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Life forms classification and biological spectrum in natural and human impacted ecosystems of Senapati district, Manipur, India

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ABSTRACT

The present study deals with the life-form and biological spectrum of natural and human impacted ecosystems of Senapati district, Manipur. Biological spectrum was compared with Raunkiaer's normal spectrum. Based on the position of their perennating buds of the plants, the study area has been designated with the Phanero-therophytic phytoclimate. A total of 99 species belonging to 51 families were accounted. Dominance of trees and shrubs vegetation showed the significance of Phanerophytes indicating the ameliorating role of the upper canopy in regulating the microclimate, maintenance of diversity and establishment of herbaceous plants and ecosystem function. Predominance of therophytes is attributed to anthropogenic disturbance like tree felling, introduction of weeds, cattle grazing etc. Presence of more annuals in the present study indicates their invasive nature in all the land uses. Land use change and the anthropogenic disturbance are the most important factors affecting the life form, biological spectrum and species diversity in the present study. Further disturbance may facilitate the phytoclimate into thero-phanerophytic type in future.

Key words : *Phanero-therophytic, Phytoclimate, Diversity, Microclimate, Biological spectrum*

Introduction

Vegetation analysis helps in understanding the potential role of the plant species in capturing maximum carbon and helps in mitigating climate change. For the implication of carbon budgets and sink capacity, it is also important to analyze and understand the relationships between species diversity and the accumulation of biomass and carbon stock in different land uses. Conversion of natural habitat into other land uses has greatly reduced the vegetation structure. On the basis of the plants physiognomy and growth performance, the individual species in a community can be grouped into various life forms. This life form is the product of the gene pool and tolerance towards climatic variation.

As plant life forms are closely associated with the existing environment, biological spectrum is considered as the sensitive indicator of the prevailing physical and biological factors. Raunkiaer (1934) framed the concept of life forms on the basis of the biological spectrum. Curtis and McIntosh (1950) described the interrelationship between analytical and synthetic phytosociological characters Cain (1950) defined life form as the overall life processes that evolved directly in response to the environment. The occurrence of similar or different biological spectrum will indicate the phytoclimate of that particular vegetation under study. He classified the plant species into five main classes: phanerophytes, chamaephytes, hemicryptophytes, cryptophytes and therophytes. Meher- Homji (1981) compiled the life form spectra for different regions of India based on the average annual rainfall, length of the dry season, mean temperature of the coldest month of the year.

Puri *et al.* (1990) have identified ten types of phytoclimates of India based on Raunkiaer's life form classes. Life form study also provides important information on the response of a community in relation to that particular environmental factor (Mueller-Dombois and Ellenberge, 1974). Earlier, life forms in Manipur were studied by Usharani (2004); Ranita *et al.,* (2010); Devi *et al.,* (2014); Singh and Gupta (2015); Arila and Gupta (2016).

Vegetation nature also played a great role in soil respiration (Niirou and Gupta 2018) thereby affecting the carbon cycle. Both structure and diversity of vegetation have a strong functional role in controlling important ecosystem processes like biomass production, cycling of water and nutrients, etc. (Gower *et al.,* 1992). It is important to analyse and be aware of the relationship between species diversity, tree density and carbon stock in different land uses (Niirou and Gupta, 2017). Turner and Cole (1973) reported that the importance of forest biomass and its distribution are essential for the understanding the many aspects of forest ecology and ecosystem dynamics as they provide a basis for determination of productivity, energy flow and chemical composition in mineral cycling studies. The present study was carried out with the objective; to analyse vegetation attribute such as life form and biological spectrum across different land uses in hill district of Senapati, Manipur.

