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BASELINE STUDIES FOR THE PROPOSED NATURE STUDIES CENTRE AT KALADY IN THE MALAYATTOOR FOREST DIVISION

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CONTENTS

GENERAL INTRODUCTION

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1. GENERAL INTRODUCTION

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Contents

Malayattoor (Ernakulam District, Kerala State, India) is a well known place in the central part of Kerala, mainly because of the presence of one of the seven Churches which St. Thomas established in the State. The place is also historically reputed as it is very proximal to the birth place of Ad1 Shankara at Kalady, where there exists a temple and a Stupa (tower), and is the seat of the proposed first Sanskrit University in India. For the reasons mentioned above, at present, Malayattoor often visited by both pilgrims and tourists, and to facilitate this, a tourist complex is also coming up there to provide accommodation and recreational facilities to the people who

visit the area. Also, there is a forest path that leads to the top of the hillock Kurishumudi at Malayattoor, where there is the Golden Cross and a church. Christians from different parts of South India come here to worship, almost round the year, which was rather seasonal in the past. To enjoy the sylvan environment of Malayattoor, lot of tourists and also people visiting the birth place of Adi Shankara and the Stupa at Kalady also extend their trips to Malayattoor. An added attraction of Malayattoor is the Manappattu Chira - a shallow but vast pond at the foothills of Kurishumudi with boating facility - which is now being beautified by the Tourism Development Corporation to attract more visitors.

It is near this well known religious and tourist centre that Kerala Forest Department is planning to establish the "Adi Sankara Nature Study Centre" with financial support from the World Bank. As envisaged, the Study Centre tries to incorporate informative details on various aspects of natural and man-made forests of the State to be of educative value to nature lovers, students, forest dwellers, scientists, tourists, etc. who frequent the area. For this, information on various aspects of the natural and man-made forests of Kerala is a pre-requisite and the present study is intended to generate the same for Kurishumudi and surrounding forest areas of Malayattoor.

1.1. LOCATION

The study area comes within the Kalady Forest Range of Malayattoor Forest Division, situated between $9^{o}47'$ and $10^{o}17'$ North

latitude and 76°16' and 76°57' East longitude, in the Ernakulam District of Kerala State (Fig. 1.1). The Forest Division includes four ranges, namely Kalady, Kodanad, Kothamangalam and Thodupuzha with a total of about 680 km^2 of forest land belonging to it with an effective forest cover of 570 km^2 (Chandrasekharan, Forest Resources of Kerala, 1973).

Kalady Forest Range covers about 7199 ha and is bordered on the South by Periar river, East by a canal that joins Periar (locally known as Illithodu which is also the name of a place nearby), North by a tarred road that extends from Perum–Thodu to Post Office Junction near Pandupara Church and on the West by a tarred road that leads to Angamali through Manjappra village. The Range is divided into four sections (Fig. 1.2) namely Karakad (1887 ha), Kurishmudi (1118 ha), Kannimangalam (2237 ha) and Evergreen (1958 ha).

The tarred road that deviates towards North from Kalady Junction of the Main Central Road of Kerala, after traversing for about 20 km in a northern direction ends at a point called Kadapara in the foot of Kurishmudi peak. From this point, to the top of Kurishumudi, there is a forest path of about 20 m width, now planted with shade trees on both sides of it to provide shade for people during summer when they go to the church at the top of the hill for worship. The path ends at the top of Kurishumudi peak (387 m above msl), where the Golden Cross and church of St. Thomas are situated.

Kadapara, along the northern boundary of the pond Manappattu–Chira, there goes a tarred road towards West which after a course of

about 500 metres joins the road that leads to Angamali via Manjappra, mentioned earlier. Southern border of this road is the Manappattu-Chira, a shallow pond, which get almost dried up during summer, when several aquatic and semiaquatic species colonize at its bottom. Here and there, in the wet bottom of the pond, local people raise small patches of paddy crop when it is empty. The pond is with well built boundary walls around it and is provided with a boat landing platform in the middle on its sourthern side.

About 500 metres before reaching the bottom of Kurishumudi peak, there is a metalled road which takes an easterly direction and runs along the side of I11i-thodu to link the tarred road that leads to P.O. Junction near Pandupara. Similarly, a forest road that goes interior from the P.O. Junction-Manjappra--Angamali road, from near Kannimangalam Guard Station, runs through the Kannimangalam forest section and meets the above mentioned road that runs paralleled to I11i-thodu. Apart from these, there is no motorable path within the reserve forest area. Hence, many parts of it are either approachable only by foot or inaccessible mainly due to topographical peculiarities and steep slopes with steep rock, characteristic to the area.

1.2. TOPOGRAPHY

The study area is situated along the western slope of the Western Ghats of Kerala. The maximum height of the area is about 387 m above msl at the apex of Kurishumudi peak which comes down to 50 in the foothills. The whole area is hilly in character and ground

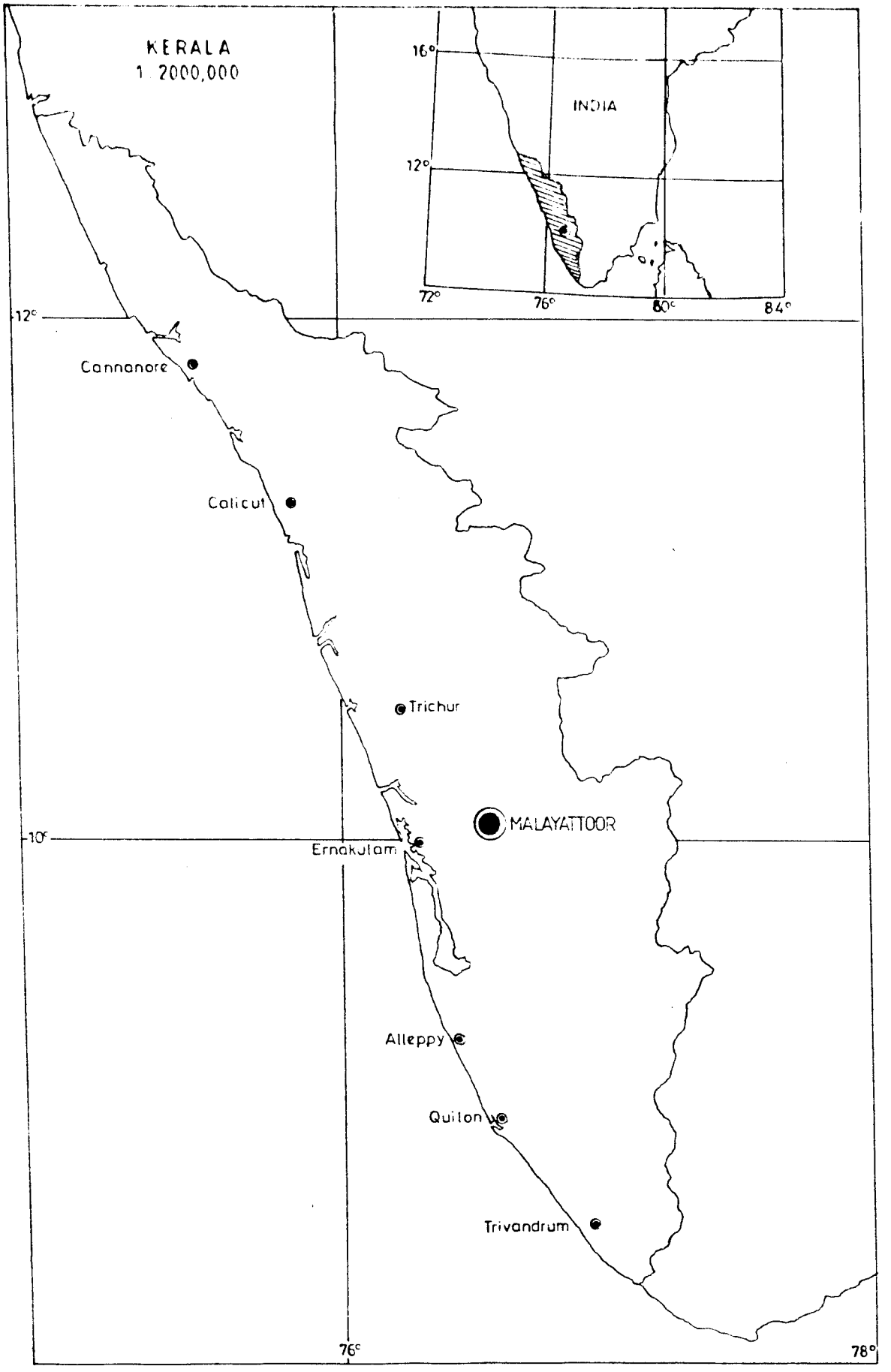

Fig.1.1. Map of Kerala showing the location of Malayattoor - the study area

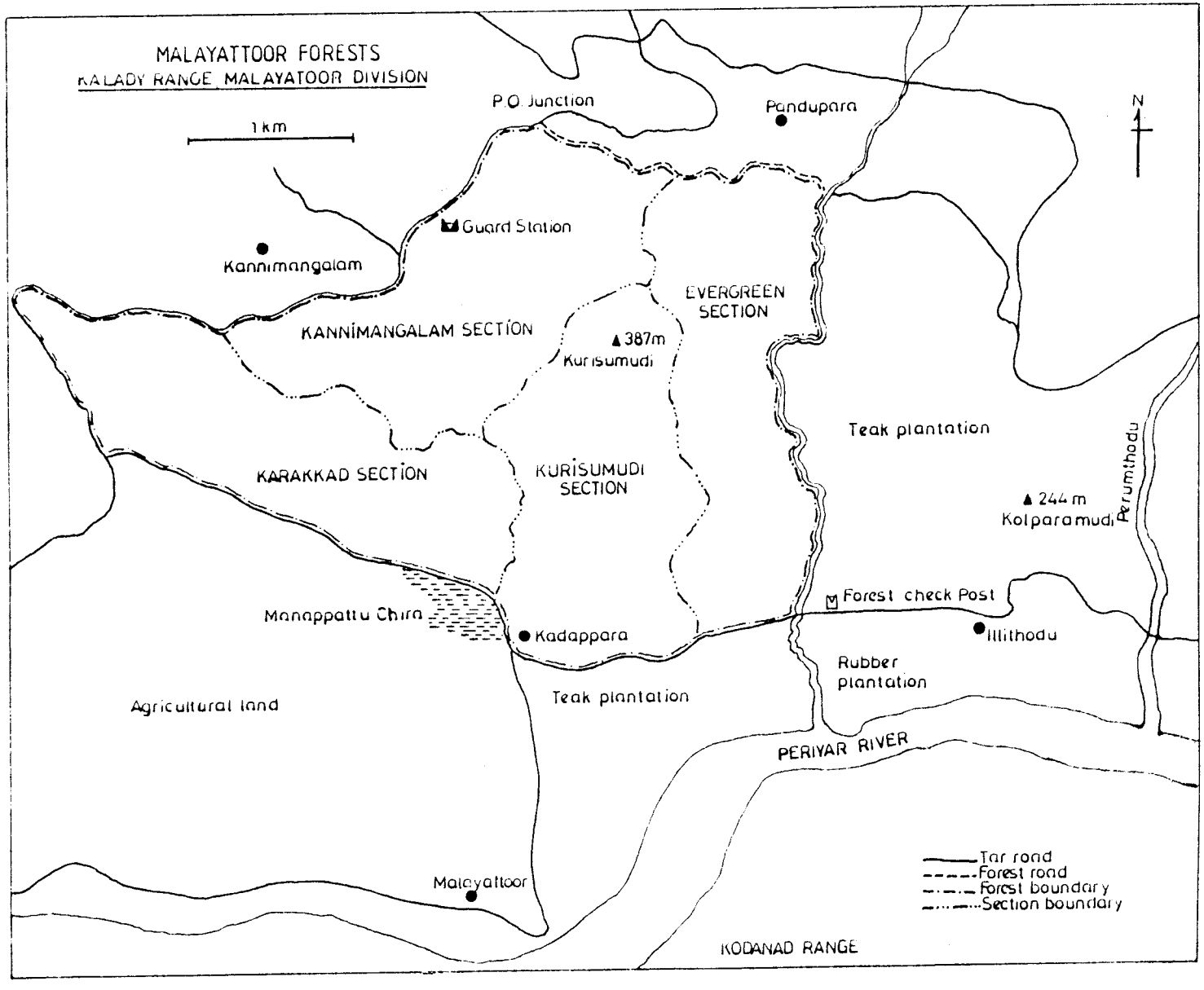

Fig.1.2. Map of Malayattoor with details on different forest sections, roads, water bodies, river and peaks.

surface is highly undulating and rugged. From the plains of Kalady, the hillock Kurishumudi suddenly rises to attain a height of 387 m above msl. The southern slope of this hillock is steep, whereas towards West, the slope is gradual. In this region plantations of Cashew are quite common. Towards the eastern side of Kurishumudi also the south-eastern part is rather undulating and gradually descending whereas the narrow top of the ridge continues in an easterly direction and after taking a southern course comes down almost suddenly to the plains. The northern side of Kurishumudi is sometimes with sudden decends with sheet rock here and there and sometimes with shallow depressions harbouring moist deciduous forests. As it reaches the foothills, plantations of teak and a disturbed natural forest which was under illegal occupation previously and evicted during the emergency period, exist. In this area are quite common fruit trees like Jack, Mango, Citrus, Tamarindus and so on, and Glyricidia as hedge, planted by the encroachers. Even boundaries of each of the encroached private holdings are seen now in this area. When it reaches the bottom of the hillock, towards the north-eastern part, there exists an extensive grassland surrounded by moist deciduous forests and teak plantations. This grassland, during rainy season, become water-logged. Around this grassy patch is seen luxuriant natural moist deciduous forests with fairly rich floristic diversity. It is through this valley that the forest road that starts from Kannimangalam traverses and meets the above mentioned road bordering Illi-thodu, the eastern boundary of the Forest Range. Towards the northern side of the ridge that traverses the area from Kurishumudi, about a kilometer East of the peak, there is a depression harbouring a small patch of evergreen forest. This evergreen patch slowly descend, engulfing a small hill

stream and a waterfall. Beyond this, the forests get transformed into moist deciduous type, followed by plantations of teak, the once encroached area and the grassy open land. Beyond the evergreen patch, the narrow ridge of the hill extending from Kurishumudi peak takes a southern direction with sheet rock here and there and merges with the agricultural land on the South-eastern boundary of the Forest Range.

The sudden change in the direction of the ridge has created an extensive valley of moist deciduous forests at a place known as Pottah towards the eastern side of Kurishumudi. This is a highly disturbed area due to human interferences like collection of green manure, fodder, firewood, medicinal plants, and so on. The valley, when it reaches the southern limit of the reserved forest, is with several extensions of sheet rock or rock overlaiden with a thin layer of soil where there is a totally failed plantation of teak. This area is now being planted up with several indigenous timber species like *Dalbergia latifolia, Albizia odoratissima, Tamarindus indica, Casuarina equisetifolia*, etc. by the Forest Department.

Here and there, bordering or penetrating into the reserved forests, are private holdings. In such holdings, crops like coconut, pineapple, cocoa, rubber, arecanut, etc. are grown by private parties. Such areas are present in Karakad and Kurishumudi sections also, quite interior, surrounded by reserved forests of the dry or moist deciduous types.

Quarrying in a common phenomenon, mainly within the reserved forests of Karakad and Kurishumudi sections. Rocky areas in the two

sections are given on lease by the Forest Department to private parties for this purpose. Several small approach roads of temporary nature also start from these quarries, connecting the nearby tarred roads, to enhance transportation facility.

There is a large canal being dug through the reserved forest area to take water from Bhoothathankettu BarrangelEdamalayar dam. This is to distribute water to the plains of Kalady for agricultural purposer;. In some areas, the canal is 10–15 m deep depending upon the topography of the area. Largescale removal of rock and soil takes place here also. There is also a small bridge being constructed to link the two portions of the reserve forest which were separated by the digging of the canal.

1.3. VEGETATION

The study area possess both natural and man–made forests. The natural forests are mainly of the tropical moist deciduous type. Man–made forests include plantations of teak and cashew. On one side, the forests of the area are highly disturbed and degraded, and on the other, plantations of teak, first established in 1865, are mostly unsuccessful due to various reasons including poor site quality. However, cashew plantations raised as an alternate crop on very poor laterite sites have performed quite well in Malayattoor. Healthy and high yielding plantations of this cash crop may be seen in the foothills, especially of the Karakad section and to some extend in the Kannimangalam part of the reserved forest.

1.3.1. Forest plantations

As mentioned earlier, in and around Kurishumudi, forest plantations of teak and cashew are quite prevalent. Failed teak plantations are also seen in Kurishumudi, Karakkad and Kannimangalam sections. Towards the western side of Kurishumudi, on the way to Evergreen section, there are areas of failed teak plantations which are now planted up with native species like *Dalbergia latifolia, Tamarindus indica, Pterocarpus marsupium,* etc. in an effort to convert those areas into a productive zones. Along the southern side of the Kurishumudi peak also similar planting progrmmes have already been started. As such, there is no successful teak plantation on the South, East and western sides of Kurishumudi hillock which faces us once we reach the bottom of Kurishumudi. However, some teak plantations of Kannimanqalam section on the northern side of Kurishumudi peak is more or less surviving. In 'the failed teak plantation areas and as undergrowth in those existing plantations in Kannimangalam section, ground flora is rather poor due to various types of disturbances and also poor site quality.

Towards the western side of Kurishumudi, spread over in Karakad and Kannimangalam sections, are seen fairly large areas of cashew plantations that are performing quite well. Most of the cashew plantations were raised on lateritic areas, bordering the sides of the tarred road that leads to Angamali via Manjappra. In the cashew plantations, eventhough human interferences are very high, species of *Osbeckia, Ziziphus, Alstonia, Memecylon, Syzygium,* etc. are quite common which are mostly bushy in nature.

1.3.2. Natural forests

Within the four sections of Kalady range, viz. Karakad, Kannimangalam, Kurishumudi and Evergreen, the forest types met with include evergreen, semievergreen, moist deciduous, dry deciduous and scrub vegetation. At the outset, it is worth mentioning that all the forest portions of the Kalady Range are in a much fragmented and degraded state due to various reasons., the most important among them being human interferences and poor site factors.

1.3.2.1. Evergreen forests

The only patch of evergreen forest in the whole of the study area is seen in a depression of the mount Kurishumudi, towards its north-eastern side. Here, there is a rich assemblage of several evergreen species which include trees, woody shrubs, herbs, lianas and tuberous species. The top canopy is composed of lofty trees like *Myristica dactyloides, Knema attenuata, Vateria indica, Artocarpus hirsutus,* etc. The middle storey trees include *Baccaurea courtallensis, Caryota urens, Hydnocarpus pentandrus, Saraca asoca, Ixora brachiata, Chionanthus mala-elengi, Olea dioica, Neolitsea cassia,* and so on. On the ground, stunted trees and large shrubs like *Xanthophyllum flavesrens, Ixora arborea, Polyalthia longifolia, Polyalthia rufesrens, Dichapetalum gelonoides, Maesa perrottetiana, Ancistrocladus heyneanus, Sapindus emarginatus, Nothopegia travancorica,* etc. and ground herbs like species of *Nilgirianthus, Ophiorrhiza, Pavetta, Peperomia, Calamus, Elatostemma, Begonia, Chasalia, nitia,* etc. are fairly common. Also, epiphytic on tall and medium

sized trees of the forests may be seen orchids like *Dendrobium macrostachyum, Vanda tessellata,* etc. There is a small hill stream strating from a depression within this evergreen patch, which after a steep fall of about 15 m hiqh, continues to flow into the plains and joins with Perum-thodu, far beyond the eastern boundary of the reserved forest. Along the sides of this hill stream may be seen species like *Calamus thwaitesii, Saraca asoca, Ochlandra travancorica,* and so on. growing luxuriantly. The everqreen patch, in its northern limit, merges with the moist deciduous forest of Kannimangalam section which in turn borders the teak plantations.

1.3.2.2. Moist deciduous forests

The moist deciduous forests are rather well distributed in the study area, eventhough it is much fragmented and degraded. Bordering the evergreen patch, both on its southern and northern limits in the Kurishumudi and Kannimanqalam sections, a major share of moist deciduous forest of the study area is seen. Also, in the Kannimangalam section, starting from the Kannimanqalam Guard Station premises, it extends eastwards up to the bottom of the hill that abode the evergreen forest patch. Similarly, towards the eastern side of the path that leads to Kurishumudi top up to the forest path from Pottah to evergreen patch is a fairly extended patch of moist deciduous forests clothing the slanting hillside. This, and also the patch in Kannimangalam section, are in a much degraded state, mainly due to human interferences. Dominant tree species met with in the forest type at Malayattoor include *Albizia odoratissima, Dalbergia latifolia, Dalbergia lanceolaria, Pterocarpus marsupium, Terminalia paniculata, Grewia tiliaefolia, Lagerstroemia microcarpa, Dillenia pentagyna,*

Tetrameles nudiflora, etc. Subcanopy trees like *Chionanthus mala-elengi*, *Grewia tiliaefolia*, *Haldina cordifolia*, *Aglaia roxburghiana*, *Madhuca longifolia*, etc. and climbers like *Calycopteris floribunda*, *Zizyphus oenoplia*, *Calamus thwaitesii*, *Pothos scandens*, *Ancistrocladus heyneanus*, *Asparagus racemosus*, *Wagatea spicata*, *Dalbergia horrida*, etc. are also common in the forest type, depending upon the level of degradation and availability of moist and shady conditions. The forest floor is also fairly rich with several shrubaceous species and ground herbs like species of *Psychotria*, *Pavetta*, *Chasalia*, *Ixora*, *Grewia*, *Glycosmis*, *Cipadessa*, *Canthium*, *Breynia*, *Bridelia*, *Securinega*, *Asparagus*, *Cyclea*, *Cissampelos*, *Anamirta*, *Ancistrocladus*, and so on.

It is in this moist deciduous forest type that two patches of aquatic/semiaquatic formations are seen in the whole of the study area. In one such patch, a species of aroid, viz. *Lagenandra ovata* is seen colonized in an area of about a hectare. It is form this marshy area that a small water course starts and proceeds to form a canal that crosses the forest road and runs further eastwards to join Illithodu. The other aquatic formation found in the study area is below the evergreen patch on the hillside and during summer it transforms into a carpetted grassland extending to about 3–4 hectares. Here and there, within this open grassland, bushes of *Xeromphis uliginosa*, *Ixora arborea*, etc. are seen. Boarding this open area are also seen an array of tree species and lianas like *Albizia odoratissima*, *Chionanthus mala-elengi*, *Elaeocarpus munronii*, *Dalbergia latifolia*, *Pterocarpus marsupium*, *Terminalia paniculata*, *Dalbergia horrida*, *Calycopteris floribunda*, etc. During rainy season the grass carpetted area get a thin layer of water, which drains quickly through one end of it

as a canal. During this season, truly aquatic species like *Eriocaulon quinquangulare, Impatiens chinensis, Utricularia graminifolia,* etc. are seen in plenty. As such, this qreen-carpetted area and the forest surrounding it makes this spot very picturesque and attractive.

Bordering the moist deciduous forest in the Kannimanqalam section are teak plantations. Naturally, all over in the forest type here, a sprinqling of *Tectona grandis* trees is seen.

1.3.2.3. Dry deciduous forests

The forest type is distributed mostly along hilltops, rocky areas and disturbed outskirts of Malayattoor reserved forests. It is seen in the eastern and western part of the mountain chain with patches here and there, depending upon moisture and site conditions. Trees like *Xylia xylocarpa, Grewia tiliaefolia, Terminalia paniculata, Pterocarpus marsupium, Lagerstroemia microcarpa, Dalbergia lanceolaria, Dillenia pentagyna, Trema orientalis,* etc. are seen in the forest type either in groups or as scattered trees between the rocky outcrops. The forest type also contains scattered, stunted trees of *Tectona grandis.* Climbers like *Ziziphus oenoplia, Asparagus racemosus, Dalbergia horrida, D. volubi1is, Calycopteris floribunda, Wagatea spicata, Breynia rhamnoides, Bridelia scandens, Securinega leucopyrus,* etc. are seen on such trees. Ground flora in the forest type is rather poor and the plants like *Leea indica, Abrus precatorius, Luffa acutangula, Hemidesmus indicus, Naregamia alata,* etc. that come up during monsoon are mostly removed as qreen manure and fodder.

1.3.2.4. Scrubs

Scrub forests of Malayattoor are seen mostly around cashew plantations, especially in the Karakad section. Here also, removal of plants for fodder, green manure, firewood, etc. is quite prevalent, rendering the vegetation highly degraded and sparse. Bushy shrubs like *Memecylon edule, Osbeckia aspera, Osbeckia zeylanica, Cipadessa baccifera, Canthium angustifolium, Glycosmis mauritiana, Helicteris isora, Ixora coccinea,* etc. may be seen with climbers like *Asparagus racemosus* and *Cissampelos pareira* in this zone. In the shurbby areas, excessive leaching is a common phenomenon, exposing the laterite cap, on which the shrubby species struggle to survive as clumps and harness humus and water for their survival.

1.4. REMARKS ON THE FOREST TYPES OF MALAYATTOOR

As mentioned earlier, in general, natural forests of Malayattoor are in a much degraded state. This is the outcome of an array of factors, of which human interferences can be ranked as the prime disturbing factor that affect the natural flora of this region. Removal of lorry loads of green manure has highly affected the regeneration of several tree species like *Xylia xylocarpa, Grewia tiliaefolia, Dalbergia latifolia,* etc. and there are areas within the forest where only huge trees of the said species are seen without any seedlings or saplings. Groundflora is also completely removed from certain parts of the forests, where accessibility and transportation facilities are better. Excessive leaching mainly due to the removal of ground flora, forest fire, colonization of weeds like *Mikania micrantha, Eupatorium*

adenophorum and *Lantana camera* var. *aculeata,* removal of firewood, windfall due to the creation of open areas here and there in the forests, etc. are all factors that had contributed substantially to the degradation of the natural forests of Malayattoor. Still, there exists small patches of evergreen, semi–evergreen, moist deciduous and dry deciduous forests which must be preserved *in toto* to serve as demonstration areas, when the Nature Study Centre will be established. Same is the case with the aquatic formations of the area which are really curious to any nature lover.

Two extensive pure patches, one of *Pterocarpus marsupium* and the other of *Terminalia paniculata* are seen in the Kannimangalam section. Possibly planted earlier, they are growing very well and serve as an indicator of the performance of native species in almost pure patches, similar to monoculture forest plantations.

ANGIOSPERM FLORA AND SPECIALISED ECOLOGICAL NICHE OF MALAYATTOOR

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2. ANGIOSPERM FLORA AND SPECIALIZED ECOLOGICAL NICHE OF MALAATTOOR

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Contents

ABSTRACT

Floristic surveys were conducted to cover four forest sections of Kalady Range in Malayattoor Division, viz. Kurishumudi, Karakad, Kannimangalam and Evergreen. From the natural flora and forest plantations of the region, altogether 215 taxa of flowering plants (angiosperms) were recorded during the survey. They belong to 183 genera and 74 families, which are enumerated in the report with up to date names, citations to Hooker's Flora of British India (1872-97) and Gamble's Flora of the Presidency of Madras (1915–36). Brief notes are also provided for each of them with regard to their diagnostic features, medicinal and other economic importance and availability and distribution within the area. Three specialised ecological niche, viz. an evergreen patch, two pure patches of *Pterocarpus marsupium* and *Terminalia paniculata* and an aquatic formation with *Lagenandra ovata* and species of *Utricularia, Eriocaulon* and *Impatiens* dominating, were also analysed for their floristic make-up and details presented in the report.

2.1. INTRODUCTION

The botanical component of the study envisages to generate information on the following aspects pertaining to the natural flora of the region. The study was restricted to four forest sections of Kalady Forest Ranqe namely Karakad, Kurishumudi, Kannimangalam and Evergreen sect

1. Preparation of a checklist of the flora of the region

11. Analysis of the floristic composition of different ecological associations of specialized ecological niche, if any, in the study area.

111. Establishment of a herbarium of demonstrative value, to elucidate the identity, availability and distribution of various components of the forest flora of the region.

2.2. METHODOLOGY

During the one year operational duration of the project, monthly field surveys were conducted collect, as many herbarium samples as possible, of flowering or fruiting materials of flowering plants (angiosperms) growing naturally or planted in the study area. Necessary field notes were also recorded during such field surveys. It is very well known that, within the short duration of the project, all the plant species could not be collected in the flowering or fruiting state to make them into herbarium specimens. Therefore, the occurrence of several species, mostly very common, were recorded by field observations. They are also incorporated into the floristic enumeration that is presented in this report, with whatever notes that could be gathered at the time of field observations. While progressing the floristic surveys, notes were also taken on the specialized ecological formations that are found in the region. This information formed the basis of that part of the report which follow.

The specimens collected were processed and made into herbarium specimens following standard methods. Their identifications were confirmed by consulting the Herbarium of Botanical Survey of India, Coimbatore. Two specimens for each species were collected from the study area and lebelled with up-to-date botanical name, local name, distribution details, habit and other notes. They are kept ready for establishing the demonstration herbarium as and when necessary infrastructure facilities are developed as part of the Nature Study Centre.

2.3. REVIEW OF LITERATURE

Apart from the inclusion of some species found in Malayattoor in national, regional or State floras like those of Hooker (1872-97), Bourdillon (1908), Rama Rao (1914), Gamble (1915-36), etc. there is no published literature specific to the flora of Malayattoor forests. Of course, Nair (1989), while generating benchmark data on the proposed Pooyamkutty hydro-electric project area had intensively surveyed certain forest areas coming under Malayattoor Forest Division, which does not include this part of the Forest Division.

In the recent Working Plan for Malayattoor Forest Division for 1974-75 to 1984-85, Kurian Akkara(l980) had endevoured to list out about 191 plant species as occurring in the Forest Division with details like botanical names, family names, local names, habitat and trade names. As there is no mention about their exact locality of occurrence and distribution within the Division with four widely separated forest ranges, there is no indication available from this list

as to what are the species occurring in the study area, which form only a part of the Kalady Range. Viswanathan's (1956) Working Plan for the Muvattupuzha part of the Malayattoor Forest Division also, obviously, does not include this area and hence the list contained in this Working Plan is also not indicative of the plant wealth of this part of Malayattoor forests.

2.5. FLORA

Floristic surveys conducted for about an year could collect or record a total of 215 species of flowering (angiosperms) plants from the four forest sections of Malayattoor, viz. Kurishumudi, Karakad, Kannimangalam and Evergreen. For species marked with astrix, specimens are available in the demonstration herbarium and the remaining taxa are field records.

In the floristic enumeration that follows, different families are arranged according to the system of Bentham and Hooker **(1862-83).** They are given following the sequence and concept of families as given in Gamble's Flora of the Presrdency of Madras (1915-35), except for Leguminosae where the subfamilies Papilionaceae, Caesalpiniaceae and Mimosaceae are treated as separate families. This is to facilitate easy reference by students, nature lovers and tourists who visit the study area, as Gamble's Flora will be more familiar to them as compared to other old or recent floras covering region. While enumerating different taxa, effort has been made, as far as possible, to

give the latest name of the species with full citation and also synonyms, if any, by which the species are known in Hooker's, (1872-97) Flora of British India (FBI) and Gamble's (1915-35) Flora of the Presidency of Madras (FPM), with citations given to them as abbreviated. This again is to facilitate those who consult the floristic list to gather more information on each taxa, as such details can not find a place in a checklist like this. Brief notes are also added on the general habit, distribution and medicinal or other economic importance of various taxa in the four forest sections of Malayattoor forests, both for which herbarium specimens could be collected during the study period and also which are field recorded species.

In the enumeration part, within each family, genera are arranged alphabetically. Whenever more than one species is present within a genus, they are also enumerated in an alphabetical sequence. Local names, wherever available, are also provided for each plant.

2.5.1. DICOTYLEDONS

RANUNCULACEAE

Naravelia Adans.

****Naravelia zeylanica*** (L.) A. DC. Syst. 1:167. 1817; FBI 1:7. 1872; FPM 1:3. 1915.

Tendril climbing shrubs with light yellow flowers and tailed seeds. Rare, along hedges above Pottah area on the way to Evergreen section.

DILLENIACEAE

Dillenia L.

Dillenia pentagyna Roxb. Pl. Corom. 1:21. t.20. 1795; FBI 1:38. 1872: FPM 1:6. 1915.

Large trees with leathery leaves. Fairly common in the open, degraded and fire affected areas of Kurishumudi section and lower elevations of Evergreen section.

ANNONACEAE

Artabotrys R. Br.

Artabotrys zeylanicus Hook. f. Fl. Brit. India 1:54. 1872; FPM 1:14. 1915.

Straggling shrubs with oblong lanceate leaves and brown flowers in fascicles. Rare, in Pottah area on the way to the Evergreen section.

Polyalthia Bl.

+Polyalthia longifolia (Sonner.) Thw. Enum. Pl. Zeyl. 398. 1864; FBI 1:62. 1872; FPM 1:16. 1915.

Shrubs with greenish white flowers. Rare, as an undergrowth in the Evergreen section.

****Polyalthia rufescens*** Hook. f. et Thoms. Fl. Brit. India 1:66. 1872; FPM 1:16. 1915.

Woody shrubs with black stem and pale white flowers. Rare, in the Evergreen section as an undergrowth in the dense, shady forests.

MENISPERMACEAE

Anamirta Colebr.

****Anamirta cocculus*** Wt. ***et*** Arn. 446. 1834; FBI 1:98. 1871: FPM 1:27. 1915.

Large climbing shrubs with broadly ovate, cordate leaves and greenish flowers in long panicles. Common in Kurishumudi section. A medicinal plant.

Cissampelos L.

Cissampelos pareira L. Sp. Pl. 1031. 1753; FBI 1:103. 1872; FPM **1:30.** 1915.

Twining undershrubs with pale white flowers and rounded leaves. Fairly common along hedges and on bushes in Kannimangalam, Karakad and Kurishumudi sections. A medicinal plant.

Cyclea Arn. *ex* Wt.

Cyclea peltata (Lamk.) Hook.f. ***et*** Thoms. Fl. Ind. 1:201. 1855; FPM 1:31. 1915. -- C. ***burmanii*** (DC.) Hook. **f.** *et* Thoms. Fl. Ind. 1:201. 1855; FBI 1:104. 1872.

Twining undershrubs with peltate leaves which are almost triangular in shape. Fairly common along the hedges, especially in Kannimangalarn and Kurishumudi sections. A plant having medicinal properties.

PAPRVERACEAE

Argemone L.

****Argemone mexicana*** L. Sp. Pl. 508. 1753; FBI 1:117. 1872; FPM 1:35. 1915.

Along the sides of the forest path that leads to the top of Kurishumudi peak. A cosmopolitan weed common in the area. A medicinal herb.

CAPPARIDACEAE

Cleome L.

****Cleome monophylla*** L. Sp. Pl. 672. 1753; FBI 1:170. 1872; FPM 1:41. 1915.

Erect pubescent herbs with simple leaves and violet flowers. Rather

common on the top of the hill near Evergreen patch, in the soil accumulated in rock depressions during monsoon.

***Cleome viscosa** L. Sp. P1. 762. 1753; FBI 1:170. 1872: FPM 1:41. 1915. Erect herbs with 3–5 foliate leaves and yellow flowers. Rather, common during monsoon in soil deposited in the depressions of rocks near the evergreen patch. A medicinal herb.

BIXACEAE

Flacourtia Comm. *ex* L'. H'erit.

***+Flacourtia indica** (Burm. f.) Merr. Interpr. Herb. Amb. 277. 1917. -- *F. ramontchi* L'. H'erit. Strip. Nov. 3:59. t. 30. 1785; FBI 1:193. 1872 **(excl.** var. *latifolia* and var. *occidentalis);* FPM 1:54. 1915.

Much branched thorny shrubs with green subglobose capsules. Rare, as bushes in the middle and along the sides of the grassy plain in Kannimangalam section.

Hydnocarpus Gaertn.

***Hydnocarpus pentandrus** (Ham.) Oken, Allg. Natur. 3(2):1381. 1841. -- *H. wightiana* B1. Rumph. 4:22. 1848; FBI 1:196. 1872; FPM 1:52. 1915. Marotti.

Trees with buttressed roots and globose fruits. Occasional, along the sides of seasonal water courses in Kannimangalam and Kurishumudi sections. A plant having medicinal properties.

PDLYGALACEAE

Xanthophyllum Roxb.

***Xanthophyllum flavescens** Roxb. P1. Corom. 3:82. t. 284. 1820; FBI 1:209. 1872; FPM 1:60.1915.

Large shrubs **or** small trees with dark green foliage, yellowish white flowers and green fruits. Fairly common as undergrowth in the evergreen patch.

DIPTEROCARPACEAE

Vateria L.

***Vateria indica** L. Sp. P1. 515. 1753; FBI 1:313. 1874; FPM 1:61.1915.

Tall trees with clean bole and pale white flowers in terminal, hoary

pubescent panicles. Rare but dominant trees in the Evergreen section. Yields white dammer having medicinal nroperties.

ANCISTROCLADACEAE

Ancistrocladus Wall.

Ancistrocladus heyneanus Wall. ex Grah. Cat. Pl. Bombay and Vicin. 28. 1839; FBI 1:299. 1874; FPM 1:86.1915.

Lianas or shrubs with long spathulate leaves and twining terminal branches. Fairly common as undergrowth in the evergreen forest patch and rarely seen in Kannimangalam section, in thickly shaded areas.

MALVACEAE

Abutilon Mill.

Abutilon indicum (L.) Sw. Hort. Brit. ed. 1:54. 1826–27: FBI 1:326. 1875; FPM 1:91. 1915.
Uran, Katturan.

Undershurbs with stellate hairy branches and yellow flowers. A weed, common in all the four sections of Malayattoor forests. A medicinal plant.

****Abutilon persicum*** (Burm. f.) Merr. Philip. J. Sci. 19:364. 1921. -- A. ***polyandrum*** (Roxb.) Wt. ***et*** Arn. Prodr. 55. 1834; FBI 1:325. 1875; FPM 1:91. 1915.

Herbs with yellow flowers. Fairly common in the disturbed, open areas above Pottah on the way to Evergreen section, as a weed.

Bombax L.

****Bombax insigne*** Wall. Pl. Asiat. Rar. 1:71. t. 79,80. 1830.; FBI 1:349. 1874; FPM **1:l00.** 1915.

Trees with unarmed trunk and obovate, cuspidate leaflets. Common in Kurishumudi section.

Hibiscus L.

+Hibiscus platanifolius (Willd.) Sw. Hort. Brit. ed. 1:51. 1826–27; FPM **1:98.** 1915. -- ***H. collinus*** Roxb. Fl. Ind. 3:198. 1832; FBI 1:338. 1874.

Undershrubs with green, pointed fruits. Rare undergrowth above Pottah in the disturbed forest areas.

Hibiscus surattensis L. Sp. P1. *696*. 1753; FBI 1:334. 1874; FPM *1:97.*

A prickly trailing herb with many branchlets. Stem red in colour and with yellow flowers. Fairly common in the outskirts and disturbed areas of Kurishumudi section.

Sida L.

Sida cordifolia L. **Sp.** PI. **684. 1753;** FBI **1:324. 1874;** FPM **1:89. 1915.** Kurum-thotti.

Much branchea herbs or undershurbs witn woody base **and** yellow flowers. Common in the forest openings at lower altitudes of all the four sections of Malayattoor forests. A medicinal plant.

Thespesia Soland. *ex* Corr.

Thespesia lampas (Cav.) Dalz. *ex* Dalz. & Gibs. Bombay F1. **19. 1861; FBI** 1:345. **1874. -- *Hibiscus lampas*** Cav. Diss. 3:154. t. 56. f. **2. 1787;** FPM 1:98. **1915.**

Small trees with densely stellate hairy young parts, cordate palmately **3** lobed leaves and large yellow flowers. Frequent in Kurishumudi section. Fruits and roots medicinal.

STERCULIACEAE

Helicteris L.

Helicteris isora L. **Sp.** P1. **963. 1753;** FBI **1:365. 1874;** FPM **1:107. 1915.**
Edampirii-Valampi 1.

Shrubs with brick red flowers and characteristically twisted fruits. Fairly common in Kurishumudi section and lower part **of** Evergreen section. A medicinal plant.

Melochia L.

Melochia corchorifolia L. **Sp.** Pl. 675. **1753;** FBI **1:374. 1874;** FPM **1:ll0. 1915.**

Herbs with reddish brabches and terminal, yellow flowers. Common in the plains of Kurishumudi and Karakkad sections.

Sterculia L.

Sterculia populnifolia Roxb. Fl. **Ind.** 3:148. 1832; FBI 1:361. 1874; FPM **1:106. 1915.**

Large shrubs or small trees with heavy canopy, light yellowish flowers and pink fruits. Rare, on the flat top of the hill near Evergreen section, along the sides of rocks.

TILIACEAE

Grewia L.

Grewia glabra Bl. Bijdr. 115. 1825. -- *G. disperma sensu* Dunn in Gamble FPM 1:118. 1915. (*non* Rottl. *ex* Spreng., 1825); *G. laevigata sensu* Mast. in Hook. f., FBI 1:389. 1874 (*auct. non* Vahl 1790).

Medium sized trees with ovate-lanceate leaves and white flowers in axillary cymes and deeply 2 lobed drupes. Rare, in Kurishumudi section.

