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ASSESSMENT OF PLANT SPECIES IN A SUB-TROPICAL FOREST ECOSYSTEM OF MANIPUR, NORTHEAST INDIA

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Abstract: The present study deals with assessment of plant diversity in a sub-tropical forest of Langol hills, Manipur, Northeast India. The forest vegetation was dominated by *Lithocarpus fenestrata* Roxb., *Schima wallichii* (DC) Korthals and *Quercus serrata* Thunb. A total of 282 species of plants were recorded from across the study sites, representing 210 genera and 82 families. Out of 282 species, 81, 38, 123, 25 and 15 were trees, shrubs, herbs, climbers/lianas and ferns respectively. Poaceae was the dominant family representing 26 different plant species followed by Asteraceae with 20 different plant species. The presence of large number of species indicates that the present forest harbours high species richness.

Keywords: **Plant diversity, sub-tropical, *Lithocarpus fenestrata* Roxb., Poaceae, species richness.**

I. INTRODUCTION

Biodiversity is the single greatest resource that humankind has garnered from nature during our long cultural development and is an extremely valuable resource. Yet the more intensively we use this resource, the more we threaten its long term future. Our awareness of the disappearance of biodiversity has brought with it long overdue appreciation of the magnitude of our loss and a determination to develop the tools to protect our future. Tropical forests are repositories of much of the world's biodiversity and play a crucial role in the regulation of global climate. However, many tropical forests are under great anthropogenic pressure and require management interventions to maintain the overall biodiversity, productivity and sustainability. The loss of biodiversity is considered to be one of the most important of all the negative effects of degradation of tropical forests. Despite the increased awareness and energy invested in biodiversity conservation, the rate of biodiversity loss has not measurably reduced, the world has more poor people than ever and economic development is being achieved at the price of measurable climate change (Mianka *et al*. 2010).

The state of Manipur in North-Eastern India is a part of Indo-Burma biodiversity hotspot which is one of the 34 biodiversity hotspots of the world (Mittermeier *et al*. 2005). The state is rich in diversity and endemism and harbours a unique flora. However, the genetic wealth of the state has been depleted considerably during the recent past, because the natural forests are being destroyed extensively by various anthropogenic activities such as collection of fuel wood and timber and including the age-old practice of shifting cultivation, causing serious threats to the rich diversity of the region. A number of studies have been reported on the structure and functioning of forest ecosystems in Manipur (Yadava and Singh 1988; Kikim and Yadava 1998, 2001; Devi and Yadava 2006). However, there is lack of information on the influence of biotic disturbances on the structure and plant diversity of the sub-tropical forest ecosystem of Manipur. Therefore, the present study was undertaken to examine the plant diversity in a reserve forest of Langol hills, Manipur, Northeast India and the study is intended to give important directions to conservation and management of natural resources including biodiversity for the present and future human requirements.

II. MATERIALS AND METHODS

Study area

The study site ($24^0$45'N latitude and $93^0$55'E longitude) has an area of 50 hectares and is located within the Langol Reserved Forest at a distance of 12 kms from Imphal along NH 39 and at an altitude ranging from 780m-900m above mean sea level. Although the forest is protected, it is subjected to anthropogenic disturbances in the form of firewood extraction, removal of litter and selective cutting of trees for timber by the local people living around the forest. The Reserved forest harbours several timber yielding plants, which also have social and economic values. It has slope from moderate to steep. The forest sites were dominated by *Lithocarpus fenestrate*, *Schima wallichii* and *Quercus serrata*. According to Champion and Seth (1968), the present forest falls under East Himalayan sub-tropical wet hill forest type 8B/C1.

Climate

The climate of the area is monsoonic with warm moist summer, a distinct rainy season and cool dry winter. The mean maximum temperature varied from 22.1^0C (January) to 29.5^0C (August) and the mean minimum temperature varied from 5.4^0C (January) to 22.7^0C (August). The mean monthly rainfall ranged from 21.6mm (December) to 226.4mm (July). The total mean annual rainfall is 1379.80 mm. The average relative humidity of air varied between 59.7% (March) to 82.2% (July). Soil of the study area was reddish in colour, loamy-sand in texture and acidic in nature.