Study Area

The study area comprised of the subtropical forest of Senapati district, Manipur North East, India. Four study sites were demarcated, three sites at Thangal Ecological Park viz. Undisturbed Oak forest (UOF) (Latitude 25°122.1133 N, Longitude 93°592.9003 E, elevation 1,192 m a.s.l), Disturbed Oak Forest (DOF) (Latitude 25°122.0673 N, Longitude 93°592.9153 E, elevation 1,218 m a.s.l), Pine Plantation (PP) (Latitude 25°122.0883 N, Longitude 93°592.8283 E, elevation 1,146 m a.s.l). The fourth site was selected at Tunggam TNK village hill Orchard Plantation (OP) (Latitude 25°162.1453 N, Longitude 94°022.2963 E,

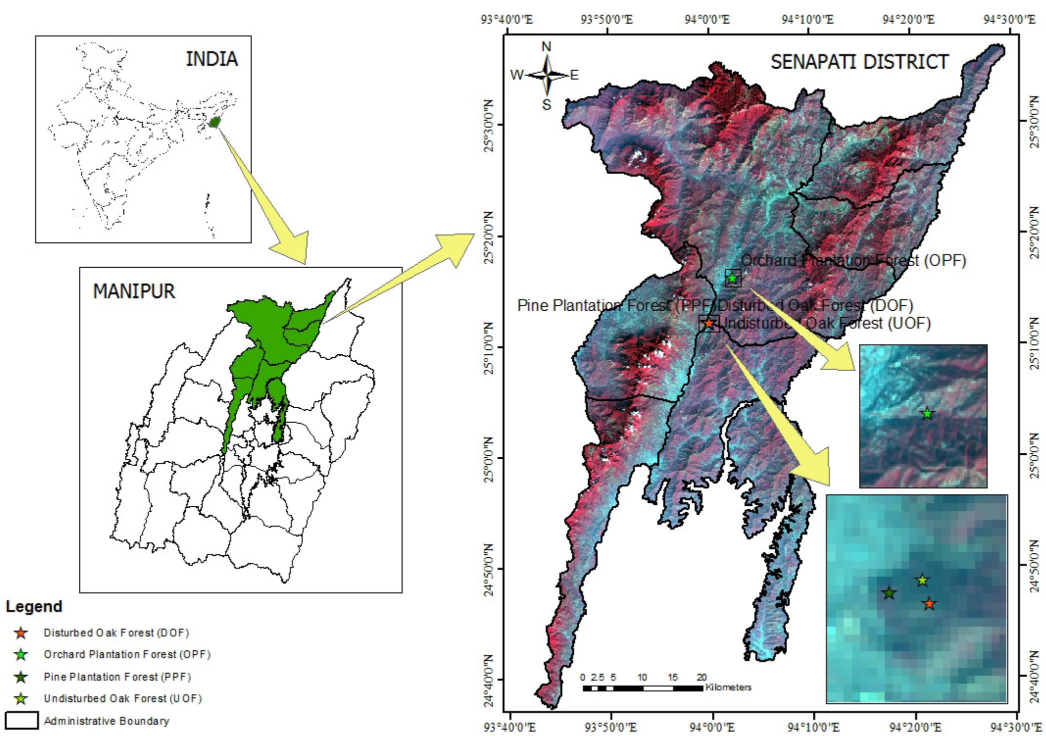

Fig. 1. Map showing the location of the study sites in Senapati District, Manipur

elevation 1,245 m a.s.l) owned privately by local (Fig.1). The three forests are community forests belonging to Mayangkhang people in Manipur during 2015–2017. The pine plantation is well-protected and is exclusively covered by *Pinus kesiya*. The study area received an average annual rainfall of 1754.05 mm during the study period. The average monthly temperature varied from a maximum of 30.0°C in the month of July to a minimum of 4.1°C in December. The period has been classified into three main seasons; summer (March-May) which is warm and dry, rainy (June - October) warm and humid and winter (November-February) cold and dry.

Vegetation Analysis

Analysis of floristic diversity was carried out during September, 2015 when the majority of the plants were at the peak of their growth. The plants species were placed into various life-forms as per (Raunkiaer, 1934). The percentage of species belonging to different life form such Phanerophytes (Ph), Chamaephytes (Ch), Crytophytes (Cr), Hemicryptophytes (H) and Therophytes (Th) were calculated using the formula:

$$\text{Percentage of life-form} = \frac{\text{Number of species of a given life form}}{\text{Total number of species of all life forms}} \times 100$$

The important quantitative analysis such as density, frequency, basal cover, IVI of herbs, shrubs and tree species were studied as per methods of Curtis and McIntosh (1950). In each site 10 quadrates of 10 m x 10 m for trees 5 m x 5 m for shrubs and 1 m x 1m for herbs were laid down randomly.

