2.1 Location and Physiography

Kerala State lies along the Southern West coast of India between 8°018’ and 12°48’ N latitude and 74°52’ and 77°22’ E longitude. It is bounded by Karnataka in the North, Tamil Nadu in the South and East and the Arabian Sea in the West. The state has an area of 38,863 km², which is about 1.18 percentage of the total area of the country. Administratively the state is divided into 14 districts (Fig.1). Due to the presence of the long tract of Western Ghats along the eastern side (wind ward side) and Arabian Sea along the western side, the physiography of the state is highly diversified. The state has a complex topography with mountains, valleys, ridges and coastal area. The altitude varies from sea level to 2695 m above mean sea level (Anamudy), which is the highest peak in Peninsular India. Based on the altitude the land is divided into three regions:

a) The Mountainous Region: consists of the hilly ranges of Western Ghats clothed with dense forest vegetation. The eastern boarder of Kerala is bounded by an almost unbroken mountain chain, called “Sahyaparvatha”, with major hills like Agasthyamala, hill tracks of Ranni – Punalur area, Periyar Tiger Reserve, Forests of Idukki viz. Anamala, Eravikulam, Devikolam cardamom hills and Sholayar, Parambikulam, Nelliampathy in Thrissur and Palakkad districts. The continuity of the Ghats is broken by a gap, the ‘Palghat Gap’ [about an average of 30 kms width (Sasidharan 2004 ) ] which lies in the Palakkad district of the state and is the main trade route to other states of the country. To the northern side of the gap lies the Nilgiri Plateau and the Nilgiri Biosphere Reserve constitute the virgin forests of Silent Valley and the adjacent forests of Nilambur and Wyanad area. Continuous with these forests lies the forests of Kannur and Kasargod districts.

b) The Midland Region: Consists of lateritic hilly tracts of low altitude (7.5 – 75 msl). This area is thickly populated and is under intense cultivation. The major cash crop, the rubber tree is commonly cultivated here, besides paddy, coconut, arecanut and cashew. Sacred groves and some protected areas in this region represent the relics of the rich vegetation of the past.
c) The Low lands or Coastal Region: Represent flat, sandy belts with a series of backwaters and estuaries as intrusion from the sea. This is almost continuous from the north to south and is formed by the enrichment of about 41 rivers and their tributaries. Mangroves and coastal vegetation are confined to this region.

2.2 Geology and Soil
The Mountain ranges bordering the eastern side of the state is considered as the post Jurassic uplifts due to the continental movements. These regions show similarities with some of the mountains in Sri Lanka. Precambrian rock consisting mainly of Gneisses, Charconites and Schists is an important character of this region. The formation of soil has been influenced by climate, geology, and biotic interactions. Due to high heterogeneity in the topography, the soil differs from place to place.

The main soil types of Kerala state are:

a. Alluvial Soil: In Kuttanadu areas the soil is alluvial. The alluvial soil is also drained by water bodies from slopes make marshy areas in the uplands also. The alluvial soil on the banks of the main rivers is fertile and constitutes the paddy fields.

b. Peaty Soil: Peaty soils or Kari Soils are found usually along those areas which get submerged during monsoon. The soil is black, heavy and highly acidic and non porous.

c. Red Soil: A major portion of the state is covered by Red soil which is generally well drained and poor in nutrients.

d. Laterite and Lateritic Soil: Seen in the midlands as well as parts of the high land regions. It contains high concentration of metals like Iron, Aluminium, Manganese etc. and poor in organic matter. The soil is moderately drained.

e. Forest Soil: The ground of forest is covered by vegetation and forest litter and hence forest soils are black in colour containing much decomposed organic matter. This soil is well drained with high gravel content. It is rich in minerals and has high organic content which enable the soil to retain water.