Methods

For the assessment of plant biodiversity of the forest sites, frequent visits were made and extensive floristic survey was carried out through quadrat method. The specimens of trees, shrubs, herbs, climbers or lianas and ferns were collected and herbaria were prepared for the specimens. They were identified with the help of the Flora of British India (Hooker 1872-1897), Dicotyledonous and Monocotyledonous plants of Manipur (Deb 1961), Flora of Manipur (Chauhan *et al*. 2000) and the Herbaria of the Regional Botanical Survey of India, North Eastern Circle, Shillong were consulted for correct identification of plant specimens. The species richness and family divergence have been evaluated for the forest sites.

III. RESULTS

Plant diversity and species richness within families

A total of 282 species (81 trees, 38 shrubs, 123 herbs, 25 climbers or lianas and 15 ferns) were recorded from across the study sites representing 210 genera and 82 families (Appendix 1).

Among families, Poaceae (26 species), Asteraceae (20 species), Rubiaceae (14 species) and Fabaceae (13 species) were most species diverse. Cyperaceae and Moraceae were represented by eight species each, Verbenaceae and Labiatae were represented by seven species each, Araceae, Euphorbiaceae and Vitaceae by six species each, Nine families by five species each, 11 families by four species each, five families by three species each, 12 families by two species each while the remaining 33 families were represented by one species each (Table 1).

IV. DISCUSSION

The sub-tropical forests of Manipur harbours over 2380 species belonging to 1052 different genera and over 205 families, out of which 282 species or 11.85% representing 82 families were recorded from the forest of Langol hills. The number of species reported in the present study was found to be higher than the number of species reported by several workers in different tropical forests (Nangendo *et al*. 2006 (121 species); Ruschel *et al*. 2007 (78 species); Sahu *et al*. 2008 (56 species); Page *et al*. 2010 (277 species); Uniyal *et al*. 2010 (182 species)) but lower than the values reported by Tchouto *et al*. (2006) (1112 species) from rain forest of Cameroon; Hemp (2006) (523 species) from forest of Kilimanjaro; Behera and Kushwaha (2007) (336 species) from Subabsiri district of Eastern Himalaya and Pereira *et al*. (2007) (730 species) from Atlantic Montane forest of S.E. Brazil. However, these comparisons convey limited meaning since the species richness of a given area would depend on the plot dimension and the sample area is variable across studies. According to Halpern and Spies (1995), interpolation or comparison of diversity among studies are problematic due to differences in sampling design, number or area of plots, indices used to express diversity or origin of the sere.

The tendency for certain plant families to be among the most species rich across the entire elevational gradient may be because of better seed dispersal, variability in flower form or phenology and high adaptive capability. The high species richness of the families Poaceae and Asteraceae may be because many members of Poaceae and Asteraceae have evolved adaptations to the existing conditions, developed effective seed dispersal mechanisms (small seeds, wind dispersal, parachute like calyx or hooks), variability in flower form or phenology and high adaptive capability and these groups might have often speciated extensively in this region which may partly account for their success. The number of families reported in the present study is closer to the number reported by Heinrich and Hurka (2004) (77 families) from tropical dry forest of North-Western Costa Rica; Tchoucho *et al*. (2006) (97 families) from rain forest of Cameroon and Pereira *et al*. (2007) (86 families) from Montane forest of S.E. Brazil.

V. CONCLUSION

Our study reveals that the sub-tropical forest of Langol hills, Manipur is characterized by high diversity of species and families with 282 species of plants and 82 families representing 81 tree species, 38 shrub species, 123 herb species, 25 climber species and 15 fern species. Comparing the overall diversity of species and families, the present forest still possesses high diversity and need rational management strategies not only for maintaining the biodiversity but also for sustainable development. Although the study site is a reserve forest which is protected by law, illegal logging of valuable species is still a problem as its boundaries have not been fully protected and it is suggested that a separate management strategy be developed to ensure full protection of the forest and its rich biodiversity. It can be concluded that if the present forest could be properly managed with a threshold level of extraction of resources then it can contribute significantly in the conservation and management of tropical forests, thereby helping in maintaining biodiversity.