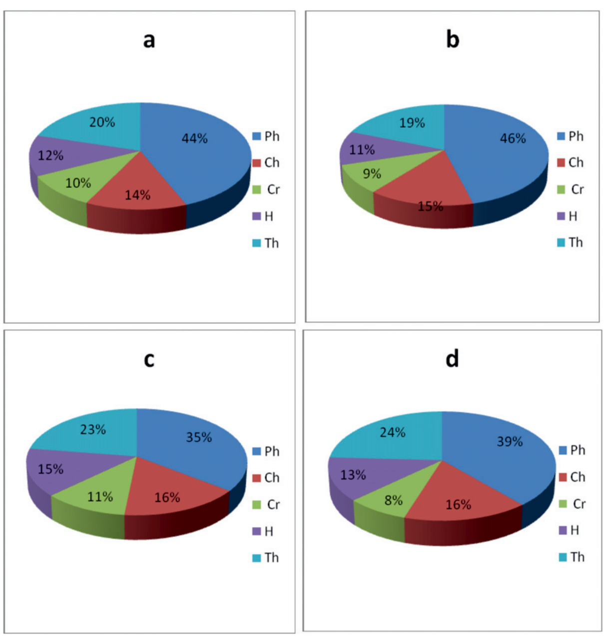

Fig. 2. Graphical Representation of Different Life forms of (a) UOF, (b) DOF, (c) PP, and (d) OP

Results and Discussion

The details of the findings are given below; Table 1 summarizes the life forms in UOF, DOF, PP, and OP. The different life form categories of the present study areas recorded 99 species belonging to 51 families based on the position of their perennating buds. When Biological spectrum was compared with the Raunkiaer's normal spectrum, the phytoclimate was designated as Phanerotherophytic in all the present study sites (Fig. 3). Total number of species in each land use; 67 in UOF (20.90% tree, 20.9 % shrub & 58.21% herb), 47 in DOF(17.02% tree, 19.15 % shrub, 63.83% herb), 51 in PP (1.96 % tree, 21.57% shrub & 76.47 %) and 36 number of species in OP(30.56% tree, 8.33% shrub, 61.11% herb).

Understanding life forms has an important implication and role in planning, management and conservation of vegetation.

The percentage of species belonging to different life form category relative to the total number of species in each land uses is presented in Fig. 2.

The study reveals that land use is the most important factor influencing the life form in land use types. In Undisturbed Oak forest (UOF), *Quercus serrata* (IVI, 103.42) and *Lyonia ovalifolia* (IVI, 33.31) were the dominant tree species and co-dominated by *Quercus griffithii* (IVI, 31.18). *Osbeckia stellata* (IVI, 39.16) and *Smilax aspera* (IVI, 37.03) were the dominant shrub species. *Gleichenia linearis* (IVI, 33.9) and *Imperata cyclidrica* (IVI, 45.16) were the dominant herb species in UOF. *Quercus serrata* (IVI, 130.58) and *Quercus griffithii* (IVI, 52.49) were the dominant tree species and co-dominated by *Lyonia ovalifolia* (IVI, 36.33). *Wendlandia glabrata* (IVI, 50.86) and *Lantana camara* (IVI, 45.28) were the dominant shrub species and *Imperata cylindrica* (IVI, 45.16) and *Solanum incanum* (32.74) were the dominant herb species in DOF.

The dominant shrubs species were *Osbeckia stellata* (IVI, 39.78) and *Melastoma malabathricum* (IVI, 32.15) whereas *Imperata cylindrica* (IVI, 21.15) and *Ciscus discolor* (IVI, 18.31) were the dominant herb species in Pine plantation.