2.3 Climate
Kerala enjoys a warm, humid, tropical climate with an average rainfall of 3,020 mm per year and a relative humidity ranging between 75 and 92 percent. The highest rainfall was recorded (5883 mm) at Neriamangalam, bordering Ernakulam and Idukki districts and the lowest (651 mm) at
Fig. 1 - MAP SHOWING THE STUDY AREA
Chinnar in Idukki district (Sasidharan, 2004), situated in the eastern slopes (leeward side) of the Western Ghats. The state receives both South–West and North-East monsoons. A major portion of the annual precipitation is received from the South-West monsoon, the so called ‘Edavapathy’ which is usually from the first week of June and lasts to September. North–East monsoon, ‘Thulavarsham’ in Malayalam, brings light showers between October and November. The southern parts of Kerala experience comparatively higher rate of both the monsoons, while the northern districts of Kannur and Kasargod receive poor rains from the North-East monsoon. The western part of the state is facing the Arabian Sea, hence South-West monsoon is more active and accounts for about 60 percent of the annual rainfall. The average day temperature varies from 23.9 – 31°C in the plains and 7.2 – 30°C in hilly areas. March - May are the hottest months and the temperature rises up to 40°C in the plains.

2.4 Phytogeography
The plant wealth of Kerala is well known in the history of plant resource studies in Asia. Based on endemism among Dicotyledonous plants of the India-Burma region, Chatterjee (1940) recognized 10 botanical regions. He treated Malabar as a botanical region with a high percentage of endemism. The latest phytogeographic classification of the Indian flora is by Balakrishnan (1966). Accordingly there are 11 phytogeographic zones and Kerala comes under the 8th zone i.e. Southern-Western Ghats (Fig.2), South-West Coast and Lakshadweep. The unique climate enjoyed by the area makes it a distinct phytogeographic region. Due to the closeness to the past cretaceous shield of Gondwana Kingdom, the floristic elements in Peninsular India, shows some similarities in the distribution of families and genera between sister geographical regions such as Malaysian Islands, Madagascar, Australia, South America and Africa. Among these, Malaysian region is more similar to the Peninsular Indian flora. The flora of the state shows similarity with that of Sri Lanka and north-eastern and lower Himalayas. Several taxa, endemic to Western Ghats are seen in Sri Lanka. Due to the unique climate prevailing in the state, it harbours a rich endemic plant diversity. About 30 percent of the Flora of Kerala is Peninsular Indian endemics (Sasidharan, 2004).
2.5 General Pattern of Vegetation

The varied topographical features, high precipitation and geological conditions have favoured the formation of diverse vegetational groups from high altitude shola forests on the high ranges to the coastal mangrove forests. The main forest types in Kerala according to Champion and Seth (1968) are:

a. West-coast tropical evergreen forests (Wet Evergreen)
b. West-coast semi-evergreen forests (semi-evergreen)
c. Southern moist mixed deciduous forests (moist deciduous)
d. Southern montane wet temperate forests
e. Southern montane wet grass lands
f. Southern tropical thorn forests (scrub jungle)
g. Southern dry mixed deciduous forests (Dry deciduous)
h. Southern hill top tropical evergreen forests
i. Mangroves or tidal swamp forests

**a. West-coast tropical evergreen forests (Wet Evergreen)**

Even though tropical evergreen forests of Kerala have been subjected to human interference in the past, patches of tropical evergreen forests exists along the western slopes of Western Ghats viz. Agastyamala, Sabarigiri, Idukki cardamom hills and Nilgiris including Silent Valley. These forests are characterized by species richness, particularly large trees and woody lianas and the canopy is closed. The secondary species and exotic species are usually absent. The lower shrubby layer is composed mostly of seedlings and saplings of tree species. The evergreen forests are found between 400 – 1200 m altitudes. It has been observed that there is difference in the physiognomy and composition of species with respect to altitude. The evergreen forests above 700 m. shows clear cut dominance of certain species and forms associations like, *Mesua ferrea–Callenia exarillata–Palaquium ellipticum* (Silent Valley). This is the habitat range of most of the rare herbs of Rubiaceae like *Acranthera, Argostemma, Neanotis, Byrsophyllum, Knoxia, Lasianthus, Mycetia, Neurocalyx, Ophiorrhiza, Psychotria, Saprosma and Tarenna*. In the forests above 1,100 m there is a dominance of Lauraceae members. The British members of Rubiaceae like *Rubia, Gallium, and Urophyllum* are thriving here.
Fig. 2 - WESTERN GHATS SHOWING KERALA REGION
b. **West-coast semi-evergreen forests (semi-evergreen)**