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Table 1. Plant families and number of species in mixed-oak forest, Langol hills, Manipur.

Family	No. of Species	Family	No. of Species
Poaceae	26	Fagaceae	4
Asteraceae	20	Malvaceae	4
Rubiaceae	14	Meliaceae	4
Papilionaceae	13	Myrtaceae	4
Cyperaceae	8	Orchidaceae	4
Moraceae	8	Scrophulariaceae	4
Labiatae	7	Urticaceae	4
Verbenaceae	7	Adiantaceae	3
Araceae	6	Begoniaceae	3
Euphorbiaceae	6	Flacourtiaceae	3
Rosaceae	6	Melastomaceae	3
Vitaceae	6	Umbelliferae	3
Anacardiaceae	5	Araliaceae	2
Acanthaceae	5	Bignoniaceae	2
Dioscoraceae	5	Clusiaceae	2
Lauraceae	5	Junglandaceae	2
Liliaceae	5	Lythraceae	2
Mimosaceae	5	Menispermaceae	2
Polypodiaceae	5	Polygonaceae	2
Rosaceae	5	Piperaceae	2
Zingiberaceae	5	Ranunculaceae	2
Amaranthaceae	4	Saurauiaceae	2
Commelinaceae	4	Theaceae	2
Caesalpinaceae	4	Tiliaceae	2
Dennsteadtiaceae	4	33 Families	1 each
		Total 82	282

Appendix 1. Plant diversity of mixed oak forest, Langol Hills, Manipur.

Plant type	Family	Name of species
Trees	Alangiaceae	*Alangium Chinense* (Lour) Harms
	Anacardiaceae	*Heligarna longifolia* Buch-Ham ex. Roxb.
		Lannea grandis (Dennst)
		Mangifera indica L.
		Rhus semialata Murray
		Rhus succedanea. L
	Apiaceae	*Hydrocotyle nepalensis Hook.*
		Sanicula sps
	Aquifoliaceae	*Ilex excelsa* Wall
	Aquilariaceae	*Aquilaria agallocha* Roxb.
	Araliaceae	*Brassaiopsis palmata* Kurz
	Betulaceae	*Alnus nepalensis* D. Don
	Bignoniaceae	*Oroxylum indicum* (Linn.)
		Stereospermum personatum (Hassk)
	Bixaceae	*Bixa orellana* L.
	Bombaceae	*Bombax ceiba* L.
	Caesalpiniaceae	*Bauhinia purpurea* L
		Bauhinia variegata L.
		Cassia fistula L.
	Clusiaceae	*Garcinia pedunculata* Roxb. Ex. Buch-Ham
		Mesua ferrea L.
	Dilleniaceae	*Dillenia pentagyna* Roxb.
	Ebenaceae	*Diospyros glandulosa* Lace
	Euphorbiaceae	*Emblica officinalis* Gaertn
		Mallotus philippensis (Lamk) Muell-Arg.
		Sapium eugeniaefolium Buch-Ham
	Fagaceae	*Castanopsis tribuloides* A. DC.
		Lithocarpus dealbata (Hook)
		Lithocarpus fenestrata Roxb.
		Quercus serrrata Thunb.
	Flacourtiaceae	*Flacourtia jangomas* (Lour) Raeush.
		Hydnocarpus Kurzii (King) Warb.
		Xylosma longifolium Clos.
	Juglandaceae	*Engelhardtia spicata* Bl. Bijd
		Juglans regia Linn.
	Lauraceae	*Cinnamomum camphora* Linn.
		Cinnamomum zeylanicum Breyn.
		Litsaea polyantha Juss
		Litsaea sebifera Pers
		Phoebe hainsiana Brandis
	Lythraceae	*Lagerstroemia speciosa* (L.) Pers.
	Magnoliaceae	*Magnolia hodgsonii* (Hook.f & Thomson) Keng.
	Malvaceae	*Kydia calycina* Roxb.
	Meliaceae	*Aphanamixis polystachya* (Wallich) R.N. Parker
		Azadirachta indica A. Juss.
		Melia azedarach Linn.
		Toona ciliata M. Roem.
	Mimosaceae	*Albizia chinensis* (Osbeck) Merrill.
		Albizia lebbeck (L.) Benth.
		Albizia lucidior (Steudner) Nielson
		Albizia procera (Roxb.) Benth.
	Moraceae	*Artocarpus chaplasha* Roxb.
		Artocarpus heterophyllus Lamk.
		Ficus bengalensis Linn.
		Ficus cunea Buch-Ham ex Roxb.
		Ficus glomerata Roxb.
		Ficus hispida Linn.
		Ficus sps.
	Myrtaceae	*Eucalyptus maculata var citriodora* (Hook) Bailey
		Psidium guajava L
		Syzygium cumini (L) Skeels.
		Syzygium jambos (L) Alston.
	Papilionaceae	*Derris robusta* Roxb. ex. DC.