In Orchard plantation, *Mangifera indica* (IVI,

Table 1. Life forms of trees for UOF, DOF, PP and OP in Senapati district, Manipur

Sl. No.	Trees species	Family	Life form	Habit	UOF	DOF	PP	OP
1.	*Alnus nepalensis.* D. Don	Betulaceae	Ph	Tree	+	-	-	-
2.	*Amaranthus spinosus.* Linn	Amaranthaceae	Th	Herb	+	-	+	+
3.	*Andropogon distachyos*. Linn	Poaceae	Ch	Herb	+	+	+	+
4.	*Arisaema tortuosum.* (Wallich) Schott	Araceae	Cr	Herb	+	-	+	-
5.	*Begonia palmata.* D. Don	Begoniaceae	Cr	Herb	+	-	-	-
6.	*Bidens pilosa.* Linn	Asteraceae	Th	Herb	+	+	+	+
7.	*Brachiaria distachya.*(L.) Stapf	Poaceae	Ch	Herb	+	+	+	+
8.	*Carex baccans* Nees	Cyperaceae	Th	Herb	+	+	-	+
9.	*Castanopsis hystrix.* Hooker f. & Thomson ex A.DC	Fagaceae	Ph	Tree	+	+	-	+
10.	*Centella asiatica* (Linnaeus) Urban	Apiaceae	H	Herb	+	+	+	+
11.	*Chenopodium album.* Linn.	Amaranthaceae	Th	Herb	+	+	-	+
12.	*Chloranthus officinalis*. Blume	Chloranthaceae	Ph	Shrub	+	+	+	-
13.	*Cissus discolour*.(Rex.)	Vitaceae	Ph	Herb	+	-	+	-
14.	*Citrus sinensis.* (L.) Osbeck	Rubiaceae	Ph	Tree	-	-	-	+
15.	*Colocosia esculenta.* Linn.	Araceae	Cr	Herb	-	-	-	+
16.	*Costus speciosus.*(J. Koenig).Sm.	Costaceae	Ph	Herb	+	-	+	-
17.	*Curculigo orchioides*. Gaertn	Hypoxidaceae	Th	Herb	+	+	-	-
18.	*Curcuma angustifolia*. Roxb.	Zingiberaceae	Cr	Herb	+	+	+	-
19.	*Cyanotis cristata.*(L.) D. Don	Commelinaceae	H	Herb	+	+	+	+
20.	*Cyperus rotundus.* Linn.	Cyperaceae	Cr	Herb	+	+	+	+
21.	*Desmodium heterocarpon.*(L).DC.	Fabaceae	Ch	Herb	+	+	+	+
22.	*Dianella tenuifolia.*(L). DC.	Xanthorrhoeaceae	Cr	Herb	+	+	+	+
23.	*Digitaria sanguinalis.* Linn. Scop.	Poaceae	Th	Herb	+	+	+	+
24.	*Diospyros glandulosa.* Lace	Ebenacea	Ph	Tree	+	+	-	-
25.	*Disporum pullum*. Salisb.	Colchicaceae	H	Herb	+	-	+	-
26.	*Duchesnea indica*. (Jacks). Focke	Rosaceae	H	Herb	+	-	-	+
27.	*Elaeocarpus lanceifolius.* Roxburgh	Fabaceae	Ph	Tree	+	-	-	+
28.	*Elephantopus scaber.* Auct non L.	Asteraceae	Cr	Herb	+	+	+	+
29.	*Emblica officinalis.* Linnaeus	Phyllanthaceae	Ph	Tree	+	+	-	+
30.	*Engelhardtia spicata.* Lechen ex Blume	Juglandaceae	Ph	Tree	+	+	-	-
31.	*Eupatorium adenophorum.*Spreng	Asteraceae	Th	Herb	+	+	+	+
32.	*Ficus hirta.* Vahl	Moraceae	Ch	Herb	+	+	+	-
33.	*Ficus sagittata* J. Konig ex Vahl	Moraceae	Ch	Herb	+	+	+	-
34.	*Fragaria vesca.* Linn.	Rosaceae	H	Herb	+	+	+	+
35.	*Galinsoga parviflora.* Linn.	Asteraceae	Th	Herb	+	-	-	+
36.	*Glechoma hederacea.* Linn.	Lamiaceae	Ch	Herb	+	-	-	+
37.	*Gleichenia linearis* (Burman f.) C.B.Clarke	Gleicheniaceae	Cr	Herb	+	+	+	-
38.	*Gmelina arborea.* Roxburgh	Verbenaceae	Ph	Tree	-	-	-	+
39.	*Gnaphalium indicum.* Linn	Asteraceae	Th	Herb	+	+	+	+
40.	*Gynura crepidioides.* Benth.	Asteraceae	Th	Herb	+	+	+	+
41.	*Hedychium coccineum.* Buch.-Ham. ex. Sm.	Zingibaraceae	Cr	Herb	+	+	-	-
42.	*Hedyotis hispida.* Retz	Rubiaceae	H	Herb	+	+	+	-
43.	*Holmskioldia sanguinea.* Retz.	Lamiaceae	Ph	Shrub	+	+	+	+
44.	*Houttuynia cordata.* Thunb.	Saururaceae	H	Herb	+	-	-	+
45.	*Impatiens arguta.* Hooker f. & Thomson	Balsaminaceae	Ch	Herb	+	-	-	-
46.	*Imperata cylindrica.* Linn. Raeusch	Poaceae	H	Herb	+	+	+	+
47.	*Justicia simplex*. D. Don.	Acanthaceae	Ch	Herb	+	+	+	+
48.	*Knoxia sumatrensis.* (Retz.)DC	Rubiaceae	Ch	Herb	-	+	+	+