Grewia lawsoniana J. R. Drumm. in Gamble, Fl. Presid. Madras 1:84. 1915.

Trees or erect straggling or climbing shrubs with 3-7 ribbed densely pubescent leaves and yellow flowers in axillary clusters. Rare, in the Kurishumudi section.

Grewia serrulata DC. Prodr. 1:510. 1824. -- *G. disperma* Rottl. *ex* Spreng. Syst. 2:579. 1825; FPM 1:119. 1915. -- *G. laevigata* Vahl, Symb. Bot 1:34:1790; FBI 1:389. 1874.

Small trees with rough leaves and white flowers. Along the sides of the path that leads to Kurishumudi top in degraded forest areas.

Microcos L.

Microcos paniculata L. Sp. Pl. 514. 1753. -- *Grewia microcos* L. Syst. Nat. ed. 12:602. 1766; FBI 1:392. 1872; FPM 1:114. 1915.

An erect shrub with simple, alternate, ovate, obovate or lanceate, slightly toothed leaves and white flowers in terminal panicles. Not common, in the disturbed forests of Kannimangalam and Kurishumudi sections. A medicinal plant.

ELAEOCARPACEAE

Elaeocarpus L.

Elaeocarpus munronii (Wt.) Mast. in Hook. f. Fl. Brit. India 1:407. 1874; FPM 1:124. 1915.

Trees with highly branched, dense crown and egg-shaped fruits. Very rare, along the sides of the water course in the evergreen patch and also bordering the grassland in Kannimangalam section.

MALPIGHIACEAE

Hiptage Gaertn.

Hiptage benghalensis (L.) Kurz, J. Asiat. Soc. Bengal, Pt. 2. Nat. Hist. 43:136. 1874. -- ***Hiptage madablota*** Gaertn. Fruct. Sem. P1. 2:169. t. 116. f. 4. 1790; FBI 1:418. 1874; FPM 1:128. 1915.

Large climbing shrubs, with simple, opposite, oblong, acuminate leaves and yellow flowers in terminal and axillary panicles. Rare, in Kurishumudi section. Leaves medicinal.

GERANIACEAE

Biophytum **DC.**

****Biophytum sensitivum*** (L.) DC. Prodr. 1:690. 1824; FBI 1:436. 1872; FPM 1:133. 1915.
Mukkutti.

Herbs with rosetted leaves, short stem and yellow flowers produced on slender, erect stalks. Common in open areas of all the four forest sections of Malayattoor, mostly at lower elevations. A herb with medicinal properties.

Impatiens **L.**

****Impatiens chinensis*** L. Sp. P1. 937. 1753; FBI 1:444. 1874; FPM 1:139. 1915.

Small succulent herbs with simple, opposite, linear-oblong leaves and pink flowers. Common, in Kannimangalam section in the grassland area during monsoon. A medicinal plant.

RUTACEAE

Glycosmis Correa

****Glycosmis mauritiana*** (Lamk.) Tanaka, Bot. Not. 1928: 159. 1928. -- **G. *pentaphylla*** sensu Narayanaswami, Rec. bot. Surv. India 14(2):12. 1941; FPM 1:153. 1915.
Kattu-panal,

Rromatic shrubs with fleshy berries. Common in the outskirts and open areas of the forest, especially in Kannimangalam section. A medicinal shrub.

Naringi Rdans.

****Naringi crenulata*** (Roxb.) Nirolson, F1. Hassan Dt. 387. 1976. --- ***Limonia acidissima*** *auct.* multi.; FBI 1:507. 1875. FPM 1:157. 1915.

Branched herbs with bright green leaves and white, prominent flowers.

Common on laterite cuttings around Pottah, at lower elevations of Malayattoor forests. A medicinal plant.

MELIACEAE

Aglaia Lour.

****Aglaia elaegnoidea*** (Juss.) Benth. F1. Austrl. 1:383. 1863. -- A. ***roxburghiana*** Miq. Ann. Bot. Mu~.Luqd. Batav. 4:41. 1868; FBI 1:555. 1875; FPM 1:180. 1915.

Trees with dense foliage and brownish flowers. Rather rare in Kannimangalam section. Fruits medicinal.

Cipadessa B1.

****Cipadessa baccifera*** (Roth) Miq. Ann. Bot. Mus. Lugd. Batav. 4:6. 1969–70; FPM 1:176. 1915. ***-- C. fruiticosa*** B1. Brijdr. 162. 1825; FBI 1:545. 1875.

Shrubs with pubescent branchlets, qreenhish-yellow flowers and scarlet fruits. Kannimanqalam and Karakad sections in the outskirits of forests and along hedges; rather common.

Naregamia Wt. ***et*** Arn.

Naregamia alata Wt. ***et*** Arn. Prodr. 117. 1834; FBI 1:542. 1875; FPM 1:174. 1915.

Undershrubs with 3 foliate, petiolate, winged leaves; leaflets sessile, cuneate or obovate. Common in the Kurishumudi section. A plant having medicinal properties.

DICHAPETALACEAE

Dichapetalum Du Petit – Thou.

****Dichapetalum gelonioides*** (Roxb.) Engl. Pflam. 3(4): 348. 1891; FPM 1:188. 1915. ***-- Chailletia gelonioides*** Bedd. For. Nan. Bot. 59. t. 9/1. 1871; FBI 1:570. 1875.

Undershrubs with elliptic or elliptic-lanceate leaves and pale white

flowers clustered in the axils. A rare species forming part of the ground flora in Evergreen section.

ICACINACEAE

Nothapodytes Bl.

+Nothapodytes nimmuniana (Grah.) Mabb. Bot. Hist. Hort. Malab. 88. 1980. -- ***Mappia foetida*** Miers, Ann. Mag. Nat. Hist. 2,9:395. 1852; FBI 1:1875; FPM 1:141. 1915.

Shrubs with slender, woody branches and white flowers. Rai?, in the shaded forest floor of Kannimangalam section.

RHAMNACEAE

Ziziphus Mill.

****Ziziphus oenoplia*** (L.) Mill. Gard. Dict. ed. 8: 3. 1768; FBI 1:634. 1875; FPM 1:220. 1915.
Thudali-mullu, Kotta-valli.

Armed lianas with globose fruits, black when ripe. A common undergrowth in forest plantations and open areas of Kannimangalam section. A medicinal plant.

****Ziziphus rugosa*** Lamk. Encyl. Meth. Bot. 3:319. 1789; FBI 1:636. 1875; FPM 1:221. 1915.
Thodali

Straggling, thorny shrubs with cream-coloured fruits. Rare in the Evergreen section, especially along the sides of the small canal originating from there. Flowers are medicinal.

VITACEAE

Leea D. Royen ex L.

****Leea asiatica*** (L.) Ridsd. in Bot. & Hist. Hort. Malab. 189. 1980. -- ***L. aspera*** Edgew. Trans. Linn. Soc. London 20:36. 1846; FBI 1:665. 1875; FPM 1:240. 1918.

Large shrubs with greenish white flowers. Rare, in Kurishumudi section.

****Leea indica*** (Burm. f.) Merr. Philp. J. Sci. Bot. 14:245. 1919. --L. ***sambucina*** Willd. Sp. P1. 1:1177. 1797; FBI 1:666. 1875 *(pro parte);* FPM 1:240. 1918.
Mani-paranta

Straggling or erect shrubs with stem often striated when old. Rather rare in Evergreen, kurishumudi and Kannimangalam sections, in forest openings. A medicinal plant.

SAPINDACEAE

Cardiospermum L.

Cardiospermum helicacrbum L. Sp. P1. **366. 1753;** FBI **1:670. 1875;** FPM **1:244. 1918.**

Delicate, straggling or climbing herbs with tendrils and membraneous, inflated fruits. A weed in the open areas and waste places of Karakad and Kurishumudi sections. A medicinal plant.

Sapindus L.

****Sapindus laurifolius*** Vahl, Symb. Bot. 3:54. 1794; FPM 1:250. 1918. -- *S. trifoliata auct.* non L.; FBI 1:6B2. 1873 (pro parte).

Stunted trees with creamy white flowers and leathery leaves. Rare, near the evergreen patch on top of the hill. A medicinal plant.

ANACARDIACEAE

Anacardium L.

Anacardium occidentale L. Sp. P1. 383. 1753; FBI 2:20. 1876; FPM 1:260. 1918.
Kasu-mavu, Paranki-mavu.

Spreading trees with rough, resinous bark and colourful, fleshy fruits producing the cashewnut of commerce. Often raised as plantations, especially in Karakad and Kannimangalam sections, rarely running wild. An exotic from North America.

Mangifera L.

Mangifera indica L. Sp. P1. **200. 1753;** FBI 2:13. 1876; FPM 1:259. 1918.

Trees, common in the outskirts and homesteads, often in cultivation, rarely running wild in Kannimangalam section. A medicinal plant.

Nothopegia El.

****Nothopegia travancorica*** Bedd. ***ex*** Hook. f. Fl. Brit. India 2:40. 1876; FPM 1:265. 1918.

Woody shrubs with black stem and white flowers. Very rare, forming part of the undergrowth in the evergreen patch of Evergreen section.

PAPILIONACEAE

Abrus L.

Abrus precatorius L. Syst. Nat. (ed. 12) 2:472. 1767; FBI 2:175. 1876; FPM 1:349. 1919.

Rather conspicuous, wiry climbers with pink flowers and usually scarlet seeds. Common in Kurishumudi section. A medicinal plant.

Butea Roxb. *ex* Willd.

Butea parviflora Roxb. Fl. Ind. 3:248. 1832. -- ***Spathalobus roxburghii*** Benth. Pl. Jungh. 238. 1851-52; FBI 2:193.1876; FPM **1:358.** 1919.

Huge lianas with twisted stem and compound leaves, often hanging from the top of trees. Very rare, in the periphery of the evergreen patch on top of the hill. A plant with medicinal properties.

Crotalaria L.

Crotalaria juncea L. Sp. P1. 714. 1753; FBI 2:79. 1876; FPM 1:297. 1919.

Erect herbs with yellow flowers. Rather common in open areas, especially in the outskirts and plains of Karakad and Kurishumudi sections.

Crotalaria walkeri Arn. Nov. Acto. Acad. Caes. Leop. - Nat. Cur. 18(1):328. 1840; FPM 1:294. 1919. -- **C.** ***semperflorens*** Vent. var. ***walkeri*** (Arn.) Baker in FBI 2:78. 1876.

Herbs with white flowers. Rare in the disturbed forests above Pottah, in the openings.

Dalbergia L.f.

Dalbergia horrida (Dennst.) Mabb. Taxon 25:538. 1977. -- ***D. sympathetica*** Nimmo ***ex*** Grah. Cat. Pl. Bombay & Vicin. 55. 1839; FBI 2:234. 1876; FPM **1:381.** 1918.
Ana-mul lu.

Scandent, woody plants with strong thorns, climbing on trees. Rare, in Kannimanqalam section, on trees bordering the open grassy area there.

Dalbergia lanceolaria L.f. Suppl. Pl. 316. 1781; FBI 2:235, 1876; FPM 1:270. 1918.
Velleti, Mala-muringa.

Much branched trees with rough, flaking bark and almost bifarious branchlets producing pinkish blue flowers. Rare, in Kannimanqalam, Karakad and Kurishumudi sections. Bark and seeds medicinal.

Dalbergia lotifolia Roxb. Pl. Corom. t. 113. 1799 & Fl. Ind. 3:221.1832; FBI 2:231. 1876; FPM 1:383. 1918.

Trees with flaking bark, imparipinnate leaves and creamy white flowers. Rather rare, in Kurishumudi, Kannimanqalam and lower parts of Evergreen section. A medicinal plant.

Dalbergia volubilis Roxb. Pl. Corom. t. 191. 1805; FBI 2:235. 1876; FPM 1:279. 1918.
Cheru-mu lu.

Erect shrubs or lianas with ridged old stem and white, bluish **or** pink-ish tinged flowers. Very rare, in Kurishumudi, Kannimangalam and Karakad sections. Roots and leaves of this plant are medicinal.

Desmodium Desv.

****Desmodium gangeticum*** (L.) DC. Prodr. 2:237. 1825; FBI 2:168. 1876. incl. var. ***maculatum*** Gamble; FPM 1:345. 1918.

Undershrubs with green fruits. Rare, as undergrowth in the disturbed forest areas above Pottah towards the top of the hill. A medicinal plant.

****Desmodium motorium*** (Houtt.) Merr. J. Arn. Arb. 19:345. 1938. **-- *D. gyrans*** (L.f.) DC. Prodr. 2:326. 1825; FBI 2:174. 1876; FPM 1:348. 1918.

Erect undershrubs with glabrous stem and branches, leaves trifoliate, ovate, oblong and flowers pink in axillary racemes. Common in Kurishumudi section.

****Desmodium triquetrum*** (L.) DC. Prodr. 2:326. 1825; FBI 2:163. 1876; FPM 1:345. 1918.

Erect herbs with purple flowers and green fruits. Common on the way up to Evergreen section, in disturbed open areas. Extract of leaves medicinal.

****Desmodium velutinum*** (Willd.) DC. Prodr. 2:328. 1825. **-- *D. latifolium*** DC. Prodr. 2:328. 1825; FBI 2:328. 1876. (pro syn.); FPM 1:346. 1918.

Undershrubs with pinkish red flowers. Rare, in the open areas of the hill top, near the evergreen patch. Roots medicinal.

Erythrina L.

Erythrina indica Lamk. Encyl. Meth. **Bot.** 2:391. 1785; FBI 2:188. 1876; FPM 1:249. 1918.

Deciduous, armed trees with very prominent red flowers in terminal inflorescence. Rare, in the outskirts and along hedges of Kurishumudi section.

Pongamia Vent.

Pangamia pinnata (L.) Pierre, Fl. Cochinch. sub. t. 385. 1899. -- ***P. glabra*** Vent. Jard. Malm. 28. 1803; FBI 2:240. 1876; FPM 1:385. 1918.

Trees with spreading branches and pinkish white flowers in pendulous, terminal panicles. Rare, in the outskirts of the forests of Kurishumudi section. A medicinal plant.

Pterocarpus Jacq.

Pterocarpus marsupium Roxb. Pl. Corom. 5:2,9, t. 116. 1798; FBI 2:239. 1876; FPM 1:385. 1918.
Venga, Chora-venga.

Trees with fissured bark and yellow flowers in showy terminal inflorescence. Scattered in the forests of Kurishumudi and Evergreen sections, with a pure patch of the species in Kannimangalam section. Gum and leaves of this tree are medicinal.

Rhynchosia Lour.

****Rhynchosia rathii*** Benth. ex Aitch. Cat. Pl. Punjab & Sindh 50. 1869. -- ***Rhynchosia sericea*** Span. Linnaea 15:195. 1841, *non* Hook. ***et*** Arn. 1834; FBI 2:225. 1876; FPM 1:375. 1918.

Climbing shrubs with trifoliate leaves, purple flowers in long axillary, dense racemes and flat, densely villous pods. Rare, in Kurishumudi section.

Tephrosia Pers.

****Tephrosia purpurea*** (L.) Pers. Syn. 2:329. 1807; FBI 2:112. 1876; FPM 1:320. 1918.

Herbs or undershurbs in the outskirts of the forest, especially in Karakad and Kannimangalam sections. A weed.

CAESALPINIACEAE

Bauhinia L.

****Bauhinia malabarica*** Roxb. Fl. Ind. 2:321. 1832; FBI 2:277. 1878; FPM 1:407. 1919.

Trees with white flowers. Rather rare in the dry deciduous forests, along the sides of Kurishumudi peak.

Caesalpinia L.

Caesalpina mimosoides Lamk. Encycl. Meth. Bot. 1:452. 1785; FBI 1:256. 1878; FPM 1:394. 1919.

Very prickly climbing shrubs with many short pinnae, each with 10–20 pairs of small leaflets and bright yellow flowers in axillary or terminal racemes. Common in Kurishumudi section.

Cassia L.

Cassia fistula L. Sp. Pl. 377. 1753; FBI 2:261. 1878; FPM 1:400. 1919.
Kani–konna, Konna.

Deciduous trees with bright yellow drooping inflorescence, often planted and also running wild in the lower parts of all the four sections of Malayattoor forests. A medicinal tree.

Cassia siamea Lamk. Encyl. Meth. Bot. 1:648. 1785; FBI 2:264. 1878; FPM 1:402. 1919.

Trees with dense crown and yellow flowers in showy clusters. Often planted along both the sides of the path that leads to Kurishumudi top.

Delonix Raf.

Delonix regia (Bojer *ex* Hook.) Raf. Fl. Tell. 2:92. 1836. -- ***Poinciana regia*** Bojer *ex* Hook. Bot. Nag. t. 2884. 1829; FBI *2:260.* 1878; FPM 1:396. 1919.
Gul–mohr.

Trees with brick–red, very attractive flowers. An avenue tree, planted along the sides of the path that leads to Kurishumudi top.

Saraca L.

Saraca asoca (Roxb.) de Wilde, Blumea 15:393. 1968. -- ***S. indica auct. non*** L. 1769; **FBI** 2:271. 1878; FPM 1919.

Graceful trees with dense foliage and red flowers produced on terminal branches. Very rare, along the sides of the hill stream that originates from the Evergreen section. A highly medicinal tree.

Wagatea Dalz.

***Wagatea spicata** Dalz. Hook. J. Bot. Kew. 3:90. 1851; FBI 2:261. 1874; FPM 1:397. 1919.

A prickly, shrubaceous straggler or climber with brown stem and scarlet calyx and orange petals for the flowers. Common in the moist deciduous forests of Kannimangalam section.

MIMOSACEAE

Acacia Mill.

***Acacia auriculiformis** A. Cunn. ex Benth. in London J. Bot. 1:377. 1842.

Trees, planted in the outskirts and along the sides of the path that leads to the top of Kurishumudi. Flowers yellow.

***Acacia torta** (Roxb.) Craib, Kew bull. 1915: 410. 1915; FPM 1:428. 1919. -- *A. intsia* Willd. var. caesia (Wt. et Arn.) Baker in Hook. f. FBI 2:297. 1878.

Straggling lianas with pale white flowers in globose inflorescence. Common, in the open areas of Kannimangalam, Evergreen and Kurishumudi sections.

Albizia Durazz.

***Albizia chinensis** (Osbeck. f.) Merr. Am. J. Bot. 3:575. 1916. -- *A. stipulata* Boiv. Encyl. 19, 2:33. 1838; FBI 2:300. 1878; FPM 1:433. 1919.

Deciduous trees with pinkish flowers in terminal inflorescence. Rare, in Kannimangalam section and also below Evergreen section, in the Pottah area. A medicinal tree.

***Albizia lebbeck** (L.) Benth. in Hook. London J. Bot. 3: 87. 1844; FBI 2: 298. 1878; FPM 1:432. 1919.
Vaka.

Deciduous trees with bipinnate leaves and white flowers in terminal, umbellate heads. Rather rare, in all the four sections of Malayattoor forests. A medicinal plant.

***Albizia odoratissima** (L.f.) Benth. in Hook. London J. Bot. 3:88. 1844; FBI 2:229. 1878; FPM 1:431. 1919.
Kunni-vaka, Puli-vaka.

Huge trees with dark, rough bark and white, fragrant flowers in terminal inflorescence. Fairly common in Kannimangalam and in Pottah area on the way to Evergreen section.

Mimosa L.

Mimosa pudica L. Sp. Pl. **518. 1753;** FBI **2:29l. 1878;** FPM **1:421. 1919.**
Thotta–vadi.

Armed, prostrate herbs with rose–coloured flowers. Common in the waste, open areas of the foothills. A weed. The whole plant is medicinal.

Xylia Benth.

****Xylia xylocarpa*** (Roxb.) Theob. in Mason Burma ed. Theob. 2:541. 1883; FPII **1:417. 1919. - *X. dolabriformis*** Benth. in Hook. J. Bot. 4:417. **1844** *(nom. illeg.);* FBI **2:286. 1878.**
Irul, Iru–pool.

Rather rare, deciduous trees with rough bark and creamy white flowers, in the drier areas of all the four forest sections of Malayattoor. A medicinal plant.

COMBRETACEAE

Calycopteris Lamk.

Calycopteris floribunda (Roxb.) Lamk. Encyl. Meth. Bot. **2:41. 1811;** FBI **2:449. 1878;** FPM **2:467. 1919.**
Pullani–valli.

Scandent shrubs with peeling bark, rather common in Kannimangalam section, especially adjacent to the teak plantations. A medicinal plant.

Terminalia L.

****Terminalia crenulata*** Roth, Nov. P1. Sp. **380. 1821.** -- *T. tomentosa* var. *typica* C. B. Clark in FBI 1:447. 1878; FPM 1:465. 1919.

A large tree with nearly glabrous, rather thin leaves and glabrous fruits. Rather rare, in the drier areas of Kurishumdui section. Bark medicinal.

****Terminalia paniculata*** Roth, Nov. P1. Sp. **383. 1821;** FBI **2:448. 1878;** FPM 1:465. ,1919.
Maruthu.

Trees with rough, black bark and terminal reddish, showy inflorescence. Fairly common in all the four sections of Malayattoor forests. Flowers medicinal.

LECYTHIDACEAE

Careya Roxb.

Careya arborea Roxb. Pl. Corom. 3:14. t. 218. 1819; FBI 2:511. 1879; FPM 1:488. 1919.
Pezhu.

Deciduous trees with fibrous bark and leaves aggregated towards the apex of branchlets. Rare, in the outskirts of the forest in Karakad and Evergreen sections. Bark medicinal.

MELASTOMATACEAE

Hemecylon L.

Memecylon umbellatum Burm. f. Fl. Ind. 87. 1768; FPM 1:504. 1919. -- ***M. edule*** Roxb. Pl. Corom. 1:82. 1798; FBI **2:563.** 1879 ***(excl. var.).***
Kanali.

Woody shrubs with deep blue flowers crowded in the axils of leaves and yellow fruits borne in the axils. Rather rare in the open, dry areas of Kurishumudi and Karakad sections. A medicinal plant.

Osbeckia L.

Osbeckia aspera (L.) El. Flora 474. 1831; FBI 2:519. 1879; FPM 1:492. 1919.

Shrubs with short branches and terminal, deep rose-coloured flowers. Common in laterite cuttings of Karakad section.

Osbeckia zeylanica L.f. Suppl. 215. 1781; FBI 2:516. 1879; FPM 1:494. 1919.
Kalam-patta.

Erect herbs with hairy branches, purple flowers and truncate capsules. Rather common in the outskirts of Karakad section in drier areas.

LYTHRACEAE

Lagerstroemia L.

Lagerstroemia microcarpa Wt. Ic. Pl. Indiae Orient. t. 109. 1839. -- *L. lanceolata* Wall. ***ex*** Clarke, FBI 2:576. 1879; FPM 1:513. 1919.
Venthekku, Vellilavu.

Tall deciduous trees with smooth, pale-white bark peeling off regularly, and flowers tinged rose, produced terminally. Rare, on the way sides to Kurishumudi top and lower part of Evergreen section, at Pottah.

Lagerstroemia speciosa (L.) Pers. Syn. 2:72. 1806. -- *L. flos-reginae* Retz. Obs. But. 5:25. 1788; FBI 2:577. 1879; FPM 1:513. 1919.

An ornamental tree with thick foliage, peeling bark and mauve flowers. Planted along the pathsides to Kurishumudi top, running wild in Kannimanqalam and Karakad sections, especially near seasonal water courses. Fruits medicinal.

PASSIFLORACEAE

Passiflora L.

Passiflora foetida L. Sp. Pl. 959. 1753; FBI 2:599. 1879; FPM 1:524. 1919.

Tendril climbing herbs with a foetid smell, bearing white flowers and yellow, edible fruits. Rare, in the forest outskirts of Kurishumudi section. A medicinal herb.

CUCURBITACEAE

Diplocyclos (Endl.) Post & Ktze.

****Diplocyclos palmatus*** (L.) Jeffry, Kew Bull. 15:352. 1962; FBI 2:622. 1879. -- *Bryonopsis lancinosa* Naud. Ann. Sc. Nat. Ser. 4,12:141. 1859 *(non* (L.) Naud.); FPM 1:534. 1919.

Slender climbers with deeply 5 - lobed leaves and yellow fascicled flowers. Rare, in the drier areas of Kurishumudi section.

Luffa Mill.

****Luffa acutangula*** (L.) Roxb. Hort. Beng. 70. 1814; FBI 2:615. 1879. -- *L. amara* Roxb. Hort. Beng. 70. 1814; FPM 1:533. 1921.

Climbers with usually scabrous and pubescent leaves and small fruits. Rare, in Kurishumudi section as climbers on hedges. A medicinal plant.

DASTICACEAE

Tetrameles R. Br.

Tetrameles nudiflora R. Br. Obs. 230. 1826; FBI 2:657.1879 FPM 1:544.1921.

Lofty, deciduous trees with buttressed base, huge trunk and 1ess

branched apex bearing white flowers. Rather common as isolated trees in the highly degraded forest above Pottah, on the way to Evergreen section. Bark medicinal.

BEGONIACEAE

Begonia L.

Begonia malabarica Poir. in Lamk. Encyl. Meth. Bot. 1:393. 1785; FBI 2:655. 1879; FPM 1:546. 1919.

Erect herbs with Jointed, reddish stem, oblique leaves and rose-coloured flowers. Rare, in shaded, wet areas on the way to Evergreen section.

ALANGIACEAE

Alangium Lamk.

****Alangium salvifolium*** (L.f.) Wagner in Engl. Pflanzenr. 4, 20B: 9. 1910; FPM 1:572. 1919. **-- *A. lamarckii*** Thw. Enum. P1. Zeyl. 133. 1859; FBI 2:741. 1879.

Shrubs with very attractive and edible, red fruits. Rare, along hedges in forest openings above Pottah on the way to Evergreen section. A medicinal plant.

RUBIACEAE

Canthium Lamk.

****Canthiurn angustifolium*** Roxb. F1. Ind. 2:169. 1824.; FBI 3:135. 1880. **-- *Plectronia rheedii* (DC.)** Bedd. var. ***angustifolia*** Gamble, FPM 2:625. 1925.

Armed shrubs with greenish–white flowers, common as an undergrowth in the Kannimangalam section.

Chasalia Comm. ex Poir.

****Chasalia ophioxyloides*** (Wall.) Gard. Bull. Strait Settl. 6:474. 1930. -- *C. curviflora sensu* Hook. f. F1. Brit. India 3:176. 1880; FPM 1921.

Herbs with dark blue flowers, rarely found as an undergrowth in the Evergreen section. A medicinal plant.

Haldina Ridsdl.

Haldina cordifolia** (Roxb.)* Ridsdl. Blumea 24:361. 1978. -- ***Adina cordifolia Hook. f. ex Brandis For. Fl. N.W. & Central India 263. 1874; FBI 3:24. 1880; FPM 2:584. 1921.
Manja-kadambu.

Trees with rough bark, almost rounded, cordate leaves and globose inflorescence bearing pinkish-white flowers. Rare, in Kannimangalam section near the Guard station, in moist deciduous forests. A medicinal plant.

Hedyotis L.

Hedyotis umbellata (L.) Lamk. Encyl. Meth. Bot. 1:272. 1789. -- ***Oldenlandia umbellata*** L. Sp. Pl. 174. 1753; FBI 3:66. 1880; FPM 2:601. 1921.

Erect or suberect herbs with much branched stem and white flowers. Fairly common in the plains of Karakad and Kurishumudi sections. A medicinal plant.

Ixora L.

Ixora brachiata Roxb. Fl. Ind. 1:391. 1820; FBI 3:142. 1880; FPM 2:631. 1921.

Shrubs with green buds and red stalk for the flowers and red fruits. Rather common, a5 undergrowth in the evergreen patch.

Ixora coccinea L. Sp. Pl. 110. 1753; FBI 3:145. 1880; FPM 2:631. 1921.
Chethi, Thechi.

Shrubs with red, corymbose flowering branches and red, pulpy, edible fruits. Rare, in the lateritic soil, especially in the cuttings and other openings of Karakad, Kannimangalam and Evergreen sections. An important medicinal plant.

Knoxia L.

Knoxia sumatrensis (Retz.) DC. Prodr. 4:569. 1830. -- *K. corynbosa auct.* ***non*** Willd. 1797; Wt. ***et*** Arn. Prodr. 439. 1834; FBI 3:128. 1880; FPM 2:622. 1921.

Erect herbs with oblong-lanceate leaves and flowers in corymbose panicles. Rare, in Kurishumudi section.

Nussaenda L.

Mussaenda glabrata (Hook. f.) Hutch. ***ex*** Gamble, Fl. Presid. Madras 2:610. 1921. -- ***M. frondosa*** var. ***glabrata*** Hook. f. FBI 3:90. 1880.
Vella.

Straggling shrubs with brick red flowers having white showy calyx lobes Rather common, in the forest outskirts above Pottah, in disturbed areas. c\ medicinal plant.

Ophiorrhiza L.

Ophiorrhiza mungos L. Sp. P1. **150. 1753;** FBI **3:77. 1880;** FPM **2:608. 1921.**

Undershrubs with simple, opposite leaves and white flowers in subumbellate cymes An undergrowth in Kurishumudi section. Roots medicinal.

Psychotria L.

****Psychotria congesta*** (Wt. et Arn.) **Hook.** f. F1. Brit. Ind. 3:162. **1880;** FPM **2:640. 1921.**

Herbs with white flowers. Very rare, in the crevices of rocks in the Evergreen section.

Psychotria octosulcata Talbot, J. Bombay nat. Hist. Soc. **ll:237. 1897;** FPM **2:642. 1921.**

Shrubs with terminal, white flowers growing in shades. Fairly common in the Evergreen section and rare in Kannimangalam and Kurishumudi sections.

Xeromphis Rafin.

Xeromphis uliginosa (Retz.) Mahesw. Bull. bot. Surv. India **3:92. 1961. -- *Randia* uliginosa** (Retz.) DC. Prodr. **4:386. 1830;** FBI **3:ll0. 1880;** FPM **2:615. 1925.**

Armed shrubs with creamy white flowers. Rather rare, forming bushes in the grassland of Kannimanqalam section. Fruits and roots medicinal.

COMPOSITCIE

Ageratum L.

Ageratum conyzoides L. Sp. P1. **839. 1753;** FBI **3:243. 1881;** FPM **2:677. 1925.**

A softly hairy annual herb with simple, opposite, ovate leaves and bluish white small flowers in corymbose heads. Common in Kurishumudi section. A weed with medicinal properties.

Blainvillea Cass.

Blainvillea acmella (L.) Philips, Blumea 6:350. 1950; FRI **3:305.** 1878. -- ***B. rhomboidea*** Cass. Dict. Nat. 29:493. 1823; FPM *2:706.* 1921.

Erect, scabrous herbs with smelling leaves and white, terminal inflorescence. A weed growing in waste places and shaded areas in almost all the four sections of Malayattoor forests.

Blumea DC.

Blumaea lacera (Burm. f.) DC. in Wt. Contrib. Ind. Jot. 14. 1834; FBI 2:263. 1878; FPM *2:687.* 1925.

Smelling herbs with yellow flowering heads. Rather common in open areas of almost all the four sections of Malayattoor forests. A medicinal plant.

Elephantopus L.

Elephantopus scaber L. Sp. P1. 814. 1753; FBI 3:242. 1878; FPM 2:676. 1921.
Ana-chuvadi.

Herbs with rosetted, spathulate leaves and violet flowering heads. Weed, common in the waste places of Kurishumudi and Karakad sections. A medicinal herb.

Emilia Cass.

Emilia sonchifolia (L.) DC. in Wt. Contrib. Ind. Bot. 24. 1834; FBI 3:336. 1881; FPM **2:716.** 1924.
Muya1-chev1an.

Herbs with very variable leaves and pinkish flowering heads. A weed in the waste places of Kannimangalam and Karakad sections. A medicinal plant.

Eupatorium L.

Eupatorium adenophorum Spreng. Syst. 3:420. 1826.
Seema-pacha, Communist-pacha.

Glandular hairy, straggling or erect herbs with pinkish or bluish white flowering heads. An exotic weed, gregarious in the outskirts and disturbed areas of the forest in all the four sections.

Mikania Willd.

****Mikania micrantha*** H.B.K. Nov. Gen. et Sp. 4:134. 1820; K.K.N. Nair, Evergreen (KFRI Newsletter) 20:13-14. 1988.

Gregarious, straggling herbs with pale white flowers. Very common weed in forest openings especially in Kurishumudi, Kannimangalam and Pottah areas on the way to Evergreen section.

MYRSINACEAE

Maesa Forssk.

***Maesa perrottetiana** A. DC. Trans. Linn. Soc. London 17:80. 1834; FPM 2:749. 1921. -- ***M. indica** var. ***perrottetiana** (A. DC.) Clarke in FBI 3:509. 1882.

Undershurbs with very small bluish-white flowers produced on slender stem. Very rare, as undergrowth in Evergreen section. A medicinal herb.

SAPOTACEAE

Madhuca Hamilton *ex* Gmel.

***Madhuca longifolia** (Koen. ***ex** L.) Mac Bride, Contr. Gray Herb. Harward n.s, 53:17. 1918. -- Bassia longifolia Koen. ***ex** L. Mant. 2:563. 1771; FBI 3:544. 1882; FPM 2:537. 1921.

Deciduous trees with fissured bark and terminal flowers. Rather rare, in Karakad and Kannimangalam sections, especially near seasonal water courses. A medicinal plant.

OLEACEAE

Chionanthus L.

***Chionanthus mala-elengi** (Dennst.) P.S. Green, Bull. bot. Surv. India 26:123-124. 1985. -- ***Linociera malabarica** Wall. ***ex** G. Don Syst. 4:53. 1838; FBI 3:607. 1882; FPM 2:794. 1921.

Graceful trees with leathery leaves and white flowers with reddish tinge. Rather common in Kannimanqalam section especially around the open grassland and rarely seen in Evergreen section.

Olea L.

***Olea dioica** Roxb. Fl. Ind. 1:105. 1820; FBI 3:612. 1882; FPM 2:796. 1921.

Small trees with bright green foliage, white flowers and blue coloured fruits. Fairly common in the perifery of the evergreen patch. Bark medicinal.

APOCYNACEAE

Ervatamia (DC.) Stapf

Ervatamia heyneana (Wall.) Cooke, F1. Presid. Bombay 2:134. 1904; FPM 2:813. 1923. - ***Tabernaemontana heyneana*** Wall. in Edgw. Bot. Reg. t. 1273. no.7. 1829; FBI 3:647. 1882.
Pala,Koonam–pa1a.

Trees with milky latex, fragrant flowers and yellow fruits. Rare, in the disturbed forest patches on **the** way to Evergreen section. A medicinal plant.

Holarrehna R. Br.

****Holarrehna antidysentricd*** (Roth) *A.* DC. Prodr. 8:413. 1844; FBI 3:644. 1882; FPM 2:811. 1923.

Shrubs with profuse milky latex, showy white flowers and green fruits. Rare, along the sides of rocks right on the top of the hill, near the evergreen patch. Has medicinal properties.

Rauvolfia L.

****Rauvolfia serpentina*** (L.) Benth. ex Kurt, For. F1. Burma 2:171. 1877; FBI *3:632.* 1882; FPM 2:807. 1923.

Herbs with deep red flowers and fruits maturing black in colour. A rare undergrowth in the Evergreen section. A popular medicinal plant.

ASCLEPIADACEAE

Hemidesmus R. Br.

****Hemidesmus indicus*** (L.) R. Br. in Aiton, Hort. Kew. ed. 2, 2:75. 1811; FBI 4:4. 1884; FPM 2:825. 1923.
Naru–neendi.

Much branched twining herbs with wiry stem and tuberous roots producing yellowish white flowers. Rare, along hedges, mostly in the Kurishumudi section. A medicinal plant.

GENTIANACEAE

Canscora Lamk.

****Canscora diffusa*** (Vahl) R. Br. Prodr. 451. in obs. 1810; FBI 4:103. 1883; FPM 2:878. 1923.

A very pretty slender, annual herb with pink flowers and leaf like bracts. Rare, in wet areas of Kurishumudi section. A medicinal herb.

BORAGINACEAE

Heliotropium L.

***Heliotropium** scabrum Retz. Obs. Bot. 2:8. 1781; FBI 4:152. 1883; FPM 2:897. 1923.

Erect or procumbent herbs in wet areas and forest openings. Common in the foothills of Kurishumudi section. A medicinal plant.

CONVOLVULACEAE

Argyreia Lour.

***Argyreia nervosa** (Burm. f.) Bojer, Hort. Maurit. 224. 1837. -- *A. speciosa* (L.f.) Sweet, Hort. Lond. 289. 1827; FBI **4:185.** 1883; FPM 2:907. 1923.

Scandent shrubs with ovate-deltoid leaves, flowers in axillary and terminal cymes and indehiscent fruits. Rare, in the forest outskirts at Kurishumudi.

Evolvulus L.

***Evolvulus alsinoides** (L.) L. Sp. Pl. ed. 2(1):392. 1762; FBI 4:220. 1883; FPM 2:923. 1923.

Spreading herbs with hairy branches, oblong-lanceate leaves and light blue flowers. Common in the open areas and waste places of Karakad and Kurishumudi sections. A common ingredient in Ayurvedic medicines.

Xpomoea L.

Ipomoea hederifolia** L. Syst. Nat (ed. 10) 925. 1759. -- ***quamoclit pheonica** (Roxb.) Choisy, Mem. Soc. Phys. Geneve. 6:433. 1834; FPM 2:919. 1923. ***Ipomoea coccinea auct. Clarke in Hook. f. FBI 4:199. 1883. ***nun*** L. 1753.

Twining herbs; stem sparsely pubescent with ovate to sub-orbicular leaves, solitary flowers in lax cymes and subglobose fruits. Rare, in forest outskirts of Kurishumudi section.

Merremia Dennst. ex Endl.

***Merremia vitifolia** (Burm. f.) Hall. f. Bot. Jahrb. Syst.

1893; FPM 2:928. 1923. -- ***Ipomoea vitifolia*** (Burm. f.) Bl. BiJdr. 765'. 1825; FBI 4:213. 1883.

Twining herbs with hirsute stem, palmately 5-7 lobed leaves and flowers in 1–3 flowered axillary cymes. Rather common in Kurishumudi section, in the outskirts.

SOLANACEAE

Physalis L.

Physalis minima L. Sp. Pl. 183. 1753; FBI 4:238. 1883; FPM 2:939. 1923.
Jgota-nodian.

Succulent herbs with hispid branches and bladder-like fruits. A weed, rather very common in waste places and wet areas of the outskirts of Karakad and Kurishumudi sections. A medicinal plant.

Solanum L.

****Solanum violaceum*** Ort. **Hort.** Mart. Dec. 56. 1798. **-- *S. indicum auct. non* L.**; FBI 4:234. 1883; FPM 2:938. 1923.

Undershrubs with spinous stem and leaves and white terminal flowers with yellow anthers. Common in the outskirts of the forests at Pottah, as a weed. A medicinal herb.

SCROPHULARIACEAE

Scoparia L.

Scoparia dulcis L. Sp. Pl. 116. 1753; FBI 4:289. 1884; FPM 2:964. 1923.

Erect, branched herbs with globose capsules produced profusely. Common in wet areas of the forest outskirts, especially of Kurishumudi section. A medicinal plant.

Torenia L.

****Torenia bicolor*** Dalz. in Hook. J. Bot. Kew Gard. Misc. 3:38. 1851; FBI 4:278. 1884.; FPM 2:957. 1923.

Trailing herbs with sparsely hairy stem, broadly ovate or deltoid leaves, axillary flowers and linear oblong capsules. Common, in wet areas of the outskirts of the forest adjacent to Kurishumudi section.

OROBANCHACEAE

Aeginetia L.

***Aeginetia indica** L. Sp. Pl. 632. 1753; FBI 4:320. 1884; FPM 2:974. 1924.

Very colourful herbs with pink stem and flowers. A root parasite, very rare, growing along the sides of rocks in Evergreen and Kannimangalam sections.

***Aeginetia pedunculata** Wall. Pl. Asiat. Rar. t. 219. 1832; FBI 4:320. 1884; FPM 2:974. 1924.

Herbaceous root parasites with reddish stem and orange coloured flowers. Very rare, in the Pottah area on the way to Evergreen section.

LENTIBULARIACEAE

Utricularia L.

***Utricularia graminifolia** Vahl, Enum. 1:95. 1804; FPM 2:981. 1924. -- ***U. caerulea auct. non** L.; FBI 4:331. 1884.

Erect, filiform herbs with pinkish white flowers. Common during monsoon in the grassland area of Kannimangalam section, in a thin layer of water among grasses.

ACANTHACEAE

Nilgirianthus Bremek.

***Nilgirianthus barbatus** (Nees) Bremek. Verh. K. Ned. Akad. Wt. 41(1):174. 1944. -- *Strobilanthus barbatus* Nees in Wall. Pl. Asiat. Rar. **3:85.** 1832; FBI 4:437. 1884; FPM 1:1037. 1924.
Kuringi.

Undershrubs with light green foliage and white flowers. A fairly common undergrowth in the evergreen forests of Evergreen section.

Thunbergia Retz.

***Thunbergia fragrans** **Roxb.** Pl. Corom. t. 67. 1796; FBI 4:390. 1884; FPM 2:1007. 1924.

A slender herb with variable, narrow, oblong, lanceate leaves, and axillary, solitary flowers. Rare, in Kurishumudi section, along the wet sides of rocks.

Callicarpa L.

