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Vegetation and Floristic Studies in Nallamalais, Andhra Pradesh, India

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Abstract: The hills of Nallamalais form a part of the Eastern Ghats in Andhra Pradesh, India situated in between 15°20'-16°30' N and 78°30'-80°10' E. The rocks are of Kurnool and Cuddapah formations. The vegetation is broadly divided into forest, grassland and hydrophytic categories. Under climax forest vegetation, three broad types were recognized i.e., southern dry mixed deciduous, south Indian moist deciduous and scrub. Nine edaphic vegetation types were noticed in the study area. Its flora was poorly documented. Therefore floristic surveys were carried out between 1999 to 2006, which resulted in record of total of 1541 angiosperm taxa. They fall under 778 genera and 144 families, bringing out the genus species ratio as 1:2. The dominant families were Poaceae (178 taxa), Papilionaceae (116), Euphorbiaceae (83), Cyperaceae (79) and Asteraceae (63). The life form spectrum was dominated by therophytes (37.1%) denoting a typical tropical arid climate. Nallamalais represents seven worst invasive exotic species namely *Cassia uniflora*, *Lantana camara*, *Parthenium hysterophorus*, *Hyptis suaveolens*, *Mimosa pudica*, *Cleome viscosa* and *Prosopis juliflora*, which may pose survival threat to the indigenous flora.

Key words: Vegetation, flora, Nallamalais, Eastern Ghats Andhra Pradesh

INTRODUCTION

The survival of man is intimately related to the availability of different plant resources. The plant wealth of a country is its pride and acquiring knowledge of flora and vegetation is of immense scientific and commercial importance. India is a big country covering wide diversity in environmental and biogeographical conditions which lead to the development of a wide range of vegetation types (Champion and Seth, 1968) and represents a very rich flora including a large number of endemic species (Chatterjee, 1940; Nayar, 1980; Reddy *et al.*, 2002). To make a consolidated and up-to-date account of the flora, a region wise systematic botanical survey is essential. This will help to compile the knowledge of country's present plant wealth with emphasis on distribution and status.

MATERIALS AND METHODS

Study Area

Nallamalais are range of parallel hills of the Eastern Ghats in Andhra Pradesh, India situated in between 15°20'-16°30' N and 78°30'-80°10' E (Fig. 1). From the Palnad basin in the north to Seshachalam in the south the Nallamalais run a distance of about 430 km, with an average width of 30 km and occupy about 6740 km², oriented in north-south direction. The hills stretch across portions of Kurnool, Prakasham, Nalgonda, Guntur and Cuddapah districts. The altitude ranges from

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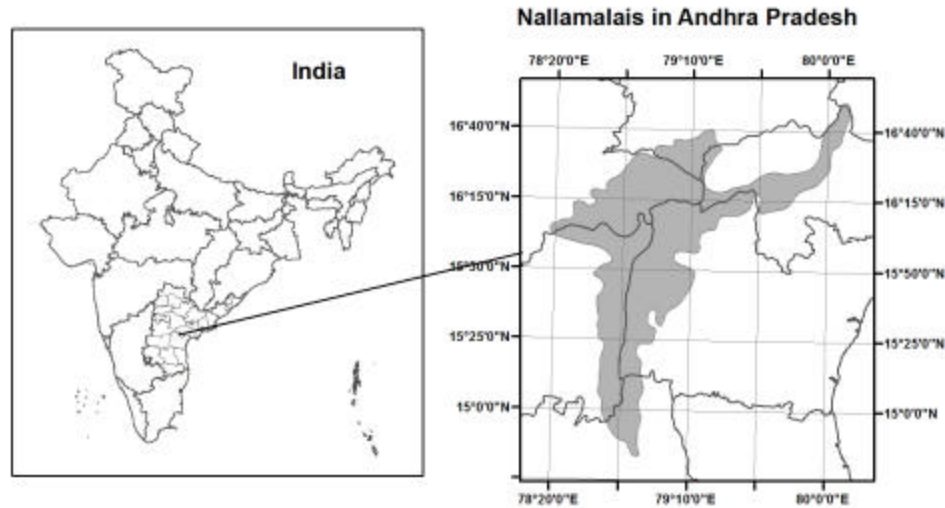


Fig. 1: Location map of Nallamalais, Andhra Pradesh, India

200 to 950 m. Botanically the Nallamalais have received little attention and some stray collections from these areas are recorded in Flora of the Presidency of Madras (Gamble and Fischer, 1915-1935). Later Ellis undertook plant explorations in Nallamalais with seven botanical tours during 1963-1977. Forest fires and other anthropogenic pressures seem to have affected the vegetation considerably. The semi-nomadic tribe called Chenchus have slightly affected the vegetation by their living in small groups called Gudems. Chenchus are dependent on forests for their food, medicine and other needs. Ethnobotanically also, this region appears to be very important (Reddy and Raju, 2000; Reddy *et al.*, 2005).