Table 1. *Continued ...*

Sl. No.	Trees species	Family	Life form	Habit	UOF	DOF	PP	OP
49.	*Lantana camara.* Linn.	Verbenaceae	Ph	Shrub	+	+	+	+
50.	*Lithocarpus dealbatus* (Roxburgh) Pearson	Fagaceae	Ph	Tree	+	+	-	+
51.	*Lithocarpus polystachyus*. (Wall. Ex A. DC.)	Fagaceae	Ph	Tree	-	-	-	+
52.	*Lophatherum gracile.* (Brongn.)	Poaceae	Th	Herb	+	+	+	+
53.	*Lyonia ovalifolia.* (Wall.) Drude	Ericaceae	Ph	Tree	+	+	-	-
54.	*Maesa indica* (Roxburgh) de Candolle	Primulaceae	Ph	Shrub	+	+	+	-
55.	*Mangifera indica.* Linn	Anacardiaceae	Ph	Tree	-	-	-	+
56.	*Melastoma malabathricum* Linn	Melastomataceae	Ph	Shrub	+	+	+	+
57.	*Molineria capitulata.* (Lour) Kuntze	Hypoxidaceae	Cr	Herb	+	+	+	+
58.	*Mucuna monosperma.* Roxb. ex Wight	Fabaceae	Ph	Herb	+	+	+	-
59.	*Myrica esculenta.* Buch-Ham ex. D. Don	Myricaceae	Ph	Tree	+	+	-	-
60.	*Oplismenus burmanii.* Retz P. Beauv.	Poaceae	Th	Herb	+	+	+	+
61.	*Osbeckia stellata.* Buch.-Ham ex. D. Don	Melastomataceae	Ph	Shrub	+	+	+	+
62.	*Oxalis corniculata.* Linn.	Oxalidaceae	H	Herb	+	+	+	-
63.	*Parkia roxburghii.* G. Don.	Fabaceae	Ph	Tree	-	-	-	+
64.	*Phyllanthus urinaria.* Linn	Phyllanthaceae	Ph	Herb	+	+	+	+
65.	*Pinus kesiya.* Royle ex. Gordon	Pinaceae	Ph	Tree	-	-	+	-
66.	*Piper nigrum.* Linn	Piperaceae	Ph	Herb	+	+	-	-
67.	*Plantago erosa.* Wall	Plantaginaceae	Ch	Herb	+	+	+	+
68.	*Polygonum chinensis.* Linn	Polygonaceae	Ph	Herb	+	+	+	+
69.	*Pouzolzia hirta.* Blume ex. Hassk	Urticaceae	Ch	Herb	+	+	+	+
70.	*Pratia nummularia.* (Lam) A. Braun & Asch.	Caryophyllaceae	Ch	Herb	+	+	+	+
71.	*Prunus rufa*. Wallich ex. Hooker.	Rosaceae	Ph	Tree	-	-	-	+
72.	*Psidium guajava.* Linn	Myrtaceae	Ph	Tree	-	-	-	+
73.	*Pteridium aquilinum.* (Linn.) kuhn	Pteridaceae	H	Herb	+	-	+	+
74.	*Pyrus pashia.* Buch-Ham ex. D. Don	Rosaceae	Ph	Tree	+	+	-	-
75.	*Quercus griffithii.* Hooker. & Thomson ex Miquel	Fagaceae	Ph	Tree	+	+	-	+