		Erythrina variegata L.
		Butea monosperma (Lamk) Toub.
	Pinaceae	*Pinus kesiya* Royle ex Gordon.
	Proteaceae	*Grevillea robusta* A. Cunn.
	Rhamnaceae	*Ziziphus mauritiana* Lam.
	Rosaceae	*Photinia notoniana* Wall.
		Pyrus pashia Buch-Ham.
	Rubiaceae	*Wendlandia grandis* (Hook.f) Cowan.
		Wedlandia wallichii Wight & Arn.
	Sapindaceae	*Sapindus emarginatus* Vahl, Symb.
	Saurauiaceae	*Saurauia punduana* Wallich.
		Saurauia roxburghii Wallich.
	Symplocaceae	*Symplocos crataegoides* Buch-Ham ex D. Don.
	Theaceae	*Eurya nitida* Korth.
		Schima wallichii (DC) Korthals.
	Urticaceae	*Celtis australis* Linn.
		Morus laevigata Wall.
	Verbenaceae	*Callicarpa arborea* Roxb.
		Gmelina arborea Roxb.
		Vitex glabrata R. Bor.
Shrubs	Araliaceae	*Heptapleurum venulosum* Seem.
	Asteraceae	*Blumea lanceolaria* (Roxb.) Druce.
		Eupatorium odoratum L.
		Eupatorium triplinerve Vahl, Symb.
		Vernonia subsessilis DC.
	Boraginaceae	*Tournefortia argentea* Linn.
	Caesalpiniaceae	*Cassia alata* L.
	Caprifoliaceae	*Sambucus javanica* Blume.
	Elaeagnaceae	*Elaeagnus latifolia* Linn.
	Euphorbiaceae	*Andidesma* sps.
		Kirganelia reticulata (Poir) Baill.
	Malvaceae	*Hibiscus rosa-sinensis* L.
		Urena lobata L.
		Urena sinuata L.
	Melastomaceae	*Osbeckia stellata* Don ex. C.B. Clarke.
	Mimosaceae	*Mimosa pudica* Linn.
	Moraceae	*Ficus hirta* Vahl Enum.
	Myrsinaceae	*Maesa indica* Wall.
	Papilionaceae	*Butea minor* Buch-Ham.
		Crotalaria saltiana Anders.
		Crotalaria sericea Retz.
		Desmodium heterocarpon (L.) DC.
		Desmodium laxiflorum DC.
		Desmodium sequex Wallich.
	Rosaceae	*Rubus hexagynus* Roxb.
		Rubus rugosus Smith.
	Rubiaceae	*Adenosacme stipulata* Hook. f
		Canthium angustifolium Roxb.
		Ixora coccinea Linn.
		Ixora lanceolaria Colebs.
		Mussaenda glabra Vahl, Symb.
		Pavetta indica L.
	Solanaceae	*Solanum torvum* Swartz.
	Tiliaceae	*Triumfetta tomentosa* Noronha
	Verbenaceae	*Clerodendron infortunatum* Gaertn.
		Clerodendrum serratum Spreng.
		Holmskioldia sanguinea Retz.
		Lantana camara Linn.
Herbs	Acanthaceae	*Hygrophila serphyllum* T. Anders.
		Justicia simplex Don.
		Lepidagathis ceylanica Nees.
		Ruellia prostrata Lamk.
	Alismaceae	*Sagittaria guayanensis* H.B & K.
	Amaranthaceae	*Achyranthes aspera* Linn.
		Achyranthes bidentata Bl.
		Amaranthus viridis Linn.
		Gomphrena hispida Linn.
	Araceae	*Arisaema consanguineum* Schott.
		Arisaema petiolulatum Hook. f.

