invaluable ecological tool and matrix with which to simplify, characterize and compare the complexity of species assemblages (Christensen and Peet 1984 and Magurron 1988). Peter et al. (1989) suggests that, it is becoming increasingly clear that the biodiversity that enchants biologist and daunts conservationist is also of tremendous direct economic importance. Indeed it seems likely that the only alternative to massive social and economic disintegration and ever-increasing misery in much of the third world lies in finding ways to combine the preservation and sustained utilization of biodiversity of tropical forest (Gentry 1991e). Wilcove et al. (1986) noted that, comparison of edge-width measurements for tropical and temperate forests supports the notion that temperate communities are more resistant to changes brought by habitat fragmentation than are tropical communities and that population may persist in smaller patches of suitable habitat that is possible in tropics. Concern of widespread threats to biodiversity (e.g. United States Environmental Protection Agency 1990, Raven and Wilson 1992)
underscore the importance of monitoring and quantifying species richness at the regional scale.

Grime (1979); Oliver (1981) and Hunter (1990), noted that there is a vast literature on the pattern and process of response of local plant diversity to anthropogenic disturbance in forests. In order for local disturbance to translate into a regional pattern, disturbance must be widespread regionally and association between disturbance and diversity must be consistent locally (M.A. Stopanian et al. 1997). Other studies (Wilson 1974; Harper 1977; Deuser and Shugart 1978; August 1983 and Bersier and Meyer 1995) suggest that simple forest systems, such as even-aged monocultures or systems in which certain species are removed, provide equality habitat for fewer wildlife species than do more complex stand. Simplification of the system may not be the only or even most important cause of increased local instability (Pimm 1984). A final possibility is that, the decline in forest diversity with elevation on tropical mountains and possibly elsewhere may be related to elevational declines in the rates of plant growth and forest turnover and allocation to plant anti-herbivore defenses (Givnish 1999). At higher elevation's the rates of plant growth, competitive exclusion and normality might be expected to slow as a consequence of cooler temperature, decrease rate of N mineralization and nitrification (Marrs et al. 1988; Heaney and Proctor 1989 and Tanner et al. 1990).
Table 7: Comparative account of plant biodiversity in different forest of the world.

<table>
<thead>
<tr>
<th>Type of forest</th>
<th>No. of trees</th>
<th>No. of shrubs</th>
<th>No. of herbs</th>
<th>Total</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainforest Australia</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>94</td>
<td>Fox <em>et al.</em> (1997)</td>
</tr>
<tr>
<td>Boreal old growth swamp forest</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>148</td>
<td>Mikail <em>et al.</em> (1997)</td>
</tr>
<tr>
<td>Sal forest India</td>
<td>12</td>
<td>20</td>
<td>20</td>
<td>52</td>
<td>Pande (1999)</td>
</tr>
<tr>
<td>Tropical semi evergreen forest</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>89</td>
<td>Kadavul and Parthasarathy (1999)</td>
</tr>
<tr>
<td>Eastern Ghat India</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Dipterocarpus turbinatus</em> Garjan forest, Bangladesh</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>85</td>
<td>Chowdhury <em>et al.</em> (2000)</td>
</tr>
<tr>
<td>Lowland forest of eastern Himalaya India</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>87</td>
<td>Uma Shanker (2001)</td>
</tr>
<tr>
<td>Forest of central Himalaya India</td>
<td>15</td>
<td>31</td>
<td>46</td>
<td>92</td>
<td>Khera <em>et al.</em> (2001)</td>
</tr>
<tr>
<td>Dipterocarpus forests of Manipur, India</td>
<td>16</td>
<td>36</td>
<td>67</td>
<td>119</td>
<td>Present study</td>
</tr>
</tbody>
</table>