76.	*Quercus serrata.* Murray	Fagaceae	Ph	Tree	+	+	-	-
77.	*Rhus chinensis* P. Miller	Anacardiaceae	Ph	Tree	+	+	-	-
78.	*Rubus ellipticus.* (Smith)	Rosaceae	Ph	Shrub	+	+	+	+
79.	*Rubus rugosus.* Heget Schw.	Rosaceae	Ph	Shrub	+	+	+	+
80.	*Sarcandra glabra.* (Thunb) Nakai	Chloranthaceae	Ph	Herb	+	+	-	-
81.	*Schima wallichii* Choisy	Theaceae	Ph	Tree	+	+	-	+
82.	*Scutelleria discolar.* Colebr.	Lamiaceae	Ch	Herb	+	+	+	+
83.	*Sellaginella bryopteris* (L.) Baker	Selaginellaceae	Ch	Herb	+	+	-	-
84.	*Setaria palmifolia* (K.D. Koenig) Stapf.	Poaceae	H	Herb	+	+	+	+
85.	*Sida cordifolia.* Linn	Malvaceae	Ph	Herb	+	+	+	+
86.	*Smilax aspera.* Linn	Smilacaceae	Ph	Shrub	+	+	+	-
87.	*Smilax zeylanica.* Linn	Smilacaceae	Ph	Shrub	+	+	+	-
88.	*Smithia sensitiva.* (Aiton)	Fabaceae	Th	Herb	+	-	+	-
89.	*Solanum americanum.* Miller	Solanaceae	Th	Herb	+	+	+	+
90.	*Solanum incanum* Linn.	Solanaceae	Th	Herb	+	-	+	-
91.	*Spermacoce neohispida.* Linn.	Rubiaceae	Th	Herb	+	+	+	+
92.	*Spilanthes clava.* DC	Asteraceae	Th	Herb	+	+	+	+
93.	*Strobilanthes consors.* CB Clarke	Acanthaceae	Ph	Shrub	+	+	+	-

Table 1. *Continued ...*

Sl. No.	Trees species	Family	Life form	Habit	UOF	DOF	PP	OP
94.	*Syzygium campanulatum.* (Roxb.) Walp.	Myrtaceae	Ph	Tree	+	+	-	-
95.	*Thalictrum foliolosum.* DC	Ranunculaceae	Ch	Herb	+	+	+	+
96.	*Trevesia palmata.* (Roxb. ex Lindl.)	Araliaceae	Ph	Tree	+	-	-	-
97.	*Tridax procumbens.* Linn.	Asteraceae	Th	Herb	+	+	+	+
98.	*Urena lobata.* Linn.	Malvaceae	Ph	Shrub	+	+	+	+
99.	*Wendlandia glabrata.* DC	Rubiaceae	Ph	Shrub	+	+	+	-

45.98) and *Gmelina arborea* (IVI, 42.64) were the dominant tree species. *Lantana camara* (IVI, 167.34) were the dominant shrub species, whereas *Colocasia esculenta* (IVI, 47.91) and *Imperata cylindrica* (IVI, 39.60) were the dominant herb species in OP.