	Arisaema tortuosum (Wall) Schott.
	Colocasia affinis Schott.
Asteraceae	*Ageratum conyzoides* L.
	Bidens biternata (Lour) Merr & Sherff.
	Conyza japonica (Thunb.) Less.
	Dichrocephala integri folia (L.f.) O. Kuntze
	Eclipta prostrata L.
	Elephantopus scaber L.
	Galinsoga parviflora Cav., Ic, et. Descr.
	Gnaphalium polycaulon Pers.
	Siegesbeckia orientalis L.
	Sonchus arvensis Linn.
	Spilanthes acmella var *paniculata* (DC) C.B Clarke
	Spilanthes clava D.C.
	Tridax procumbens L.
	Vernonia cinerea (L). Less.
	Xanthium strumarium Linn.
Balsaminaceae	*Impatiens balsamina* L.
Begoniaceae	*Begonia acutifolia* Jacq.
	B. laciniata Roxb.
	B. picta Smith Exot.
Commelinaceae	*Aneilema scaberrimum* Kunth.
	Commelina kurzii CB.Cl.
	Murdannia nudiflora (Linn) Brenan.
	Pollia secundiflora (Bl) Backer
Euphorbiaceae	*Phyllanthus urinaria* Linn.
Gentianaceae	*Swertia purpurascens* Wall. ex. C.B. Clarke.
Haemodoraceae	*Peliosanthes teta* Anders.
Lamiaceae	*Geniospermum coloratum* (Don) Kuntze Rev.
	Leucas aspera Spreng.
	Phryma leptortochya Linn.
	Plectranthus macranthus Hk. f.
	Pogostemon elsholtzioides Benth.
	Salvia coccinea Juss ex Murr.
	Scutellaria discolor Colebr.
Liliaceae	*Polygonatum multiflorum* Allioni Fl. Pedem.
	Smilacina fusca Wall.
Lobeliaceae	*Pratia begonifolia* Lindl.
Lythraceae	*Ammannia rotundifolia* Ham.
Melastomaceae	*Sonerila khasiana* CB.Cl.
	Sonerila maculata Roxb.
Orchidaceae	*Arundina graminifolia* (D. Don) Hoehr.
	Habenaria acuminata Thwa.
	Habenaria lucida Wall.
	Zeuxine nervosa Benth.
Oxalidaceae	*Oxalis acetosella* L.
Papilionaceae	*Phaseolus calcaratus* Roxb.
	Phaseolus fuscus Wall.
Piperaceae	*Peperomia heyneana* Miq. Syst. Pip.
	Piper sylvaticum Roxb.
Plantaginaceae	*Plantago erosa* Wall.
Polygalaceae	*Polygala chinensis* L.
Polygonaceae	Fagopyrum cymosum *Meissn.*
	Polygonum rude Meissn
Primulaceae	*Anagalis sps.*
Ranunculaceae	*Ranunculus diffuses* DC.
	Ranunculus scleratus L.
Rosaceae	*Fragaria indica* Andr.
Rubiaceae	*Anotis calycina* Wall.
	Hedyotis corymbosa (L.) Lamk
	Hedyotis diffusa Willd.
	Knoxia sumatrensis (Retz) DC.
	Rubia albicaulis Boiss.
	Spermacoce ocymoides Burm.
Scrophulariaceae	*Lindernia anagallis* var *grandiflora* (Spr)
	Lindernia cordifolia (Colsm) Merr Enum.
	Lindenbergia philippinensis Benth.
	Torenia vagans Roxb.
Tiliaceae	*Triumfetta annua* L.