***Callicarpa tomentosa** (L.) Murr. Syst. Veg. ed. 13:130. 1774. -- **C. lanata** L. Mant. 2:331. 1771; FBI 4:567. 18135; FPM 2:1092. 1924.*

Fulvous stellate hairy trees with leaves crowded towards the apex of branchlets. Rather rare in Kannimanyalam section, in disturbed forests and teak plantations. A medicinal plant.

Clerodendrum L.

***Clerodendrum serratum** (L.) Moon. Cat. P1. Ceylon 46. No. 382. 1824; FBI 4:592. 1885; FPM 1:1100. 1924.*

Shrubs with 4-angular stem, elliptic-lanceate, acuminate, serrate leaves and flowers in terminal panicles. Rare, in the open, disturbred areas of Kurishumudi section. A weed with medicinal properties.

***Clerodendrum vircosum** Vent. Jard. Malm. t. 25. 1803. -- **C. infortunatum auct. multi.** non L.; FBI 4:594. 1885; FPM 2:1100. 1924. Peruvu.*

Shrubs with white flowers, common in distrubed areas and forest openings, especially in Kurishumudi, Karakad and Kannimanqalam sections. A medicinal shrub.

Lantana L.

***Lantana camara** L. var. **aculeata** (L.) Mold. Torreya 34:9. 1934. -- **L. aculeata** L. Sp. P1. 627. 1753; FPM 2:1087. 1924. - **L. camara auct. non** L.; FBI 4:562. 1885.*
Konqini, Seema-pacha.

Straggling, armed shrubs with angular stem, yellowish red flowers and globular fruits. An exotic weed, straggling on hedges in Kurishumudi section, possessing medicinal properties.

Stachytarpheta Vah1

***Stachytarpheta jamaicensis** (L.) Vahl, Enum. P1. 1:206. 1804; -- S. **indica** (L.) Vahl, Enum, P1. 1:206. 1804; FBI 4:564. 1885; FPM 2:1090. 1924.*
Seema-kongini.

Herbs with simple, opposite, elliptic or ovate leaves and blue flowers in terminal slender spikes with closely packed bracts. Rather common as a hedge plant in the outskirts of Kurishumudi section. A medicinal plant.

Tectona L.f.

Tectona grandis L..f. Suppl. P1. 151. 1781; FBI 4:570. 1885; FPM **2:1092. 1924.**
Thekku.

The common teak tree growing in Malayattoor, both in plantation and in wild. A medicinal tree.

LAMIACEAE

Hyptis Jacq.

Hyptis suaveolens (L.) Poit. Ann. Mus. Nat. Hist. Paris **7:472. t. 29. 1806;** FBI **4:630. 1885;** FPM **2:1129. 1924.**

Herbs with pungent smell and hispid branches. Common in the open, dry areas of Karakad and Kurishumudi sections and on the rocky flat top of the hill near the evergreen patch.

Leucas R. Br.

Leucas aspera (Willd.) Link, Enum. Hort. Berol. **2:112. 1822;** FBI 4:690. 1885; FPM 2:1150. 1924.
Thumba.

Herbs with angled, hipid, green stem and terminal white flowers. Common in the plains of Kurishumuci and Karakad sections. A medicinal plant.

Pogostemon Desf.

****Pogostemon paniculatus*** (Willd.) Benth. in Wall. Pl. Asiat. Rar. l:30. 1830: FBI 4:631. 1885; FPM 2:1132. 1925.

Aromatic herbs with bluish white flowers. A common weed in the out-skirts of forests and waste places, especially in Kurishumudi and Karakad sections.

NYCTAGINACEAE

Boerhavia L.

Boerhavia diffusa L. Sp. Pl. **3.1753;** FPM **2:1162. 1925.** -- ***B. repens*** L. Sp. Pl. **3. 1753;** FBI 4:709. 1885.

Diffuse, trailing herbs with light reddish stem and pinkish flowers. Fairly common in wet, open areas in the outskirts of the forests of Kurishumudi section. A medicinal plant.

AMARANTHACEAE

Achyranthes L.

Achyrrnthes aspera L. Sp. P1. 204. 1753; FBI 3:730. 1885; FPM 2:1176. 1925.

An erect herb reaching 3 feet in height with velvetty, orbicular, obovate or elliptic, usually obtuse, thick leaves and slender spikes; the fruits easily adhere to animals or clothings. Rather common in the outskirts of Kurishumudi section. A medicinal plant.

Aerva Forsk.

Aerva lanata (L.) Juss. Ann. Mus. Hist. Nat. Paris 2:131. 1803; FBI 4:728. 1885; FPM 2:1178. 1925.

A small herb with long tap root and many pubescent shoots, simple, alternate, obovate leaves and very small greenish white flowers in small dense axillary spikes. A weed in the outskirts of the forests around Kurishumudi section. A medicinal plant.

PIPERACEAE

Peperomia Ruiz. *et* Pav.

Peperomia dindigulensis Miq. Syst. Piper. 122. 1843; FBI 5:98. 1886; FPM 2:1210. 1925.

Erect or subdecumbent, fleshy herbs with greenish spikes towards the apex of branches. Rare, in shaded areas, sometimes epiphytic on rocks or trees in the Evergreen section of Malayattoor forests.

Piper L.

****Piper longum*** L. Sp. P1. 29. 1753; FBI 5:83. 1886; FPM 2:1205. 1925.

Slender undershrubs with ovate or ovate-oblong glabrous leaves and cylindrical, thick fruiting spikes; the fruits are red when ripe. In the forest floor of Kurishumudi section as an undergrowth. A medicinal plant.

MYRISTICACEAE

Knema Lour.

****Knema attenuata*** (Hook. f. ex Thoms.) Warb. Monogr. Myrist. 590. 1897; FPM 2:1215. 1925. -- ***Myristica attenuata*** Wall. *ex* Hook. *f.* et Thoms. Fl. Ind. 157. 1855; FBI 5:110. 1886.

Lofty trees with clean, straight trunk, yellowish flowers and light yellow pubescent fruits. Fairly common in the evergreen patch on top of the hill.

Myristica Gronov.

Myristica dactyloides Gaertn. Fruct. 1:195. t. 41. 1788. – *M. beddomei* King, Notes Roy. bot. Gard. Calcutta 4:291. t. 118. 1893; FPM 2:1215. 1925. – *M. laurifolia* Hook. f. var. *lanceolaria* Hook. f. FBI 5:103. 1886.

Tall trees with straight, :lean trunk and pubescent branchlets. Fairly common in the evergreen patch as a top canopy tree. A medicinal tree.

LAURACEAE

Litsea L.

****Litsea stocksii*** Hook. f. F1. Brit. India 5:176. 1886; FPM 2:1236. 1925.

Trees with lanceate–oblong leaves and creamy white perianth and ellipsoid berries. Rare, in Kurishumudi section. A medicinal plant.

Neolitsea (Benth.) Merr.

Neolitsea cassia (L.) Kosterm. J. Sci. Res. Indonesia 1:85. 1952. – ***N. zeylanica*** (Nees) Merr. Philipp. J. Sci. Bot. Suppl. 1(1):57. 1906; FPM 2:1230. 1925. -- ***Litsea zeylanica*** Nees, Amoen. Bot. Bonn. Fasc. 1:58. t. 5. 1823; FBI 5:176. 1886. (pro parte).

Trees with terminal inflorescence and fruits with persistent perianth lobes. Rather rare, in Evergreen and Kannimangalam forest sections of Malayattoor. A medicinal and aromatic tree.

LORANTHACEAE

Dendrophthoe Mart.

Dendrophthoe falcata (L.f.) Etting, Derikschr. Akad. Wissen. Math. Natur. Cl. 32:52, 53, 58. fig. 14. 1872. ***--Loranthus longiflorus*** Descr. Lamk. Encyl. Meth. Bot. 3:598. 1789; FBI 5:214. 1886; FPM 2:1253. 1925.
Ithi-kanny, Ithil.

Shrubaceous branch parasites on trees with pink fruits. Rather common on trees like *Tectona grandis* L.f. and *Pterocarpus marsupium* Roxb. in Karakad and Kannimangalam sections. A medicinal plant.

Helixanthera Lour.

***Helixanthera wallichiana** (Schult.) Danser, Bull. Jard. Bot. Burtz. 3,10:317. 1929. -- *Loranthus intermedius* Wt. ex Hook. f. FBI 5:265. 1886; FPM 2:1251. 1925.

Branch parasites on small trees of *Xeromphis uliginosa*, in the opening of the forest where the grassland is seen in Kannimangalam section.

EUPHORBIACEAE

Antidesma L.

***Antidesma alexiteris** L. Sp. P1. 1027. 1753 *(pro parte);* FBI 5:359. 1887. -- *A. zeylanicum* Lamk. Encyl. Meth. Bot. 1:207. 1783; FPM 2:1297. 1925.

Undershrubs with green fruits. Rather rare in the evergreen patch, forming part of the ground flora.

***Antidesma bunius** Spreng. Syst. Veg. 1:826. 1825; FBI 5:358. 1887; FPM 2:1298. 1925.

Shrubs with dark green foliage and green fruits. A rare undergrowth in the Evergreen section. Leaves medicinal.

Aporusa B1.

***Aporusa lindleyana** (Wt.) Baill. Etud. Gen. Euph. 645. 1874; FBI 5:349. 1887; FPM 2:1309. 1925.
Vetti.

Small trees with globular fruits. Rare, in Kannimangalam section, in open areas. Roots medicinal.

Baccaurea Lour.

***Baccaurea courtallensis** (Wt.) Muell.- Arg. DC. Prodr. 15(2):459. 1866; FBI 5:367. 1887; FPM 2:1310. 1925.

Graceful trees with red flowers and red fruits produced cauliflorously. Fairly common in the evergreen patch.

Baliospermum B1.

***Baliospermum montanum** (Willd.) Muell. in DC. Prodr. 15:1125. 1866; FPM 3:1342. 1925. -- *B. axillare* B1. Bijdr. 604. 1826; FBI 5:461. 1887.

Leafy undershrubs with leaves variable in size and shape; large leaves

ovate, otlonq or rounded and small ones lanceate. Rare, in forested areas of Yurishumudi section. A medicinal plant.

Breynia Forst. f.

***Breynia rhamnoides** (Retz.) Muell. - Arg. DC. Prodr. 15(2):440. 1866; FBI 5:330. 1887; FPM 2:1304. 1925.

Shrubs, 1-3 m high with green fruits. Rare, in the openings and along hedges in Kannimanqalam section. A medicinal plant.

Bridelia Willd.

***Bridelia scandens** (Roxb.) Willd. Sp. P1. 4:979. 1806; FPM 2:1281. 1925. -- *B. stipularis* Hook. f. *(non* Bl.) FBI 5:270. 1887 *(pro parte).*

Stragglers with brown flowers and green fruits. Very common in Kannimangalam section, along hedges. All parts of the plant medicinal.

Croton L.

***Croton bonplandianum** Baill. Adansonia 4:339. 1864. -- C. *sparsiflorus* Morong. in Ann. N.Y. Acad. Sci. 7:221. 1893; FPM 2:1316. 1925.

Erect, much branched herbs with greenish-white flowers in terminal inflorescence. A weed in waste places, especially along the way sides to Kurishumudi top.

***Croton caudatus** Geisel. Croton Monogr. 73. 1807; FBI 5:388. 1887; FPM 2:1315. 1925.

Shrubs with creamy white flowers. Rather common along the sides of the hill stream in Evergreen section. A medicinal plant.

Euphorbia L.

***Euphorbia antiquorum** L. Sp. P1. 450. 1753; FBI 5:255. 1887; FPM 2:1273. 1925.

Armed fleshy shrubs with copious milky latex and jointed green stem devoid of leaves. Often planted along hedges around Kurishumudi and Karakad sections. Latex medicinal.

Jatropha L.

***Jatropha gossipifolia** L. Sp. P1. 1006. 1753; FBI 5:583. 1887; FPM 2: 1340. 1925.

Shrubs with watery latex and reddish flowers in terminal clusters.

Common in Kurishumudi section in waste places and also at Illithodu in the outskirts of the forests. A medicinal plant.

Kirganelia Baill.

***Kirganelia reticulata** (Poir.) Baill. Etud. Gen. Euphorb. 613. 1858; FPM 2:1294. 1925. -- ***Phyllanthus reticulatus** Poir. Lamk. Encyl. Meth. Bot. 5:298. 1804; FBI 5:288. 1887.

Branched shrubs with distichous leaves and globose, purple fruits. Rare, in the forest outskirts of Karakad and Kurishumudi sections.

Macaranga Thou.

***Macaranga peltata** (Roxb.) Muell. - Arg. DC. Prodr. 15(2):1010. 1866; FPM 2:1326. 1925. -- ***M. roxburghii** Wt. Ic. Pl. India Orient. t. 1852. 1853; FBI 5:445. 1887.
Vatta, Oothooni.

Trees with latex and almost circular leaves. Rather common in disturbed forest areas of all the four sections of Malayattoor forests, especially in the otskirts. Gum medicinal.

Mallotus Lour.

***Mallotus philippensis** (Lamk.) Muell. - Arg., Linnaea 34:196. 1865; FBI 5:442. 1887; FPM 2:1322. 1925.

Shrubs or small trees with creamy white flowers. Common in the moist deciduous forests and teak plantations of Kannimangalam section. Whole plant is medicinal.

Phyllanthus L.

***Phyllanthus emblica** L. Sp. Pl. 982. 1753; FBI 5:289. 1887. -- ***P. officinalis** Gaertn. Fruct. 122-123. 1790; FPM 2:1275. 1925.
Nelli.

Medium sized trees with linear-oblong leaves and depressed globose, edible fruits. Rare, in the deciduous forests of Kannimangalam, Karakad and Kurishumudi sections. A medicinal plant.

Securinega Comm. ex A. Juss.

***Securinega leucopyrus** (Willd.) Muell. in DC. Prodr. 15(2):451. 1866. -- ***Fluggea leucopyrus** Willd. Sp. Pl. 4:757. 1806; FPM 2:1296. 1925.

Shrubs with greenish white flowers and green fruits. Rare, in Kannimangalam section, in the openings. Leaves medicinal.

ULAMCEAE

Trema Lour.

***Trema orientalis** (L.) Bl. Mus. Bot. Lugd. Bat. 2:62. 1856; FBI 5:484. 1888; FPM 3:1350. 1928.
Amathali, Malan-thodali.

Aggressive trees with pale greenish-white flowers. Fairly common in the forest openings and disturbed areas of Kannimangalam section. A medicinal plant.

MORACEAE

Artocarpus J.R. & G. Frost.

***Artocarpus hirsutus** Lamk. Encyl. Meth. Bot. **3:210.** 1789; FBI 5:541. 1888; FPM 3:957. 1928.
Anji1i.

Tall trees with thick crown and edible fruits. Rather rare in Kurishumudi and Karakad sections and lower elevations of Evergreen section. Dried leaves medicinal.

Ficus L.

***Ficus benghalensis** L. Sp. P1. 1059. 1753; FBI 5:499. 1888; FPM 3:1361. 1928.
Aal, Aal-maram.

Spreading trees with aerial roots and orange-coloured fruits. Along pathsides in the outskirts of Kurishumudi section. A medicinal plant.

***Ficus callosa** Willd. Mem. Acad. Roy. Sci. Hist. Berlin 102. 1798; FBI 5:516. 1888; FPM 3:1364. 1928.

Trees with buttressing base and smooth bark, producing green fruits. Rare, along the forest boundary in Kannimangalam section.

***Ficus religiosa** L. Sp. P1. 1059. 1753; FBI 5:513. 1888; FPM 3:1363. 1928.

Stunted trees with green fruits. Rare, along the sides of rocks on the flat hilltop near the evergreen patch. A medicinal plant.

Ficus tinctoria** Forst. f. ssp. ***parasitica** (Willd.) Corner, Gard. Bull. Str. Settl. 17:476. 1960. -- *F.* ***gibbosa** Bl. var. ***parasitica King, Ann. Roy. Bot. Gard. 1:t. 2 a-b. 1887; FBI 5:497. 1888; FPM 1928.

Medium sized trees with latex and green fruits. Rather common in the forests of Kurishumudi section. Leaves and roots medicinal.

Streblus Lour.

Streblus asper Lour. Fl. Cochinch. 615. 1760; FBI 5:489. 1888; FPM 3:1353. 1925.

Shrubs with twiggy branches and rough leaves. Rare, in the dry, open areas of Kannimangalam section near the forest guard station. A medicinal plant.

URTICACEAE

Boehmeria Jacq.

****Boehmeria glomerulifera*** Miq. in Zoll. Syst. Verz. Ind. Archip. 101, 104. 1854. -- ***B. malabarica*** Wedd. Arch. Mus. Hist. Nat. Paris 8:35. 1855-56; FBI 5:575. 1888; FPM 3:1387. 1931.

Shrubs with white flowers clustered in the axils. Fairly common as undergrowth in semi-evergreen forest in Evergreen section.

Elatostemma Forst. *et* Forst. f.

Elatostemma lineolatum Wt. lc. Pl. Ind. Orient. t. 1934. 1853; FBI 5:565. 1888; FPM 3:1376. 1931.

Shade-loving herbs with distichous leaves, much variable in shape. Fairly common in the evergreen forest floor of Evergreen section.

Laportea Gaud.

Laportea crenulata (L.) Chew, Gard. Bull. Singapore 21:200. 1965. - ***Fleurya interrupta*** (L.) Gaud. Freyc. Voy. Bot. 497. 1830; FBI 5:548. 1888; FPM 3:1372. 1931.
Chori-kannam.

Herbs with stinging hairs and yellowish flowers. Occasional, in Kannimangalam section as undergrowth along stream sides, and also on the way to Evergreen section. Seeds and roots medicinal.

Pouzolzia Gaud.

Pouzolzia zeylanica (L.) Benn. Pl. Jav. Rar. 67. 1838. -- ***P. indica*** (L.) Guad. Freyc. Voy. Bot. 503. 1826; FBI 5:581. 1888; FPM 1931.

Erect herbs with greenish-white flowers. Rare, in shades and along the sides of rocks in the Pottah area on the way to Evergreen section. A medicinal plant.

ORCHIDACEAE

Acampe Lindl.

Acampe praemorsa (Roxb.) Blatt. & Mc Cann, J. Bombay nat. Hist. Soc. 35:1495. 1932. -- ***Saccolobium wightianum*** Hook. f. Fl. Brit. India. ***6:62.*** 1890; FPM 3:1447. 1928.

Epiphytic herbs with stout, elongated stem, thick roots and leaves that are distichuos and linear-oblong. Flowers yellowish red colour and lip white with red stripes. Fairly common on trees of Kurishumudi section, in thick forests. A medicinal plant.

Dendrobium Sw.

****Dendrobium macrostachyum*** Lindl. Gen. ***et*** Sp. Orch. 78. 1830; FBI 5:735. 1890; FPM 3:1416. 1928.

Subpendulous, epiphytic herbs with drooping, showy inflorescence. Rare, on tree trunks in Kannimangalam and forests on the way to evergreen patch.

Geodorum Jack.

****Geodorum densiflorum*** (Lamk.) Schltr. Feddes Rep. Beih. 4:269. 1919; FPM 3:1437. 1928. -- **G.** ***purpureum*** R. Br. Ait. Hort. Kew ed. 2,5:207. 1813; FBI 6:17. 1890.

Pseudobulbous leafy herbs with incurved inflorescence and pale rose flowers, dropping compact at the apex only. Rare, in Kurishumudi section.

Pholidota Lindl.

Pholidota pallida Lindl. Bot. Reg. sub. **t.** 1777. 1825. -- *P.* ***imbricata sensu*** Lindl. Bot. Reg. t. 1213. 1825; FBI 5:845-46. 1888; FPM 3:1431. 1928.

Pseudobulbous epiphytes with creamy white flowers borne on slender spikes. Rare, in teak plantations of Kannimangalam and Kurishumudi sections.

Rhynchostylis Bl.

****Rhynchostylis retusa*** Bl. Bijdr. 286. **pl.** 49. 1825; FBI 6:32. 1890; FPM 3:1440. 1928.

Herbs with pale pink flowers, spotted with darker pink colour. Rare, in Curishumudi section. A medicinal orchid.

Satyrium Sw.

Satyrium nepalense D. Don, Prodr. F1. Nepal. 26. 1825; FBI 6:168. 1890; FPM **3:1476.** 1928.

Ground orchids with white flowers. Very rare, in the thickets on the flat top of the hill near evergreen patch. A medicinal orchid.

Vanda R. Br.

Vanda tessellata (Roxb.) Hook. *ex* D. Don in London Hort. Brit. 372. 1830; FPM 3:1445. 1928. -- *V.* ***roxburghii*** R. Br. in Bot. Reg. 6:t. 506. 1820; FBI 6:52. 1890.
Mara-vazha.

Epiphytic on trees with spreading fleshy leaves and subpendulous inflorescence. Rare, in Kannimangalam section and in the Pottah part of the reserve forest on the way to Evergreen section. A medicinal orchid.

ZINGIBERACEAE

Costus L.

Costus speciosus (Koen.) Smith, Trans. Linn. Soc. London 1:249. 1800; FBI 6:249. 1892; FPM 3:1490. 1928.
Ana-kuva, Kanna-kuva.

Erect, fleshy herbs with red inflorescence and pinkish-white flowers. Common, above Pottah on the way to evergreen patch. A medicinal plant.

Curcuma L.

Curcuma neilgherrensis Wt. Ic. P1. India Orient. t. 2006. 1853; FBI **7:210.** 1892; FPM 3:1482. 1928.

Tuberous herbs with oblong-lanceate leaves and dense spikes with pale yellowish green bracts. Rather rare, in the open forests on the way to Evergreen section. A medicinal plant.

Globba L.

Globba ophioglossa Wt. lc. P1. India Orient. t. 2002. 1853; FBI 6:201. 1890; FPM 3:1480. 1931.

Erect herbs with flat, distichous leafy stem and deep yellow flowers in terminal inflorescence. Rare, above Pottah on the way to Evergreen section, in the openings.

MUSACEAE

Ensete Bruce

Ensete superbum (Roxb.) Cheesm. Kew Bull, 1947:100. 1948. -- ***Musa superba*** Roxb. Pl. Corom. t. 223. 1805. FBI 6:261. 1890; FPM 3:1497. 1931.
Kal lu-vazha.

Plants with pseudostem, very attractive, especially when in flower. Very rare, in the shady areas of Kurishumudi section and on the rock sides along the hill top before the evergreen patch.

AMARYLLIDACEAE

Curculigo Gaertn.

****Curculigo orchioides*** Gaertn. Fruct. 1:63. t. 13. 1788; FBI 6:278. 1892; FPM 3:1502. 1931.

Scapigerous herbs with yellowish flowers. Common in open, dry areas of Kurishumudi and Kannimangalam sections. Roots medicinal.

DIOSCOREACEAE

Dioscorea L.

****Dioscorea oppositifolia*** L. Sp. Pl. 1033. 1753; FBI 6:292. 1892; FPM 3:1512. 1931.

Herbaceous climbers with brown flowers. Common in the openings along the sides of Kurishumudi hill. Underground stem medicinal.

Dioscorea pentaphylla L. Sp. Pl. 1032. 1754; FBI 6:289. 1892; FPM 3:1511. 1931.
Nuran, Kattu-kachil.

Shrubaceous climbers, twining to the left, producing underground tubers. Rather rare, in the Kurishumudi section, along hedges and in the thickets. Tubers medicinal.

LILIACEAE

Asparagus L.

Asparagus racemosus Willd. Sp. Pl. 2:152. 1799; FBI 6:316. 1892; FPM 3:1517. 1931.
Sathavari.

Slender, armed climbers with light yellow stem and green falcate leaves producing slender tuberous roots. Rare, in Kannimanqalam section, in small thickets. Roots medicinal.

Dracaena Vand. *ex* L.

****Dracaena terniflora*** Roxb. Fl. Ind. 2:159. 1832; FBI 6:,328. 1892; FPM 3:1521. 1931.

Erect undershrubs with leafy stem and white terminal inflorescence. Undergrowth, fairly common in the Evergreen section.

Gloriossa L.

****Gloriossa superba*** L. Sp. Pl. 305. 1753; FBI 6:358. 1889; FPM 3:1519. 1931.
Naadi-poovu.

Slender climbers with leaf apex transformed into tendrils and very prominent flowers. Rare, in the lower part of Kurishumudi section and on the way to Evergreen section above Pottah. A medicinal plant.

COMMELINACEAE

Amischophacelus Rolla Rao *et* Kammathy

****Amischophacelus axillaris*** (L.) Rolla Rao *et* Kammathy, J. Linn. Soc. London 59:306. 1966. -- ***Cyanotis axillaris*** (L.) Schult. *et* Schult. f. Veq. 7(2):1154. 1830; FBI 6:388. 1894; FPM 3:1550. 1931.

Creeping herbs with reddish brown, straited stem and blue flowers. Karakad and Kurishumudi sections, in wet, shaded areas.

Commelina L.

Commelina benghalensis L. Sp. Pl. 41. 1753; FBI *6:370.* 1894; FPM 3:1539. 1931.

Diffuse herbs with blue flowers. Common in dry open areas along the lower altitudes of Karakad, Kurushumudi and Pottah areas.

Floscopa Lour.

***Floscopa scradens** Lour. F1. Coch:inch. 193. 1790; FBI 5:390. 1892; FPM 3:1552. 1931.

Subscandent herbs with elliptic-lanceate leaves, small purple flowers and ellipsoid capsules. Rare, along the wet sides of rocks in Kurishumudi section.

Murdannia Royle

***Murdannia zeylanicum** (Dl.) Bruck. Engl. & Prantl, Pflanzenfam. 15a:173. 1930. -- ***Aneilena zeylanicum** Clarke in DC. Won. Phan. 3:206. 1881; FBI *6:376.* 1883; FPM 3:1544. 1931.

Subpendent herbs with fleshy stem and bluish flowrs. Rather common above Pottah on the way to Evergreen section, along the wet sides of rocks.

PALMACEAE

Calamus L.

Calamus thwaitesii** Becc. *et* Hook. f. F1. Brit. Ind. 6:441. 1892. -- **C. *thwaitesii var. ***camaranus*** Becc. in FBI 6:441. 1892; FPM 3:1567. 1931.

Common in the evergreen patch and **also** scattered in the Kannimanqalam section. Only seedlings and no mature plants are seen. The common commercial cane.

Caryota L.

***Caryota urens** L. Sp. P1. 1189. 1753; FBI 6:422. 1892; FPM 3:1560. 1931.
Choondappana, Kalipana.

Tall palms with leaves crowded towards the apex of the trunk. Seedlings and half-grown trees of this palm are rather common in the evergreen patch. Notably, no mature palms were seen in the area. A common palm with many uses.

ARACEAE

Lagenandra Dalz.

***Lagenandra ovata** (L.) Thw. Enum. P1. Zeyl. 334. 1864; FBI 6:495. 1993; FPM 3:1576. 1931.
Karim-pola.

Gregarious marshy herbs with purplish flowers, forminq a pure patch in kannimangalam section, in a partially aquatic depression.

Pothos L.

***Pothos scandens** L. Sp. P1. 965. 1753; FBI 6:551. 1894; FPM 3:1592. 1931.
Pareel, Pareelkai-valli.

Root climbers with leaves having winged petioles. Rather common in Kannimangalam section, on trees bording the seasonal water course. Stem and leaves medicinal.

ERIOCULACEAE

Eriocaulon L.

***Eriocaulon quinquangulare** L. Sp. P1. 87. 1753; FBI *6:582.* 1893; FPM 3:1620. 1931.

Herbs with thick leaves and white globose inflorescence produced on long stalks. Common during monsoon, in the watery, open grassland of Kannimangalam section.

GRAMINEAE

Bambusa Schreb.

Bambusa bamhos (L.) Voss, Besch. Pflanzen. deutsche Gaerten 2:584. 1896. -- ***Bambusa arundinacea*** Willd. Sp. P1. 2:245. 1799; FBI 7:395. 1896; FPM 3:1859. 1931.

Armed, arborescent bamboos with green stem. Common, as discontinuous patches on the hill top, near the Evergreen section. Commercially important bamboo.

Cymbopogon Spreng.

Cymbopogon flexuous (Nees ***ex*** Steud.) Wats. in Atkin. Gar. N.W. Bov. 392. 1882; FPM 3:1756. 1931. -- ***Andropogon nardus* L.** var. ***flexuosus*** Nees ***ex*** Steud. in DC. Mon. Phan. *6:603.* 1889; FBI *7:206.* 1896.

Tall aromatic grasses forming clumps in open, lateritic dry soils especially above Pottah and in some parts of Karakad section. A medicinal grass.

Cynodon Rich.

Cynodon dactylon (L.) Pers. Syn. P1. 1:85. 1805; FBI 7:288. 1896; FPM 3:1835. 1931.
Karuka-pullu.

Trailing, stoloniferous herbs forming mat on the ground. Common in open areas and along path sides of Karakad and Kurishumudi sections. A highly medicinal grass.

Ochlandra Thw.

Ochlandra travancorica Benth. in Gamble, Ann. Roy. Bot. Gard. Calcutta 7: t. 111. 1896; FBI 7:419. 1897; FPM 3:1863. 1934.

Tall grasses with culms about 1-1.5 cm in diameter and dull white flowers. Rather rare, along the sides of the stream that originates from the Evergreen section. A species of high commercial im ortance far pulp and cottage industries.

2.6. SYNOPSIS OF THE FLORA

Altogether, there are 215 taxa of angiosperms recorded from the four forest sections of Malayattoor, namely Kurishumudi, Karakad, Kannimangalam and Evergreen. They belong to 183 genera and 74 families of flowering plants. Out of them, 63 families are dicotylednous and the remaining 11 families are Monocotyledons. With regard to generic and species content of these two groups, there are 155 genera and 185 species of dicotyledons and 29 genera and 30 species of monocotyledons. The data is tabulated below (Table **2.1).**

able 2.1. Family, generic and species content of dicots and monocots in Malayattoor flora.

Group	Families	Genera	Species
Dicots	63	154	185
Monocots	11	*29*	*30*
Total	**74**	**183**	**215**

With regard to generic representation, the families Papilionaceae and Euphorbiaceae have 17 and 16 species each, respectively,

representing the families with maximum number of genera and species within them in the study area. Among rest of the families, following are represented by 4 or more genera as shown in parenthasis. Rubiaceae **(11),** Compositae (7), Malvaceae **(5),** Caesalpiniaceae ***(6),*** Mimosaceae (4), Verbenaceae **(5),** Convolvulaceae **(4)** and Urticaceae (4). The rest of the dicotyledonous families are with only 3,2 or single genus as representatives in the flora of the region. Among monocotyledons, Orchidaceae with 7 genera and Commelinaceae and Gramineae with 4 genera each rank **as** first three families in generic concentration and the rest of the families are represented by 3 or a less number of genera. A majority of families of both dicotyledons and monocotyledons contain only one or two genera and a few species as represented in the area. This is partly because of the very high disturbance on the flora of the region bringing down the diversity.

Desmodium (4 species), *Ficus* (4 species) and ***Dalbergia*** (4 species) are the genera with maximum species content in the Malayattoor flora. Rest of the genera of both dicotyledons and monocotyledons possess only one, two or rarely 3 species each in the study area. A majority of genera are represented only by a single spcies under them which also indicates the highly disturbed and degraded status of the flora of the region.

2.7. FLORA OF SPECIALIZED ECOLOGICAL NICHE

As mentioned earlier, the flora of Malayattoor forests contain floristic combinations that resulted in evergreen, moist deciduous,

dry deciduous,, scrub and isolated pure patches of certain species like *Terminalia paniculata* and *Pterocarpus marsupium*. They are in addition to those small aquatic or semi-aquatic formations which are mostly seasonal in nature. With regard to the forest types seen in the area, there is nothing characteristic to the region apart from the fact that they are at various stages of degradation. As specialized ecological niche, only the evergreen formation, pure patches of *Terminalia* and *Pterocarpus* and aquatic formations of seasonal nature deserve consideration as they are quite characteristic in this highly degraded forest tract (Fig.2.1).

2.7.1. Evergreen patch

This is a small forest patch occurring in a depression towards the North-eastern side of Kurishumudi peak. An area of 4-5 ha comes under this ecological niche, which still posses almost all features of a truly evergreen forest - closed top canopy, sparse subcanopy and poor ground flora composed of shade and humidity loving species. Accumulation of humus harbouring a rich microflora and occurance of several smaller animal species had made this patch locally known a5 'Patta-kund'. As in the case of any other virgin evergreen forest, from here also, there originates a small hill stream which suddenly descends to about 15 metres within the patch itself and subsequently proceeds through the moist deciduous forest and teak plantations to Join I11i-thodu flowing along the boundary of the reserved forests. Even on sunny days, due to the closed nature of the canopy, sunlight seldom penetrates to the ground, and because of this, the ground is

humid throughout the year. As a peculiarity of the forest type in Malayattoor may be mentioned the total absence of blood-sucking leeches which are quite common in the evergreen forests of Kerala. Floristically, the vegetation type is not very much diverse as in the of any other part of Kerala where the forest type is seen. The top canopy of the vegetation of the region includes lofty trees with dense crown like *Myristica malabarica, Hydnocarpus pentandrus, Saraca asoca, Knema attenuata, Vateria indica* and so on. The subcanopy trees of the patch include *Baccaurea courtallensis, Xanthophyllum flavescens, lxora arborea, Chionanthus mala-elengi, Neolitsea* ***cassia,*** *Antidesma bunius,* etc. The endemic palm *Caryota urens* with lot of seedlings and medium-sized plants is a common feature of the vegetation here. Surprisingly, there is not even a single fully grown palm belonging to the species in the evergreen patch of Malayattoor. Ground flora is composed of herbaceous species like *Elatostemma lineolatum, Nilgirianthus barbatus, Pavetta blanda, Calamus thawitesii, Dracaena terniflora, Chasalia curviflora, Ancistrocladus heyneanus,* etc. In fact, *Ancistrocladus heyneanus* is rather profusely growing in the region other than any other element of the ground flora. As a typical example of an evergreen forest, this patch can be of demonstrative value for the visitors of the Nature Study Centre which is very near to and is accessible by foot.

2.7.2. Pure patches

In Kannimangalam section, there are two pure patches, one of *Pterocarpus marsupium* and the other of *Terminalia paniculata,* each naving an extent of about 5-6 hectares. It seems they were raised

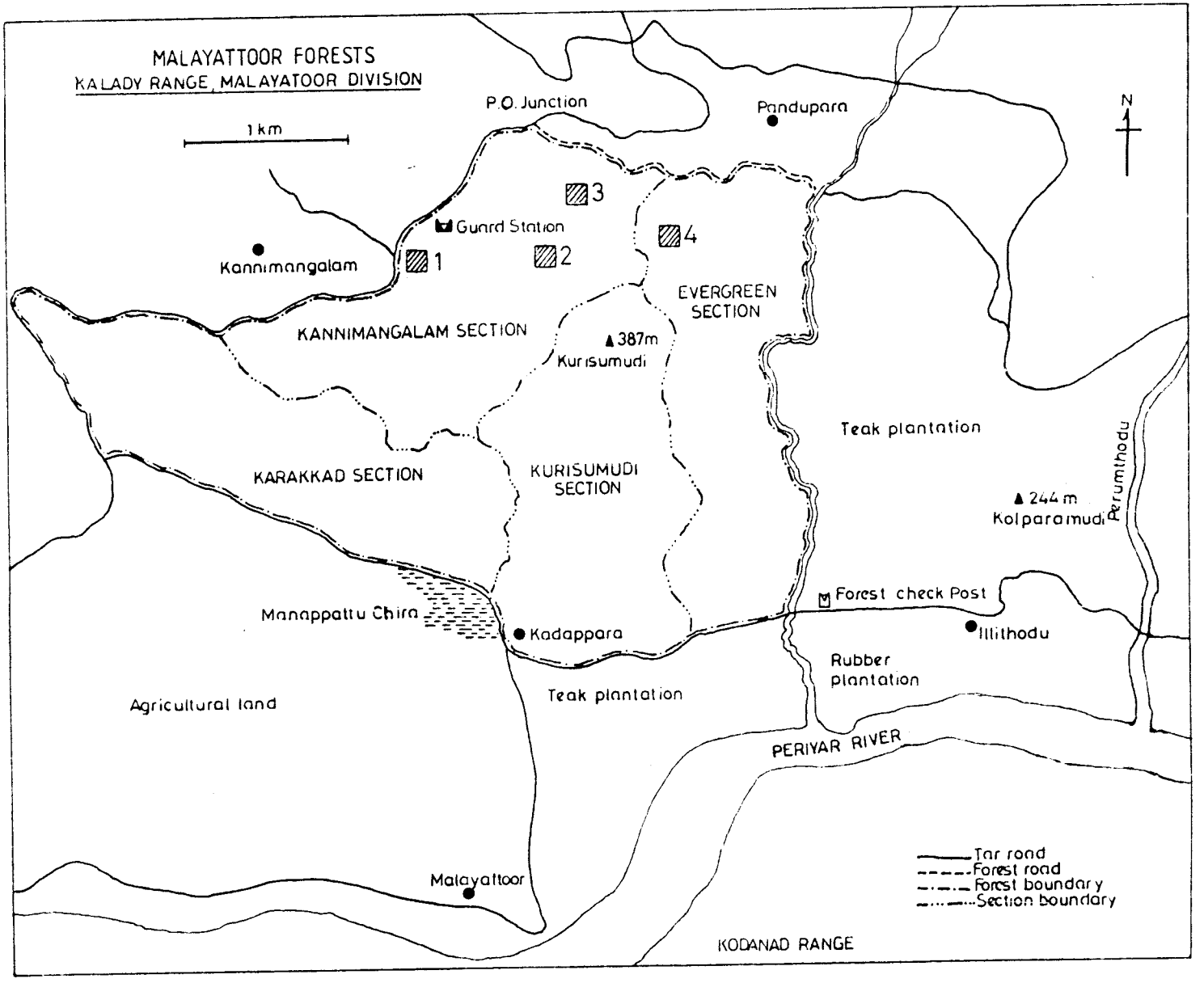

Fig.2.1. Map of the study area showing locations of specialised ecological niche, viz. 1. Pure patch of *Pterocarpus marsupium*, 2. Pure patch of *Terminalia paniculata*, 3. Aquatic formation, and 4. Evergreen patch.

earlier, but now growing in the natural condition without any silvicultural or management inputs. Eventhough ground flora is very poor in these two patches, the tree flora is by and large composed of one of these two species only giving the appearence of a monoculture plantation. The pure patch of *Pterocarpus marsupium* is located in the western perifery of Kannimangalam section, beyond a small seasonal h 11 stream. The area is with several rocky outcrops and ground f ora is formed mostly by species like *Asparagus racemosus, Eupatorium adenophorum, Cipadessa baccifera, Microros paniculata, Canthium angustifolium, Clerodendrum viscosum, Curculigo orchioides, Cymbopogon flexuosus,* etc. During summer, the area is almost devoid of a luxuriant ground flora and graceful stands of *Pterocarpus marsupium,* all of the same size and height, are seen almost as a pure stand. Growth is also found to be very good for the trees.

The pure patch of *Terminalia paniculata* is also in the Kannimangalam section, in a valley along the sides of a seasonal water course. Here also, practically, the ground flora is formed only of seasonal herbs and lofty, clean-boled trees of this species are evenly distributed as a monoculture plantation which extends to about 5-6 hectares. Along the borders of this pure patch are plantations of teak. Species like *Cyclea peltata, Cissampelos pareira, Glycosmis mauritiana, Nothapodytes nimmoniana, Wagatea spicata, Canthium angustifolium, Calamus thwaitesii* and *Pothos scandens* are quite prevelant here adding to the floristic diversity of this pure patch of *Terminalia paniculata.*

2.7.3. Aquatic formations

Eventhough there is no true aquatic vegetation in the study area, a seasonal aquatic formation and a wetland pure patch formed of the avoid species, ***Lagenandra ovata,*** are found in the Kannimangalam section of Malayattocrr forests which are quite characteristic ecological formations.

As mentioned earlier, the grassland formation in Kannimangalam section, which during monsoon get covered by a thin layer of water, is regularly drained by a small canal that runs from one end of it. In this grassland area, during monsoon when it becomes wet and marshy, aquatic species like ***Utricularia graminifolia, Impatiens chinensis, Eriocaulon quinquangulare,*** etc. colonize giving a graceful appearence to the whole area when those species are in bloom. During summer, the grassland is left with only certain bushy species like ***Xeromphis uliginosa, Flacourtia indica*** and ***Helixanthera wallichiana,*** concentrated in 2-3 patches leaving the rest of the area as an open grassland. The noteworthy feature of the grassland here is that it always remain as a grass carpet without any growth, except for the shrubaceous species found here and there. As such, this is a peculiar ecological niche in the whole of the Malayattoor forests worth preserving as a demonstration area. Along the sides of this grassland there is a very luxuriant growth of tree species and climbers like ***Chionanthus malaelengi, Dalbergia horrida, Aporusa lindleyana, Elaeocarpus munronii, Xeromphis uliginosa, Neolitsea cassia*** and ***Mallotus philippensis.***

2.8. GENERAL OBSERVRTIONS AND CONCLUSIONS

In general, the flora of Malayattoor forests is scanty in nature, due to degradation of the vegetation types met with there by various factors and also because of the presence of sheet rock and lateritic caps here and there. Floristic diversity is; also rather very poor as is evident from the checklist and synopsis of the flora given earlier. Tree species are also less in number, so also liana. Ground flora is not rich and invasion of weeds like ***Mikania*** *micrantha, Eupatorium adenophorum, Argemone mexicana, Lantana* ***camera var.*** *aculeata,* etc. is quite common both in the outskirts and also quite interior in the forest. As most of the elements of the ground flora are exotic weeds that are aggressive, there is every possibility that the native ground herbs were suppressed to a maximum extent, thereby reducing their diversity and representation in the area. Added to this, there is heavy anthrcpogenic influences by way of large scale removal of fodder, green manure and other economically or medicinally important species which also have contributed to the general decline of the vegetation, so also its diversity and regeneration.