Floristically rich Nallamalais with varied topography and environmental factors along with its phytogeographical position was not explored well in the past. Therefore, the present floristic study was carried out to explore the whole of Nallamalais.

Rocks and Soils

The rocks fall into two distinctly recognizable formations, viz., the Cuddapah and Kurnool formations of the archaean age. Sandstones in mixtures of quartzites, shales and outcrops of barites and manganese ores occur. There are three types of soil: red, mixed varieties and black. The red and mixed varieties occur along the bases of Nallamalais. Towards the interior of the forests, the soil is red with calcareous shales. The humus content is almost negligible. The black soil occurs in plains where cultivation is practised (Krishnan, 1956).

Climate

Nallamalais fall under dry region of Peninsular India. The hot period is from March to May, the temperature reaching upto 45°C. The average annual rainfall for whole of Nallamalais is about 74 cm. The full impact of rainfall is on Gundlābrahmeswaram plateau, which receives about 127 cm.

Vegetation

The vegetation of the Nallamalais divided into (a) Forest, (b) Grassland and (c) Hydrophytic vegetation.

Forest Vegetation

Champion and Seth (1968) classified the forest types of India under 16 type groups. But, due to heavy physical and anthropogenic influences the degraded stages of original climax vegetation types are hardly distinguishable. The following types were recognized in the study area.

Southern Dry Mixed Deciduous Forests

The soil of these forests is porous, rich in nutrients and is of laterite type. Fallen leaves and twigs make humus after decomposition during rainy season. The plants during dry season shed their leaves to check transpiration and become leafless. Because of this, they are called deciduous forests. *Tectona grandis* (Teak) is a chief commercial tree species of these forests.

These in dominance have the following trees: *Anogeissus latifolia*, *Tectona grandis*, *Cassia fistula*, *Cassine glauca*, *Cleistanthus collinus*, *Cochlospermum religiosum*, *Dalbergia lanceolaria*, *D. paniculata*, *Diospyros melanoxylon*, *Ehretia laevis*, *Gardenia turgida*, *Givotia moluccana*, *Haldinia cordifolia*, *Hardwickia binata*, *Hymenodictyon orixense*, *Ixora arborea*, *Lagerstroemia parviflora*, *Mitratyna parvifolia*, *Nyctanthes arbor-tristis*, *Phyllanthus emblica*, *Pterocarpus marsupium*, *Schrebera swietenoides*, *Semecarpus anacardium*, *Stereospermum personatum*, *Strychnos nux-vomica*, *Terminalia alata*, *Wrightia arborea*, *W. tinctoria*, *Ziziphus xylopyrus* and *Xylia xylocarpa*.

Some of the common shrubs of dry deciduous forests are the following: *Desmodium pulchellum*, *D. velutinum*, *Erythroxylum monogynum*, *Grewia hirsuta*, *G. flavescens*, *G. rothii*, *Helicteres isora*, *Leea asiatica*, *Woodfordia fruticosa*. The commonly seen climbers are: *Ampelocissus latifolia*, *A. tomentosa*, *Cayratia pedata*, *Cocculus hirsutus*, *Combretum albidum*, *Cryptolepis buchananii*, *Derris scandens*, *Gymnema sylvestre*, *Jasminum auriculatum*, *Olex scandens*, *Rivea hypocrateriformis*, *Ventilago maderaspatana* and *Wattakaka volubilis*.

South Indian Moist Deciduous Forest

This type of forests is restricted to areas where rainfall is more and soil moisture is comparatively high. These areas are well sheltered and because of perennial streams water and moisture are available in good quality. Even here the forests have been disturbed because of forest fires, which are common in the immediate vicinity to dry deciduous forests and grasslands.