This forest type is found below 700 m. as the name indicates it is intermediate between evergreen and moist deciduous types where several evergreen species are find growing mingled with deciduous species. Here there is a clear cut three layer stratification. The common species are, *Antiaris toxicaria, Artocarpus hirsutus, Polyalthia fragrans, Terminalia bellerica, Tetrameles nudiflora, Aporusa lindleyana, Ficus nervosa* and *Holoptelia integrifolia*. The Rubiacea members like *Hedyotis, Ixora, Mussaenda, Ophiorrhiza, Oxyceros, Pavetta* and *Tarenna* are met here.

c. **Southern moist mixed decidous forests (moist decidous)**

This type of forest is seen below 700 m. The canopy looks similar to that of semi-evergreen forests during monsoon time due to the presence of broad leaved species, however, the species reveal their identity during summer, they shed the leaves and remain bare for weeks. The common species include *Dalbergia sissoides, Albizia lebbeck, Alstonia scholaris, Gmelina arborea, Grewia tilifolia, Lagerstroemia microcarpa, Tectona grandis, Terminalia paniculata, Wrightia tinctoria* and *Xyia xylocarpa*. Some tree members of Rubiaceae like *Haldina cordifolia, Hymenodictyon obovatum, Hymenodictyon orixense, Mitragyna parvifolia, Mitragyna tubulosa* and *Tamilnadia uliginosa* are survive here.

d. **Southern montane wet temperate forests**

This type of forest is seen above 1200 m. the climate is almost temperate. This type is characterized by dwarf plants with high branching. The branches are densely clothed with moss and epiphytes like *Bulbophyllum, Coelogyne, Oberonia, Usnea*. There is no stratification of trees. Some of the common members thriving here are *Actinodaphne bourdollonii, Cinnamomum sulphuratum, Elaeocarpus munronii, Pittosporum neelgherrense, Turpinia nepalensis*, etc. The members of the family Rubiaceae like *Rubia cordifolia, Galium asperfolium* and *Gallium rotundifolium* are inhabit this zone.
e. **Southern montane wet grasslands.**

This category is seen in the hill tops at high altitudes. The vegetation is dominated by grasses. Here the soil is shallow and has high wind currents. The common grasses are *Arundinella leptochloa, Cymbopogon flexuosus, Ischaemum indicum* etc. The grassland supports the growth of several herbaceous and subshrubby species. The common herbaceous members include terrestrial orchids like *Arundina graminifolia, Brachyporythis iantha, Pectilis gigantea, Habaneria longicornum* etc and the Rubiaceae members like *Knoxia sumatrensis, Neanotis indica*, etc.

The sub-shrubs usually seen in this region include *Hypericum mysoorensis, Lobelia nicotianaefolia, Strobilanthes kunthianus* and members of Rubiaceae like *Hedyotis santhapaui, Hedyotis buxifolia, Knoxia sumatrensis, Pleiocraterium verticillare, Wendlandia thyrsoidea* etc.

f. **Southern tropical thorn forests (Scrub jungle)**

This type of forests are the outcome of low precipitation, and are confined in the eastern slopes of the Western Ghats. This area comes under the rain shadow regions in Idukki (Chinnar) and Palakkad (Attappadi) districts. The species are adapted to thrive the extreme climate prevailing here, and are usually Xerophytic, thorny with less branching. The major species representing the area are *Albizia amara, Albizia lathamii, Capparis* species, *Strychnos potatorum* and the Rubiaceae members include *Catunaregam spinosa and Tamilnadia uliginosa*.