However, in certain pockets, still there are patches of more or less undisturbed forest vegetation with several native or rare and endangered species. Example of such areas include the evergreen patch with lofty trees like *Vateria indica, Knema attenuata* and rare trees of *Saraca asoca.* In this patrh, there are also quite a good number of endemic species of South-West India namely *Baccaurea courtallensis, Nilgirianthus barbatus, Polyalthia rufescens, Ancistrocladus heyneanus, Caryota urens, Nothopegia travancorica,* etc. and two species the

curious root parasitic herb:, ***Aeginetia indica*** and ***Aeginetia pedunculata.*** Similarly, in Kannimanqalam and Kurishumudi sections also there are a few noteworthy species like ***Grewia lawsoniana, Grewia glabra, Canscora diffusa, Piper longum*** and orchids like ***Acampe praemosa, Geodorum densiflorum, Rhynchostylis retusa,*** and so on. It is only the Karakad section which is very poor in native flora, mainly due to the establishment of cashew plantations, poor site quality and very heavy human disturbances. It is hoped that, with the establishment of the Nature Study Centre, there will be more attention given for the protection of the flora of the region. It is also expected that people, who will be educated on the importance of our floristic wealth and need to protect it through the activities of the Nature Study Centre, will contribute much to the cause of conserving the flora of Malayattoor in future.

2.9. AKNOWLEDGEMENTS

We are thankful to the Kerala Forest Department for financial support to undertake this study. Thanks are also extended to Dr. S. Chand Basha, Director, KFRI for his continued interest and facilities made available for the study. The identities of several specimens were confirmed at Herbarium of the Botanical Survey of India, Coimbatore and we are thankful to Dr. N.P. Balakrishnan, Dr. A.N. Henry and Shri. P. Bhargavan for the same. Officials of the Kerala Forest Department at Malayattoor and Kodanad extended all help and cooperation during field visits and to them also we are very much grateful. The maps presented in this report were prepared by Shri. Subash Kuriakose, KFRI and to him also we are grateful.

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APPENDIX I

INDEX TO MEDICINAL PLANTS

SPECIES INDEX

MACROFUNGAL FLORA AND CHECKLIST OF PLANT DISEASES OF MALAYATTOOR

K. V. Sankaran and E J. M. Florence

3. MACROFUNGAL FLORA AND CHECKLIST OF PLANT DISEASES OF MALAYATTOOR

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Content

ABSTRACT

An inventory of the macrofungal flora of Malayattoor forests was prepared by making intensive collections from the area for a period of one year. A survey for the occurrence of plant diseases in the area was also conducted during the same period.

A total of 44 species of fungi belonging to 28 genera were collected from the study area. The majority (61%) of the fungi belonged to Aphyllophorales (Basidiomycotina). The Agaricales (Basidiomycotina) was represented by eleven species, Ascomycotina by five and Myxomycetes by one species. Of the fungi collected, 14 species were reported to be very frequent in distribution in Kerala and elsewhere in India, 16 were common and one species, viz. ***Phellinus dependens,*** infrequent. The occurrence of the following four species, viz. ***Coriolopsis telfarii, Loweporus fusco-purpureus, Microporellus obovatus*** and ***Trdmetes varians*** were only rarely recorded from India. This study forms the second report of ***M. obovatus*** and ***T. varians*** in India.

The survey for plant diseases revealed the occurrence of a total of 25 foliar diseases affecting *23* species of plants. ***Colletotrichum gloeosporioides*** was the most frequent fungus associated with leaf diseases. Other pathogens included ***Sclerotium rolfsii, Phomopsis*** spp., ***Colletotrichum dematium*** and a species of ***Bortryosphaeria.*** Of the diseases recorded, all except three (viz. ***Colletotrichum*** leaf spot of ***Haldina rordifolia*** and ***Strychnos nux-vomica*** and ***Phomopsis*** leaf spot of ***Clerodendrum viscosum)*** formed new host records for the respective fungi in India.

The study indicated that continued exploration and systematic study of fungi in tropical forests would bring to light many unknown and poorly known species which are economically important and which may be of potential use in biotechnology.

3.1. INTRODUCTION

The fungi are a major component of tropical ecosystems throughout the world. They are involved in innumerable interactions with plants, animals and man, ranging from saprophytism to parasitism and symbiosis (Subramanian, 1982). However, the biodiversity of fungi has not received much attention mostly due to lick of awareness among biologists of the significance of fungi in evolution, ecosystem function and human progress (Hawksworth, 1991).

It is widely accepted that the tropical fungal flora is more diverse in form and structure. But, only very few attempts have been made to study the tropical fungi systematically. Vast tracts in the tropical belts, and diverse habitats and substrates in them remain completely unexplored for fungi (Subramanian, 1982).

It is against this background that the present study was undertaken. The main objectives of the study were:

i. to gather information on the macrofungal flora of the Malayattoor forests of Kerala, and.

ii. to prepare a checklist of plant diseases in the area.

3.2. MATERIALS AND METHODS

3.2.1. Collection and identification of macrofungi

Collection of the macrofungi were made during September, 1991 to October, 1992. General macrocharacters of the fruit bodies

including colour of different tissues were noted in the field itself. The fruitifications were wrapped in paper bags and brought to the laboratory. Spore deposits were taken on microslides by keeping fresh fruit body in humid condition. Measurements and detailed observation of the fruit bodies were made in the laboratory.

Microscopic details of various representative areas of the fruit body, hyphal system and spores of members of Aphyllophorales were studied as suggested by Teixeira (1962). Five percent KDH and lactophenol were used as the general mounting media. Congo red and cotton blue were also used. Amyloid reaction of the spores were studied using Melzer's reagent. Identifications of the fungi were based on macro and micro characters of the fruit body. Type of rot produced by the fungus on wood was also considered for identifying members of Aphyllophorales. Books and monographs used for identifying the macrofungi include, i. Indian Polyporaceae by Bakshi (1971), ii. a preliminary polypore flora of East Africa by Ryvarden and Johansen (1980), iii. studies on wood-inhabiting macrofungi of Kerala by Ganesh (1988), iv. a preliminary agaric flora *of* East africa (Pegler, **1977),** v. Agaric flora of Sri Lanka (Pegler, 1986) and vi. The agaricales in modern taxonomy (Singer, 1975).

Isolation of fungi associated with plant diseases

Samples of plant parts showing symptoms of various diseases were collected from the study area during September, 1991 to October, *1992.* In the laboratory, small portions of the infected tissues were surface

sterilized in 0.1% mercuric chloride solution and washed in several changes of sterile water. These were then plated on potato-dextrose agar (PDA) and incubated at 25 + 2°C for one week. The morphology of the isolates was studied and identification done using mycological keys and monographs.

3.3. RESULTS AND DISCUSSION

3.3.1. Macrofungal flora

An enumeraton of macrofungi collected from Malayattoor forests follows. The distribution of these fungi in India and their economic importance are also given with each of the species.

1. ***Chlorophyllum molybdities*** (Meyer ex **Fr.)** Massee (Agaricales – Basidomycotina)

   Locality (L): Illithode, Malayattoor, Kerala. Date of collection (Date): 26 Sept. 1991. Distribution: Very common in Kerala (Little Flower, 1983) and other parts of India (Manjula, 1983).

2. Clarkeinda trachodes (Berk.) Singer (Agaricales – Basidiomycotina)

   L: Illithode. Date: 26 Sept. ***1991.*** Distribution: Common. Reported from Kerala by Leelavathy ***et a1.(1981)*** and Little Flower

3. ***Collybia leucophaea*** (Berk. & **Br.)** Sacc. (Agaricales-Basidiomycotina)

L: Mulamkuzhi, Malayattoor, Kerala. Date: 20 July 1992. Distribution: Common. Reported from Kerala by Manimohan (1988).

4. ***Coriolopsis caperata*** (Berk.) Murr. (Aphyllophorales-Basidiomycotina)

L: Mulamkuzhi, Malayattoor, Kerala. Date: 21 Oct. 1992. Distribution: Common. Reported from Assam, Bengal, Madhya Pradesh, Andamans and Madras (Bakshi, 1971). Known to occur in Nilambur, Silent Valley and Wynad (Kannoth and Begur reserve forests) forests in Kerala (Ganesh, 1988). Economic Importance (EI): *Associated* with white fibrous rot of dead logs.

5. ***Coriolopsis telfarii*** (Kl.) Ryv. (Aphyllophorales-Basidiomycotina)

L: Illithode, Malayattoor, Kerala. Date: 26 Sept. 1991. Distribution: Rare. Reported as ***Polyporus zeylanicus*** Berk. by Bakshi ***et al.*** (1972) from Dehra Dun. Ganesh (1988) recorded C. ***telfarii*** from Nilambur, Tirunelli (Wynad Dt.) and Malakkappara (Trichur Dt.) in Kerala. EI: Causes white rot *of* wood.

6. ***Favolus brasiliensis*** (Fr.) Fr. **(Aphyllophorales-Basidiomycotina)**

L: Mulamkuzhi. Date: 23 Oct. 1992. Distribuion: Common. Known to occur in Uttar Pradesh, Sikkim, West Bengal (Bakshi, 1971; Bilgrami ***et al.*** 1991) and Kerala (Ganesh, 1988). EI: Causes white fibrous rot.

7. ***Flavodon flavus*** (K1.) Ryv. (Aphyllophorales-Basidiomycotina)

L: Illithode, Mulamkuzhi and Kannimanqalam. Date: *26* Sept.1991, 22 Oct. 1992, 23 Oct. 1992. Distribution: Common in Kerala and other States of India (Bakshi, 1971). EI: Associated with white fibrous rot.

8. Fomitopsis rhodophaeus (Lev.) Imaz. (Aphyllophorales-Basidiomycotina)

L: Illithode and Mulamkuzhi. Date: 22 Oct. 1992. Distribution: Common in Kerala forests (Ganesh, 1988). Known to occur in Karnataka, Tamil Nadu and West Bengal (Bakshi, 1971). EI: Causes brown cuboidal rot of wood.

9. ***Hexagonia tenuis*** (Hook.) Fr. (Aphyllophorales-Basidiomycotina)

L: Illithode, Kannimanqalam and Kurisumudi. Date: 26 Sept. 1991, 23 Oct. 1992. Distribution: Common in Kerala and other States in India (Bakshi, 1971; Ganesh, 1988). EI: Causes white fibrous rot of wood.

10. ***Hygrocybe conica*** (Scop. : Fr.) Kummer (Agaricales-Basidiomycotina)

L: Mulamkuzhi. Date: 20 July 1992. Distribution: Common in Kerala (Little Flower,1983)

11. ***Lenzites acuta*** Berk. (Aphyllophorales-Basidiomycotina)

L: Illithode, Mulamkuzhi, Kannimangalam and Kurisumudi. Date: 26 Sept. 1991, 21 Oct. 1992, 23 Oct. 1992. Distribution: Widespread

throughout India. Occurs in all types of habitats including forests, wooded areas, garden, timber depots and exposed wooden structure of buildings (Bakshi, 1971; Ganesh, 1988; Bilgrami, ***et al.*** 1991). Synonym: ***Daedalea flavida*** Lev. EI: Causes white spongy rot of dead branches of living trees. This is one of the commonest species found in Kerala which shows a lot of morphological variations (polymorphic).

12. ***Lepista hyalodes*** (Berk. & Br.) Pegler **(Agaricales-Basidiomycotina)**

L: Illithode. Dated: 26 Sept. 1991. Distribution: Very common in Kerala (Manimohan & Leelavathy, 1989).

13. ***Loweporus*** *fusco-purpureus* (Pers.) Ryv. (Aphyllophorales-Basidiomycotina)

L: Illithode and Mulamkuzhi. Date: 22 Oct. 1992. Distribution: Rare. Known to occur in Andaman and Nicobar Islands (Bakshi, 1971). Collected from Sholayar (Trichur) and Nadukani (Nilambur) forests in Kerala by Ganesh (1988). EI: Associated with white fibrous rot.

14. ***Leucocoprinus birnbaumii*** (Corda) Singer (Agaricales-Basidiomycotina)

L: Kurishumudi. Date: 20 July 1992. Distribution: Very common in Kerala (Little Flower, 1983) and other parts of India (Manjula, 1983).

15. ***Marasmiellus purpureoalbus*** (Petch.) Singer (Agaricales-Basidiomycotina)

L: Illithode. Date: 26 Sept. 1991. Distribution: Very common in Kerala (Manimohan and Leelavathy, 1989).

16. ***Marasmius haematocephalus*** (Mont.) Fr. **(Agaricales-Basidiomycotina)**

L: Kurishumudi. Date: 20 July 1992. Distribution: Common. Known to occur in Kerala (Manimohan, 1988) and Tamil Nadu (Manjula, 1983).

17. ***Microporellus obovatus*** Ryv. (Aphyllophorales-Basidiomycotina)

L: Kurisumudi, Malayattoor, Kerala. Date: 23 Oct. 1992. Distribution: flare. This is the second record of this fungus from India. Ganesh (1988) reported its occurrence in Nilambur, Sholayar and Vellarimala (Wynad) forests in Kerala. EI: Associated with white fibrous rot of wood.

18. ***Microporus affinis*** (Blume & Nees ex. Fr.) Kuntze **(Aphyllophorales-Basidiomycotina)**

L: Illithode. Date: 26 Sept. 1991. Distribution: Widely distributed in forests of Kerala (Ganesh, 1988). Known to occur in other States of India also (Bakshi, 1971; Bilgrami, ***et al.*** 1991). EI: Causes white rot of wood.

19. Microporus xanthopus **(Fr.)** Kuntze (Aphyllophorales-Basidiomycotina)

L: Illithode, Mulamkuzhi and Kurisumudi. Date: 26 Sept. 1991, 21 Oct. 1992, 23 Oct. 1992. Distribution: Common in Kerala forests

growing mostly on small branches or twigs (Ganesh, 1988). El: Causes white rot.

20. ***Nigroporus vinosus*** (Berk.) Murr. (Aphyllophorales-Basidiomycotina)

L: Mulamkuzhi. Date: 21 Oct. 1992. Distribution: Common in Kerala forests (Ganesh, 1988). Reported to occur in Dehra Dun, Assam and West Bengal (Bakshi, 1971). EI: Associated with white spongy rot of wood.

21. ***Phellinus fastuosus*** (Lev.) Ryv. (Aphyllophorales-Basidiomycotina)

L: Mulamkuzhi. Date: 21 Oct. 1992. Distribution: Common on living hard wood trees in evergreen forests and open areas in Kerala (Ganesh, 1988). Known to occur in other States in India also (Bakshi, 1971; Bilgrami, ***et al.*** 1991). EI: Causes heart rot in ***Terminalia*** **spp.** and other trees.

22. ***Phellinus dependens*** (Murr.) Ryv. (Aphyllophorales - Basidiomycotina)

L: Illithode and Mulamkuzhi. Date: 22 Oct. 1992. Distribution: Not common. Reported from Sholayar and Kathiyur reserve forests in Kerala (Ganesh, 1988). Bakshi (1971) recorded it from Nainital (U.P.) and the Himalayas. EI: Associated with white pocket rot of heart wood.

23. ***Phellinus gilvus*** (Schw.) Pat. **(Aphyllophorales-Basidiomycotina)**

L: Illithode, Kurisumudi. Date: 26 Sept. 1991, 23 Oct. 1992. Distribution: Cosmopolitan. EI: Causes white rot of commercially important timber species in Kerala (Ganesh, 1988).

24. ***Polyporus arcularius*** (Batsch.) Fr. (Aphyllophorales-Basidiomycolina)

L: Illithode and Mulamkuzhi. Date: 22 Oct. 1992. Distribution: Widespread. Reported from several parts of Uttar Pradesh, Orissa and Kerala (Bakshi, 1971; Ganesh, 1988; Bilgrami, ***et al.*** 1991). EI: Causes white rot of wood.

25. Polyporus grammocephalus Berk. (Aphyllophorales-Basidiomycotina)

L: Mulamkuzhi. Date: 31 Oct. 1992. Distribution: Very common in the plains of North and South India (Bakshi, 1971; Bilgrami, ***et al.*** 1991). Ganesh (1988) reported its occurrence in several parts of Kerala. EI: Causes white stringy rot of wood.

26. ***Pycnoporus sanguineus*** (Linn. ex Fr.) Murr. (Aphyllophorales-Basidiomycotina)

L: Illithode and Mulamkuzhi. Date: 22 Oct. *1992.* Distribution: Very common in Kerala and other parts of India (Bilgrami, ***et al.*** 1991). Synonym: ***Polyporus sanguineus.*** EI: Causes white stringy rot.

27. Rigidoporus lineatus (Pers.) Ryv. (Aphyllophorales-**Basidlomycotina)**

L: Illithode, Mulamkuzhi and Kurisumudi. Date: 26 Sept. 1991, 21 Oct. 1992, 23 Oct. 1992. Distribution: Widely distributed in teak plantations and natural forests in Kerala (Ganesh, 1988). Recorded from Uttar Pradesh, West Bengal and South Andamans (Bakshi, 1971). EI: Associated with white pocket rot of wood.

28. Skeletocutis nivea (Jungh.) Keller (Aphyllophorales-Basidiomycotina)

L: Mulamkuzhi. Date: 21 Oct. 1992. Distribution: Cosmopolitan. Recorded from Parambikulam, Nilambur and Calicut University Campus in Kerala (Ganesh, 1988). EI: Associated with white fibrous rot of decorticated branchlets.

29. Termitomyces microcarpus (Berk. & Br.) Heim. (Agaricales-Basidiomycotina)

L: Mulamkuzhi. Date: 20 July 1992. Distribution: Very common in Kerala and other parts of India (Manjula, 1983; Leelavathy, ***et al.*** 1985). EI: edible.

30. ***Termitomyces eurrhizus*** (Berk.) Heim. (Agaricales-Basidiomycotina)

L: Mulamuzhi. Date: 20 July 1992. Distribution: Common. Reported from Kerala (Leelavathy ***et al.,*** 1985) and other parts of India (Manjula, 1983; Bilgrami, ***et al.*** 1991). EI: edible.

31. ***Termitomyces heimii*** Natarajan **(Agaricales-Basidiomycotina)**

L: Illithode. Date: 20 July 1992. Distribution: Common. Known to occur in Kerala (Leelavathy, ***et al.*** 1985). EI: edible

32. ***Trametes cingulata*** Berk. (Aphyllophorales-Basidiomycotina)

L: Kannimangalam, Malayattoor, Kerala. Data: 23 Oct. 1992. Distribution: Common throughout India (Bakshi, 1971). Known to occur in Parambikulam, Sholayar and Silent Valley forests in Kerala (Ganesh, 1988). EI: Causes white rot of timber.

33. ***Trametes lactinea*** (Berk.) Pat. (Aphyllophorales-Basidiomycotina)

L: Illithode and Mulamkuzhi. Date: 22 Oct. 1992. Distribution: Common in plains of India (Bakshi, l971; Bilgrami, ***et al.*** 1991). Collected from Tirunelli (Wynad) in Kerala by Ganesh (1988). EI: Associated with white stringy rot.

34. ***Trametes scabrosa*** (Pers.) G.H. Cunn. (Aphyllophorales-Basidiomycotina)

L: Mulamkuzhi. Date: 21 Oct. 1992. Distribution: Widespread in open areas and evergreen forests in Kerala (Ganesh, 1988). EI: Causes white stringy rot. An ubiquitous member of polyporaceae.

35. ***Trametes varians*** Van der Byl. (Aphyllophorales-Basidiomycotina)

L: Kurisumudi. Date: 23 Oct. 1992. Distribution: Rare. This is the second record of this fungus from India. It has been reported earlier from Sultan Battery (Kerala) by Ganesh (1988). EI: Associated with white pocket rot.

36. *Xylaria* spp. (species 1 to 4) **(Sphaeriales-Ascomycotina)**

L: Kurisumudi. Date: 23 Oct. 1992. Distribution: The genus is cosmopolitan in distribution.

37. ***Cookenia*** sp. **(Pezizales-Ascomycotina)**

L: Mulamkuzhi. Date: 21 Oct. 1992. Distribution: Widespread in the tropics.

38. *Stemonitis* sp. **(Stemonitales-Myxomycetes)**

L: Mulamkuzhi. Date: 21 Oct. 1992. Distribution: Widespread.

The collections also included one unidentified species each of *Flavolus, Phellinus* and *Hexagonia.*

A total of 44 species of fungi belonging to *28* genera were collected from the study area. The majority (61%) *of* the fungi belonged to Aphyllophorales (Basidiomycotina). Agaricales (Basidiomycotina) was represented by eleven species, Ascornycotina by five and Myxomycetes by one species. Of the fungi collected (those identified to species level), 14 species were reported to be widespread in distribution in Kerala and elsewhere in India, 16 species were common and one species viz., *Phellinus dependens* infrequent in occurrence. The following four species, viz. *Coriolopsis telfarii, Loweporus fusco-purpureus, Microporellus obova**tus*** and *Trametes varians* were only rarely recorded from India. This report forms the second record of *M. obovatus* and *T. varians* in India.

Though most of the species recorded during this study were common on occurrence in Kerala/India, a few of the rare species could also be collected. It is felt that a detailed study (spread over a longer period) on the macrofungal flora of the area would be much more rewarding.

3.2. SURVEY FOR PLANT DISEASES

A checklist of various plant diseases recorded Malayattoor forests is provided in Table 3.1.

Table 3.1. Checklist of diseases of various plants recorded from Malayattoor forests

Sl. No.	Host	Locality	Disease	Fungus associated	Symptoms
1.	*Artabotrys zeylanicus* Hook.f. & Thoms.	Mulamkuzhi	Leaf spot	*C. gloeosporioides*	Brownish black spots with dark brown margins.
2.	*Bridelia crenulata* Roxb.	Kannimangalam	Leaf spot	*C. gloeosporioides*	Leaf spots with dull white necrotic areas and light brown margins.
3.	*Calycopteris floribunda* (Roxb.) Poir.	Mulamkuzhy	Leaf spot	*C. gloeosporioides*	Leaf spots pale brown in colour with dark brown mar-margins.
4.	*Cassia fistula* L.	Illithode	Leaf spot	*C. gloeosporioides*	Angular spots dark brown in colour with a light brown halo in the centre.
5.	*C. fistula* L.	Mulamkuzhy	Leaf blight	*Sclerotium rolfsii* Sacc.	Dull brown spots increasing rapidly in size to cover major portion of the lamina. Leaves got dried up within a period of 10 days.
6.	*Cissus heyneana* (Wall.) Planchon	Illithode	Leaf spot	*Colletotrichum gloeosporioides*	Leaf spots irregular, brownish in colour; coalesced to form large necrotic areas when infection progressed.

Sl. No.	Host	Locality	Disease	Fungus associated	Symptoms
7.	*Clerodendrum viscosum* Vent.	Illithode	Leaf spot	*Phomopsis clerodendri* Kamal & Singh	Dull brown spots turning to dark brown with age.
8.	*Dioscorea bulbifera* L.	Mulamkuzhi	Leaf spot	*Colletotrichum gloeosporioides*	Initially small dull white spots turning later to light brown necrotic areas.
9.	*Eupatorium adenophorum* Spreng.	Kurisumudi	Leaf spot	*Phoma* sp.	Dull white to pale brown angular spots coalesced to form large irregular spots with age.
10.	*Glycosmis mauritiana* (Lamk.) Tanaka	Kurisumudi	Leaf spot	*Phoma* sp.	Small brownish spots with yellow margins. Spots becoming irregular in shape when the disease progresses
11.	*Grewia tiliaefolia* Vahl	Illithode	Leaf spot	*Colletotrichum gloeosporioides* & *Phomopsis* sp.	Initially dark brown spots turning to pale brown later on. Spots surrounded by dark brown margins.
12.	*Haldina cordifolia* (Roxb.) Ridrdl.	Illithode	Leaf spot	*Colletotrichum gloeosporioides* (Penz.) Sacc.	Irregular light brown spots on leaves. Spots coalesced to form dark brown necrotic areas when the infection progressed.

Sl. No.	Host	Locality	Disease	Fungus associated	Symptoms
13.	*Helicteres isora* L.	Illithode	Leaf spot	*C. gloeosporioides*	Light brown spots with dull white margins.
14.	*Hyptis suaveolens* (L.) Poir.	Illithode	Leaf spot	*C. gloeosporioides*	Initially small dull white spots enlarged to become irregular to round dark brown necrotic areas.
15.	*H. suaveolens* (L.) Poir.	Kurisumudi	Leaf spot	*Phomopsis* sp.	Pinhead spots, dark brown in colour. Spots coalesced usually along the margins. Premature defoliation noticed.
16.	*Ipomoea hederifolia* L.	Kurisumudi	Leaf spot	*Phomopsis* sp.	Light brown spots with dark brown margins.
17.	*Jasminum rottlerianum* Wall. *ex* A.DC.	Mulamkuzhi	Leaf spot	*Sclerotium rolfsii*	Initially dull white spots turning to cream coloured necrotic areas with dark brown margins with age. In some case yellowish zonations around leaf spots.
18.	*Merremia vitifolia* (Burm.f.) Hall.f.	Illithode	Leaf spot	*Colletotrichum gloeosporioides*	Dark brown spots with light yellow margins.
19.	*Naravelia zeylanica* (L.) DC.	Mulamkuzhy	Leaf spot	*C. gloeosporioides*	Dark brown spots with blackish margins.

Sl. No.	Host	Locality	Disease	Fungus associated	Symptoms
20.	*Pellionia heyneana* Wedd.	Mulamkuzhi	Leaf spot	*C. gloeosporioides*	Dull yellow spots surrounded by characteristic yellowish zonations.
21.	*Piper longum* L.	Kurisumudi	Leaf spot	*C. dematium* (Pers. *ex* Fr.) Grove.	Initially the spots appeared light brown in colour. Spots coalesced to form dark brown necrotic areas when the infection progressed.
22.	*Pothos scandens* L.	Mulamkuzhi	Leaf spot	*C. gloeosporioides*	Initially minute brownish spots scattered all over the lamina. These spots coalesced to form irregular light brown spots.
23.	*Schleichera oleosa* (Lour.) Oken	Mulamkuzhy	Leaf spot	*Botryosphaeria* sp.	Irregular to round spots light brown in colour with dark brown margins.
24.	*Sterculia balanghas* L.	Mulamkuzhy	Leaf spot	*C. gloeosporioides*	Dull white spots with pale yellow margins.
25.	*Strychnos nux-vomica* L.	Kurisumudi	Leaf spot	*C. gloeosporioides*	Small irregular spots light brown in colour with pale yellow margins. Spots coalesced to give a blighted appearance to the leaves.

A total of 25 foliar diseases affecting 23 species of plants were recorded from Malayattoor forests during the present survey. No disease other than leaf diseases was observed during the study period. ***Colletotrichum gloeosporioides*** was the most frequent fungus associated with the diseases. It was isolated from majority (60%) of the affected leaf samples. ***Sclerotium rolfsii*** could be isolated from leaf spots in *2* plants. ***Phomopsis*** spp. were found to be associated with foliar infections in ***Hyptis suaveolens*** and ***Ipomea hederifolia.*** Combined infection by ***Collitotrichum gloeosporioides*** and ***Phomopsis*** **sp.** was noticed in ***Grewia tiliaefolia.*** Incidence of pathogens such as ***Phoma*** sp., ***Colletotrichum dematium*** and ***Botryosphaeria*** **sp.** were also recorded.

Colletotrichum gloeosporioides is world-wide in distribution and has an extremely wide host range (Mordue, 1971). In India, it is reported to cause diseases in a large number of cultivated and wild plants (Bilgrami, ***et al.*** 1991). Colletotrichum leaf spot of ***Haldina cordifolia*** and ***Strychnos nux-vomica*** recorded during this survey has been reported earlier from Kerala by Nair, ***et al.*** (1989) and Sankaran, ***et al.*** (1980). All the other leaf spot diseases caused by ***C. gloeosporioides*** enlisted here, are new host records for this fungus in India (Bilgrami, ***et al.*** 1991).

Diseases caused by ***Sclerotium rolfsii*** occur mainly in tropical and subtropical areas where high temperatures prevail during the rainy season (Aycock, 1966). The infection of foliage of plants by

S. *rolfsii*, though not very common, has been reported earlier on different hosts in USA and Indonesia (Aycock, 1966). *Cassia fistula* and *Jasminum rottlerianum* are new host records for *S. rolfsii*.

Phomopsis spp. and *Phoma* spp. are also widespread in occurrence causing diseases in several plant specices (Sutton, 1980). The occurrence of *Phomopsis clerodendri* on *Clerodendrum viscosum* was reported earlier by Kamal and Singh (1980) from Gorakhpur in Uttar Pradesh. There are no earlier reports on the association of *Phomopsis* spp. with leaf spot disease in *Ipomea hederifolia* and *Hyptis suaveolens* (Bilgrami, *et al.* 1991). The association of *Phoma* spp. with foliar infection in *Glycosmis mauritiana* and *Eupatorium adenophorum* are reported here for the first time from India. Likewise, *Piper longum* and *Schleichera oleosa* are new host records for *Colletotrichum dematium* and *Botryosphaeria* sp., respectively.

The results of this study indicate that continued exploration and systematic study of both saprophytic and parasitic fungi in tropical forests would bring to light many unknwon and poorly known species which are economically important and which may be of potential use in biotechnology.

3.4. ACKNOWLEDGMENTS

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WILDLIFE AND LANDUSE PATTERN OF MALAYATTOOR

P. Vijayakumaran Nair and E. A. Jayson

4. WILDLIFE AND LANDUSE PATTERN OF MALAYATTOOR

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Contents

ABSTRACT

In this report, a list of larger mammals, reptiles, amphibians, fishes_ and birds observed from the study area falling in the forests of Malayattoor is provided. Side by side, landuse pattern of the area was also analysed using GIS techniques. Larger mammals found in the area include Bonnet Macaque *(Macaca radiata)*, Sambar *(Cervus unicolor)*, Wild boar *(Sus scrofa)* and Jackal *(Canis aureus)* and indirect evidences on the occurrence of Porcupine, Pangoline, Hare and Today cat were noted. Flying lizard *(Draco dussumieri)*, a Malayan element in South Indian fauna, is alsc observed in the study area apart from 71 bird species inhabiting the region. Detailed landuse pattern which will be useful for the establishment *of* the Nature Study Centre is also added based on GIS analysis.

4.1. **INTRODUCTION**

The Malayattoor Nature Study Centre is proposed to *be set* up in an area of i5 km^3 of forest land. This comes within the Kalady range of Malayattoor forest division. The place is well known as it is a notable pilgrim centre. Just below the proposed area, a fresh water lake is situated. The Periyar river is situated a few kilometers to the South.

For the purpose of this study, an area of about 24 km^2 and ranging between $76^{o}29'$ to $76^{o}32'$ and $10^{o}11.3'$ to $10^{o}13.7'N$ is chosen (Fig. 4.11. The area contains fairly good patches of dry and moist deciduous forests. There are also a few patches of semi-evergreen/evergreen forests. The majority of the area is, however, a degraded forest. Degradati in has taken place because of reasons like annual fire, fuelwood and leaf manure collection by local people, forest plantation activities and general rocky nature of the area. A considerable part is also under teak plantations. The failed plantation areas have been planted with cashew, eucalypts and miscellaneous species of trees. There are about half a dozen granite mining quarries in and around the proposed area. Altitude of the study area varies from 100 m to 380 m. Because of this altitudinal range within a short distance, a large part of the area is very steep. The north-eastern face of the hill is a rocky cliff (Fig. 4.2).

The present status of wild animals in the area is examined. The data collected for this component as well as the data from landuse component is brought into a Geographic Information System (GIS) framework. This is primarily intended to serve as a management tool during the process of establishment of the study centre. From the database, sites for meeting different plantation requirements, cropping requirements and infrastructure planning can be selected. The database contains topographical information including gradient, status of flora and fauna, soil and present landuse. In this report, two aspects are covered namely Wildlife component and GIS component.

4.2. METHODOLOGY

4.2.1. Fauna

4.2.1.1. Mammals

The observations were carried out from August, 1991 to September, 1992. Eight field trips were made during the study period. The entire study area was surveyed on foot for detecting the presence of animals. The method of line transects were employed to census mammals in the intensive study areas (Rodgers, 1991). Four line transects were identified in the study area covering all representative vegetation types namely, evergreen, moist-deciduous, teak plantations and cashew plantations. The location of the transects are shown in Fig. 4.1, the following is their description.

i. Bottom of Kurishumudi to top of Kurishumudi (1,500 m),
ii. Kannampuzha estate to Pattapparakundu (2,000m),
iii. Kannimanqalam Junction to Evergreen camp shed (1,500m), and
iv. Inside cashew plantations near Kurishumudi (1,000m).

While moving through the transects, all the mammals noticed on both sides of the transects were recorded, and following details were also collected.

i. Name of species,
ii. Number of animals in the group,
iii. Activity at the time of observation, and
iv. Vegetation type.

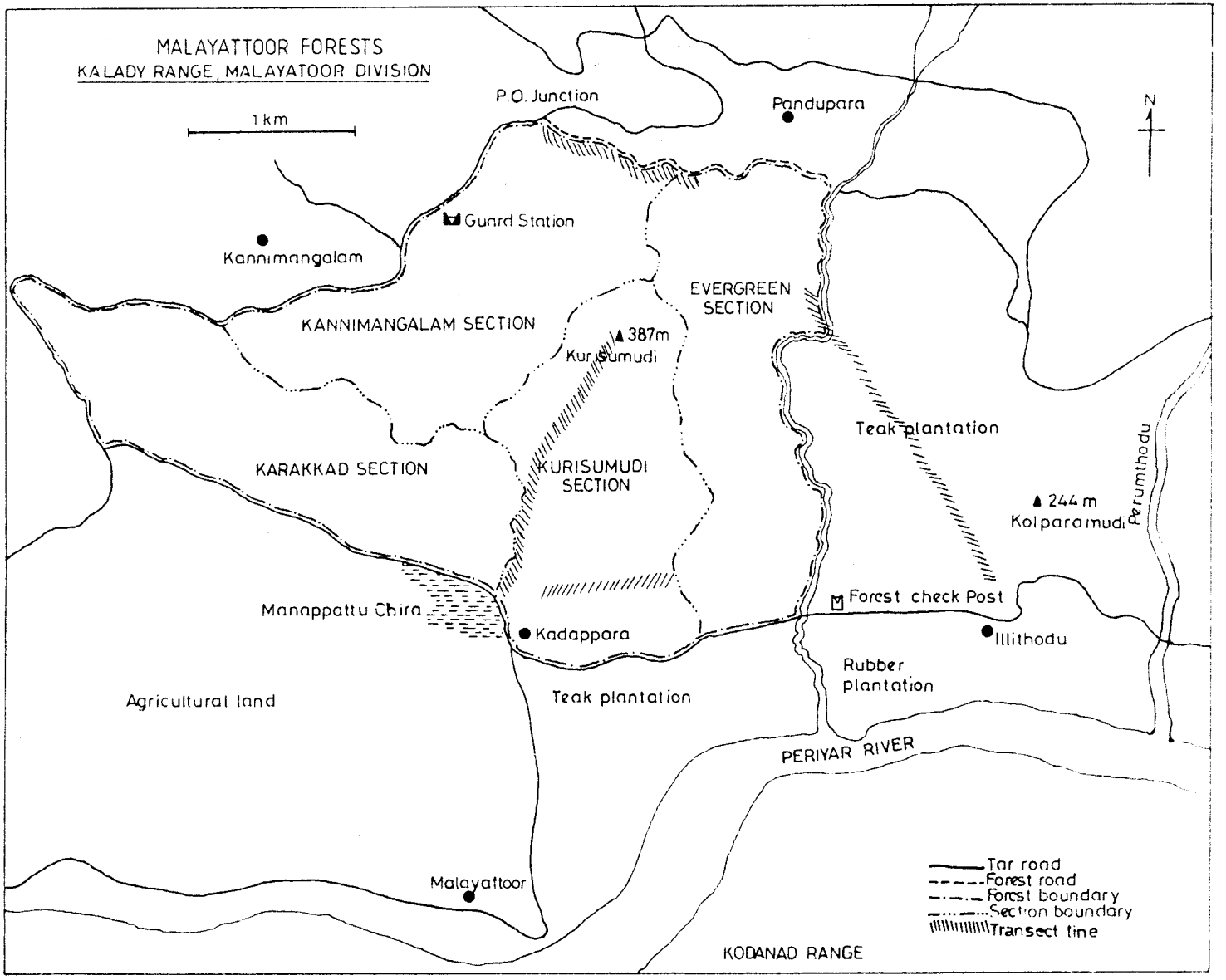


Fig.4.1. Study area showing the location of transects

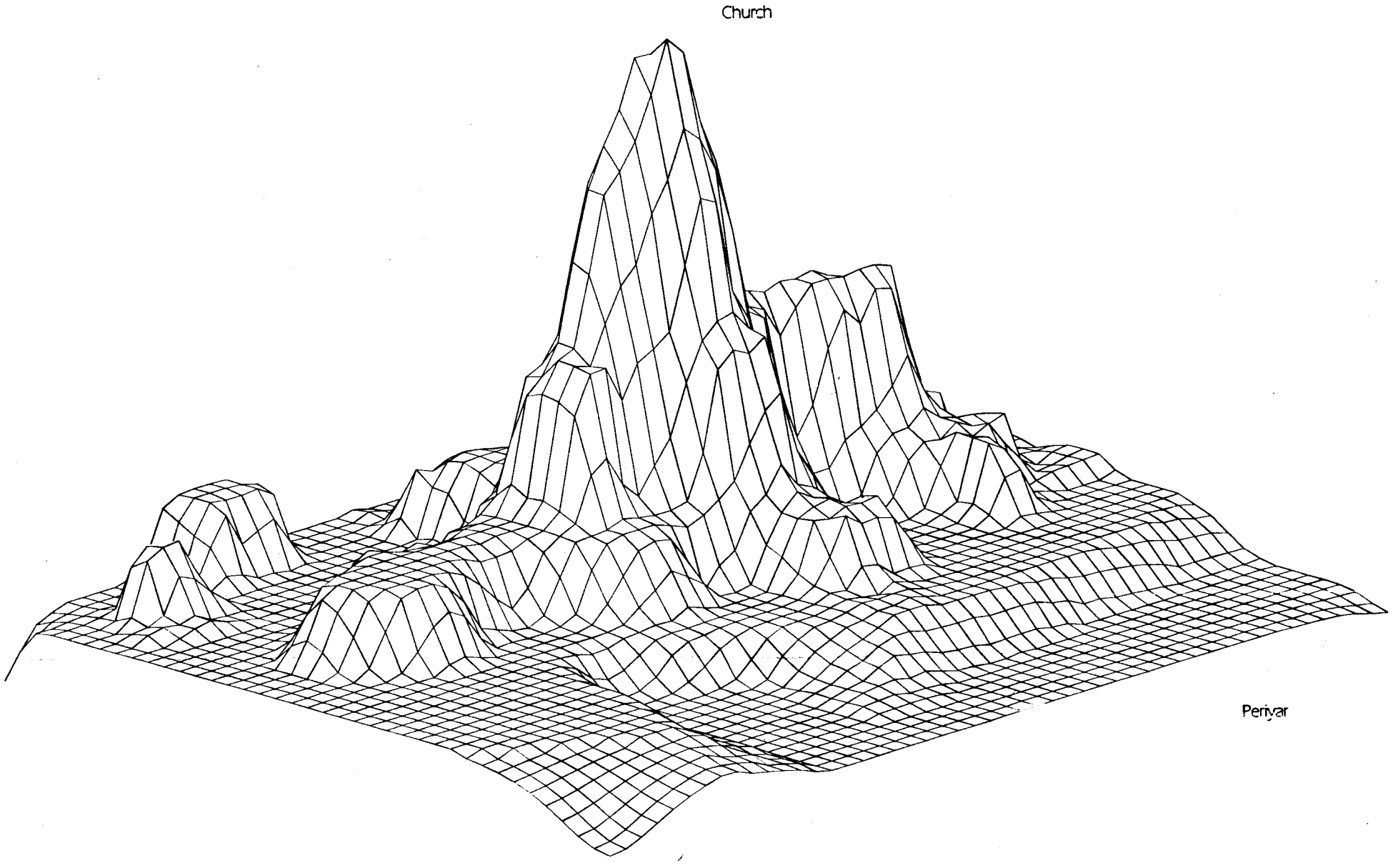


Fig.4.2. Orthographic view of the study area

Apart from this, all indirect evidences of animals such as presence of pellets, scats, spoor, pugmarks, foot prints, dungs and droppings were noted down and identified.

4.2.1.2. Birds

Line transect sampling and point sampling methocs were used for censusing birds. Four line transects were chosen with .one kilometre length. All the transects were covered between 7 AM to 12 noon. Fifteen minutes were spent at each point for point sampling of birds. This method was employed in areas not covered by the line transects. All the vegetation types identified in the area were covered with these two methods.