The common trees of these forests include: *Haldinia cordifolia*, *Careya arborea*, *Dillenia pentagyna*, *Ficus virens*, *Glochidion zeylanicum*, *Mangifera indica*, *Oroxylum indicum*, *Stereospermum personatum*, *Terminalia bellirica*, *T. chebula*, *Bauhinia semla*, *Mallotus philippensis*. The common shrubs are: *Grewia hirsuta*, *Clerodendrum serratum* etc. The common herbs: *Adiantum lunulatum*, *Andrographis paniculata*, *Desmodium gangeticum*, *Costus speciosus*, *Lindernia* sp., *Barleria* sp. The common climbers: *Bauhinia vahlii*, *Pueraria tuberosa*, *Marsdenia tenacissima*, *Lygodium flexuosum*, *Dioscorea bulbifera* and *Ichnocarpus frutescens*.

Scrub

This type of vegetation is usually confined to the bases of hills, bordering villages and generally in much disturbed and degraded dry deciduous forests. These areas have low rainfall, rocky areas and poor soils. The common species are *Balanites roxburghii*, *Dichrostachys cinerea*, *Diospyros chloroxylon*, *Acacia chundra*, *A. leucophloea*, *Capparis divaricata*, *Albizia amara*, *Canthium parviflorum*, *Catunaregum spinosa*, *Maytenus emarginata* etc. Canopy is found always as open even during rainy season. However, *Lantana camara* is known to invade and form thickets in some areas.

The following are rather localized types of broad vegetation types, viz.,

- **Boswellia type:** This is an edaphic type formed due to the substratum being rocky and soil shallow and poor. Its main tree species is *Boswellia serrata*, associated with *Chloroxylan swietenia*. The vegetation is sparse and the undergrowth is poor.
- **Terminalia alata type:** This is one of the major types in the dry deciduous forests. *Anogeissus latifolia* forms another component of these forests.
- **Phoenix humilis type:** This interesting type of forest occurs in scattered condition, where forest fire recurrence is more.
- **Calamus type:** This gregarious plant community consisting of *calamus rotang*.
- **Dry evergreen scrub:** Interestingly several evergreen plants are seen intermixed with dry deciduous forests. These are confined to foot hills, where soil moisture is high. The predominant species are *Manilkara hexandra*, *Memecylon umbellatum*, *Atalantia monophylla* etc.
- **Tropical riparian fringing forests:** These forests are interspersed amidst the forests, where ever streams and rivers flow. The plants constituting such forests include *Glochidion zeylanicum*, *Mangifera indica*, *Barringtonia acutangula*, *Terminalia arjuna*, *Anogeissus acuminata*, *Homonoia riparia*.
- **Prosopis scrub:** *Prosopis juliflora* an exotic species, invades degraded forest lands and forms gregarious clumps.
- **Bamboo type:** Two Bamboo species (*Dendrocalamus strictus* and *Bambusa arundinacea*) are often gregariously found in interspaces of trees.
- **Hardwickia type:** This is a edaphic hill forest of semiarid areas.

Grassland Vegetation

Landscape unit dominated by grasses which ranges from village grazing lands, extensive low pastures of dry regions to rolling grassy downs in the hilly regions are included under grassland vegetation. They vary according to season, altitude and other biotic pressure. The dominant grasses are *Heteropogon contortus*, *Capillipedium huegelii*, *Sehima nervosum*, *Dichanthium pertusum*, *Cynodon dactylon*, *Cymbopogon* sp., *Eragrostis* sp., *Ischaemum indicum*, *Arundinella pumila*, *Themeda trindra*, *Thysanolaena maxima* etc. on the roadsides *Chrysopogon aciculatus* and *Sporobolus diander* are most common. Leguminous herbs such as *Alysicarpus* sp., *Desmodium triflorum*, *Indigofera linifolia* and *Zornia gibbosa* are frequently associated with grasslands.

Hydrophytic Vegetation

A number of springs, rivers, ponds, ditches, reservoirs and muddy banks of hilly streams support hydrophytic flora. Supply of oxygen, carbon dioxide, mineral salts, nature of substratum, depth of water, temperature and high turbidity affect the characters and extent of the aquatic vegetation. The common species are *Aeschynomene aspera*, *A. indica*, *Bacopa monnieri*, *Hydrilla verticillata*, *Vallisneria spiralis*, *Utricularia bifida*, *Ceratophyllum demersum*, *Lemna perpusilla*, *Wolffia arrhiza*, *Nymphaea pubescens*, *Nelumbo nucifera*, *Eichhornia crassipes*, *Marsilea quadrifolia*, *Sopubia delphinifolia*, *Typha angustata*, *Phragmites karka* and *Schoenoplectus articulatus*.