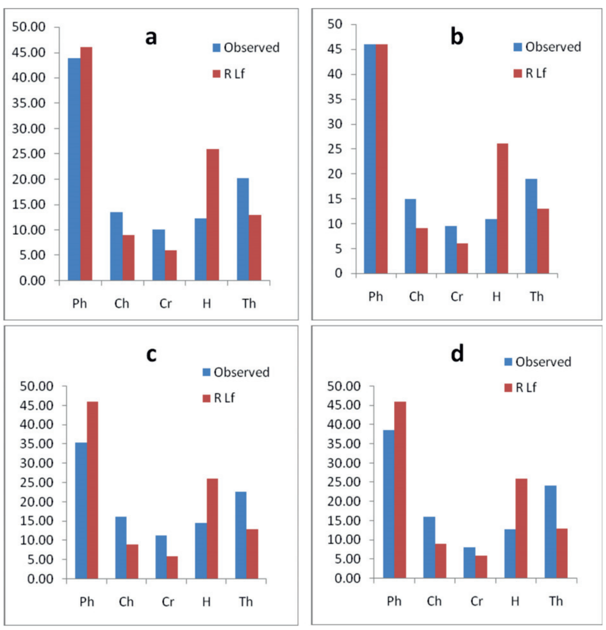

Fig. 3. Comparison of Biological Spectrum of (a) UOF, (b) DOF, (c) PP, and (d) OP with

Raukiaer's Life Form (R Lf)

Vegetation composition and diversity patterns are very important ecological parameters correlated with the prevailing environmental variables. The number of species recorded was lesser than 125 species as reported from sacred groves of Manipur (Usharani, 2004) and 111 species in subtropical Montane forest of Manipur (Arila and Gupta, 2016). But higher than 67 species in Teak-Dipterocarpus forest of Manipur (Ranita *et al.*, 2010). Life-form composition of the community indicates the various adaptations of species to its climatic condition and plays an important role to community building (Jamir *et al.*, 2006). The phyto-climate was classified as Phanero-therophytic in all the present study sites. Phanerophytes are woody tree, shrubs and lianas in which the perennating buds are located above the ground. The present study is comparable with the findings as reported by Arila and Gupta (2016) in similar agroclimatic zone of Senapati district. Dominance of trees and shrubs vegetation showed the significance of Phanerophytes indicating the ameliorating role of the upper canopy in regulating the microclimate, maintenance of diversity and establishment of herbaceous plants and ecosystem function. Therophytes are the annuals that complete their life cycle in favorable condition and survive in the form of seeds during unfavorable conditions. The next dominant life form in the present study is therophyte indicating the disturbed environmental conditions. Predominance of therophytes is attributed to anthropogenic disturbance like tree felling, introduction of weeds, grazing etc (Khan *et al.*, 2011). Arila and Gupta (2016) also reported similar phyto-climate in the subtropical hill forest of Senapati district. Singh and Gupta (2015) reported phanero-therophytic type in subtropical forest of Manipur. Both the natural and human impacted land uses in Senapati district have significant impacts on the soil nutrients and soil carbon stock (Niirou *et al.*, 2017) which in turn might have an influence on the growth form of the plants and biological spectrum. Presence of more annuals in the present study indicates their invasive nature with disturbed nature of the forest in all the sites. Also the higher percentage of therophytes (annuals) and chaemophytes (herbaceous perennial plants with perennating buds just above the ground) in each study site indicates the biotic pressure faced in the particular area due to competitive ability and thus dwindling the regeneration of woody species. Presence of higher percentage of phanerophytes in all the study sites were the characteristics of suitable bioclimatic and predominance of woody plants.

Conclusion

Analysis of biological spectrum revealed the phytoclimate as Phanero-therophytic in all the present study sites. Predominance of therophytes is attributed to anthropogenic disturbance like tree felling, introduction of weeds, grazing and biotic pressure, trampling etc in the existing land use. Presence of more annuals in the present study indicates their invasive nature with disturbed nature. Thus different land use and the anthropogenic disturbance are the most important factor affecting the life form, species diversity and biological spectrum in the present study. Moreover, further disturbance in the present land uses may facilitate the phytoclimate into thero-phanerophytic type in future. We recommend further research that explores the impact of land use activities on the dynamics of these systems.

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