4.2.2. Geographic Information System (GIS)

For GIS implementation, data is recorded on the following map layers (Figs. 4.3 to 4.6).

4.2.2.1. Altitude and topography

This information was obtained from 1:25,000 scale survey of India toposheets.

Communication

Communication layer included roads and foot path obtained from Survey of India maps and also marked from the field.

4.2.2.3. Water bodies

Lakes, rivers and streams were recorded from toposheets.

4.2.2.4. Landuse data

The information obtained from available satellite images and aerial photographs were found to be insufficient for the purpose. The landuse was recorded by field checking on the 1:5000 scale map on the study area prepareu by the land surveyor of the Forest Department. The accuracy of roads, plantations and boundary was closely examined and corrections and subclassifications marked on the map. In this way, forest and plantations of different degradation status could be marked. The maps were digitized using the Roots digitizing package (Curson-Rickert, 1992). The maps were converted to high resolution grid images (about 10 m x 10 m) and transported to **GIS** package for analysis. IDRISI was the **GIS** package used for the analysis (Eastman, *1992).*

4.3. RESULTS

4.3.1. Fauna

Faunistically, the area is not very rich when compared to wildlife sanctuaries in Kerala. The degraded natural forests and large scale human habitations around are the reasons. However, the avifauna is fairly rich. This is probably due to the presence of diverse types of habitats such as natural forest, plantations and agricultural lands. The valley on the north-eastern side of the church is probably

the best anxmal habitat. The comparatively dense forest with the presence of streams and some degree of remoteness makes it a rich animal habitat. The area immediately behind the proposed nature study centre is contiguous with a fairly large forest tract. Elephants rarely visit some parts of the study area. The degraded areas and plantations have only animals like Porcupine, Hare and Wild pigs.

4.3.1.1. Mammals

Sightings of large mammals were very few. Following specie were observed in the study area.

	Common name	Scientific name
1.	Bonnet Macaque	*Macaca radiata*
2.	Sambar	*Cervus unicolor*
3.	Wild Boar	*Sus scrofa*
4.	Jackal	*Canis aureus*

Indirect evidences of Porcupine *(Hystrix indica),* Pangoline *(Manis crassicaudata),* Hare *(Lepus nigricollis)* and Toddy cat *(Paradoxurus hermaphroditus)* were also recorded. A lone female adult Sambar was sighted in the evergreen forests behind the Kurishumudi. Wild pigs were sighted throughout the study area and in the evergreen forests. Bonnet Macaques were seen near Kurishumudi and in the evergreen forests. A troop composed of 8 to 10 individuals in both the areas. A single Jackal was sighted near Kurishumudi during the study period.

In the course of study, a Flying Lizard *(Draco dussumieri)* was observed in the evergreen patches of Pattapparakundu. A single male was observed gliding from tree to tree, at a height of about 10 m.

Bright lemon-yellow throat appendage was waved intermittently during the observation.

4.3.1.2. Birds

Seventy one species of birds were recorded from the study area. Maximum number of birds were recorded from evergreen forests and moist deciduos forest, followed by teak and cashew plantations. List of biros recorded from the study area is given in Table 4.1.

Yabitat use of birds: The pilgrims path from bottom of Kurishumudi to top of Kurishumudi is planted with tree species like *Acacia, Eucalyptus,* Jack, Mango and other miscellaneous species. This patch has a width of about 50 m. Both sides of this way is bordering with teak plantations and due to this it has an ecotone effect. Following species *of* birds were recorded from this area.

	Common name	Scientific name
1.	Chestnutheaded Bee-eater	*Merops leschenaulti*
2.	Smaller green Barbet	*Megalaima viridis*
3.	Yellowfronted Pied Woodpecker	*Picoides mahrattensis*
4.	Redwhiskered Bulbul	*Pycnonotus jocosus*
5.	Black Drongo	*Dicrurus adsimilis*
6.	Common Myna	*Acridotheres tristis*
7.	Southern tree Pie	*Dendrocitta luecogastra*
8.	Jungle Crow	*Corvus macrorhynchos*
9.	Blackheaded Cuckoo Shrike	*Coracina melanoptera*
10.	Goldenfronted Chloropsis	*Chloropsis aurifrons*
11.	Jungle Babbler	*Turdoides stri*
12.	Indian Robin	*Saxicoloides fulicata*

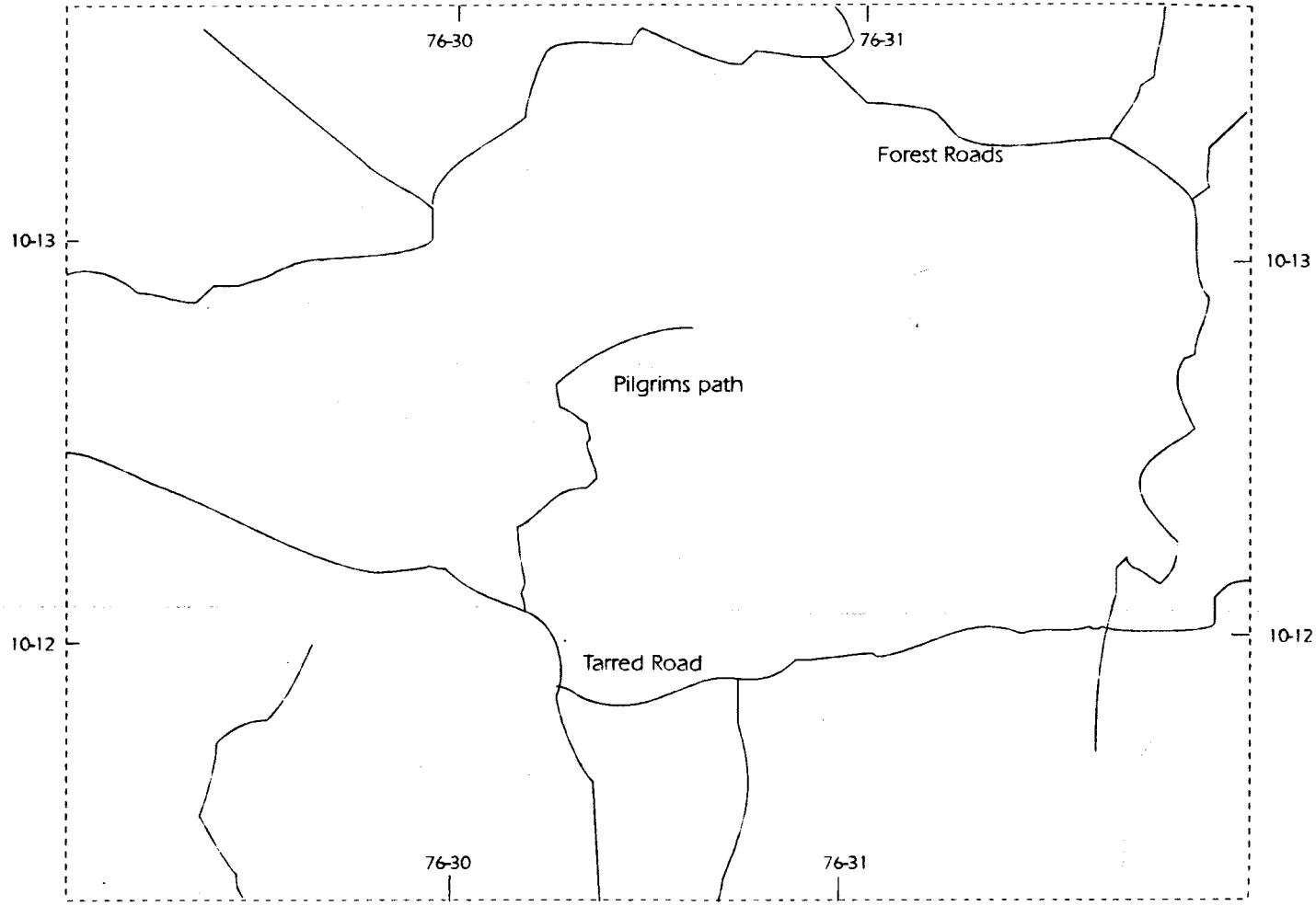


Fig.4.3. The roads layer in the study area

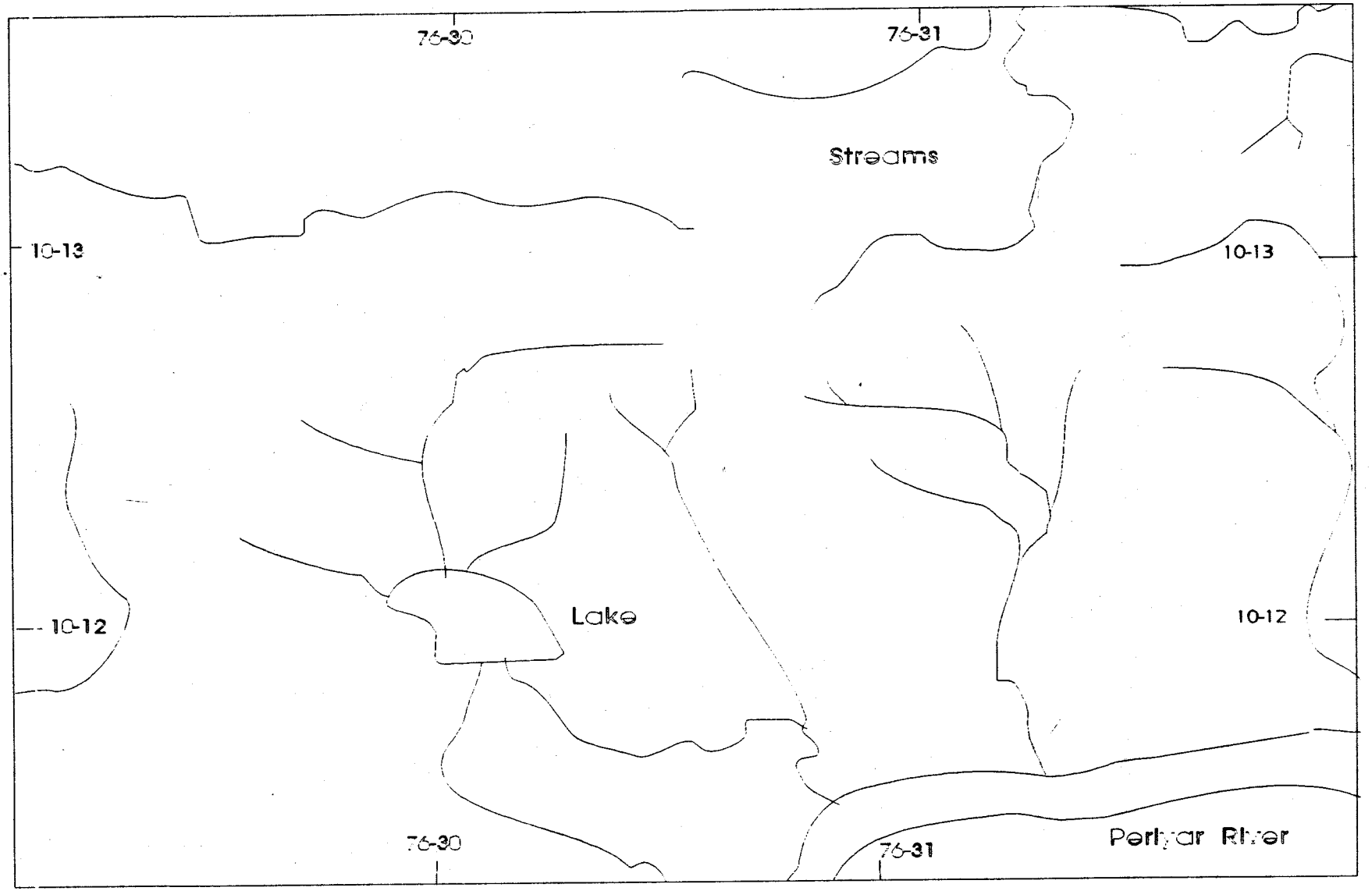


Fig.4.4. The water bodies layer in the study area

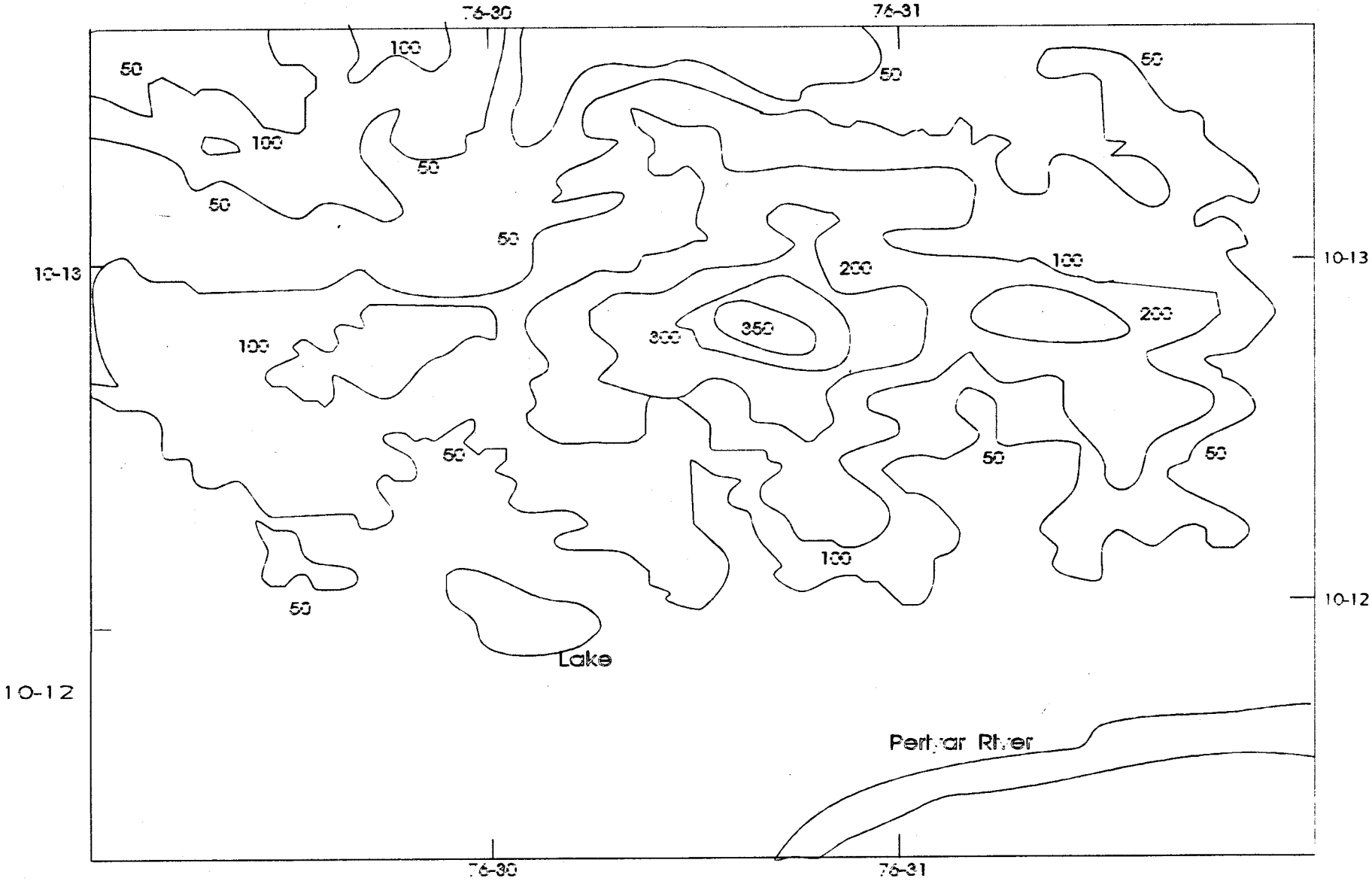


Fig.4.5. The contour layer of the study area

Table 4.1. List of birds recorded from the study area

Common name	Scientific name	Habitat
Family: *Phalacrocoracidae*		
1. Little Cormorant	*Phalacrocorax niger*	Reservoir
Family: *Ardeidae*		
2. Pond Heron	*Ardeola grayii*	Reservoir
Family: *Accipiridae*		
3. Blackwinged Kite	*Elanus caeruleus*	MDF&Forest edges
4. Black Eagle	*Ictinaetus malayensis*	Forest
5. Crested Serpent Eagle	*Spilornis cheela*	MDF and evergreens
Family: *Phasianidae*		
6. Grey Jungle Fowl	*Gallus sonnerattii*	MDF
7. Red Spur Fowl	*Ga11operdix spadicea*	MDF
8. Jungle Bush Quail	*Perdicula asiatica*	Evergreen
Family: *Rallidae*		
9. Whitebreasted Waterhen	*Amaurornis phoenicurus*	Reservoir
Family: *Charadriide*		
10. Redwattled Lapwing	*Vanellus indicus*	Grasslands
Family: *Columbidae*		
11. Spotted Dove	*Streptopelia chinensis*	Forest Edges
12. Greyfronted Green pegion	*Treron pompadora*	MDF
Family: *Psittacidae*		
13. Roseringed Parakeet	*Psittacula krameri*	Forest Edges
Blossomheaded Parakeet	*Psittacula cyanocephala*	Forest Edges

Common name	Scientific name	Habitat
Family: Cuculidae		
14. Common Hawk–Cuckoo	*Cucuusvarius*	MDF
15. Indian Cuckoo	*Cuculus micropterus*	MDF
16. Koel	*Eudynamys scolopacea*	MDF
17. Crow–pheasant	*Centropus sinensis*	Bushes
Family: Strigidae		
18. Brown Wood Owl	*Strix leptogrammica*	Forest
19. Brown Fish Owl	*Bubo zeylonensis*	Near Reservoir
20. Jungle Owlet	*Glaucidium radiatum*	MDF
Family: Caprimulgidae		
21. Indian Jungle Nightjar	*Caprimulgus indicus*	MDF
Family: Alcedinidae		
22. Whitebreasted Kingfisher	*Halcyon smyrensis*	Reservoir
23. Small Blue Kingfisher	*Alcedo atthis*	Streams
Family: *Meropidae*		
24. Chestnutheaded Bee–eater	*Merops leschenaulti*	Forest Edges
25. Green Bee–eater	*Merops orientalis*	Teak plantations
Family: Coraciidae		
26. Indian Roller (Fairy Bluebird)	*Coracias benghalensis*	Edges
Family: Vupupidae		
27. Hoopoe	*Upupa epops*	Forest Edges

Common name	Scientific name	Habitat
Family: Bucerotidae		
28. Malabar Grey Hornbill	*Tockus griseus*	Forest
Family: Capitonidae		
29. Small Green Barbet	*Megalaima viridis*	Forest
Family: Picidae		
30. Small Yellownaped Woodpecker	*Picus chlorolophus*	MDF
31. Indian Goldenbacked Threetoed Woodpecker	*Dinopium javanense*	MDF
32. Lesser Goldenbacked Woodpecker	*Dinopium benghalense*	Teak Plantation
33. Heartspotted woodpecker	*Hemicircus canente*	Forest edges
Family: Hirundinidae		
34. House Swallow	*Hirundo tahitica*	Near habitation
Family: Laniidae		
35. Baybacked Shrike	*Lanius vittatus*	MDF
36. Brown Shrike	*Lanius cristatus*	MDF
Family: Oriolidae		
37. Golden Oriole	*Oriolus oriolus*	MDF
38. Blackheaded Oriole	*Oriolus xanthornus*	Evergreen
39. Blacknaped Oriole	*Oriolus chinensis*	MDF
Family: Dicruridae		
40. Black Drongo	Dicrurus adsimilis	Teak plantations
41. Racket-tailed Drongo	*Dicrurus paradiseus*	MDF
42. Bronzed Drongo	*Dirurus aeneus*	Evergreen

Common name	Scientific name	Habitat
Family: *Sturnidae*		
43. Common Myna	*Acridotheres tristis*	Habitations
44. Jungle Myna	*Acridotheres fuscus*	MDF
Family: *Corvidae*		
45. Indian Tree Pie	*Dendrocitta vagabunda*	MDF
46. Whitebellied Tree Pie	*Dendrocitta leucogastra*	Evergreen
47. House Crow	*Corvus splendens*	Habitations
46. Jungle Crow	*Corvus macrorhynchos*	Habitations
Family: *Campephagidae*		
49. Large Wood Shrike	*Tephrodornis virgotus*	MDF
50. Blackheaded Cuckoo Shrike	*Coracina me1anoptera*	MDF
51. Scarlet minivet	*Pericrocotus flammeus*	MDF
Family: *Irenidae*		
52. Goldenfronted chloropsis	*Chloropsis aurifrons*	Edges
53. Goldmantled chloropsis	*Chloropsis cochinchinesis*	Edges
Family: *Pycnonotidae*		
54. Redwhiskered Bulbul	*Pycnonotus jocosus*	Rocky areas
55. Red vented Bulbul	*Pycnonotus cafer*	Scrubs
56. Yellowbrowed Bulbul	*Hypsipetes indicus*	Evergreen
Family: *Timalinae*		
57. Whiteheaded Babbler	*Turdoides affinis*	Bushes
56. Jungle Babbler	*Turdoides striatus*	Bushes
Family: *Muscicapinae*		
59. Paradise Flycatcher	*Terpsiphone paradisi*	Evergreen
60. Blacknaped Flycatcher	*Hypothymis azurea*	MDF

Common name	Scientific name	Habitat
Family: Sylviinae		
61. Tailor Bird	*Orthotomus sutorius*	Edges
62. Dull Green Leaf Warbler	*Phylloscopus trochiloides*	MDF
Family: Turdinae		
63. Magpie Robin	*Copsychus sau1aris*	Habitation
64. Indian Robin	*Saxicoloides fu1icata*	Dry area
Family: Paridae		
65. Grey Tit	*Parus major*	MDF
Family: Sittidae		
66. Velvetfronted Nuthatch	*Sitta frontalis*	Edges
Family: Montaci11ida*e*		
67. Yellow Wagtail	*Motacilla flava*	Near water
68. Pied Wagtail	*Motacilla alba*	Near water
Family: Nectariniidae		
69. Purplerumped Sunbird	*Nectarinia zeylonica*	Scrubs
70. Small Sunbird	*Nectarinia minima*	Trees
Family: Ploceidae		
71. Blackheaded Munia	*Lonchura malaca*	Teak plantations

Undergrowth in the teak plantations were sparse. Only few species of birds were recorded from the teak plantations. Following is a list of common birds found in the teak plantations.

	Common name	Scientific name
1.	Spotted Dove	*Streptopelia chinensis*
2.	Racket-tailed Drongo	*Dicrurus paradiscus*
3.	Scarlet Minivet	*Pericrocotus flammeus*
4.	Redwhiskered Bulbul	*Pycnonotus jocosus*
5.	Jungle Babbler	*Turdoides striatus*
6.	Indian Robin	*Saxicoloides fulicata*
7.	Blackheaded Munia	*Lonchura malaca*

Cashew plantations hardly harboured any species of birds. Whiteheaded Babbler, Redwhiskered Bulbul, Magpie Robin and Black Drongo were mostly seen in the cashew plantations.

Evergreen forests found at Pattapparakundu and in the evergreen section contained the following species of birds.

	Common name	Scientific name
1.	Crested Serpant Eagle	*Spilornis cheela*
2.	Grey Jungle Fowl	*Gallus sonnerattii*
3.	Malabar Grey Hornbill	*Tockus griseus*
4.	Golden Oxiole	*Oriolus orilus*
5.	Black Drongo	*Dicrurus adsimilis*
6.	Golden fronted chloropsis	*Chloropsis aurifrons*
7.	Yellowbrowed Bulbul	*Hypsipetes indicus*

another important vegetation type found in the area is moist deciduous forest. Following species were found in this forest type.

Common name	Scientific name
1. Grey Jungle Fowl	*Gallus sonnerattii*
2. Spotted Dove	*Streptopelia chinensis*
3. Blossomheaded Parakeet	*Psittacula cynocephala*
4. Chestnutheaded Bee-eater	*Merops leschenaulti*
5. Small Green Barbet	*Megalaima viridis*
4. Goldenbacked woodpecker	*Dinopium javenense*
7. Blackheaded Oriole	*Oriolus xanthornus*
8. Black Drongo	*Dicrurus adsimilis*
9. Racket-tailed Drongo	*Dicrurus paradiscus*
10. Scarlet minivet	*Pericrocotus flammeus*
11. Purplerumped Sunbird	*Nectarinia zeylonica*

Pied Wagtail, Pond Heron, Whitebreasted Kingfisher and Little Cormorant were found in the vicinity of the newly formed reservoir. No migrant water fowls were seen in the reservoir.

Food and feeding: Mixed feeding flocks were found in the edges and evergreen forests. In the forest edges the mixed feeding flock included species like Magpie Robin, Black Drongo, Whiteheaded Babbler and Scarlet Minivet. Some stray observations on feeding is worth mentioning. Black Drongo were found feeding on insects like *Glynocera malabarica.* Common Myna, Racket-tailed Drongo and Jungle Babblers were feeding on *Hyblea purea* larvae in the infected teak plantations. Blackheaded Cuckoo Shrike was found feeding on insects on *Delonyx regia* tree and Goldenbacked Woodpeckers, Jungle Babblers and Racket-tailed Drongo were found on *Xylia xylocarpa.* Small Green Barbet was found feeding on Tetramelus flowers.

4.3.1.3. Reptiles

The following species of reptiles were reported from the study area.

	Common name	Scientific name
1.	Tortoise	--
2.	Cobra	*Naja naja*
3.	Krait	*Bungarus caeruleus*
4.	Russell's Viper	*Vipera russelli*
5.		*Trimeresurus malabaricus*
6.	Rat snake	*Ptyas mucosus*
7.	Water snake	*Xenochrophis piscator*
8.	Python	*Python molurus*
9.	Green whip snake	*Ahaetulla* sp.
10.	Common Garden Lizard	*Caloles versicolor*
11.	Chamae1eon	*Chamaeleon zeylanicus*
12.	Monitor lizard	*Varanus bengalensis*
13.	Dragon	*Draco dussumieri*
14.	Skinks	*Mabuya* sp.

4.3.1.4. Amphibians

Following species of amphibians were recorded from the study area.

	Common name	Scientific name
1.	Green Frog	*Rana hexadactyla*
2.	Common Frog	*Rana tigerina*
3.	Tree frog	*Rhacophorus* sp.
4.	Toad	*Ansonia* sp.

Fishes

Following species of fishes were recorded from the study area.

1. *Ophiocephalus* sp.
2. *Tilapia* sp.
3. Smaller carps
4. *Saccobranchus*
5. *Wallago atto*

4.3.2. Geographic Information System (GIS)

As mentioned earlier altitude, roads, water bodies and landuse were the layers recorded. The Periyar river, which flows along the south western corner of the study area, is at the lowest elevation at about 10 m from sea level. The foothills up to about 200 m have relatively plain ground. The area between the hill top (387 m) and foothills is rather steep. There is motorable road almost all around the proposed site. Few short distance roads lead to plantation areas. There is a pilgrim's trek path of about 1,500 m long to the hill top. The water bodies consist of the Periyar river, the lake at the foothills and various streams draining the area. Most of these streams dry up in summer. An irrigation channel from Idamalayar towards part of the study area is under construction. The landuse was recorded in detail. The landuse pattern inside the sampled area and immediate surroundings are tabulated (Table 4.3) separately. The following table (Table 4.2) shows the overall landuse pattern in the 24 km^2 area which covers the proposed 15 km^2.

Table 4.2. Overall landuse pattern of 24 km^2 area around the study centre

Sl. no.	Landuse	# of cells	% Area
1.	Evergreen/semi evergreen	2,586	1.2
2.	Moist deciduous forest	23,930	11.5
3.	-Do- degraded	18,448	8.9
4.	Dry deciduous forest	7,149	3.4
5.	-Do- degraded rub	8,735	4.2
6.	Barren rocky area	2,590	1.2
7.	Teak plantations full grown	19,949	9.6
8.	·Do- medium grown	600	0.3
9.	Teak replanted	1,881	0.9
10.	Teak + fresh miscellaneous	6,200	3.0
11.	Cashew plantations	7,973	3.8
12.	Rubber plantations	13,796	6.6
13.	Eucalyptus	78	0.03
14.	Coconut	52	0.02
15.	Plantain	134	0.06
16.	Homesteads	72,696	34.9

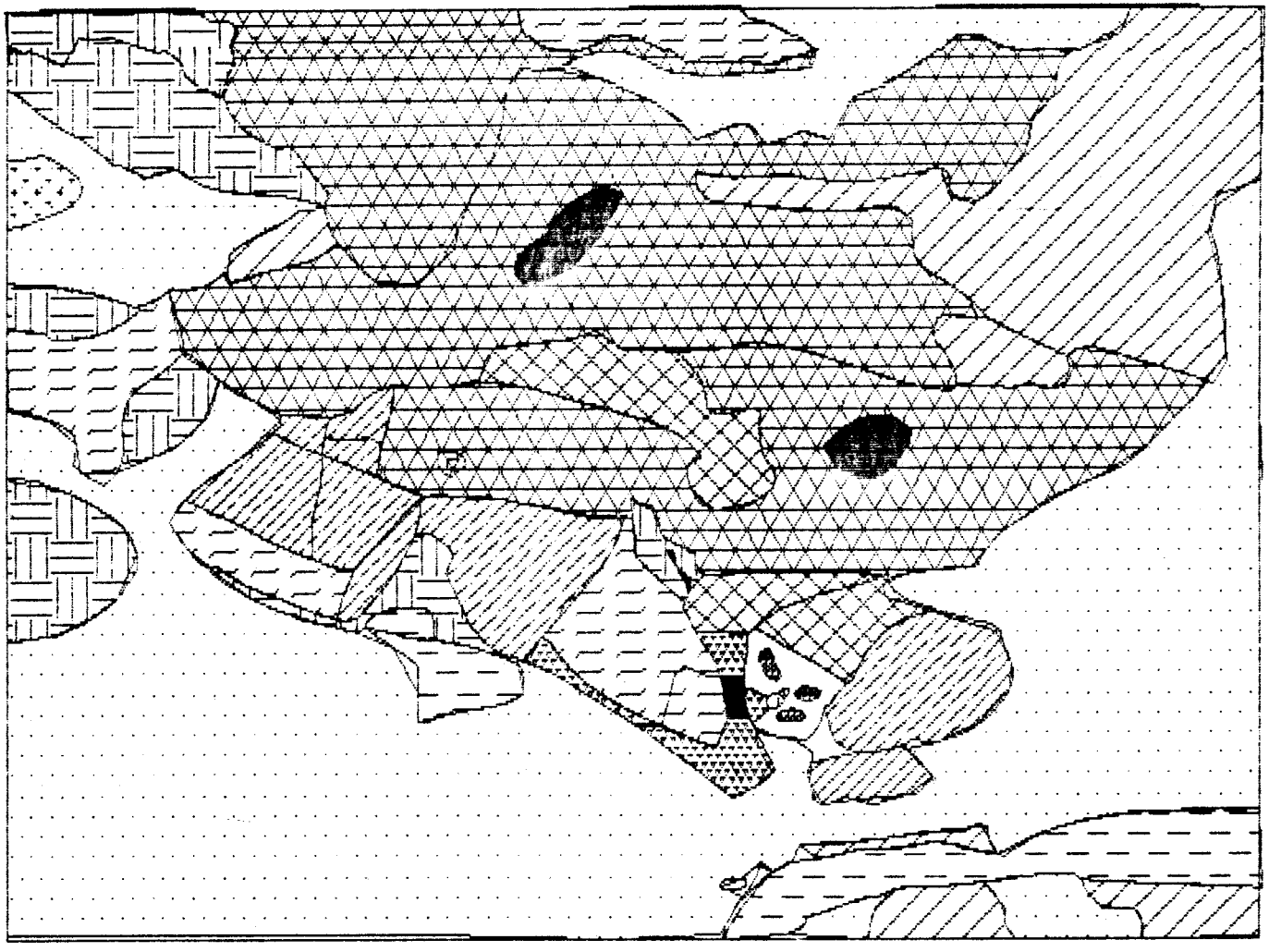
Sl. no.	Landuse	# of cells	% Area
17.	Paddy	602	*0.3*
18.	Lake + river	5,718	2.7
19.	Quarry	127	0.1
20.	Replanted with miscellaneous trees	2,372	1.1
21.	Others	34,724	28.2

The non-forest area is either homesteads or plantations of rubber, cashew or other crops. Homesteads contain coconut trees, plantain and a variety of other crops. There are patches of rubber estates on the western side. There are also patches of cashew plantations. There is a small area of paddy cultivation by the side of a rivulet. There is a rocky area and a belt of deciduous forest around it on the north-western side. On the eastern side teak plantations and degraded deciduous forests predominate. The southern sides are habitations, lake, river and teak plantations (Fig. 4.6). The forests on the eastern side have been reduced to scrub vegetation due to biotic disturbance and rocky terrain. There are patches of semi-evergreen/evergreen forests near Kannimangalam valley near the church, and at Pattapparakundu.

The land use inside the sampled area around Kurishumudi and the enclaves is described below.

Table 4.3. Landuse pattern of the sampled area of 15 km^2

Sl. no.	Landuse	# of cells	% Area
1.	Evergreen/semi evergreen	685	0.6
2.	Moist deciduous forest	4,038	3.3
3.	-Do- degraded	9,792	8.0
4.	Dry deciduous forest	2,337	1.1
5.	-Do- degraded/scrub	4,658	3.8
6.	Barren rocky area	0	0.0
7.	Teak plantations full grown	1,353	1.1
8.	-Do- medium grown	600	0.5
9.	Teak replanted	1,876	1.5
10.	Teak + fresh miscellaneous	6,205	5.1
11.	Cashew plantations	3,459	2.9
12.	Rubber plantati ons	1,992	1.6
13.	Eucalyptus	79	0.1
14.	Coconut	57	0.05
15.	Plantai n	132	0.1
16.	Homesteads	42,671	0.0



Evergreen
Moist deciduous
-do- degraded
Dry deciduous
-do- degraded
Barrer rocks
Teak full grown
Teak medium
Teak replanted
Teak+miscellanecus
Cashew plantations
Rubber plantations
Eucalyptus
Coconut
Plantain
Home stead
Paddy
Granite quarries
Others

Fig.4.6. The landuse layer of the study area

Sl. no.	Landuse	# of cells	% Area
17.	Paddy	0	0.0
18.	Lake + river	5,700	4.6
19.	Quarry	134	0.1
20.	Replanted with miscellaneous trees	2,360	1.9
21.	Others	12,386	5.8

The proposed nature study centre contains mainly moist deciduous forests and teak plantations. The moist deciduous (landuse #2) regions contain *Lagerstroemia microcarpa, Tetrameles nudiflora, Terminalia paniculata, Terminalia bellerica, Xylia xylocarpa,* etc. There is almost a pure patch of natural *Lagerstroemia microcarpa* near the cultivated enclave. The forest near the habitation is degraded due to grazing, fire and leaf manure collection. There is a patch of moist deciduous forest near the Illithode farm also. The relatively dry parts on the western side of the church harbour dry deciduous forest (landuse #4) with *Terminalia tomentosa, Pterocarpus marsupium, Terminalia paniculata, Terminalia bellerica, Artocarpus hirsuta, Xylia xylocarpa, Tetramelus nudiflora, Macaranga peltata,* etc. Some parts of this have been severely degraded (landuse #5). A homogenous patch of *Lagerstroemia speciosa* and another of *Terminalia tomentosa* are found in the area. These are the growths of the afforestation programmes taken up in the past.

The area has been subjected to much plantation activities in the past. Teak plantations were attempted about 60 years ago. Areas with landuse #7 contain mature teak plantation. Landuse #8 include teak plantations of about 20–30 years age and medium height. Landuse #9 is actually failed teak plantation areas, which have been recently re-planted. These areas now have the look of a 3–5 year old teak plantation. There is high incidence of teak borer *Cossus cadambae* in the area. There are two large patches of cashew plantations (landuse #11) and a small patch of eucalyptus is also found inside the area. A fresh water lake (landuse #20) and a tourism department guest house have come up at the foot hills.

There is an enclave of cultivation totally inside the area. There are notable patches of agricultural area along the southern side. The enclave inside is planted with plantain near the stream and rubber around it. The crops in the other part include coconut and plantain, as pure crops as well as in combination (landuse #16). The potential of using the information in various layers for planning is dealt with in the discussion part.

4.4. DISCUSSION

As the area is highly degraded due to various human activities, it is only logical that the large mammals would be very scarce. Only little area remains unaltered. Indirect evidences of elephants were found about one kilometre away from the camp shed in the evergreen section.

The presence of Draco or Flying Lizard is worth mentioning. This species is an example of Malayan element in the fauna of Southern India. Similar species of genus Draco occur in eastern Himalayas and further East. Even though the distribution of Flying Lizard is said to be common in many parts of Kerala, its distribution is erratic (Daniel, 1983). Suqathan (1984) reported this species from the nearby Thattakkadu forests. Inger and others (1984) reported this species from Ponmudi area in South Kerala.

The GIS analysis provides detailed landuse pattern. The database created can be used in a variety of ways during the execution phase of the study centre. Selection of sites for buildings is one example. Level ground near to the road can be located from the database. It also can provide information on alignment of new roads. An optimum route that covers different plantations and crop patterns can also be generated. Forests can be examined for proximity habitations, water availability, etc. The database can also be used for irrigation planning.

4.5. ACKNOWLEDGEMENTS

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STATUS SURVEY OF INSECT FAUNA OF MALAYATTOOR

George Mathew

5. STATUS SURVEY OF INSECT FAUNA OF MALAYATTOOR

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Contents

ABSTRACT

About 400 species of insects belonging to 11 insect Orders have been collected during this study. Of them, the identity of about 250

species have been confirmed. A major share of insects recorded in this study belongs to Lepidoptera and Hemiptera.

The distribution of insects in the various biocoenoses in the study area indicated rich species diversity in the zone of interqradation between natural forests and adjoining teak plantations due to occurrence of duel ecological condition?. The forest margins adjacent to farmlands showed a preponderance of agricultural pests. Of the teak and cashew plantations covered in this study, the latter was relatively poor in the faunal elements, probably due to the scarce understorey vegetation. The impact of forest disturbance on the fauna was evident. Wherever such disturbances were noticed, there was a reduction in species diversity coupled with local outbreaks of a few species. However, the existing habitats support a characteristic fauna which include some endemic as well as protected species.

5.1. INTRODUCTION

Insects constitute about three fourth of all the living species. Of about 1.4 million species of invertebrates that have been described, 0.75–1 million are insects (Wells, ***et al.*** 1983). A major share of insects that have been described are from forests. Tropical forests which occupy about 7% of the land area hold about 2/5th of known species. Recent studies in the rain forests of Panama, Peru and Brazil using canopy fogging method have indicated that there could be as many as 30 million species of insects in the forests. Due to deforestation, the insect life in these forests is fast becoming extinct

at an alarming rate even before we could understand their role in the ecosystem.

Systematic studies on the forest insects of India may be said to have started with the establishment of the Forest Research Institute, Dehra Dun in 1914. Detailed studies were made on the phytophagous as well as wood feeding insects. However these studies were quite inadequate considering the vast as well as diversified forest ecosystems of India which range from the boreal Himalayan forests to the tropical wet evergreen forests of the western ghats. The most comprehensive treatise on the forest insects of India contained only 3378 species (Beeson, 1941). Attempts to list the forest insects were continued resulting in a series of publications dealing with some 2140 plant species (Bhasin and Roonwal, 1954-58; Mathur and Singh, 1959-61). Insects being dominant components in many food webs in both the production and decomposition chains of the forest ecosystem, are important in the sustenance of natural habitats. Many species of wild plants are insect pollinated. They are also important as natural enemies of various pest species and as indicators of environmental quality. The ecological as well as economic importance of many species of Insects is still unknown. Due to disturbances in the habitat a major portion of the insect fauna is fast disappearing. Information on the faunistic elements as well as their interactions is essential for developing ecologically sound conservation strategies.

As per a recent estimate by the Zoological Survey of India, about 67,000 species of insects have been recorded from India. However

no information is available on the extent of forest insects. Information on the faunal elements is required in order to utilize the rich genetic diversity to our advantage.

5.1.1. Study area

The proposed site of the Nature Study Centre comprises about 484 ha of forest land in the Malayattoor Forest Divison. A major portion of this area belongs to moist deciduous forests besides plantations of teak and cashew. The river Periar flows along the East. On the South and West are agricultural lands which were originally natural forests. In the North the area merges with the forests of Chalakudy Forest Division. The teak plantations are above 30 years age and are planted on the eastern and northern regions. In the West are the cashew plantations. The natural forests contain species like *Haldina cordifolla, Terminalia crenulata, Dillenia pentagyna, Bombax malabaricum, Xylia xylocarpa, Schleichera oleosa* and *Grewia tiliaefolia.*

5.2. MATERIALS AND METHODS

The insects were sampled either by sweep nets or by setting up traps. Sampling was carried out during different months of the year. For sweep net sampling a belt transect of 5 m width was taken in plantations while a line transect was taken in the natural forests.