Plan of Work

Floristic surveys were undertaken in Nallamalais during 1999 to 2006, covering all the seasons. Plant specimens were collected from different places, randomly throughout Nallamalais, taking Srisailam as the central camp. Subsidiary camps were selected to cover wide range of habitats including forests, grasslands, cultivated lands, ponds and lakes, river beds etc. The plant specimens were collected either in the flowering or the fruiting condition, preferably both. At least three specimens of

each species with a size of about 25 cm were collected. Each specimen was numbered as it is collected and the detailed notes are entered in the field note book. When a taxon identification appeared uncertain in the field, more than three specimens were collected for later validation. Life form categories were identified according to Raunkiaer's system of classification (Raunkiaer, 1934). Provisional identification of specimens were made with the help of Flora of Presidency of Madras (Gamble and Fischer, 1915-1935) and Flora of Tamil Nadu Carnatic (Matthew, 1984). Later identifications were confirmed with the help of the authentic specimens deposited at Central National Herbarium, Howrah (CAL), Madras Herbarium, Coimbatore and Department of Botany, Kakatiya University, Warangal.

RESULTS AND DISCUSSION

Floristic Richness and Taxonomic Diversity

Total of angiosperm taxa comes to 1541, since naturalized species were also collected. They fall under 778 genera and 144 families, bringing out the genus species ratio as 1:2, while this ratio is 1:3.3 for the Deccan-Malabar region and 1:7 for the Indian subcontinent (Hooker, 1906). Where as Ellis (1987) in Flora of Nallamalais recorded 743 taxa comprising 419 genera and 109 families. Present studies, added 798 (52%) taxa to the Flora. The presence of 1541 taxa conclude that Nallamalais as one of the plant diversity rich area in Peninsular India. Based on habit, flora comprises 854 taxa (56.7%) under herbs, followed by 281 (18.2%) trees, 196 (12.7%) climbers and 190 (12.3%) shrubs.

The class Magnoliopsida (Dicotyledons) are represented by 1144 species belonging to 591 genera, 115 families. The Liliopsida (Monocotyledons) includes 397 species belonging to 187 genera, 29 families. The ratio of the dicotyledons to the monocotyledons is 4.0: 1 for families, 3.2:1 for genera and 2.9:1 for species.

Table 1 shows the number of genera and species in respect of top ten dominant families represented in Nallamalais. They comprise 316 genera and 740 species, representing 40% and 48% of total genera and species respectively. Ellis (1987) recorded 69 taxa in Papilionaceae, 67 in Poaceae and 44 in Euphorbiaceae. Present study brought to light, additional 197 species in these three predominant families alone. The predominant genera are *Cyperus* (29 species), *Cassia* (19), *Euphorbia* (19), *Crotalaria* (18), *Ficus* (17), *Indigofera* (17), *Eragrostis* (16), *Acacia* (13), *Ipomoea* (12) and *Phyllanthus* (12) constitute 11% of total species collected.

Life Forms

Since the life form is related to the environment around the plants, the biological spectrum is also regarded as indicative of the prevailing environment, e.g., higher percentage of therophytes indicate long dry seasons, of chamaephytes indicate an extremely cold climate, of hemicryptophytes indicate conditions suited for the development of extensive grasslands, etc.

Table 1: Ten dominant families with their genera and species in Nallamalais (present study)

Families	Taxa	Genera
Poaceae	178	84
Papilionaceae	116	47
Euphorbiaceae	83	28
Cyperaceae	79	18
Asteraceae	63	49
Acanthaceae	49	25
Rubiaceae	49	27
Malvaceae	44	15
Convolvulaceae	40	11
Caesalpiniaceae	39	12

Table 2: Proportion of life form categories in Nallamalais

Life forms	Taxa	Percentage of taxa
Chamaephyte	59	3.8
Geophyte	252	16.4
Hemicryptophyte	172	11.2
Phanerophyte	479	31.1
Therophyte	572	37.1
Parasites	7	0.5
Grand total	1541	100.0

The biological spectrum in the present study area is characteristic of tropical arid region with the dominance of therophytes (37.1% of the recorded species) followed by phanerophytes and geophytes (Table 2). The majority of annuals were grown during July to January. Therophytes are drought evaders in the sense that the whole plant is shed during the unfavourable conditions and survive in the form of seed.