	Urticaceae	*Pilea hookeriana* Wedd.
		Pouzolzia hirta Hassk.
	Zingiberaceae	*Amomum aromaticum* Roxb.
		Globba charkii Baker.
		Globba multiflora Wall.
		Globba racemosa Smith.
		Hedychium spicatum Buch-Ham ex.Smith.
		Carex cruciata Wahlexb.
		Carex filicina Nees.
		Carex speciosa Kunth.
		Cyperus cephalotes Vahl.
		Cyperus corymbosus Roxb.
		Cyperus glomeratus Linn.
		Fimbristylis dichotoma (L.) Vahl.
		Scleria elata Thw.
	Poaceae	*Andropogon citratus* De.
		Andropogon schoenanthus Linn.
		Arundinella tuberculata Munro.
		Axonopus compressus (Swartz) Beauv.
		Brachiaria brizantha (A. Riech) Stapt.
		Brachiaria sps.
		Brachiaria villosa A. Camus
		Calamagrostis griffithiana Hk.f.
		Capillipedium assimile (Steud) A. Camus
		Cynodon dactylon (Linn.) Pers.
		Digitaria ciliaris (Retz) Koeler.
		Digitaria decumbens Steut.
		Eragrostis nigra Nees.
		Hordeum spontaneum C.Koch.
		Imperata cylindrical (Linn.) Beauv.
		Microstagium ciliatum (Trin.) A. Camus.
		Oplismenus busmanii Griff.
		Oplismenus compositus (Linn.) A. Beauv
		Panicum montanum Roxb. Ham.
		Panicum sps.
		Paspalum notatum Flugge.
		Pseudoechinolaena polystachya Stapf.
		Setaria palmifolia Stapf.
		Setaria glauca Beauv.
		Themeda triandra Forsk.
		Thysanolaena agrostis Nees.
Climbers and lianas	Acanthaceae	*Thunbergia coccinea* Wall.
	Apocynaceae	*Parameria pedunculosa* Benth.
	Araceae	*Rhaphidophora glauca* Schott.
		Rhaphidophora peepla (Roxb.) Schott.
	Asclepiadaceae	*Dregia volubilis* Benth ex. Hook. f.
	Asteraceae	*Mikania micrantha* Kunth.
	Dioscoreaceae	*Dioscorea alata* L.
		Dioscorea bulbifera Linn.
		Dioscorea deflexa Hook.f.
		Dioscorea hamiltonii Hook. f.
		Dioscorea spicata Roth.
	Liliaceae	*Smilax myrtillus* A. DC.
		Smilax parvifolia Wall.
		Smilax zeylanica Linn.
	Papilionaceae	*Derris cuncifolia* Benth.
		Dolichos lablab Linn.
	Passifloraceae	*Passiflora suberosa* Linn.
	Menispermaceae	*Tinospora cordifolia* (Willd) Miers.
		Stephania japonica (Thunb) Miers.
	Vitaceae	*Cissus adnata* Roxb.
		Cissus assamica (Law) Craib.
		Cissus discolor Bl. Bijdr.
		Vitis repanda Wight & Arn.
		Tetrastigma bracteolatum Planch.
		Tetrastigma serrulatum Planch.
Pteriophytes	Adiantaceae	*Adiantum lunulatum* (Burm)
		Adiantum venustum (Don) Bedd.
		Cheilanthes farinosa (Forst) Klf.

Dennsteadtiaceae	*Blechnum orientale* Linn.
	Pteris eretica L.
	Pteris semipinnata L.
	Pteris vittata L.
Gleicheniaceae	*Dieranopteris linearis* (Burm. f.)
Polypodiaceae	*Ctenites sps.*
	Cyclosorus sps.
	Drynaria coronans (Wall) Bedd.
	Drynaria quercifolia (L.) Bedd.
	Pleopeltis rhycophyla (Hook). Bedd.
Schizaceae	*Lygodium flexuosum* (L) SW.
Selaginellaceae	*Selaginella bryopteris* Baker.