Insects collected in the samplings were recorded. Information thus gathered were further supplemented by making light trap catches at different placer;. A modified Pensylvanian type light trap operated by a 6 watt battery was used. An 8 watt UV tube was used for illumination. Habitats selected for sampling by light traps are the following:

i. Natural forests
ii. Teak plantations
iii. Cashew plantations
iv. Valleys along the natural forests including banks of streams
v. Edges of plantations

5.3. RESULTS

5.3.1. Fauna

Altogether 400 species of insects belonging to 75 families have been recorded in this study. The Orders Lepidoptera and Hemiptera contained maximum number of species. Coleoptera, Hymenoptera and Diptera were only poorly represented (Table 5.1). The relative numbers of various groups of insects recorded in this study need not be taken as an indication for their actual abundance as the sampling was confined to only one season. However, the data gathered herein give some baseline information on the faunal elements for future comparisons.

An examination of the species listed in this study indicates that many of the insects recorded here were economically important as

pests of various aqricultural crops and forest trees. The high proportion *of* agricultural pests could be due to the close proximity of the study area to agricultural farms. The important agricultural pests recorded include *Nymphula depunctalis* (paddy case worm), *Scirpophaga incertulas* (paddy stem borer), *Nephotettix virescens* (paddy hopper); *Riptortes* spp., (pests of pulse crops); *Utetheisa pulchella, Achaea Jana and Prodenia* ***litura*** (pests of vegetables) as well as *Otheri: ancilla* (fruit pest). The tree pests included *Helopeltis antonii* (Cashew bug), *Oregma* sp. (bamboo aphid), *Rhipiphorothrips cruentatus* (pest of several tree species), *Hyblaea puera* (teak defoliator), *Alcterogystia cadambae* (teak borer), *Eurema* spp. (defoliator of *Albizia* spp.) *Oenospila quadraria* (defoliator of mango trees) as well as *Eumelia rosalia* (defoliator of *Xylia xylocarpa).* Certain species of Hesperiidae *(Tagiades menaka* , *Celaenorhinus ambareesa and C. leucocera)* as well as some unidentified Lycaenidae found in the teak plantations were very characteristic being not found in similar habitats elsewhere. It may also be noted here that the butterflies recorded from this area included two species having protected status under the lndian Wildlife Act, viz. *Hypolimnas missipus* and *Castallus rusimon.* The butterflies *Tirumala limniace leopardus, Parantica aglea aglea* (Danaidae) and *Pachliopta pandiyana* (Papilionidae) listed in this study are endemic to southern India.

Distribution pattern of insects in the study area

Observations on the habitat preferences of various species recorded in this survey have indicated distinct patterns of insect

distribution within different ecological niches found in this area. The specialities of faunal elements found in the various habitats are discussed below.

5.3.2.1. Natural forests

The natural forest strips in the study area exhibited varying degrees of disturbances leaving patches of open areas whic got subsequently colonised by secondary vegetation which included various species of weeds and shrubs. Several such areas showed excessive growth of the exotic weed *Mikania micrantha* which completely suppressed the ground vegetation. Such patches of natural forests were found to be poor in the faunal diversity although large populations of one or more species of chrysomelid beetles *(Hoplasoma* sp. and *Aulacophora foevicollis)* were noticed to colonise such areas.

Insect fauna of undisturbed patches of natural forests, especially at higher elevations, appears to be much diverse; but detailed studies could not be undertaken due to poor accessibility.

Observations on the incidence of various insects on different forest trees have indicated that there were no major pest damage except for occasional incidence of certain pests on *Dillenia pentagyna, Xylia xylocarpa* and *Haldina cordifolia.* In all the above cases the damage was caused by leaf feeding caterpillars.

5.3.2.2. Zone of intergradation between natural forests and teak plantations

The edges of natural forest where it merges with the teak plantations were probably the best habitats with regard to the survival of

a wide variety of insects. An important feature of this habitat is the availability of different types of ecological conditions, viz. the dry conditions offered by the more or less open canopy of the teak plantation and the cool, shady habitat formed by the closed canopy of the adjoining natural forest. This condition is ideal for the survival of a large number of species having varied ecological requirements. Butterflies formed the major group of insects colonising this habitat. The pierids *Leptosia nina, Eurema blanda, E. hecabe* and *Catopsilia pomona;* the nymphalids *Hypolimnas bolina, H. missipus, Moduza procris, Junonia sp., Ariadne merione, Euthalia garuda and Neptis hylas* as well as the danaids *Parantica aglea aglea, Tirumala limniace leopardus, Danaus genuita and Euploea core* which prefer the open habitats, were found abundantly in the teak plantations where they subsisted on the nectar from *Cassia tora, Caesalpinia cristata, Clerodendron viscosum, Chromolaena odoratum, Helicteres isora, Mimosa pudica,* etc. growing under teak. The canopy was occupied by the pierid *Delias eucharis* probably due to its preference for its preferred host mistletoe.

Inside the natural forest especially along the edges, large aggregations of the papilionids *Troides helena, T. minos and Papilio polymnester parinda* were noticed on plants like *Mussaenda laxa.* The satyrids *Mycalesis* sp., *Elymnias caudata* and *Melanitis* sp. besides several species of moths mostly belonging to Geometridae and Pyralidae were present on the understorey vegetation close to ground level.

Besides Lepidoptera, this habitat was also found to be rich in grass hoppers, crickets, ants and wasps. Three species of acridids,

viz. ***Acrida exultata, Attractomorpha crenulata,*** and *Oxya* ***velox*** were found in fairly large numbers on various shrubby plants growing in the plantation. About 10 species of ants were noted on the ground as well as on the trunks of trees of which ***Polyrachis rastellata*** and ***Phidologiton diversus*** were very characteristic to this area. Wasps belonging to Vespoidea and Sphecoidea as well as a few species ut bees have also been collected from this area.

5.3.2.3. Banks of streams

Thick vegetation consisting of trees like ***Schleichera oleosa, Lagerstroemia reginae, Baccaurea courtellensis, Trewia polycarpa,*** etc. have been found growing along the banks of streams. Many groups of insects preferring cool, moist conditions like the Lycaenidae ***(Curetis sp., Castalius rosimon,*** Odonata, as well as several water insects (Dytiscidae, Belostomatidae, Hydrophilidae) were abundantly found in this habitat. The marshy lands along the streams also attracted several species of insects notably butterflies and dragonflies. Small aggregations of the butterflies of ***Graphium sarpedon teredon, Tros hector, Papilio polytes*** and ***Catopsilia*** sp. have been noticed on patches of grass or boulders in such areas.

5.3.2.4. P1antations

Plantations of teak and cashew were two distinct habitats in the study area. Most teak plantations located adjacent to the natural forests had luxuriant understorey vegetation which supported several groups of insects as discussed earlier. However, plantations adjacent to human settlements had very scarce ground flora probably due to

continued grazing by cattle as well as other disturbances of anthropogenic origin. Such areas often showed predominance of certain weeds like ***Hyptis*** sp., ***Cassia tora,*** amaranthus, milk weed, etc. As a result the fauna also showed specialisations and contained more common species.

Moths of the caseworms ***Nymphula depunctalis*** and *N.* ***fluctuosalis,*** the stem borer ***Scirpophaga incertulas,*** the cutworm ***Prodenia litura*** as well as the hairy caterpillar ***Porthesia*** sp. have been collected in fairly large numbers. Other species of moths collected from this area included some vegetable pests like ***Utetheisa pulchella,*** *Argina* ***cribraria, Diacrisia obliqua and Achaea janata. Eumelia rosalia,*** a pest of ***Xylia xylocarpa*** has also been recorded from this area. In addition to these, several species of cicadellids and chrysomelid beetles were found in good numbers on various weeds found in this habitat. The cicadellids included ***Nephotettix virescens, Jassus indicus*** and ***Cofana maculata.*** Of the beetles recorded from this habitat, ***Halys dentatus, Aulacophora foevicollis, Phyllotreta cruciferae*** and ***Haltica cyanea*** were the common ones. This habitat was also noted for the predominance of the milkweed butterflies ***Danaus genuita*** and ***Tirumala limniace leopardus.***

Incidence of pests was another aspect covered in this study. In teak plantations, the skeletonizer ***Hyblaea puera*** and the borer ***Alcterogystia cadambae,*** were noticed in some plantations under observation. Of these, the first was present uniformly throughout the plantations during September to October. However, this insect was not found to cause much economic damage. Incidence of *A.* ***cadambae*** was

noticed in some plantations in the kurishumudi area. As much a5 40 % of trees in some patches were found to be heavily affected by this insect with a high degree of tree mortality. As this insect is likely to spread to other teak plantations in the study area, it is essential that appropriate control measures are undertaken. For this, the strategy suggested by Mathew (1990) may be followed. This involves extraction of the affected trees d iring silvicultural operations and protecting the trees from mechanical injuries due to lopping of branches, plucking of leaves, etc.

In the cashew plantations the relative number of insects collected was less probably due to sparse undergrowth. The trees were found to be affected by the usual pests which included the leaf webber *Lamida* ***moncusalis*** (Pyralidae) and the inflorescence bug Helopeltis *antonii* (Miridae).

5.4. DISCUSSION

The insect fauna of Malayattoor is interesting in that it contains faunal elements belonging to diverse ecological niches. The forest area in this region is fragmented and the different biocoenoses have characteristic vegetation and associated invertebrate fauna. Of the various habitats recognized in this study, the natural forests and the adjacent teak plantations harboured a rich and diverse fauna due to the availability of duel ecological conditions. The area of interqradation between natural forests and the warm teak forests offer ideal conditions for the survival of a variety of insect species

having different ecological requirements. Among the insects recorded from this area were some endemic species which included *Tagiades menaka, Celaenorhinus ambareesa* (Hesperiidae); *Pachliopta pandiyana* (Papilionidae); *Tirumala limniace leopardus* and *Parantica aglea aglea* (Danaidae). The butterflies *H. missipus* and *Castalius rosimon* recorded from this area are having protected status under the Indian Wildlife Act. The riverine fauna was very rich in odonates, water beetles and certain groups of butterflies. A comparison of forest plantations in this area indicated much species diversity in the teak plantations located adjacent to natural forests. Teak plantations in the vicinity of agricultural lands which were Subject to heavy grazing were scarce in the faunal elements. Some of these plantations were also found to be affected by the borer *Alcterogystia cadambae.*

Disturbances to forest vegetation is known to have repercussions on animal survival (Webb, 1989). A recent study on the impact of selection felling on forest fauna (Johns, 1985) has indicated that although some species are not affected by changes in the flora, several others may find survival difficult. The imbalances in the species composition may also affect the functioning of the ecosystem. Lenski (1982) who studied the impact of forest cutting an the diversity of ground beetles has reported a significant increase in the within genus component of species diversity following forest cutting. The abundance of certain species of Chrysomelidae *(Hoplasoma* sp., *Aulacophora* sp., etc.) on the secondary vegetation in the disturbed patches cf natural forests reported in the present study could be due to the erosion of species diversity consequent to disturbances. Although the forests of Malayattoor are very much fragmented and disturbed, it ai11 contains

faunal elements which are of interest as being endemic or rare. By conserving the existing natural habitats in this area we will be able to protect the surviving species. Although the Malayattoor forests are to varying degrees of disturbances, there is much to conserve especially the insects by the establishment of the Nature Study Centre.

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Table 5.1. Taxonomic break up of insects recorded in this study

Order	No. of family represented	No. of species coll. from different habitats *					Total No. of species
		1	2	3	4	5	
Odonata	2					7	7
Orthoptera	3	-	9	-	4	-	15
Dictyoptera	2	5	5	-	-	-	10
Heteroptera	22	16	15	9	48	10	98
Thysanoptera	1	-	2	-	-	-	2
Neuroptera	2	-	1	-	-	2	3
Trichoptera	1	-	-	-	-	5	5
Lepidoptera	21	32	52	13	44	5	148
Diptera	2	2	1	-	1	-	4
Hymenoptera	4	-	19	-	5	-	24
Coleoptera	15	25	19	14	17	-	77
Total	75	82	123	38	121	29	393

* 1. Natural forest
2. Teak plantation
3. Cashew plantation
4. Edges of forests adjoining farm lands
5. Banks of streams

5.7. APPENDIX

LIST OF INSECTS RECORDED FROM THE MALAYATTOOR FORESTS

Order/Family/Species	Habitats*
ODONATA	
Neurothemis tullia tullia **Drury**	5
Dipl aeodes trivial is **Ramb.**	5
Orthetrum sabina **(Drury)**	5
unidentified species (4 Nos.)	
ORTHOPTERA	
Acrididae	
Acrida exultata **(Walker)**	2
Heiroglyphus banyan **Fb.**	2
Orthacris **sp.**	2
Oxya velox **(Fb.)**	2,5
Atractomorpha crenulata(Fb.)	2
Catantops **sp.**	2
Trilophidea **sp.**	2
Spathosternum prasiniferum **(Wlk.)**	2
Gryllidae	
Liogryllus bimaculatus **De Geer**	1,2
Gryllotalpidae	
Gryllotalpa africana **Pallas**	1,4
DICTYOPTERA	
Blattidae	
unidentified species (3 Nos.)	1,2
Mantidae	
Unidentified species *(2* Nos.)	1,2
HEMIPTERA	
Miridae	
Helopeltis antonii **Signoret**	3
Pachypeltis maesarum **(Kirkaldy)**	3
Calocoris angustatus **Lethierry**	1,2
Enicocephalidae	
Enicocephalus **sp.**	1,5

Nabidae	
Nabis sp.	1,5
Tingitidae	
Stephanites typicus **Distant**	3,4
Cochlocheila bullita **Stal**	3,4
Urentius echinus **Distant**	2,4
Dulinus conchatus **Distant**	3,4
Pyrrhocoridae	
Dysdercus cingulatus Fb.	1,2
Lygaeidae	
Oxycarenus 1aetus Kirby	1,2
Reduvidae	
Unidentified species' (4 Nos.)	2,4
Coreidae	
Riptortes linearis (Fb.)	4
R.pedestris(Fb.)	4
Leptocorisa varicornis (Fb.)	4
Cletus bipunctatus (**Westwood**)	4
Plataspididae	
Coptosoma cribraria (Fb.)	**2,4**
Pentatomidae	
Aspungopus janus (Fb.)	**2,4**
Nezara viridula **(Lin.)**	**4**
Bagrada picta (Fb.)	**4**
Halys dentatus **(Lin.)**	**4**
Menida histrio (Fb.)	**4**
Dolicoris indicus **Stal**	**4**
Tessarotoma javanica **Thunk.**	**4**
Cercopidae	
Phymatostetha deschampsi **Lethi.**	**1,4**
Clovia lineaticollis **(Motsch.)**	**4**
Cicadellidae	
Nephotettix virescens **Dist.**	**4**
N. higropictus **Sta1**	**4**
Krishna strigicollis **Spinola**	
Kolla unimaculata **(Signoret)**	1

Jassus indicus Lethi.	4
Cicadella spectra Dist.	4
Neodartus acocephaloides Melich.	4
Deltocephalus **sp.**	1,2
Penthimia **sp.**	1,4
Cofana unimaculata (Sign.)	1,4
Bothrogonia ferruginea **Fb.**	1,4

Membracidae

Gargara mixta (Buckton)	**3,4**
Leptocentrus taurus **(Fb.)**	**3,4**
Tricentrus sp.	**3,4**
Anchon pilosum Westwood	**4**

Meenoplidae

Nisia atrovinosa Lethi.	1,2

Cicadidae

Platypleura ***polita*** *(Wlk.)*	1

Derbidae

Proutista moesta (Westwood)	4
Diostrombus carnosus(Westwood)	4

Eurybrachidae

Eurybrachys tomentosa **(Fb.)**	**4**

De1phacidae

Nilaparvata lugens (Stal)	**4**
Sogatella furcifera (Haworth)	**4**

Coccoidea

Iceria sp.	**3,4**
Drosicha mangiferae **Green**	2,4

Psyllidae

Phacopteron lentiginosum Buckt.	1
Diaphorina citri Kuwayama	2

Aleurodidae

Bemisia tabaci Gennadius	**4**
Aleurocanthus **sp.**	**4**

Aphididae

Aphis craccivora Koch.	**4**
Oregma **sp.**	2

Thysanoptera

Heliothrips biformis (Baqnall)	2
Rhipihorothrips cruentatus Hood	2

NEUROPTERA

Chrysopidae

Chrysopa sp.	5
Ankylopteryx sp.	5

Myrmeleonidae

Palpares infirmus Fb.	2

TRICHOPTERA

Unidentified species (5 Nos.)	5

LEPIDOPTERA

Hesperidae

Gangara thyrsis Moore	2,4
Parnara mathias Fb.	2,4
Celaenorhinus ambareesa Moore@	1,2
C.leucocera (Kollar)	2
Tagiades menaka Moore @	2
Tagiades sp.	1,2

Nymphalidae

Precis iphita Cramer	1,2
Ariadne merionecramer	1,2,3
Euthalia garuda Moore	2,4
Hypolimnas bollina	1,2
H.missipus Lin.	1,2
Tanaecia lepidia	2
Junonia lemonias	2
Junonia stygia	2
Junonia sp.	2
Moduza procris Cram.	2
Cirrochroa thais thais Felder	1
Elymnias caudata Butler	2
Neptis hylas varmona Moore	2
Neptis sp.	2
Limnites sp.	2

Lycaenidae

Curetis sp.	2
Castalius rosimon (Fb.) #	2,5
Lampides boeticus Lin.	

Papilionidae

Troides minos Cramer	1,2
Troides helena Lin.	1,2
Papilio demolius Lin.	2,4
P.polymnester Cramer	2
P.polytes Lin.	2,4
Graphium sarpedon teredon Felder	2,5
G.agamemnon agamemnon Lin. @	2,5
Pachliopta pandiyana Moore	2,5
P.aristolochiae Rothschild	2,3,4
P.hector (Lin.)	2,3,4

Pieridae

Leptosia nina Fb.	2,3,4
Eurema hecabe Lin.	2,4
E.blanda Boisd.	2,4
Catopsilia pomona	2
C.pyranthe	2
Catopsilia sp	2
Delias eucharis Drury	2,4

Satyridae

Mycalesis igila Fruhstorpher	1,2
Melanites leda ismene Cramer	1,2

Danaidae

Euploea core Cramer	2,3,4
Parantica aglea aglea Stoll. @	2,4
Tirumala limniace leopardus Butl. @	2,4
Danais chrysippus Lin.	2,3,4

HETEROCERA

Cossidae

Alcterogystia cadambae (Moore)	2,4

Pyralidae

Nymphula depunctalis Guenee	4
N.fluctuosalis Zell.	4
Gargela sp.	4
Cataclysta blandialis Wlk.	4
Aulacodes peribocalis Wlk.	4
Scirpophaga incertulas Wlk.	4
Lamida moncusalis Wlk.	3
Phlyctaenodes flavofimbriata	2
Pygospila tyres Cram.	2
Glyphodes caesalis Wlk.	2
Eutectona machaeralis Wlk.	4

Thyrididae

Rhodogastria sp.nr.myrtacea (Hamp.)	1

Geometridae

Oenospila quadraria Guenee	2,3
Eumelia rosalia Cramer	2
Synegia paradaria Guenee	1
Agathia lycaenaria Guenee	1

Lymantriidae

Euproctis icilia Stoll	1,4
Dasychira horsefieldi Saunders	1,4
Psalis pennatula Hubn.	4
Porthesia sp.	4

Arctiidae

Estigmene lactinea Cramer	1,4
Creatonotus gangis Lin.	4
Pericallia ricini Fb.	2,3,4
Utetheisa pulchella Lin.	2,4
Amsacta albistriga Wlk.	3,4
Argina cribraria Clerk	3,4
A.argus Koller	4
Diacrisia obliqua Wlk.	3,4
Asura conferta Wlk.	3,4

Hypsidae

Hypsa alcifron Cramer	1

Noctuidae

Ophiusa coronata Fb.	1
Nyctipao macrops Lin.	1
Othereis ancilla Cramer	4
O.fullonica Lin.	4
Prodenia lituralis Boisd.	4
Eublemma angulifera Moore	4
Oruza bipars (Hampson)	1
Risoba repugnans Walker	1
Achaea janata Lin.	4
Anomis flava Fb.	4
Ramadasa pavo Wlk.	1
Mocis frugalis Fb.	1
Anticarsia irrorata Fb.	1
Polyoricta dimidialis Fb.	1

Hyblaeidae

Hyblaea puera Cram.	4

Sphingidae

Theretra oldenlandiae (Fb.)	4
Rhyncholobus acteus (Cramer)	1
Acherontia styx Westwood	4
Macroglossum gurans Wlk.	3,4

Lasiocampidae

Trabala vishnu Lefevere	1
Estigmena pardalis Wlk.	1

Eupterotidae

Eupterote sp.	1

Cochliidae

Parasa lepida Cramer	1
P.bicolor Wlk.	1
Miresa bracteata Butler	1

Zygaenidae

Artona zebraica Butler.	1

DIPTERA

Agromyzidae

Phytomyza atricornis Meigan	4

Unidentified family (1 sp.)	2

HYMENOPTERA

Vespoidea

Unidentified spp. (2 Nos.)	2

Sphecoidea

unidentified spp. (4 Nos.)	2

Formicidae

Odontomachus haematodes Lin.	2
Diacamma vagans Smith	2
Myrmecaria brunnea Saunders	2
Cremastogaster sp.	2,4
Solenopsis geminata Fb.	2,4
Phidologiton diversus Jerd.	2
Tetramorium sp.	2,4
Phidole sp.	2
Oecophila smaragdina Fb.	3

Camponotus sericeus Fb.	2,4
Camponotus sp.	2,4
Polyrachis rastellata Latreille	2
Xylocopidae	
Xylocopa verticalis	2
X. rufescens	2
COLEOPTERA	
Carabidae	
Unidentified sp. (13 Nos.)	1,2,3
Scarabaeidae	
Heliocopris sp.	1,2
Gymnopleurus sp.	1,2
Rutellidae	
Unidentified sp. (1 No.)	3,4
Staphylinidae	
Unidentified sp.(1 No.)	4
Tenebrionidae	
Unidentified sp. (6 Nos.)	4
Dytiscidae	
Unidentified sp. (1 No.)	5
Elateridae	
Unidentified sp. (1 No)	5
Pausidae	
Unidentified sp. (1 No.)	2
Meloidae	
Unidentified sp. (1 No.)	3
Lycidae	
Unidentified sp. (1 No.)	3

Lampyridae	
Unidentified sp. (1 No.)	2
Cerambycidae	
Cerosterna scabrator Fb.	4
Glenea sp.	1
Chrysomelidae	
Dicladispa armigera (Olivier)	4
Leptispa pigmoea Baly	4
Phyllotreta cruciferae Goeze	4
Haltica cyanea Weber	1,4
Chlamys sp.	4
Hoplasoma unicolor (Illiger)	1,4
Aulacophora fovecollis (Lucas)	1,4
Coccinella arcuata	1
Curculiaidae	
Apoderus tranquebaricus Fb.	1
Myllocerus viridanus Fb.	1,4
Platypodidae	
Platypus cavus Strohm.	1
Bostrychidae	
Sinoxylon anale Les.	1,2
S. atratum Les.	1,2

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* Habitats

1. Natural Forest
2. Teak plantation
3. Cashew Plantation
4. Edges of Forests adjoining farm lands
5. Banks of streams

@ Endemic species
\# Protected species

SOIL CHARACTERISTICS AND MAPPING OF MALAYATTOOR

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SOIL CHARACTERISTICS AND MAPPING OF MALAYATTOOR

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Contents

ABSTRACT

Natural forests have been under continuous exploitation and constant pressure from the local people for the last many decades with the result there was tremendous decline in the extent and deterioration in quality . Along with this, there is considerable change in the land use pattern leading to variations in the soil properties as well. A thorough knowledge of the nature and properties of soils of different forest ecosystems is important for proper management of the environment and utilisation of resources. This study was initiated to characterise the soils and prepare soil map of natural forests and plantations of different species of Nature Study Centre in the Malayattoor Forest Division.

Sites were selected in the evergreen and moist deciduous forests, grassland and plantations of teak *(Tectona **grandis)*** and cashew *(Anacardium **occidentale).*** Eight soil pits, each, from evergreen and moist deciduous forests, 20 from teak, five from cashew and four from grassland were taken. Samples were collected from ***0***-20, 10-40 and 49-60 cm layers of soil pits. Analyses were carried out for particle-size separates, soil pH, organic carbon, exchangeable bases, exchange acidity, extractable N,P,K,Ca and Mg. Gravel contents were also determined. Soils in the evergreen and cashew are sandy loam while in the moist deciduous and teak they are loamy sand. The soils are very strongly acid in the evergreen where as in all others, they are strongly acid. The nature and properties of soils varied considerably between vegetation types. Analysis of variance of soil properties between vegetation types showed that excluding gravel,

silt, P, Ca and Mg, all other properties differes significantly. Soils in the plantations are found to be deteriorated when compared to those in natural forests. The soils, in the evergreen dnd moist deciduous forests, teak and cashew plantations and grassland are classified into four sub types of the type red ferrallitic. They are typical red ferrallitic in the evergreen forest, lessivated in the moist deciduous forest, concretionary in %he teak and cashew plantations, and shortened in grassland.

6.1. INTRODUCTION

Soils play an important role in the growth and development of forests. Differences in soil properties influence both the composition of forest vegetation and the rate of tree growth and vice versa. A thorough knowledge of the nature and properties of soils of forest ecosystems is important for proper management of the environment and utilisation of resources. Ecosystem studies per se are relatively recent. No safe soil management system can be devised without adequate knowledge of the dynamic interaction between soil, climate and forest management. Land classification and mapping are invaluables for resource inventories and site selection. Soil mapping makes a rational use and conservation of soils and imparts significant influence a5 a basis for technical and ecological knowledge as well as for land-use planning and the conservation of natural areas (Bonneau and Souchier, 1982). Maps can also be used In determining site quality, the appropriate types of forest management and thinning regimes to

follow, and soil areas that are particularly fragile, erosive or deficient in nutrients.

No systematic attempt has so far been made to characterise the soils in the natural forests and plantations of different species of proposed Nature Study Centre. Soil mapping of this small portion has also not been carried out. This study was undertaken to evaluate the nature and properties of soils and to prepare the soil map of the proposed Nature Study Centre in Malayattoor Forest Division.

6.2. STUDY AREA

The study area is covered with evergreen and moist deciduous forests, grasslands, and plantations of teak and cashew. Major portion of the forests lie on the upper part of the hill while the plantations dominate the lower portions. Mast of the area is covered with moist deciduous forest and teak plantations. Elevation ranges from 50 m to 375 m. The hill lies East to West and belong to the crystalline rocks of Archean age comprising chiefly of granitic qneisses. The area receives bath south west and north east monsoons. The climate is warm humid for the qreater part of the year with a dry cool spell from December to February and hot summer from March to May.

6.3. SOILS

The soils have developed on hilly topography resulting in shallow soils on the upper part of the hill and on steep slopes, and moderately deep soil on mid slopes. Laterisation is a common phenomena and the presence of leaf litter accumulation is a usual feature. The soils in general are red in colour, sandy loam to loamy sand in texture and strongly acid. They are generally loose, friable, granular and porous on the surface but turn slightly compact, massive and less porous with depth.

Presence of gravel of varying-sizes is a common feature. Concretions of iron, aluminium and manganese are met with in the plantations and their contents vary considerably. Most of the feeding roots are found to be concentrated in the 0–20 cm layer. Few roots are seen beyond 60 cm. The natural forests are subjected to anthropic disturbances. Fire-wood collection on headloads to neighbouring places is a regular affair and it is noticed that this is the main source of income for the people staying near the proposed Nature Study Centre. Fire, grazing and illicit lopping of branches of trees for green manure are of common occurrence. Run off and erosion of soils are also found to be severe in the plantations. The disturbance to the ecosystem is partly due to the pilgrimage during the months of April and May every year.

6.4. METHODOLOGY

Sampling sites were selected based on a reconnaissance in the area and representative soil pits up to a depth of 60 cm were taken from evergreen and moist deciduous forests, grassland and teak (*Tectona grandis),* and cashew *(Anacardium occidentale)* plantations. Altogether 45 soil pits were taken from an area of of 1500 ha of which eight each were from evergreen and moist deciduous forests, 20 from teak plantation, five from cashew plantation and four from grassland. Soil samples were collected from 0–20, 20–40 and 40–60 cm layers of soil pits. Samples were air dried, passed through 2 mm sieve and gravel contents were determined. Analyses were carried out for particle–size separates, soil pH, organic carbon, exchangeable bases, exchange acidity, cation exchange capacity, extractables N, P, K, Ca and Mg as per standard procedures (American Society of Agronomy 1965; Jackson, 1958).

The morphological description, and the physical and chemical properties of soils in different layers in the five ecosystems are presented in Tables 6.1 to 6.45 and their mean values in different layers are given in Tables 6.46 and 6.47. Analyses of variance of soil properties (Snedecor and Cochran, 1975) between vegetation types are represented in Table 6.48. The soil map of the area is also given as Fig. 6.1.

6.5. RESULTS AND DISCUSSION

Soil properties in evergreen forests

Terrain is hilly with elevation ranging from 150 to 300 m. The soils are moderately well drained with good accumulation of fresh and partially decomposed litter. The marphological description and physl-cal and chemical properties of soils in different layers in the ever-green forest are given in Table 6.1 to 6.8 and their mean values are given in Tables 6.46 and 6.47. In general, clay contents increase while sand. pH, organic carbon, exchange acidity, cation exchange capacity, extractable N,P,K and Mg decrease with depth. There is no change for silt contents while gravel, exchangeable bases and ext actable Ca followeo no pattern. The soil is sandy loan and very strongly acid.

Mean values of gravel, sand, silt and clay in the 0-60 cm layers are 21,78,11 and 11 %, respectively. They are 5.0, 1.53%, 8. 6.4 ana 14.4 me/l00q soil for soil pH, organic carbon, exchangeable bases, exchange acidity and cation exchange capacity. Extractable N, P, k, Ca and Mg contents are 135, 6, 295, 14 and 9 ppm, respectively.

6.5.2. Soil properties in moist deciduous forests;

The forests are on hills with elevation ranging from 150 to 300 m. The soils are well drained. The morphological descriptions, and physical and chemical properties of soils in different layers in moist deciduous forest are given in Tables 6.9 to 6.16.

Table 6.1

Vegetation type : Everpreen forest Soil pit No.01

Description

0-20 cm Dark yellowish brown, loamy sand, granular, friable, moderately gravelly, abundant coarse roots, common medium and larger voids of roots, strongly acid.

20-40 cm Dark brown, loamy sand, blocky, moderately gravelly, abundant medium roots, distinct in decayed channels, strongly acid.

40-60 cm Strong brown, loam, blocky, slightly firm, many medium roots, very strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	27	22	22	24
Sand "	81	81	75	79
Silt "	10	10	13	11
Clay "	9	9	12	10
pH	5.3	5.2	5.0	5.2
Organic carbon %	2.07	1.38	0.93	1.46
Exch. bases me/100 g	1	1	1	1
Exch. acidity "	7.0	5.3	4.5	5.6
Av. N ppm	193	114	85	131
Extr. P "	5	3	6	5
Extr. K "	660	540	420	540
Extr. Ca "	26	12	12	17
Extr. Mg "	8	6	5	6
Cation exch. capacity me/100 g	8.0	6.3	5.5	6.6

Table 6.2

Vegetation type : Evergreen forest Soil pit No. 02

Description

0-20 cm Dark brown, loamy sand, granular, very friable, slightly gravelly, abundant coarse and medium roots, decaying leaves and roots forming a mat on and closely below surface, strongly acid.

20-40 cm Very dark grayish brown, loamy sand, massive, slightly gravelly, abundant medium and fine roots, medium acid.

40-60 cm Very dark grayish brown, loamy sand, massive, slightly gravelly, abundant fine roots, medium acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	11	12	12	12
Sand "	84	85	85	85
Silt "	9	9	9	9
Clay "	7	6	6	6
pH	5.5	5.6	5.6	5.6
Organic carbon %	1.98	1.44	1.14	1.52
Exch. bases me/100 g	6	4	2	4
Exch. acidity "	5.3	5.8	4.2	5.1
Av. N ppm	171	108	90	123
Extr. P "	38	28	24	30
Extr. K "	820	270	180	423
Extr. Ca "	68	48	48	55
Extr. Mg "	18	11	14	14
Cation exch. capacity me/100 g	11.3	9.8	6.2	9.1

Table 6.3

Vegetation type: Evergreen forest Soil pit No. 03

Description

0-20 cm Dark yellowish brown, loamy sand, granular, very friable, slightly gravelly, abundant coarse roots, earthworms, strongly acid.

20-40 cm Dark yellowish brown, loam, blocky, moderately gravelly, infiltration of humiferous materials from upper layer, many medium roots, very strongly acid.

40-60 cm Dark yellowish brown, loam, massive, moderately gravelly, many medium and fine roots, distinct in decayed root channels, very strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	14	22	28	21
Sand "	80	74	73	76
Sllt "	11	11	12	11
Clay "	9	15	15	13
PH	5.2	4.9	5.0	5.0
Organic carbon %	1.65	0.90	0.87	1.14
Exch. bases me/100 g	7	8	9	8
Exch. acidity "	6.5	5.5	8.5	6.8
Av. N ppm	153	82	59	98
Extr. P "	4	4	4	4
Extr. K "	140	310	390	280
Extr. Ca "	28	16	20	21
Extr. Mq "	20	8	10	13
Cation exch. capacity me/100 g	13.5	13.5	17.5	14.8

Table 6.4

Vegetation type: Evergreen forest Soil pit No. 04

Description

0-20 cm Dark yellowish brown, loamy sand, granular, moderately gravelly, very friable, abundant coarse and medium roots, common medium and larger voids of roots, strongly acid.

20-40 cm Dark yellowish brown, loamy sand, blocky, moderately gravelly, clay-humus infiltration along old root and termite channels, many medium and fine roots, very strongly acid.

40-60 cm Dark yellowish brown, loamy sand, blocky, slightly firm, moderately gravelly, many fine roots, very strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	17	17	19	18
Sand "	84	79	79	81
Silt "	9	11	11	10
Clay "	7	10	10	9
pH	5.1	4.9	4.9	5.0
Organic carbon %	2.10	0.96	1.08	1.38
Exch. bases me/100 g	11	9	9	10
Exch. acidity "	7.5	6.0	6.0	6.5
Av. N ppm	197	88	92	126
Extr. P "	6	5	9	7
Extr. K "	230	50	50	110
Extr. Ca "	22	12	16	17
Extr. Mg "	20	13	8	14
Cation exch. capacity me/100 g	18.5	15.0	15.0	16.5

Table 6.5

Vegetation type: Evergreen forest Soil pit No.05

Description

0-20 cm Dark brown, loamy sand, granular, very friable, moderately gravelly, abundant coarse and medium roots, common medium and larger voids of roots, very strongly acid.

20-40 cm Strong brown, loam, blocky, moderately gravelly, abundant medium and fine roots, distinct in decayed roo channels, very strongly acic.

40-60 cm Strong brown, sandy loam, massive, slightly firm, moderately gravelly, very strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	16	19	21	19
Sand "	79	75	76	77
Silt "	12	13	10	12
Clay "	9	12	14	11
pH	5.0	5.0	4.9	5.0
Organic carbon %	2.12	1.29	1.09	1.50
Exch. bases me/100 g	12	8	10	10
Exch. acidity "	6.5	6.2	6.2	6.3
Av. N ppm	203	101	90	131
Extr. P "	9	7	6	7
Extr. K "	230	230	50	170
Extr. Ca "	38	18	14	23
Extr. Mg "	18	5	4	9
Cation exch. capacity me/100 g	18.5	14.2	16.2	16.3

Table 6.6

Vegetation type: Evergreen forest Soil pit No.06

Description

0-20 cm Dark yellowish brown, sandy loam, granular, very friable, lightly gravelly, ahundant coarse and medium roots, organic debris at surface, strongly acid.

20-40 cm Strong brown, loam, blocky, moderately gravelly, many medium and fine roots, scattered faunal voids, very strongly acid

40-60 cm Yellowish red, loam, massive, slightly firm, slightly gravelly, abundant fine roots, very strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	47	29	32	36
Sand "	76	69	68	71
Sllt "	11	11	12	11
Clay "	13	20	20	18
pH	5.3	4.8	4.8	5.0
Organic carbon %	2.44	1.76	1.32	1.84
Exch. bases me/100 g	11	10	10	10
Exch. acidity "	6.4	5.8	5.4	5.9
Av. N ppm	212	155	117	161
Extr. P "	6	6	6	6
Extr. K "	350	310	180	280
Extr. Ca "	34	10	8	17
Extr. Mg "	10	2	2	5
Cation exch. capacity me/100 g	17.4	15.8	15.4	15.9

Table 6.7

Vegetation type: Evergreen forest Soil pit No.07

Description

0-20 cm Dark brown, loamy sand, granular, friable, moderately gravelly anundant coarse roots, plentiful decomposing organic litter and manuy roots, strongly acid.

20-40 cm Dark brown, loam, blocky, moderately gravelly, many medium roots, strongly acid.

40-60 cm Dark yellowish brown, loam massive, moderately gravelly, few fine roots, very strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	27	17	19	21
Sand "	78	73	71	74
Silt "	12	13	11	12
Clay "	10	14	18	14
pH	5.3	5.1	4.8	5.1
Organic carbon %	2.28	1.43	1.17	1.63
Exch. bases me/100 g	11	9	9	10
Exch. acidity "	6.2	7.9	7.3	7.1
Av. N ppm	209	132	101	147
Extr. P "	9	6	6	7
Extr. K "	420	140	90	217
Extr. Ca "	28	10	14	17
Extr. Mg "	10	4	7	7
Cation exch. capacity me/100 g	17.2	16.9	16.3	17.1

Table 6.8

Vegetation type: Evergreen forest Soil pit No.08

Description

0-20 cm Dark brown , sandy loam, granular, very friable, slightly gravelly, abundant coarse and medium roots, decaying leaves forming a mat on and closely below surface, very strongly acid.

20-40 cm Dark brown, sandy loam, blocky, moderately gravelly, many medium roots, decaying organic matter mixed in lower horizons, very strongly acid.

40-60 cm Strong brown, loam, blocky, moderately gravelly, few fine roots, very strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	10	18	24	17
Sand "	79	79	73	77
Silt "	10	10	12	11
Clay "	11	11	15	12
pH	4.6	4.6	4.9	4.7
Organic carbon %	2.65	1.66	1.06	1.79
Exch. bases me/100 g	8	9	10	9
Exch. acidity "	9.3	9.1	6.2	8.2
Av. N ppm	237	149	90	159
Extr. P "	6	4	5	6
Extr. K "	470	230	310	337
Extr. Ca "	18	12	12	14
Extr. Mg "	4	6	4	5
Cation exch. capacity me/100 g	17.3	18.1	16.2	17.2

Table 6.9

Vegetation type: Moist deciduous forest Soil pit No.09

Description

0-20 cm Very dark brown, loamy sand, granular, friable, moderately gravelly, abundant coarse and medium roots forming surface mat, strongly acid.

20-40 cm Dark brown, loamy sand, blocky, slightly gravelly, infiltration of humiferous materials from upper layer, many medium roots, strongly acid.

40-60 cm Dark brown, loamy sand, massive, slightly firm, slightly gravelly, few fine roots, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Grav 1 %	16	9	13	13
Sand "	87	85	85	86
Silt "	10	13	13	12
Clay "	3	2	2	2
pH	5.5	5.5	5.2	5.4
Organic carbon %	2.58	1.92	1.47	1.99
Exch. bases me/100 q	13	10	10	11
Exch. acidity "	6.1	8.3	7.9	7.4
Av. N ppm	229	149	108	162
Extr. P "	6	3	5	5
Extr. K "	1040	440	550	677
Extr. Ca "	132	32	26	63
Extr. Mq "	45	11	8	21
Cation exch. capacity me/100 g	19.1	18.3	17.9	18.4

Table 6.10

Vegetation type: Moist deciduous forest Soil pit No.10

Description

0-20 cm Dark brown, loamy sand, granular, friable, moderately gravelly, abundant coarse and medium roots, strongly acid.

20-40 cm Dark brown, loamy sand, blocky, slightly firm, moderately gravelly, many medium roots, medium acid.

40-60 cm Dark brown, loamy sand, massive, slightly firm, moderately gravelly, many fine roots, few faunal channels of termites, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	16	17	19	17
Sand "	86	86	84	85
Silt "	12	12	13	12
Clay "	2	2	3	3
pH	5.5	5.6	5.5	5.5
Organic carbon %	2.13	1.49	1.32	1.65
Exch. bases me/100 g	14	8	6	9
Exch. acidity "	8.6	8.6	8.3	8.5
Av. N ppm	207	120	109	145
Extr. P "	3	4	3	3
Extr. K "	110	440	540	363
Extr. Ca "	44	24	14	27
Extr. Mg "	17	7	7	10
Cation exch. capacity me/100 g	22.6	16.6	14.3	17.5

Table 6.11

Vegetation type: Moist deciduous forest Soil pit No.11

Description

0-20 cm Dark brown, loamy sand, granular, friable, moderately gravelly, plentiful coarse and medium roots, organic debris at surface, strongly acid.

20-40 cm Dark brown, loamy sand, blocky, slightly firm, moderately gravelly, medium and fine roots, earthworms, fine faunal voids, strongly acid.