Endemic, Threatened and Germplasm Materials

Of the 145 endemic taxa of Eastern Ghats, Nallamalais represent 27, which constitute 19% (Reddy, 2001; Reddy *et al.*, 2006). Red Data Books of Indian Plants listed only 5 species under *vulnerable* threat category (Nayar and Sastry, 1987, 1988).

Andrographis beddomei, *Alysicarpus mahabubnagarensis*, *Alysicarpus monilifer* var. *cuddapahensis*, *Andrographis nallamalayana*, *Boswellia ovalifoliolata*, *Bridelia cinerascens*, *Cleome viscosa* var. *nagarjunakondensis*, *Ceropegia spiralis* (Vulnerable), *Chamaesyce linearifolia* Sojak var. *nallamalayana*, *Chamaesyce senguptae*, *Crotalaria madurensis* var. *kurnoolica*, *Crotalaria paniculata* var. *nagarjunakondensis*, *Croton scabiosus*, *Decalepis hamiltonii*, *Dicliptera beddomei*, *Eriolaena lushingtonii*, (Vulnerable), *Hybanthus vatsavayii*, *Indigofera barberi* (Vulnerable), *Murdannia juncooides* (Vulnerable), *Oianthus disciflorus*, *Pentanema indicum* var. *sivarajanianum*, *Rhynchosia beddomei* (Vulnerable), *Rostelularia vahlii* var. *rupicola*, *Shorea tumbuggaia* Roxb., *Syzygium alternifolium*, *Pterocarpus santalinus* and *Terminalia pallida* are the endemic plants found in Nallamalais.

The wild relatives of crop plants have been recognized to be of immense value in improving the crops. Four species of wild rice are identified in Nallamalais. They are: *Oryza granulata*, *O. minuta*, *O. rufipogon* and *O. sativa*. Collection of *Oryza sativa* here bring to focus some activities of human who came to work in the coups near Gundlabrahmeswaram and now runswild. Most interestingly, wild pepper species (*Piper attenuatum*, *P. hymenophyllum* and *P. nigrum*) are present along with wild rice plants. Phytogeographically it is of interest how *Oryza minuta* could have been seen here far from the Western Ghats, when one considers absence of the taxon in the intermediary hill ranges. *Coix lachryma-jobi* is wild relative for *Zea mays*, *Atylosia scarabaeoides* for *Cajanus cajan*, *Canavalia gladiata* for *Lablab purpureus*, *Vigna trilobata* for *Vigna radiata*. In addition to it, wild forms of *Aegle marmelos*, *Feronia elephantum*, *Mangifera indica*, *Syzygium cuminii* are found throughout the Nallamalais.

Invasive Exotic Species

According to World Conservation Monitoring Centre (1992) second worst threat to existence of biodiversity is the biological invasion of exotic species. There are 124 species of naturalized exotics were recorded in the study area. Of these seven were worst invasive species namely, *Cassia uniflora*, *Lantana camara*, *Parthenium hysterophorus*, *Hyptis suaveolens*, *Mimosa pudica*, *Cleome viscosa*, *Prosopis juliflora* are invading open forests and forming dense thickets. Of these recently recorded *Cassia uniflora* spread through out the Nallamalais in within a decade (Reddy *et al.*, 2000).

Concluding Remarks

Ellis (1987) in Flora of Nallamalais recorded 743 taxa under 109 families. Our studies, supplement 798 (52%) taxa under 144 families to the Flora of Nallamalais. The presence of 1541 taxa conclude that Nallamalais as one of the plant diversity rich area in Peninsular India.

It has long been felt that intensive rather than extensive floristic studies of different geographical regions are necessary for the proper documentation, conservation plans and sustainable utilization of plant resources. Due to recurrent forest fires, indiscriminate exploitation of forest resources, destruction of forest areas for the construction of hydroelectric projects and introduction of invasive exotic species, a number of indigenous species are under pressure and may face threat of extinction in future. This article may help to identify species for conservation prioritization and to also to pay special attention for control of invasive exotic species.

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