g. **Southern dry mixed deciduous forests (Dry deciduous)**

The forest type is characterized by the predominance of hardwood deciduous tree species. The canopy is open with poor undergrowth. The common species specific to this region are *Acacia ferruginea, Albizia amara, Anogeissus latifolia, Boswellia serrata, Commiphora pubescens, Harwickia binata, Manilkara hexandra, Santalum album* and *Sterculia urens*. The Rubiaceae is represented by *Canthium coromandelicum, Catunaregam spinosa, Tarenna asiatica, Benkara malabarica* etc.
h. Southern hill top tropical evergreen forests

This forest type is seen only above an altitude of 1,500 m. There is no stratification of tree canopy into different tiers. The trees are stunted and often branched from the base. The branches are thickly clothed with epiphytes and mosses. The common species include *Actinodaphne bourdillonii*, *Garcinia travancorica*, *Isonandra candolliana*, *Mastixia arborea*, *Poeclioneuron indicum*, *Syzygium cumini*, *Turpinia nepalensis*, *Vernonia travancorica*, *Strobilanthus luridus*, *Symplocos wynadense* etc. The Rubiaceae members growing in this region are *Octotropis travancorica*, *Tricalysia sphaerocarpa*, *Urophyllum zeylanicum* etc.

i. Mangroves or tidal swamp forests

Mangrove forests are seen in the estuaries and banks of backwaters where the influence of tidal waves occurs. Now the mangrove forests of Kerala are under severe human pressure and are confined to only certain patches sporadically. Common species seen in the mangrove forests are *Avicennea marina*, *Avicennea officinalis*, *Bruguira cylindrica*, *Rhizophora mucronata*, *Acrostichum aureum*, *Cerebra odolam*, *Pandanus* spp., *Syzygium* spp., *Acanthus ilicifolius*, and climbers like *Derris trifoliata*, *Ipomoea alba*, etc. and Rubiaceae members like *Psychotria sarmentosa*, *Dentella repens* are seen.

In addition to the natural forest types explained above, some protected areas like Sacred groves are seen throughout the state which represent the rich vegetation that existed in the past. Some common species seen in these patch forests protected out of religious belief are *Hopea ponga*, *Caesalpinia bonduc*, *Gnetum ula*, *Sarcostigma klenii*, *Hydnocarpus pentadra*, *Aporusa lindelyana*, *Antiaris toxicaria*, *Minusops elengi* and Rubiaceae members like *Ixora malabarica*, *Ixora coccinea*, *Benkara malabarica*, *Morinda umbellata*, *Canthium rheedi*, *Canthium coromandelicum*, *Pavetta indica*, *Tarenna asiatica*, *Mussaenda frondosa* etc.

The midlands are converted to agricultural fields and the main crops are Rubber, Coconut, Paddy, Cashew, Arecanut, Banana etc. Some members of the past vegetation like *Cycas circinalis*, *Mussaenda frondosa*, *Artocarpus hirsutus*, *Bridelia retusa*, *Bridelia scandens*, *Psilanthus travancorensis* etc occur as reminiscent of the original vegetation.
The vegetation along the coast is dominated by herbaceous species like *Alternanthera pungens*, *Boerhaavia diffusa*, *Cyperus arenarius*, *Hydrophylax maritima* (Rubiaceae), *Hedyotis diffusa* (Rubiaceae), *Ipomoea pes-capre*, *Spermacoce hispida*, *Polycarpaea corymbosa* etc and plantation of coconut.

### 2.6 The aquatic vegetation

The state of Kerala has 44 rivers of which 41 flows towards west and make a long stretch of water bodies at the lowlands. The vegetation confined to this region are mainly hydrophytes like *Aponogeton natans*, *Hydrilla verticillata*, *Nymphaea pubescens*, *Utricularia aurea*, *Azolla filiculoides*, *Pistia stratoideae*, *Ottelia alismoides*, *Eichornia crassipes*, *Monochoria vaginalis*, *Vallisnaria nutans*, *Marselia coromandelica* etc. The wet lands of Kerala are often visited by migratory birds. The major threat facing this zone is changing land use pattern, land filling and conversion of paddy fields to commercial plots.