40-60 cm Dark brown, loamy sand, massive, slightly firm, moderately gravelly, abunoant fine roots, medium acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	22	22	18	21
Sand "	68	87	87	67
Sllt "	10	12	11	11
Clay "	2	1	2	2
pH	5.4	5.1	5.6	5.4
Organic carbon %	2.60	1.64	1.67	2.04
Exch. bases me/100 g	12	9	9	10
Exch. acidity "	9.4	8.8	8.3	8.8
Av. N ppm	241	151	133	175
Extr. P "	3	3	3	3
Extr. k "	580	90	160	283
Extr. Ca "	50	16	16	28
Extr. Mg "	7	6	6	6
Cation exch. capacity me/100 g	21.4	17.6	17.3	18.6

Table 6.12

Vegetation type: Moist deciduous forest Soil pit No.12

Description

0-20 cm Dark brown, loamy sand, granular, friable, moderately gravelly, many fine interstitial tubular pores, abundant coarse roots, much decomposing organic litter and many roots, medium acid.

20-40 cm Dark brown, loamy sand, massive, slightly firm, moderately gravelly, gradual wavy boundary, abundant medium roots, scattered faunal voids, medium acid.

40-60 cm Dark brown, loamy sand, massive, slightly firm, moderately gravelly, diffuse wavy boundary, few fine roots, few faunal channels of termites, medium acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	21	15	20	19
Sand "	89	90	89	89
Silt "	9	9	9	9
Clay "	2	1	2	2
pH	5.6	5.7	5.6	5.6
Organic carbon %	2.23	1.95	1.66	1.95
Exch. bases me/100 g	12	4	8	8
Exch. acidity "	9.4	8.8	8.3	8.8
Av. N ppm	194	142	112	150
Extr. P "	3	4	2	3
Extr. K "	390	350	390	377
Extr. Ca "	68	24	20	37
Extr. Mg "	13	7	5	8
Cation exch. capacity me/100 g	21.4	12.8	16.3	16.8

Table 6.13

Vegetation type: Moist deciduous forest Soil pit No.13

Description

0-20 cm Dark brown, loamy sand, granular, friable, moderately gravelly, abundant coarse roots, plentiful decomposing organic litter, strongly acid.

20-40 cm Very dark grayish brown, loamy sand, blocky, slightly firm, moderately gravelly, many medium roots, distinct in decayed root channels, strongly acid.

40-60 cm Dark yellowish brown, loamy sand, firm, moderately gravelly, few very fine roots, medium acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	18	27	24	23
Sand "	89	90	88	89
Silt "	9	8	10	9
Clay "	2	2	2	2
pH	5.3	5.4	5.7	5.5
Organic carbon %	2.38	1.59	1.09	1.69
Exch. bases me/100 g	17	7	6	10
Exch. acidity "	9.7	9.0	8.4	9.0
Av. N ppm	197	130	92	140
Extr. P "	7	3	2	4
Extr. K "	500	230	180	303
Extr. Ca "	110	36	20	55
Extr. Mg "	28	10	5	14
Cation exch. capacity me/100 g	26.7	16.0	14.4	19.0

Table 6.14

Vegetation type: Moist deciduous forest Soil pit No.14

Description

0-20 cm Very dark grayish brown, loamy sand, granular, friable, slightly gravelly, abundant coarse roots, faunal voids including termite nests, medium acid.

20-40 cm Very dark grayish brown, loamy sand, blocky, firm, slightly gravelly, many medium and fine roots, scattered faunal voids mainly termite channels and chambers, strongly acid.

40-60 cm Dark brown, loamy sand, blocky, firm, moderately gravelly-few fine and very fine roots, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	13	14	23	17
Sand "	86	88	83	86
Silt "	11	10	13	11
Clay "	3	2	4	3
pH	5.7	5.4	5.3	5.5
Organic carbon %	2.71	1.79	1.07	1.B6
Exch. bases me/100 g	23	15	6	15
Exch. acidity "	6.9	8.0	7.0	7.3
Av. N ppm	229	152	93	158
Extr. P "	6	2	3	4
Extr. K "	740	310	270	440
Extr. Ca "	92	36	8	45
Extr. Mg "	5	1	8	5
Cation exch. capacity me/100 g	29.9	23.0	13.0	22.3

Table 6.15

Vegetation type: Moist deciduous forest Soil pit No.15

Description

0-20 cm Very dark grayish brown, loamy sand, granular, friable, slightly gravelly, abundant coarse roots, root mat and disintegrating organic debris, medium acid.

20-40 cm Dark brown, loamy sand, blocky, firm, moderately gravelly,, many medium roots material interfingering in lower horizons through faunal voids and old root channels, strongly acid.

40-60 cm Dark brown, loamy sand, massive, firm, moderately gravelly, few medium and fine roots, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	9	17	23	16
Sand "	88	86	84	86
Silt "	11	9	10	10
Clay "	3	5	6	4
pH	5.7	5.3	5.5	5.5
Organic carbon %	1.81	0.92	0.72	1.15
Exch. bases me/100 g	20	9	4	11
Exch. acidity "	7.7	9.2	7.8	8.2
Av. N ppm	165	87	65	106
Extr. P "	6	2	4	4
Extr. K "	270	700	270	413
Extr. Ca "	82	24	24	43
Extr. Mg "	49	14	11	25
Cation exch. capacity me/100 g	27.7	18.2	11.8	19.2

Table 6.16

Vegetation type: Moist deciduous forest. Soil pit No. 16

Description

0-20 cm Dark brown, loamy sand, granular, friable, moderately gravelly, abundant coarse roots, much decomposing organic litter and many decomposing roots, medium acid.

20-40 cm Dark brown, loamy sand, blocky, slightly firm, slightly gravelly, many coarse and medium roots, pockets of filled-in material from upper horizon, medium acid.

40-60 cm Strong brown, sandy loam, massive, firm, moderately gravelly, few fine roots, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	15	12	20	16
Sand "	84	77	77	79
Silt "	9	13	12	11
Clay "	7	10	11	10
pH	5.7	5.7	5.5	5.6
Organic carbon %	2.75	1.74	1.15	1.88
Exch. bases me/100 g	7	4	4	5
Exch. acidity "	6.3	6.2	4.5	5.7
Av. N ppm	241	121	99	154
Extr. P "	11	9	8	9
Extr. K "	1210	660	50	640
Extr. Ca "	98	42	40	60
Extr. Mq "	29	16	16	20
Cation exch. capacity me/100 q	13.3	10.2	8.5	10.7

The mean values of soil properties are shown in Tables 6.46 and 6.47. Sand, organic carbon, exchangeable bases, extractable N,P,K, Ca and Mg and cation exchange capacity decrease whereas gravel, silt and clay contents increase with depth. There is no change in pH values while exchange acidity followed no trend. The soil is loamy sand and strongly acid.

The average values of gravel, sand, silt, and clay in the 0–60 cm layer are 18, 86, 11 and 3%, respectively. They are 5.5, 1.78% and 10, 8 and 18 me/100g soil for soil pH, organic carbon, exchangeable bases, exchange acidity and cation exchange capacity. Extractable N,P,K, Ca and Mg contents are 149, 4, 437, 27 and 14 ppm, respectively.

6.5.3. Soil properties in teak plantations

The plantations are on hills with elevation ranging from 50 to 200 m. The soils are well drained. Most of the area is covered with rocky out crops. The morphological description, and physical and chemical properties of soils in different layers in the teak plantation are presented in Tables 6.17 to 6.36. The mean values of soil properties are bestowed in Tables 6.46 and 6.47. Organic carbon, exchangeable bases, exchange acidity, extractable N, K, Ca, Mg and cation exchange capacity decrease while gravel, silt and clay contents increase with depth. There is no trend for sand, pH and extractable P values. The soils are loamy sand and strongly acid.

Table 6.17

Vegetation type: Teak plantation Soil pit No. 17

Description

0-20 cm Very dark grayish brown, loamy sand, granular, triable, slightly gravelly, abundant coarse roots, strongly acid.

20-40 cm Dark brown, loamy sand, blocky, slightly firm, moderately gravelly, many medium roots, occasional pieces of broken iron pan which is easily breakable, medium acid.

40-60 cm Strong brown, loamy sand, massive, firm, moderately gravelly, few medium and fine roots, few breakable pieces of laterites with reddish, yellowish and black colours, medium acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	12	25	21	19
Sand "	85	80	75	80
Silt "	11	14	15	13
Clay "	4	6	10	7
pH	5.5	5.6	5.6	5.6
Organic carbon %	2.05	0.98	0.77	1.27
Exch. bases me/100 g	6	3	3	4
Exch. acidity "	9.4	7.5	7.0	8.0
Av. N ppm	192	89	64	115
Extr. P "	8	9	3	7
Extr. K "	160	80	30	90
Extr. Ca "	42	28	22	31
Extr. Mg "	19	11	5	12
Cation exch. capacity me/100 g	15.4	10.5	10.0	12.0

Table 6.18

Vegetation type: Teak plantation Soil pit No. 18

Description

0-20 cm Strong brown, loamy sand, granular, friable, slightly gravelly, abundant coarse roots, fine faunal voids, strongly acid.

20-40 cm Dark reddish brown, sandy loam, blocky, slightly firm, slightly gravelly, many medium roots, fine subrounded Fe/Mn concretions, strongly acid.

40-60 cm Yellowish red, loamy, massive, firm, moderately gravelly, few fine roots, common medium and coarse distinct mottles becominq more prominent and slightly redder with depth, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	10	12	25	16
Sand "	79	76	74	76
Silt "	12	12	13	12
Clay "	9	12	13	12
pH	5.4	5.3	5.3	5.3
Organic carbon %	1.97	0.79	0.64	1.13
Exch. bases me/100 g	6	3	3	4
Exch. acidity "	6.7	5.9	4.9	5.8
Av. N ppm	181	65	39	***95***
Extr. P "	10	7	8	8
Extr. K "	80	130	60	90
Extr. Ca "	36	24	26	29
Extr. Mg "	12	11	10	11
Cation exch. capacity me/100 g	12.7	8.9	7.9	9.8

Table *6.19*

Vegetation type: Teak plantation Soil pit No. 19

Description

0-20 cm Dark brown, loamv sand, granular, friable, slightly gravelly, abundant coarse roots, organic debris at surface, strongly acid.

20-40 cm Strong brown, loamy sand, blocky, slightly firm, moderately gravelly, many medium roots, scattered remnants of laterite, medium acid.

40-60 cm Reddish brown, loamy sand, massive, firm, slightly gravelly, few fine routs, many medium and coarse distinct, locally prominent, multicoloured mottles, medium acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	11	20	18	16
Sand "	81	77	77	78
Silt "	12	13	13	13
Clay "	7	10	10	*9*
pH	*5.5*	5.7	5.8	*4.0*
Organic carbon %	1.21	0.72	0.67	0.87
Exch. bases me/100 g	4	7	6	6
Exch. acidity "	8.1	*5.9*	4.0	6.0
Av. N ppm	108	60	54	74
Extr. P "	3	14	3	7
Extr. K "	320	160	260	247
Extr. Ca "	30	5	46	27
Extr. Mg "	*4*	12	11	10
Cation exch. capacity me/100 q	12.1	12.9	10.0	12.0

Table 6.20

Vegetation type: leak plantation Soil pit No. 20

Description

0-20 cm Dark brown, loamy sand, granular, friable, moderately gravelly, abundant coarse roots, gradual wavy boundary, strongly acid.

20-40 cm Dark reddish brown, loamy sand, blocky, slightly firm, slightly gravelly, few fine roots, scattered remnants of laterite, strongly acid.

40-60 cm Dark reddish brown, sandy loam, massive, firm, moderately gravelly, very few very fine roots, mottled with brownish and reddish particles, medium acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	19	14	18	17
Sand "	81	79	76	79
Silt "	12	13	13	13
Clay "	7	8	11	8
pH	5.5	5.2	5.6	5.4
Organic carbon %	1.32	0.79	0.63	0.91
Exch. bases me/100 g	4	5	4	4
Exch. acidity "	7.5	6.1	5.7	6.4
Av. N ppm	117	65	40	74
Extr. P "	3	3	6	5
Extr. K "	320	290	30	213
Extr. Ca "	42	36	30	34
Extr. Mg "	10	5	6	7
Cation exch. capacity me/100 g	11.5	11.1	9.7	10.4

Table 6.21

Vegetation type: leak plantation Soil pit No. 21

Description

0-20 cm Dark brown, loamy sand, granular, friable, slightly gravelly, atundant coarse roots, decaying leaves forming a mat on and closely below surface, strongly acid.

20-40 cm Dark reddish brown, loam, blocky, slightly firm, moderately gravelly, many medium roots, clear and locally abrupt smooth boundary, strongly acid.

40-60 cm Reddish brown, loam, massive, firm, moderately gravelly, few fine roots, granite fragments of stone and gravel-size in various stages of weathering but mostly soft and easily breakable, medium acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	12	18	16	15
Sand "	79	74	74	76
Silt "	12	14	14	13
Clay "	9	12	12	11
pH	5.3	5.3	5.8	5.5
Organic carbon %	1.90	1.06	0.89	1.28
Exch. bases me/100 g	7	8	9	8
Exch. acidity "	7.2	5.2	4.5	5.6
Av. N ppm	163	88	60	104
Extr. P "	3	2	2	2
Extr. K "	290	60	320	223
Extr. Ca "	28	40	38	35
Extr. Mg "	8	8	11	9
Cation exch. capacity me/100 g	14.2	13.2	13.5	14.6

Table 6.22

Vegetation type: Teak plantation Soil pit No. 22

Description

0-20 cm Dark yellowish brown, loamy sand, granular, friable, slightly gravelly, abundant medium roots, animal voids, subsurface earthworm casts, strongly acid.

20-40 cm Dark brown, loamy sand, blocky, slightly firm, moderately gravelly, many medium roots, plentiful mottles, mostly multicoloured, strongly acid.

40-60 cm Dark brown, loamy sand, massive, firm, moderately gravelly, few fine roots, medium acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	12	19	18	16
Sand "	82	81	80	81
Silt "	13	13	13	13
Clay "	5	6	7	6
pH	5.4	5.2	5.8	5.5
Organic carbon %	1.76	1.25	1.04	1.35
Exch. bases me/100 g	18	18	16	17
Exch. acidity "	8.6	6.6	5.6	6.9
Av. N ppm	158	108	89	118
Extr. P "	9	6	4	6
Extr. K "	470	140	470	360
Extr. Ca "	38	32	38	36
Extr. Mg "	5	6	4	5
Cation exch. capacity me/100 g	26.6	24.6	21.6	23.9

Table 6.23

Vegetation type: leak plantation Soil pit No. 23

Description

0-20 cm Dark brown, loamy sand, granular, friable, slightly gravelly, abundant coarse roots, bleached quartz grains at the surface, strongly acid.

20-40 cm Dark yellowish brown, loam, blocky, firm, moderately gravelly, many medium roots, earth worms, fine faunal voids, strongly acid.

40-60 cm Dark brown, loamy sand, massive, firm, moderately gravelly, few fine roots, plentiful pieces of unrounded quartz, medium acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	10	15	21	15
Sand "	81	75	82	79
Silt "	11	13	9	11
Clay "	8	12	9	10
pH	5.2	5.3	5.6	5.4
Organic carbon %	2.03	1.09	0.96	1.36
Exch. bases me/100 g	20	14	14	16
Exch. acidity "	9.4	7.8	7.1	8.1
Av. N ppm	190	100	89	126
Extr. P "	9	4	5	6
Extr. K "	350	310	50	237
Extr. Ca "	54	28	16	33
Extr. Mg "	18	19	35	24
Cation exch. capacity me/100 g	29.4	21.8	21.1	24.1

Table 6.24

Vegetation type: Teak plantation Soil pit No. 24

Description

0-20 cm Dark brown, loamy sand, granular, slightly hard, moderately gravelly, abundant coarse roots, bleached sand grains, clear smooth boundary, medium acid.

20-40 cm Dark reddish brown, loam, blocky, firm, moderately gravelly, many medium roots, few pieces of lithomarge, few mottles, very strongly acid.

40-60 cm Strong brown, loam, massive, very firm, moderately gravelly, few very fine roots, scattered remnants of laterite, very strong acid,,

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	23	25	26	25
Sand "	82	72	70	75
Sllt "	9	12	13	11
Clay "	9	16	17	14
pH	5.6	5.0	4.9	5.2
Organic carbon %	1.85	1.51	0.64	1.33
Exch. bases me/100 g	16	12	10	13
Exch. acidity "	7.1	7.2	5.9	6.7
Av. N ppm	163	123	53	113
Extr. P "	9	3	3	5
Extr. K "	620	180	180	327
Extr. Ca "	84	28	30	47
Extr. Mg "	48	17	17	27
Cation exch. capacity me/100 g	23.1	19.2	15.9	19.7

Table 6.25

Vegetation type: Teak plantation Soil pit No. 25

Description

0-20 cm Dark yellowish brown, loamy sand, granular, slightly hard, moderately gravelly, abundant medium roots, few faunal voids, locally mixing with underlying layer, strongly acid.

20-40 cm Yellowish red, loam, blocky, firm, moderately gravelly, common medium roots, abundant mottles, very strongly acid.

40-60 cm Red loam, massive, very firm, moderately qravelly, few fine roots, plentiful concretions, very strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	18	18	19	18
Sand "	79	69	67	72
Sllt "	11	12	13	12
Clay "	10	19	20	16
pH	5.2	4.8	4.6	4.9
Organic carbon %	1.94	0.78	0.84	1.19
Exch. bases me/100 g	13	10	11	11
Exch. acidity "	7.3	6.7	6.4	6.8
Av. N ppm	179	63	80	107
Extr. P "	6	3	4	4
Extr. K "	470	180	430	360
Extr. Ca "	76	22	22	40
Extr. Mg "	12	23	24	20
Cation exch. capacity me/100 g	20.3	16.7	17.4	17.8

Table 6.26

Vegetation type: Teak plantation Soil pit No. 26

Description

0-20 cm Dark yellowish brown, loamy sand, granular, slightly hard, moderately gravelly, bleached sand grains, abrupt wavy boundary, strongly acid.

20-40 cm Dark brown, loam, blocky, firm, moderately gravelly, many medium roots, few rounded fine hard Fe/Mn concretions with shiny surface, strongly acid.

40-60 cm Dark brown, sandy loam, massive, very firm, moderately gravelly, common few medium roots, interfingering of dark coloured material from upper layer along cracks, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	19	19	20	19
Sand "	86	76	77	80
Silt "	8	12	13	11
Clay "	6	11	11	9
pH	5.5	5.4	5.3	5.4
Organic carbon %	2.67	1.53	1.41	1.87
Exch. bases me/100 g	15	12	12	13
Exch. acidity "	9.0	7.5	6.6	7.7
Av. N ppm	240	131	120	164
Extr. P "	6	3	5	5
Extr. K "	620	90	140	283
Extr. Ca "	38	32	30	33
Extr. Mg "	22	17	18	19
Cation exch. capacity me/100 g	24.0	19.5	18.6	20.7

Table 6.27

Vegetation type: leak plantation Soil pit No. 27

Description

0-20 cm Dark brown, loamy sand, granular, slightly hard, moderately gravelly, abundant coarse roots, few subrounded water washed quartz gravels less than 0.5 cm across, strongly acid.

20-40 cm Dark brown, loamy sand, blocky, slightly firm, moderately gravelly, many medium and fine roots, subrounded Fe/Mn concretions, strongly acid.

40-60 cm Dark brown, loamy sand, massive, firm, moderately gravelly, few fine roots, Fe/Mn concretions, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	26	27	26	26
Sand "	83	81	77	80
Sllt "	11	12	15	13
Clay "	6	7	8	7
pH	5.5	5.5	5.4	5.5
Organic carbon %	1.77	1.34	1.00	1.37
Exch. bases me/100 g	18	17	16	17
Exch. acidity "	9.8	9.1	8.4	9.1
Av. N ppm	149	117	91	119
Extr. P "	7	4	6	6
Extr. K "	350	470	230	350
Extr. Ca "	62	38	38	46
Extr. Mg "	26	30	26	27
Cation exch. capacity me/100 g	27.8	26.1	24.4	26.1

Table 6.28

Vegetation type: Teal..plantation Soil pit No. 28

Description

0-20 cm Dark brown, loamy sand, granular, slightly hard, moderately gravelly, abundant coarse roots, strongly acid.

20-40 cm Dark brown, sandy loam, blocky, slightly firm, moderately gravelly, many medium and fine roots, moderate amount of fine quartz locally interbedded in laterite, very strongly acid.

40-60 cm Dark yellowish brown, loam, blocky, slightly firm, moderately gravelly, few very fine roots, unconsolidated Fe/Mn concretions, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	25	29	20	25
Sand "	83	76	73	77
Sllt "	10	13	14	12
Clay "	7	11	13	11
pH	5.5	5.0	5.3	5.3
Organic carbon %	1.59	0.98	0.76	1.11
Exch. bases me/100 g	15	14	13	14
Exch. acidity "	10.9	9.5	8.2	9.5
Av. N ppm	143	85	69	99
Extr. P "	6	3	5	5
Extr. K "	310	230	140	227
Extr. Ca "	24	28	30	27
Extr. Mg "	18	20	24	21
Cation exch. capacity me/100 g	25.9	23.5	21.2	23.5

Table 6.29

Vegetation type: Teak plantation Soil pit No. 29

Description

0-20 cm Very dark grayish brown, loamy sand , granular, slightly hard, moderately gravelly, abundant coarse roots, strongly acid.

20-40 cm Dark brown, loamy sand, blocky, slightly firm, moderately gravelly, abundant medium roots, rounded Fe/Mn concretions, abrupt wavy boundary, strongly acid.

40-60 cm Dark yellowish brown, loamy sand, blocky, slightly firm, moderately gravelly, many fine roots, mottles with red patches and blotches, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	22	23	21	22
Sand "	86	80	78	81
Silt "	9	13	15	12
Clay "	5	7	7	7
pH	5.6	5.5	5.2	5.4
Organic carbon %	1.63	0.93	0.85	1.14
Exch. bases me/100 g	11	15	15	14
Exch. acidity "	10.1	9.7	8.6	9.5
Av. N ppm	151	83	71	102
Extr. P "	8	3	5	5
Extr. K "	620	90	270	327
Extr. Ca "	36	14	16	22
Extr. Mg "	20	13	10	14
Cation exch. capacity me/100 g	21.1	24.7	23.6	23.5

Table 6.30

Vegetation type: leak plantation Soil pit No. 30

Description

0-20 cm Very dark grayish brown, loamy sand, granular, slightly hard, slightly gravelly, abundant coarse roots, ruptic where boulders are outcropping, strongly acid.

20-40 cm Dark yellowish brown, loamy sand, blocky, firm, slightly gravelly, many medium roots, some thin vertical cracks, strongly acid.

40-60 cm Dark brown, loamy sand, massive, firm, moderately gravelly very few very fine roots, few hard Fe/Mn concretions, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	13	11	20	15
Sand "	85	80	81	82
Sllt "	9	13	12	11
Clay "	6	7	7	7
pH	5.4	5.4	5.2	5.3
Organic carbon %	1.37	0.88	0.92	1.06
Exch. bases me/100 g	17	15	13	15
Exch. acidity "	7.9	7.4	6.4	7.2
Av. N ppm	128	77	78	94
Extr. P "	6	6	4	5
Extr. K "	470	350	230	350
Extr. Ca "	42	30	32	35
Extr. Mg "	30	12	6	16
Cation exch. capacity me/100 g	24.9	22.4	19.4	24.2

Table 6.31

Vegetation type: Teak plantation Soil pit No. 31

Description

0-20 cm Dark brown, loamy sand, granular, very firm, slightly gravelly, abundant coarse roots, weathering gravels 2-3 mm reddish skin and blackish interior, strongly acid.

20-40 cm Dark brown, loamy sand, blocky, slightly firm, moderately gravelly, abundant medium roots, common fine and medium faint mottles, very strongly acid.

40-60 cm Dark yellowish brown, loamy sand, massive, firm, moderately gravelly, many fine roots, many fine and medium distinct mottles, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	13	16	23	17
Sand "	85	81	80	82
Silt "	10	12	13	12
Clay "	5	7	7	6
pH	5.1	5.0	5.2	5.1
Organic carbon %	1.51	0.87	0.45	0.94
Erch. bases me/100 g	10	11	11	11
Exrh. acidity "	8.6	7.0	6.4	7
Av. N ppm	139	69	38	82
Extr. P "	6	6	5	6
Extr. K "	180	90	230	167
Extr. Ca "	44	24	26	31
Extr. Mg "	12	7	10	10
Cation exch. capacity me/100 g	18.6	18.0	17.4	18

Table 6.32

Vegetation type: Teal plantation Soil pit No. 32

Description

0-20 cm Dark brown, loamy sand, granular, slightly hard, highly gravelly, abundant coarse and medium roots, strongly acid.

20-40 cm Dark brown, loamy sand, blocky, slightly firm, moderately gravelly, many medium roots, Fe/Mn nodules, rounded, medium-hard to hard, strongly acid.'

40-60 cm Dark yellowish brown, loamy sand, blocky, firm, moderately gravelly, many fine roots, many medium distinct mottles, mainly reddish yellow, red and black, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	36	26	21	28
Sand "	88	85	83	85
Silt "	8	10	11	10
Clay "	4	5	6	5
pH	5.2	5.2	5.3	5.2
Organic carbon %	2.03	1.70	0.98	1.57
Exch. bases me/100 g	17	10	15	14
Exch. acidity "	9.6	9.5	8.1	9.1
Av. N ppm	181	148	89	139
Extr. P "	9	4	9	7
Extr. K "	310	310	230	283
Extr. Ca "	62	28	18	36
Extr. Mg "	20	12	12	15
Cation exch. capacity me/100 g	26.6	19.5	23.1	23.1

Table 6.33

Vegetation type: Teak plantation Soil pit No. 33

Description

0-20 cm Very dark grayish brown, loamy sand, granular, slightly hard, slightly gravelly, abundant coarse roots, strongly acid.

20-40 cm Dark yellowish brown, loamy sand, blocky, slightly firm, moderately gravelly, many medium roots, many me'ium and coarse distinct reddish and yellowish mo.tles, strongly acid.

40-60 cm Dark brown, loamy sand, blocky, firm, highly gravelly, abundant fine roots, soft Fe/Mn nodules, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	4	16	31	27
Sand "	85	86	84	85
Sllt "	11	10	10	10
Clay "	4	4	6	5
pH	5.7	5.5	5.5	5.6
Organic carbon %	2.94	1.80	1.07	1.94
Exch. bases me/100 g	31	16	18	22
Exch. acidity "	8.8	8.2	6.7	7.9
Av. N ppm	263	145	91	166
Extr. P "	5	8	8	7
Extr. K "	270	10	50	110
Extr. Ca "	194	84	58	112
Extr. Mg "	38	17	13	23
Cation **exch.** capacity me/100 g	39.8	24.2	24.7	29.9

Table 6.34

Vegetation type: leak plantation Soil pit No. 34

Description

0-20 cm Dark yellowish brown, loamy sand, granular, friable, slightly gravelly, abundant coarse roots, many medium and coarse prominent sharp dark brown mottles with reddish fringes, strongly acid.

20-40 cm Dark brown, loamy sand, blocky, slightly firm, moderately gravelly, abundant medium roots, Fe and Fe/Mn concretions, strongly acid.

40-60 cm Dark brown, loamy sand, blocky, firm, moderately gravelly, many fine roots, few Fe and Fe/Mn nodules, slightly acid

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	14	25	19	19
Sand "	85	82	81	83
Silt "	9	10	11	10
Clay "	6	8	8	7
pH	5.1	5.3	6.2	5.5
Organic carbon %	1.65	1.06	0.63	1.11
Exch. bases me/100 g	15	21	18	18
Exch. acidity "	10.4	9.4	2.8	7.5
Av. N ppm	153	99	49	100
Extr. P "	9	11	18	13
Extr. K "	270	180	50	167
Extr. Ca "	52	32	22	35
Extr. Mg "	16	10	4	10
Cation exch. capacity me/100 g	25.4	30.4	20.8	25.5

Table 4.35

Vegetation type: leak plantation Soil pit No. 35

Description

0-20 cm Dark brawn, loamy sand, granular, slightly hard, moderately gravelly, abundant coarse roots, strongly acid.

20-40 cm Very dark grayish brown, loamy sand, blocky, slightly firm, moderately gravelly, many medium roots, Fe and Fe/Mn concretions, very fine hard to soft, very strongly acid.

40-40 cm Very dark grayish brown, loamy sand, massive, firm, moderately gravelly, many fine roots, moderately hard Fe nodules within red mottles, medium acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	20	17	26	31
Sand "	88	88	86	87
Sllt "	8	8	10	9
Clay "	4	4	4	4
pH	4.9	5.0	5.6	5.2
Organic carbon %	2.45	1.84	1.39	1.89
Exch. bases me/100 g	21	15	16	17
Exch. acidity "	11.1	9.0	7.7	9.3
Av. N ppm	212	158	101	157
Extr. P "	10	6	3	6
Extr. K "	350	325	300	325
Extr. Ca "	52	20	18	30
Extr. Mq "	16	8	8	11
Cation exch. capacity me/100 g	32.1	24.0	23.7	26.3

Table 6.36

Vegetation type: Teak plantation Soil pit No. 36

Description

0-20 cm Very dark grayish brown, loamy sand, granular, friable, slightly gravelly, abundant coarse and medium roots, strongly acid.

20-40 cm Very dark grayish brown, loamy sand, blocky, firm, moderately gravelly, many medium roots, Fe/Mn concretions mainly reddish, some black, medium acid

40-60 cm Dark brown, loamy sand, massive, very firm, moderately gravelly, many fine roots, common fine with reddish and black concretions, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	13	21	27	20
Sand "	85	83	82	83
Silt "	11	12	12	12
Clay "	4	5	6	5
pH	5.7	5.6	5.4	5.6
Organic carbon %	2.77	1.99	1.67	2.14
Exch. bases me/100 g	20	18	14	17
Exch. acidity "	11.1	10.1	9.1	10.1
Av. N ppm	219	171	102	164
Extr. P "	8	2	7	6
Extr. K "	500	350	230	360
Extr. Ca "	48	32	30	37
Extr. Mg "	23	10	10	14
Cation exch. capacity me/100 g	31.1	28.1	23.1	27.1

Mean values for gravel, sand, silt and clay in the 0-60 cm layer are 19, 80, 12 and 8%, respectively. They are 5.4, 1.32%, and 13, 7.8 and 20.8 me/100 g soil for soil pH, organic carbon, exchangeable bases, exchange acidity and cation exchange capacity, respectively. For extractable N,P,K,Ca and Mg, they are 114, 6, 250, 22 and 15 ppm, respectively.

6.5.4. Soil properties in cashew plantations

The plantations are on gently undulating terrain, elevation ranging from 50 to 100 m. The soils are well drained. The morphological description, and physical and chemical properties of soils in different layers in cashew plantation are portrayed in Tables 6.37 to 6.41. The mean values of soil properties are presented in Tables 6.46 and 6.47. Silt, clay and extractable Ca and Mg increase while sand, organic carbon, exchange acidity, extractable K and cation exchange capacity decrease with depth. There is no trend for gravel, exchangeable bases, extractable N, P values whereas soil pH values remain the same in the three layers. The soil is sandy loam and strongly acid.

The mean gravel, sand, silt and clay contents in the 0-60 cm are 22, 76, 11 and 13%, respectively. Corresponding values for soil pH, organic carbon, exchangeable bases, exchange acidity and cation exchange capacity are 5.3,1.46% and 3,6.3 and 9.3 me/100 g soil. They are 128, 6, 341, 17 and 11 ppm for extractable N,P,K,Ca and Mg, respectively.

Table 6.37

Vegetation type: Cashew plantation Soil pit No. 37

Description

0-20 cm Dark reddish brown, sandy loam, granular, very hard, highly gravelly, abundant coarse roots, darker organic spots, strongly acid.

20-40 cm Dark reddish brown, loam, blocky, slightly firm, moderately gravelly, many medium roots, common fine and medium faint browner mottles including some mottles around root channels, strongly acid.

40-60 cm Yellowish red, loam, blocky, firm, moderately gravelly, few fine roots, sub-rounded reddish Fe/Mn concretions, very strongly acid.

Properties	Depth (cm)			
	0–20	20–40	40–60	11–60
Gravel %	37	23	23	24
Sand "	77	70	67	72
Silt "	10	11	10	10
Clay "	13	i9	23	18
pH	5.2	5.1	5.0	5.1
Organic carbon %	2.07	1.47	0.96	1.50
Exch. bases me/100 q	3	3	1	2
Exch. acidity "	5.8	6.1	6.0	6.0
bv. N ppm	189	130	82	134
Extr. P "	4	2	3	3
Extr. K "	700	350	140	397
Extr. Ca "	10	22	20	17
Extr. Mg "	6	4	5	5
Cation exch. capacity me/100 q	8.8	9.1	7.0	8.0

Table 6.38

Vegetation type: Cashew plantation Soil pit No. 38

Description

0-20 cm Dark brown, loamy sand, granular, very hard, moderately gravelly, abundant coarse and medium roots, strongly acid.

20-40 cm Dark reddish brown, sandy loam, blocky, slightly firm, moderately gravelly, many medium and fine roots, Fe/Mn concretions concentrated in an indistinct stone line, strongly acid.

40-60 cm Yellowish red, sandy loam, massive, firm, moderately gravelly, many fine roots, common dark yellowish brown soft ferruginous nodules, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	18	19	16	18
Sand "	83	77	75	78
Silt "	8	11	12	10
Clay "	9	12	13	12
pH	5.4	5.2	5.3	5.3
Organic carbon %	1.81	1.35	0.86	1.34
Exch. bases me/100 g	2	3	3	3
Exch. acidity "	9.2	7.4	6.6	7.7
Av. N ppm	160	109	79	116
Extr. P "	5	8	3	5
Extr. K "	420	390	310	373
Extr. Ca "	26	26	30	27
Extr. Mg "	10	6	10	9
Cation exch. capacity me/100 g	11.2	10.4	9.6	10.7

Table 6.39

Vegetation type: Cashew plantation Soil pit No. 39

Description

0-20 cm Dark brown, *loamy* sand, granular, friable, moderately gravelly, abundant medium roots, few small faint brownish mottles, strongly acid.

20-40 cm Reddish brown, loam, blocky, firm, moderately gravelly, few medium roots, reddish patches with bleached quartz grains, strongly acid.

40-60 cm Dark red, loam, massive, very firm, moderately gravelly, very few medium and fine roots, plentiful much coloured mottles, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	17	24	24	22
Sand "	79	73	76	76
Silt "	11	13	13	12
Clay "	10	14	11	12
pH	5.3	5.3	5.5	5.4
Organic carbon %	2.08	1.55	0.96	1.53
Exch. bases me/100 g	3	3	2	3
Exch. acidity "	7.1	6.3	4.9	6.1
Av. N ppm	189	129	81	133
Extr. P "	6	7	7	7
Extr. K "	500	500	140	380
Extr. Ca "	28	28	30	29
Extr. Mg "	18	17	18	18
Cation exch. capacity me/100 g	10.1	9.3	6.9	9.1

Table 6.40

Vegetation type: Cashew plantation Soil pit No. 40

Description

0-20 cm Strong brown, loamy sand, granular, hard, moderately gravelly abundant coarse roots, common fine faint clear yellowish brown mottles, strongly acid.

20-40 cm Dark reddish brown, loam, blocky, firm, moderately gravelly, many medium roots, few Fe/Mn concretions, medium acid.

40-60 cm Red loam, blocky, very firm, moderately gravelly, few fine roots, scattered remnants of laterite, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	19	18	22	20
Sand "	80	73	72	75
Silt "	11	14	13	13
Clay "	9	13	15	12
pH	5.1	5.6	5.4	5.4
Organic carbon %	1.91	1.26	0.72	1.30
Exch. bases me/100 g	3	1	1	2
Exch. acidity "	7.0	5.1	4.5	5.5
Av. N ppm	180	112	59	117
Extr. P "	10	3	8	7
Extr. K "	490	390	420	433
Extr. Ca "	22	34	30	29
Extr. Mg "	14	14	13	14
Cation exch. capacity me/100 g	10.0	6.1	5.5	7.5

Table 6.41

Vegetation type: Cashew plantation Soil pit No. 41

Description

0-20 cm Strong brown loamy sand, granular, very hard, moderately gravelly, abundant coarse roots, gradual smooth boundary, strongly acid.

20-40 cm Dark reddish brown, sandy loam, blocky, firm, moderately gravelly, many coarse and medium roots, occasional pieces of broken iron pan, strongly acid.

40-60 cm Dark reddish brown, loam, massive, very firm, highly gravelly, abundant fine roots, scattered Fe/Mn concretions ranging from soft to hard, some infiltration in vertical streaks, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	19	23	36	26
Sand "	82	76	73	77
Silt "	10	13	13	12
Clay "	8	11	14	11
pH	5.4	5.4	5.2	5.3
Organic carbon %	2.12	1.46	1.24	1.61
Exch. bases me/100 g	1	4	3	3
Exch. acidity "	7.3	7.0	4.6	6.3
Av. N ppm	201	117	104	141
Extr. P "	7	4	7	6
Extr. K "	180	90	90	120
Extr. Ca "	24	30	32	29
Extr. Mg "	8	13	12	11
Cation exch. capacity me/100 g	8.3	11.0	7.6	9.3

6.5.5. Soil properties in grasslands

Grasslands are on hilly areas with elevation ranging from 100 to 150 m. The morphological description, and physical and chemical properties of soils in different layers in grassland are given in Tables 42 to 45. The mean values of soil properties are shown in Tables 46 and 47. The soils are well drained. Sand, organic carton, exchange acidity, extractable N, K and Ca and cation exchange capacity decrease whereas clay and pH values increase with depth. No pattern is observed for gravel, silt, exchangeable bases, extractable P and Mg contents. The soil is sandy loam and strongly acid.

The average values for gravel, sand, silt and clay in the 0–60 cm layer are 15, 78, 11 and 11%. The analogous values for soil pH, organic carbon, exchangeable bases, exchange acidity and cation exchange capacity are 5.2, 1.51% and 10, 7.4 and 17.4 me/100 g soil. Extractable N, P, K, Ca and Mg values are 127,7,330,21 and 14 ppm, respectively.

Soil properties in the different forest ecosystems - a comparison

In the study area, a comparison of soil properties in the evergreen and moist deciduous forests, grassland, teak and cashew plantations reveals the state of the site.

Table 6.42

Vegetation type: brassland Soil pit No. 42

Description

0-20 cm Very dark grayish brown, loamy sand, granular, hard, slightly gravelly, abundant medium roots, few small faint brownish mottles, strongly acid.

20-40 cm Strong brown, loam, blocky, firm, moderately gravelly, many medium roots, occasional pieces of iron pan which are easily breakable, very strongly acid.

40-60 cm Dark brown, sandy loam, blocky, firm, slightly gravelly, few fine roots, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	13	19	15	16
Sand "	81	74	77	77
Silt "	11	13	10	11
Clay "	8	13	13	12
pH	5.2	4.8	5.4	5.1
Organic carbon %	2.82	1.29	1.29	1.80
Exch. bases me/100 g	16	10	11	12
Exch. acidity "	9.6	7.2	5.0	7.3
Av. N ppm	223	103	98	141
Extr. P "	10	4	8	7
Extr. K "	470	310	270	350
Extr. Ca "	44	24	12	27
Extr. Mg "	22	20	16	19
Cation exch. capacity me/100 g	25.4	17.2	16.0	19.3

Table 6.43

Vegetation type: Grassland Soil pit No. 43

Description

0-20 cm Dark brown, loamy sand, granular, hard, moderately gravelly, abundant medium roots, some faunal voids, including termite nests, very strongly acid.

20-40 cm Strong brown, sandy loam, blocky, slightly firm, moderately gravelly, many medium roots, many fine sub-rounded Fe/Mn concretions, strongly acid.

40-60 cm Yellowish red, sandy loam, massive, slightly firm, slightly gravelly, abundant fine roots, many fine and medium distinct clear brownish mottles, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	17	20	15	17
Sand "	81	75	75	77
Silt "	11	12	11	11
Clay "	8	13	14	12
pH	4.8	5.4	5.4	5.2
Organic carbon %	2.40	1.50	0.78	1.56
Exch. bases me/100 g	11	8	10	10
Exch. acidity "	6.6	6.2	4.9	5.9
Av. N ppm	218	111	69	133
Extr. P "	11	6	7	8
Extr. K "	540	470	50	353
Extr. Ca "	56	42	34	44
Extr. Mg "	18	14	12	15
Cation exch. capacity me/100 g	17.6	14.2	14.9	15.9

Table 6.44

Vegetation type: Grassland Soil pit No. 44

Description

0-20 cm Dark brown, loamy sand, granular, friable, slightly gravelly, abundant medium roots, mat of fibrous roots along the leaves, strongly acid.

20-40 cm Strong brown, loamy sand, blocky, slightly firm, moderately gravelly, many medium roots, occasional Fe/Mn concret ons and softer nodules, strongly acid.

40-60 cm Dark brown, sandy loam, massive, firm, slightly qravelly, abundant fine roots, distinct clear reddish mottles, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	7	19	10	12
Sand "	85	79	77	80
Silt "	8	12	12	11
Clay "	7	9	11	9
pH	5.1	5.4	5.4	5.3
Organic carbon %	1.69	1.09	0.67	1.15
Exch. bases me/100 g	14	12	10	12
Exch. acidity "	11.3	9.7	7.0	9.3
Av. N ppm	143	95	58	99
Extr. P "	7	6	4	6
Extr. K "	500	430	*90*	340
Extr. Ca "	44	42	40	49
Extr. Mg "	14	12	17	14
Cation exch. capacity me/100 *g*	25.3	21.7	17.*0*	21.3

Table 6.45

Vegetation type: Grassland Soil pit No. 45

Description

0-20 cm Dark brown, loamy sand, granular, hard, slightly gravelly, abundant medium roots, surface litter and mat of fine fibrous roots, very Strongly acid.

20-40 cm Very dark grayish brown, loamy sand, blocky, firm, slightly gravelly, many medium roots, scattered remnants of laterite, strongly acid.

40-60 cm Dark brown, sandy loam, massive, very firm, slightly gravelly, few fine roots, few fine and medium faint red mottles, strongly acid.

Properties	Depth (cm)			
	0-20	20-40	40-60	0-60
Gravel %	12	12	15	13
Sand "	82	79	76	79
Silt "	10	11	12	11
Clay "	8	10	12	10
pH	5.0	5.2	5.3	5.2
Organic carbon %	2.40	1.35	0.87	1.54
Exch. bases me/100 g	7	7	8	7
Exch. acidity "	8.2	7.1	6.1	7.1
Av. N ppm	221	108	71	133
Extr. P "	11	6	4	7
Extr. K "	350	250	230	277
Extr. Ca "	26	18	18	21
Extr. Mg "	10	5	8	8
Cation exch. capacity g	15.2	14.1	14.1	14.5

Among the physical properties studied, soils in the cashew plantations have the highest gravel and clay and lowest sand contents and exchange acidity values, while in the moist deciduous forests, they are vice *versa,* except for gravel contents which are nighest in grass1and. Teak soils have the maximum silt contents where as in the other three they remain same and are lower also. Acidity is; highest in soils of evergreen forest and that in moist deciduous; is least acidic. Organic carbon, extractable N and K contents are more in moist deciduous forests, in contrary to the lowest values in teak. Soils in teak plantation process more exchangeable bases contents and cation exchange acidity values whereas they are found to be least in cashew plantations. Extractable P contents are lowest in moist deciduous forests and are highest in grassland. Evergreen forest soils contain lowest Ca and Mg contents while they are found to be highest in moist deciduous forests and teak plantations, respectively.

Thus, it could be seen that the nature and properties of soils vary considerably between vegetational types. Excluding gravel, silt, extractable P, Ca and Mg, all other properties are found to differ significantly between the five vegetation types(Tab1e 48). Hence the particular vegetation depends on the soil for its supply of water and nutrients as well as for physical support. At the same time, it implies the soil in a specific way by way via the type and amount of litter deposited on the surface, the microclimate it creates, and, as a consequence of these two influences, the result of the activity of the particular decomposer systems associated with it. The vegetation changes therefore influence the soil and eventually, its functions as a supplier of nutrients and water.

The natura1 forests are found to be disturbed. Degradation of the forests is originating from the foothi1is and radiates towards the hill top. It is possible to visualise a circle of human influence on the surrounding forests and plantations and the radius of the circle is characterised by increasing distance and declining intensity of forest degradation. Mushrooming of private lands on all sides of natural forests and plantations has attributed to a linearity in the degradation pattern on the whole and in certain cases, the pattern is radial.

The structural and functional adaptations of the natural forests to the climatic and edaphic environment are relatively efficient to maintain and conserve a viable, perpetual ecosystem when compared to the plantations. In the natural forests, it could be seen that the top soil has a more favourable structure and comparatively high organic matter content. It is also found that there is dense development of feeder roots, the microclimate is relatively even and, there is a high nutrient inventory. Combination of these characteristics result in better conservation of nutrients and topsoil by preventing losses through leaching and erosion. In terms of their texture, soils in the evergreen forests and cashew plantations are sandy loam while in the other two, it is loamy sand.

The soil belong to the group of red soils or oxisols or red ferrallitic soil. The colour of these soils is red, of different intensities and lines depending on the content of Fe_2O_3, Al_2O_3 and SiO_2. The content of crystallized forms of iron compounds is high in the plantations. The latter is evidenced by the presence of iron

concreations in most of the pits. These concretions indicate both the onset of the initial stages of laterisation and various forms of latter's manifestation. These soils have originated from the weatnering of acid crystalline rocks aided by warm humid climate and forest vegetation. Relief and tree cover play a major role in the formation and degradation of these soils. Areas devoid of natural forest are seen to be more eroded. The soil thickness decrease in slopes and again increases at the foothills, owing to the material eroded from the elevated parts of such slopes.

The natural evolution of these soils may proceed in different ways. The tropical red ferrallitic soilsmay turn into red lessivated and later by kaolinization and mottling to concretionary type and further by dehydration and compaction to laterites. The transition between these stages are closely related to the alterations of vegetation covers, the intensity of disturbance and over all, effect of fire.

Thus the soil cover is characterised by soils which are red leached with mottled horizons in the plantations. Concretions of iron are also seen in most of the pits in the plantations. The general tendency is towards laterisation which will be enhanced by alteration in the vegetation cover and other environmental impacts.

The structure of soils in the plantations of teak and cashew reveals that soil deterioration is partly due to the hardening of pre-existing lateritic soils on exposure. On slopes and where leaf litter

is burned during dry season under teak, the erosion can be very serious, indeed.

The change in the vegetation composition and structure has had its impact on the soil cover too. Most of the soils in the plantations have been Subjected to intensive erosion and thereby skeletonising. The soil thickness is maintained by deposits from hill top. In the middle portions of the slopes, the soil has been denuded as evidenced by the shortening of the humus accumulative horizon. The organic matter is the main store house of plant nutrients and the same is the result of rhythms in forest growth and development and the rates of constant exchange of matter and energy between plants and soils. Even the soils in the plantations are found to be highly deteriorated in the sense that organic matter and N decreased and the levels of most nutrients continued to decrease when compared with those of the natural forests. This also shows tha? organic matter and nutrient cycles are more open under plantations.

The decrease in soil organic matter in the plantations may be explained by the low rate of addition and incorporation of fresh and partially decomposed litter material, at the same time as the normal rate of oxidation of soil humus continues. The structural deterioration is associated with the decrease in soil humus. It is also quite likely that the small biomass of fine roots under the plantations will not be able to maintain a high porosity. A decrease in soil porosity may lead to lower infiltration rate and loss of soil moisture retention capacity which results in surface run-off and erosion.

The most obvious and remarkable features appearing from the Tables 6.1 to 6.16 are the very high and evenly distributed nutrient content of the soils in the natural forests. The only exceptions are the extractable P values which are quite low due to the fixation of P.

Mineral nutrient levels are more varied and complicated. The individual nutrient contents may both increase or decrease in conditions under forest, as a result of various management and ecological conditions. The clearing of the natural forest vegetation is a dramatic ecological event with far-reaching implications on, among else, the soil conditions of the site. Following canopy closure and up to the time of clearfelling, it is the tree crop itself and its ecological conditions that exert a dominant influence on soil and nutrient dynamics (Lundgren, 1978).

The soil pH values indicate that the monoculture has not produced much influence on soil acidity. There is a more or less closed nutrient cycle between soil and vegetation in the natural forest. A dense development of feeder roots in the litter and topsoil, often with very intense mycorrhiza development, relatively high organic matter content in the top soil, which substantially increases the nutrient retention capacity, various N fixing mechanisms and a favourable top soil structure preventing losses by surface erosion are some important adaptations to the soil conditions in the natural forest. Another fact is that the amount of organic matter and nutrients stored in the living vegetations is very high in relation to the annually circulated amount which reduces the risk of high losses during seasons

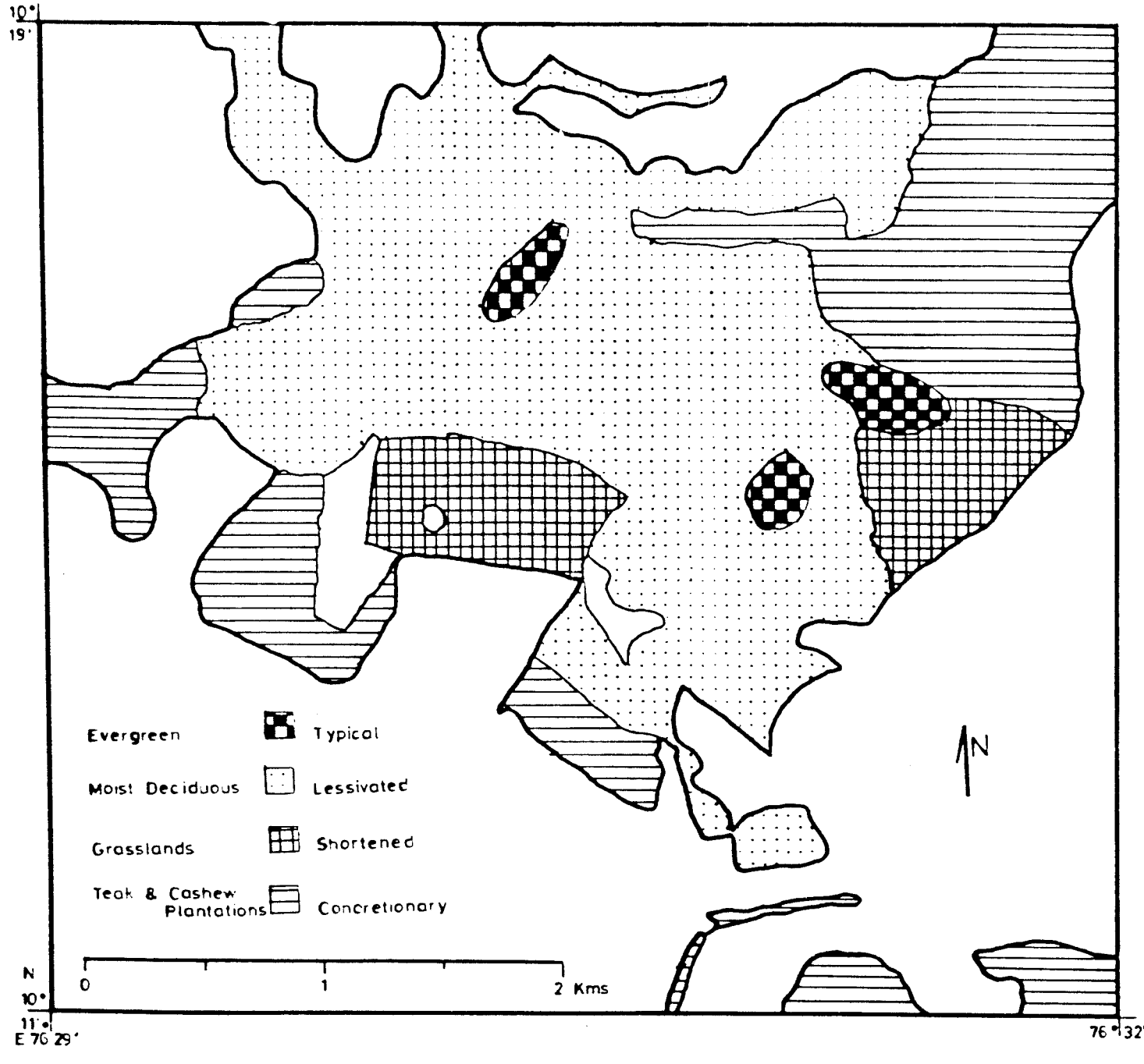

Fig.6.1. Soil map of the study area

of excessive rain fall. It is most likely that a monoculture plantations will possess. the Same spectrum of N-fixing mechanism as a natural forest.

Fears of soil changes under plantations have been repeatedly and increasingly expressed during the last decades and comparatively few studies have been carried out to elucidate the problem (Lundgren, 1978). The scarcity of factual informations on this point is striking and embarrassing. In the present study it could be seen that biological uniformity, the fragility of top soil structure, the disturbance of decomposer activity, the repeated exposure of soils to sun and rain, the effects of associated management practices have made the soils in the plantations less fertile.

The observations of Campbell and Souster (1982), Mwonga and Mochoge *(1989)* and Aborisade and Aweto (1990) on soil contrasts resulting from differences in vegetation types corroborate the present findings.

6.5.7. Soil map

The soils are classified into four subtypes of the type red ferrallitic. The base map is prepared in the scale

Ferrallitic soils are characterised by a complete weathering of the primary minerals accompanied by the elimination of the major part of the alkaline and earth bases and of a large part of the silica. In the study area, the following four subtypes of this soil type are met with (Fig. 6.1).

Table 6.46. Mean values of soil properties in the different layers in different forest ecosystems

Properties	Vegetation types/Layers (cm)														
	Evergreen forest			Moist deciduous forest			Cashew plantation			Teak plantation			Grassland		
	0-20	20-40	40-60	0-20	20-40	40-60	0-20	20-40	40-60	0-20	20-40	40-60	0-20	20-40	40-60
Gravel (%)	21	20	22	16	17	20	22	21	24	17	20	22	12	18	14
Sand "	80	77	75	87	86	85	80	74	73	83	75	78	82	77	76
Silt "	11	11	11	10	11	11	10	12	12	10	12	13	10	12	11
Clay "	9	12	14	3	4	4	10	14	15	6	9	10	8	11	13
pH	5.2	5.0	5.0	5.5	5.5	5.5	5.3	5.3	5.3	5.4	5.3	5.4	5.0	5.2	5.4
OC (%)	2.16	1.35	1.08	2.39	1.65	1.26	1.99	1.41	0.94	1.92	1.19	0.91	2.32	1.30	0.90
EB (me/100 g)	8	7	8	15	8	7	2	3	2	14	12	12	12	9	10
EA "	6.8	6.5	6.0	8.0	8.4	7.5	7.3	6.3	5.3	8.9	7.8	6.5	8.9	6.0	5.8
N (ppm)	197	116	91	213	132	101	184	190	81	171	102	73	201	104	74
P "	10	8	8	6	4	4	6	5	6	7	5	6	10	6	6
K "	415	260	209	605	403	304	458	344	220	367	201	197	465	365	160
Ca "	33	17	18	85	30	21	22	28	28	54	30	29	48	32	26
Mg "	14	7	7	24	9	8	11	11	12	19	13	13	16	13	13
CEC (me/100 g)	15.2	13.7	13.5	23	17	14	9.7	9.2	7.3	23.1	20	18.4	20.9	15.3	15.8

OC = Organic carbon; EB = Exchangeable bases; EA = Exchange acidity; CEC = Cation exchange capacity.

Table 6.47. Mean values of soil properties in the 0-60 cm layer in the different vegetation types

Vegetation types	Properties													
	Gravel	Sand	Silt	Clay	pH	Org. carbon	Exch. bases	Exch. acidity	N	Extractable P	K	Ca	Mg	CEC
	(.....%.....)					(%)	(me/100 g soil)			(.....ppm.....)				(me/100 g soil)
Evergreen forest	21	78	11	11	5.0	1.53	8	6.4	135	6	295	14	9	14.4
Moist deciduous forest	18	86	11	3	5.5	1.78	10	8.0	149	4	437	27	14	18.0
Teak plantation	19	80	12	8	5.4	1.32	13	7.8	114	6	250	22	15	20.8
Cashew plantation	22	76	11	13	5.3	1.46	3	6.3	128	6	341	17	11	9.3
Grassland	15	78	11	11	5.2	1.51	10	7.4	127	7	330	21	14	17.4

CEC = Cation exchange capacity.

Table 6.48. Analyses of variance of soil properties between vegetation types

Source	Degrees of Freedom	Sum of Squares	F Ratio
Gravel			
Between Groups	4	170.1967	2.2431 ns
Within Groups	41	777.7381	
Total	45	947.9348	
Sand			
Between Groups	4	435.5818	9.0858 **
Within Groups	41	491.3964	
Total	45	926.9783	
Silt			
Between Groups	4	8.2529	1.6077 ns
Within Groups	41	52.6167	
Total	45	60.8696	
Clay			
Between Groups	4	399.4630	10.7789 **
Within Groups	41	379.8631	
Total	45	779.3261	
pH			
Between Groups	4	0.8763	5.3870 **
Within Groups	41	1.6674	
Total	45	2.5437	
Organic carbon			
Between Groups	4	1.2473	3.2991 *
Within Groups	41	3.8753	
Total	45	5.1226	
Exchangeable bases			
Between Groups	4	463.9866	7.1090 **
Within Groups	41	668.9917	
Total	45	1132.9783	
Exchange acidity			
Between Groups	4	18.6577	3.1306 *
Within Groups	41	61.0884	
Total	45	79.7461	

Source	Degrees of Freedom	Sum of Squares	F Ratio
Extractable Nitrogen			
Between Groups	4	7765.0696	3.2419 *
Within Groups	41	24551.3000	
Total	45	32316.3696	
Extractable Phosphorus			
Between Groups	4	23.4237	1.7161 ns
Within Groups	41	139.9124	
Total	45	163.3261	
Extractable Potassium			
Between Groups	4	210934.6900	4.1439 * *
Within Groups	41	521746.0274	
Total	45	732680.7174	
Extractable Calcium			
Between Groups	4	2509.7582	2.6444 ns
Within Groups	41	9728.0679	
Total	45	12237.8261	
Extractable Magnesium			
Between Groups	4	220.9196	1.4839 ns
Within Groups	41	1525.9500	
Total	45	1746.8696	
Cation exchange capacity			
Between Groups	4	634.6968	6.9385 * *
Within Groups	41	937.6112	
Total	45	1572.3080	

ns = not significant; *, * * significant at P = 0.05 and 0.01, respectively.

6.5.7.1. Typical red ferrallitic soils

This subtype is found only in evergreen forest. The upper horizon is rich in organic matter and concretionary layers are conspicuously absent,. This subtype occupies only 3% of the total area.

6.5.7.2. Lessivated red ferrallitic soils

Located in the moist deciduous forest this subtype occupies 53% of the area. The soil is deep with more organic carbon and sand content than the typical subtype. This subtype is an indicator of the onset of vegetation degradation.

6.5.7.3. Shortened red ferrallitic soils

Intensive erosion has removed the upper layers of this subtype exposing the lower ones. These soils are low in organic matter and high in exchangeable bases. This subtype is present in 10% of the area and occurs in grasslands.

6.5.7.4. Concretionary red ferrallitic soils

This subtype is the most dominant one occupying 34% of the area. The soil is shallow, contains mottles or concretions indicating advancing stages of laterisation of the soil. This subtype occurs in plantations of teak and cashew.

6.6. CONCLUSIONS

Study of soils in evergreen and moist deciduous forests, grassland and cashew and teak plantations in the proposed Nature Study

Centre of Malayattoor forest Division reveals that they are loose in the evergreen forest with a favourable structure. Soils are sandy loam in the evergreen forest, grassland and cashew plantations while in the moist deciduous forests and teak plantations, they are loamy sand. Soils ate very strongly acid in the evergreen, whereas, in other vegetation types, they are strongly acid. The nature and properties of soils in the five ecosystems varied significantly. The soils are classified into four subtypes of the type red ferrallitic. Evergreen forest soils are typical red ferrallitic while those in the moist deciduous are lessivated. Grassland soils are classified as shortened red ferrallitic whereas soils in teak and cashew plantations are concretionary. The soils in the planta'ions are found to be deteriorated and necessary management measures are recommended to preserve and enhance the fertility of the land.

6.7. ACKNOWLEDGEMENTS

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VEGETATION ANALYSIS AND MAPPING OF MALAYATTOOR

A. R. R. Menon

7. VEGETATION ANALYSIS AND MAPPING OF MALAYATTOOR

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Contents

ABSTRACT

Landuse and land cover inventories in the form of maps are prepared for the forests of Malayattoor based on the technique of digital imaging of satellite data. The structural aspects of the vegetation of the area were studied from stratified samples using quadrat

methods, density, abundance, frequency, relative density, relative frequency, relative basal area and important value index of important species in fourteen locations of the study area is given table-wise in the report along with a land cover map of the area based on digital image processing.

7.1. INTRODUCTIDN

7.1.1. Study area

The study area possess an undulating terrain and the major forest type of the area is moist deciduous, with semievergreen forests along the river courses. The altitude of the area range from 50 to 350 m and the highest peak is Kurishumudi (387 m). The general direction of the drainage system is East – West and the area is well drained to Periyar river.

7.1.2. Vegetation analysis

The landuse/land cover inventories in the form of maps are highly essential for the optimal utilization and management of land resources. Further, information on the spatial distribution of land cover categories and the patterns of their change is a pre-requisite for planning, utilization and management of land resources of any area. This information permits a better understanding of the land utilization aspects like cropping patterns, fallow lands, forests, water bodies, etc. The land cover map of the study area was prepared

using remote sensing aata products, to get a general idea regarding, the distribution of different cover classes. The techniques of digital imaging of satellite data (IRS-1A) was mainly used for the mapping. The visual interpretation techniques were also adopted for the generation of maps from aerial photographs (Panchromatic black and white aeria1 photographs of 1975).

The information extraction from the satellite data could be achieved either through visual interpretation or digital image processing technique. The digital image analysis permits fast computer processing and handling voluminous data. Also, digital analysis allows maximisation of information extraction, removal of subjectivity in interpretation, better output accuracy, etc.

7.2. METHODOLOGY

7.2.1. Digital image analysis

The digital image analysis of satellite data (preprocessed CCT of IRS 1A-LISS2, Path 26, Row 61, of Feb. 1989) was carried out on a VAX-11/780 System at Regional Remote Sensing Service Centre (RRSSC), Bangalore, using VIPS-32 software. A false colour composite (FCC) of the row image of bands 4, 3 and 2 in red, green and blue colours respectively was created for the preliminary appraisal of the area. The false colour composites generated by various combinations of enhanced outputs and row data were initially assessed for their visual interpretability. An area of 512 x 512 Pixel size covering the field area

of approximately 1,360 km^2. was selected for processing. The supervised classification system using maximum likelihood algorithm was adopted to stratify vegetation on the basis of species Composition, type and physiognomy. Stretching and enhancement, class separability, band ratioing, smoothening, etr. are the other major functions performed. The common image enhancement techniques were also performed.

7.2.2. Aerial photo-interpretation

A vegetation map of the study area was also prepared from aerial photographs of 1975, using standard photo-interpretation techniques (Tomer and Masilkar, 1972). Black and white aerial photographs of 1:40,000 scale with 60% to 80% forward overlap, 10% to 40% lateral overlap and 23 cm x 23 cm format size were used for the study. The photo-stratification scheme was adopted for the purpose of interpretation, using various photo elements such as tone, texture, etc. Based on the interpretation key thus prepared (Table 7.15), cover class delineation was done and prefield maps were taken to field for spot checking with the existing natural stands. Density stratification of cover types were done and the major forest types were further subdivided into three density classes arbitrarly, viz. sparse (less than 30% canopy cover), medium (30-60% canopy cover) and dense (more than 60% canopy coverage). The structural aspects of vegetation was studied from the stratified samples using quadrat methods.

7.2.3. Vegetation analysis

The quadrat data was processed using the standard formulae (see Appendix I) to obtain structural statistics of vegetation (Muller-Dombois and Ellenberg, 1978). The vegetation parameters like density, percentage frequency, abundance, Important Value Index (IVl), etc. thus generated are supplemented or further references (Tables 7.1 – 7.14).

7.3. DISCUSSION FIND CONCLUSIONS

7.3.1. Mapping

The spectral separability of various forest types and land use/land cover categories has been evaluated using training set statistics. The mean spectral plots, bivariate distributinn, divergence matrix analysis and confusion matrix comparison were used for achieving the best possible classification of IRS-1A digital data (Jensen, 1986). Thus the major stages in digital image analysis performed using sample segment approach consists of the following steps.

i. loading of image from CCT to disc,
ii. locating the sample segment on the image,
iii. extraction and storing of sample segments (optional task),
iv. identification of ground truth sites and generation of training signaturs,
V. supervised classification and its evaluation (feed back loop to step 314 if necessary), and
vi. final cover class proportion in each segment.

Because of the rigged and hilly nature of the terrain (Fig. 7.1) shadows are more and are mixing with water bodies 1n the area. Hence, ratioing and normalization were done for water bodies in the area and ratioed output image was combined with the classified output image. The hardcopy outputs are taken by the Dunn Camera for further study. The colour coded classified output generated was used for the preparation of vegetation map of he study area (Fig. 7.2).

7.3.2, Vegetation analysis

The structural aspects of vegetation were studied through sampling method.;. The development of sampling methods and primitive statistical analysis of samples was substantially simultaneous with the origin of ecology. Quantitative sampling methods using small areas or quadrats were introduced in a few of the earliest vegetation studies (Pound and Clements, 1898; Raunkaier, 1934; Goodall, 1952; Greig-Smith, 1964). The phytosociological nature of the vegetation was studied from the quadrat data collected from the selected localities (Fig. 7.3). The size of the quadrat was standardised at the optimum one for the specific forest type (Sharma, et al. 1983) and it was fixed as 10 m x 10 m in the present study for the calculation convenience. Piecewise linear transect design (Anderson, et al. 1979) was adopted for each selected cover types and census quadrats were laid down systematically along the linear transect line. The census quadrat of 10 m x 10 m was thus laid at a distance 2 km apart (approximately) in the selected localities. The site selection was based on

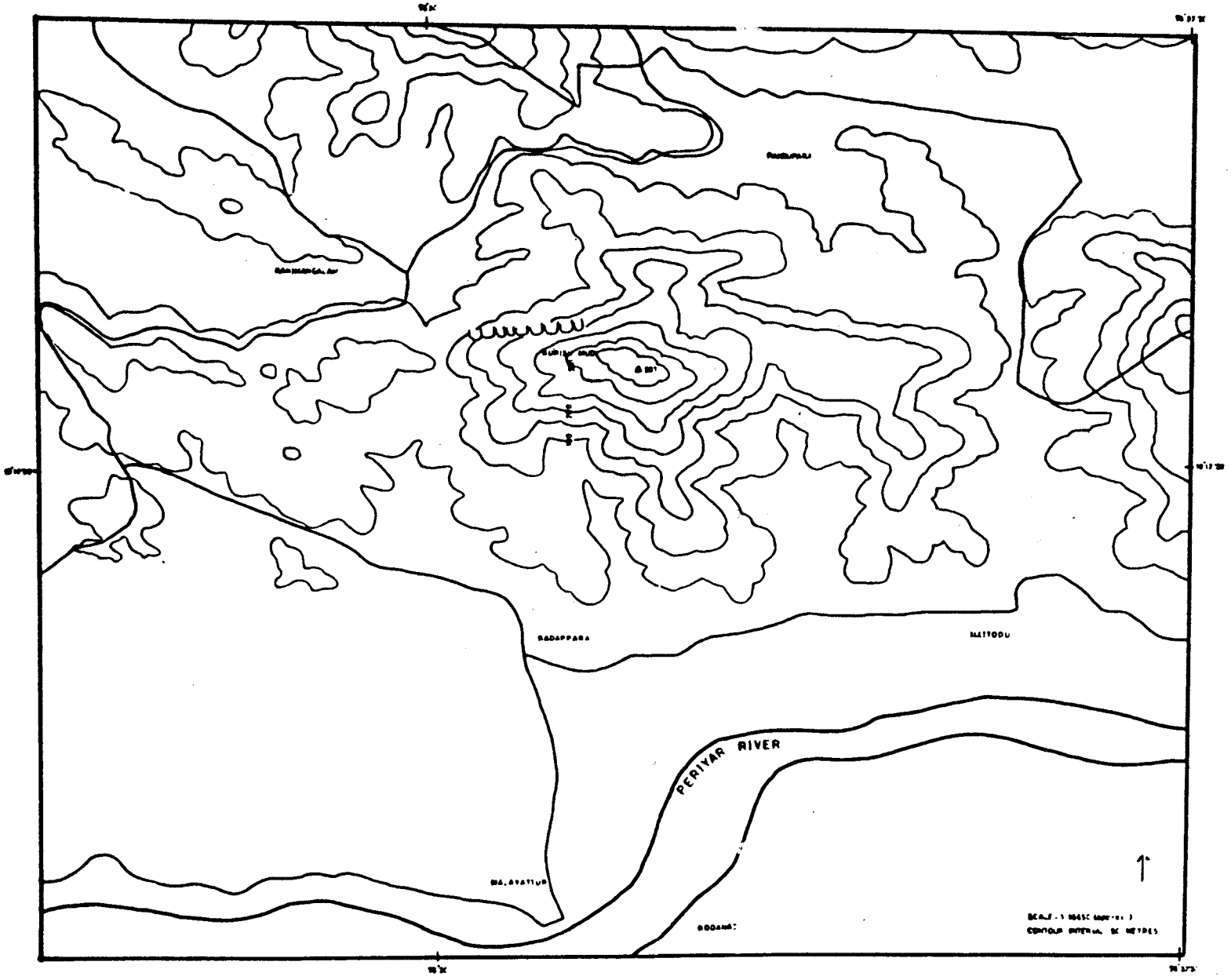

Fig.7.1. Elevation map of the study area with 50 m contour intervals

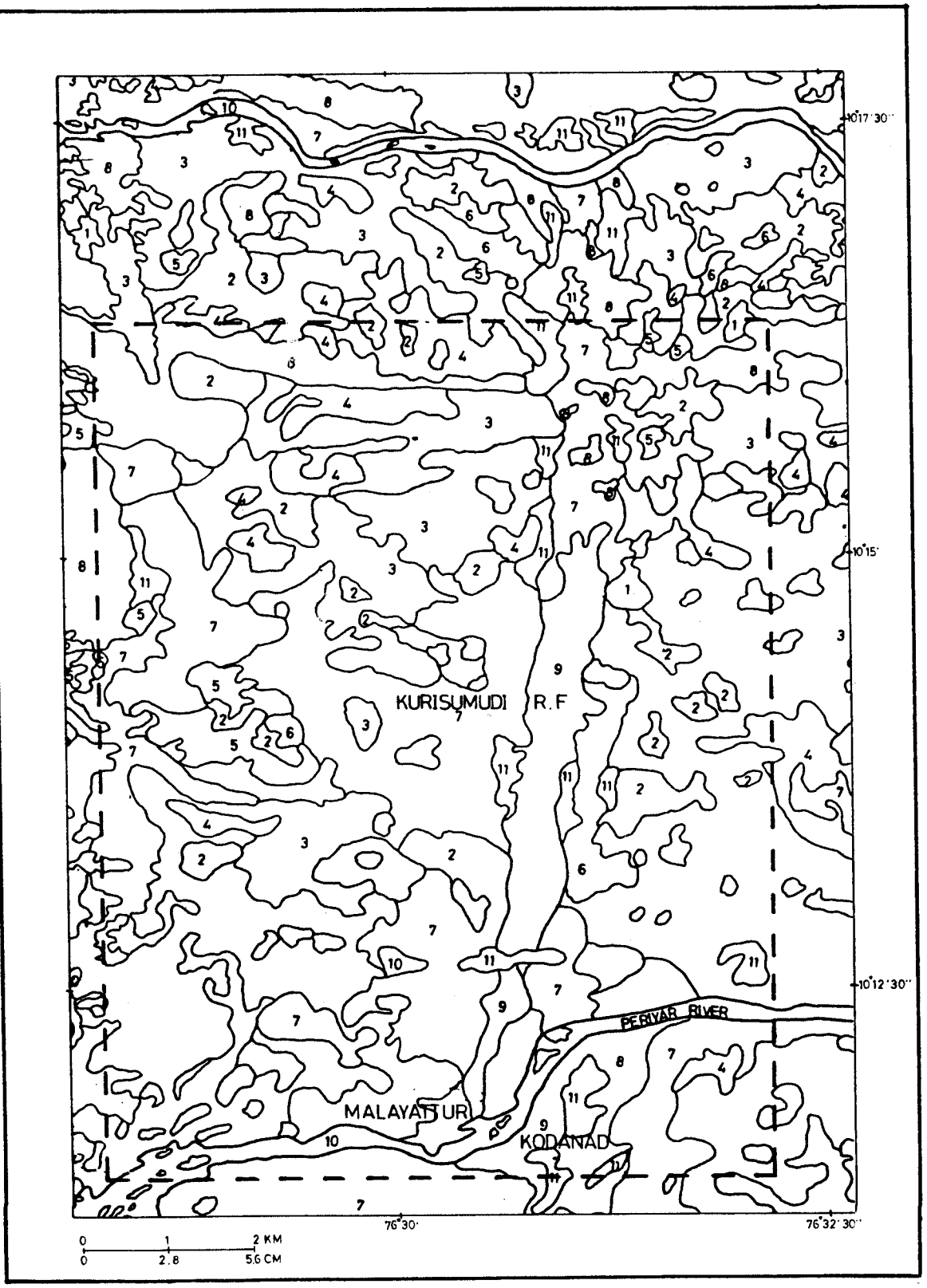

Fig.7.2. Land cover map (IRS 1A - Liss II, 26 April, 1988) of the study area (----). 1. Evergreen forest, 2. Moist deciduous forest, 3. Teak plantation, 4. Rubber plantation, 5. Cashew plantation, 6. Scrub, 7. Agricultural/fallow land, 8. Barren land, 9. Cloud, 10. Water and 11. Cliff/shadow

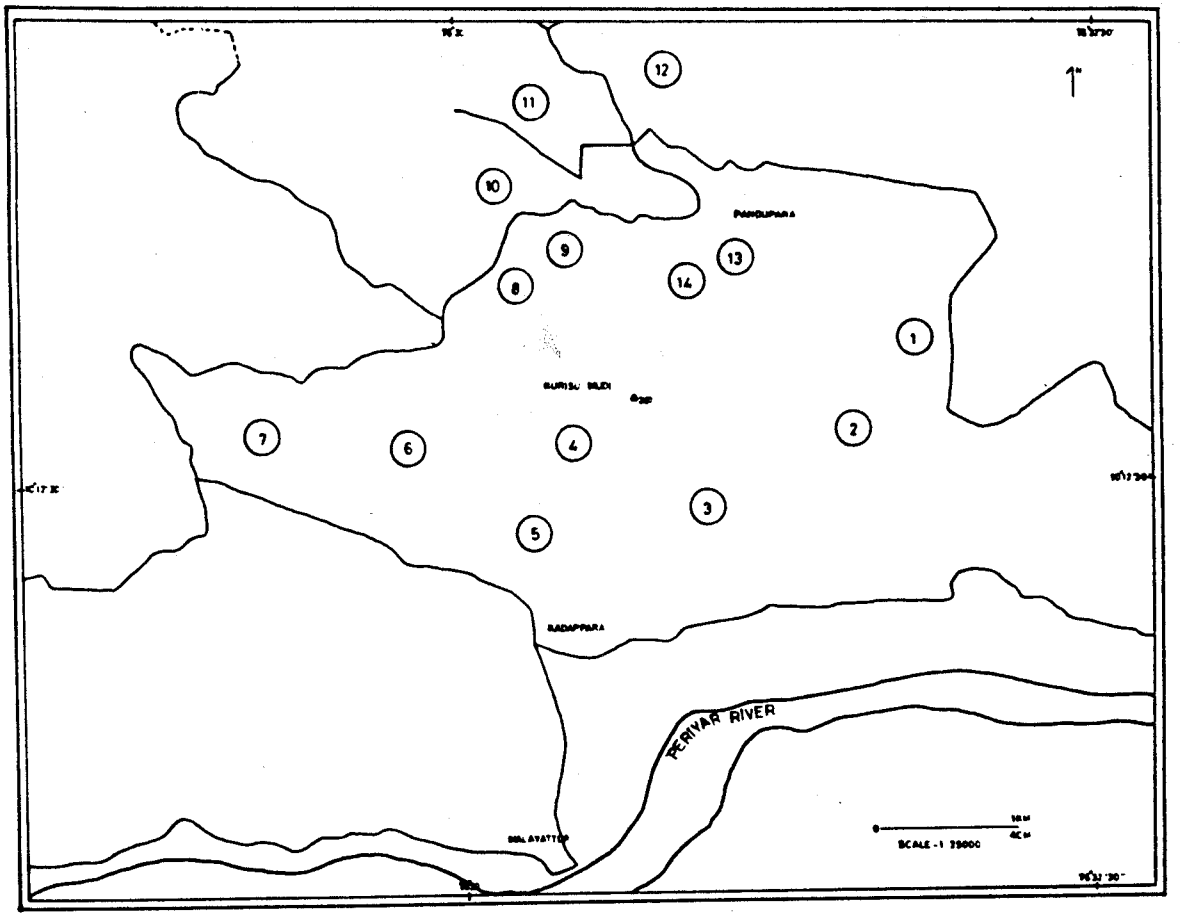

Fig.7.3. Vegetation data collection sites within the study area ⊙

the terrain physiography and cover type distribution so a5 to accommodate all the major types. A cursory perusal of the elevation map (Fig. 7.1) prepared from the Survey of India toposheets shows that most of the selected localities are within the range of 50 m to 200 m altitudinal zone, and the highest peak is at 387 m (Kurishumudi).

Table 7.1. Location: Kurishumudi

Sl. No.	Name of species	D	% F	Ab	IVI
1	*Tectona grandis*	1.1	80	1.38	52.61
2	*Terminalia crenulata*	0.9	80	1.13	61.20
3	*Bombax ceiba*	0.5	50	1.00	32.97
4	*Albizia procera*	0.3	30	1.00	25.38
5	*Ziziphus xylopyrus*	0.9	70	1.29	31.45
6	*Alstonia scholaris*	0.4	40	1.00	29.18
7	*Holarrhena antidysenterica*	1.6	90	1.78	47.38
8	*Strychnos nux-vomica*	0.3	30	1.00	19.83

Table **7.2.** Location: Kurishumudi (Cashew plantation)

Sl. No.	Name of species	D	% F	Ab	IVI
1	***Caesalpinia* sp.**	0.7	***50***	1.40	26.03
2	***Zizyphus xylopyrus***	*0.9*	70	1.29	35.89
3	***Clerodendrum viscosum***	0.4	30	1.33	15.67
4	***Meyna luxiglora***	1.0	60	1.67	39.30
5	***Anacardium occidentale***	1.4	*70*	*2.00*	*79.60*
6	***Albizia procera***	0.5	50	1.00	37.94
7	***Strychnos nux-vomica***	0.2	20	1.00	15.01
8	***Gmelina arborea***	0.2	20	1.00	*25.08*
9	***Grewia tiliaefolia***	0.3	***30***	1.00	25.48

Table 7.3. Location: Kannimangalam

Sl. No.	Name of species	D	% F	Ab	IVI
1	*Mitragyna parvifolia*	0.6	60	1.00	36.45
2	*Xylia xylocarpa*	0.8	60	1.33	49.06
3	*Grewia tiliaefolia*	0.3	30	1.00	34.62
4	*Terminalia crenulata*	0.5	50	1.00	47.32
5	*Butea superba*	0.3	20	1.50	13.49
6	*Acacia instia*	0.5	50	1.00	23.86
7	*Strychnos nux-vomica*	0.2	20	1.00	9.61
8	*Clerodendrum viscosum*	10.1	10	1.00	9.79
9	*Bambusa sp.*	*0.3*	20	1.50	--
10	*Artocarpus integrifolia*	0.2	20	1.00	10.34
11	*Dioscorea sp.*	0.2	10	2.00	13.82
12	*Ficus hispida*	0.2	20	1.00	--
13	*Macaranga peltata*	0.3	30	1.00	17.18
14	*Mallotus philippensis*	0.2	20	1.00	14.26

Table 7.4. **Location: Pandupara**

sl. No.	Name of species	D	% F	Ab	IVI
1	*Grewia tiliaefolia*	*0.8*	*60*	1.33	43.84
2	*Xylia xylocarpa*	0.6	60	1.00	37.43
3	*Acacia instia*	0.5	40	1.25	23.74
4	*Limonia acidissima*	0.5	40	1.25	24.31
5	*Gardenia* **sp.**	0.2	20	1.00	11.59
6	*Albizia procera*	0.3	30	1.00	23.55
7	*Terminalia bellirica*	0.2	20	1.00	39.59
8	*Strychnos nux-vomica*	0.3	30	1.00	19.41
9	*Bambusa* sp.	0.5	50	1.00	27.01
10	*Haldina cordifolia*	0.2	20	1.00	49.58

Table 7.5. Location: **Kolappara Mudi**

sl. No,	Name of species	D	% F	Ab	IVI
1	*Polyalthia* **sp.**	*0.5*	*50*	1.00	55.96
2	*Calamus* **sp.**	0.5	40	1.25	38.88
3	*Garcinia* **sp.**	0.3	*30*	1.00	42.04
4	*Cinnamomum* **sp.**	0.4	40	1.00	44.63
5	*Schleichera oleosa*	0.2	20	1.00	40.78
6	*Dillenia pentagyna*	0.1	10	1.00	25.02
7	*Baccaurea courtallensis*	0.2	*20*	1.00	25.11
8	*Hydnocarpus laurifolia*	*0.2*	*20*	1.00	27.60

Table 7.6. Location: **Kurusumudi (Lower slope)**

Sl. No.	Name of species	D	% F	Ab	IVI
1	*Albizia procera*	0.4	40	1.00	32.02
2	*Alstonia scholaris*	0.4	40	1.00	34.42
3	*Haldina cordifolia*	0.3	20	**1.50**	*50.09*
4	*Xylia xylocarpa*	0.2	20	1.00	25.54
5	*Grewia tiliaefolia*	0.3	30	1.00	34.27
6	*Limmonia acidissima*	0.7	40	1.75	33.17
7	*Ziziphus xylopyrus*	0.4	40	1.00	24.30
8	*Bambusa* sp.	0.3	30	1.00	19.52
9	*Cassia fistula*	0.8	*60*	1.33	46.67

Table 7.7. Location: Kannimangalam (Near Check Post)

Sl. No.	Name of species	D	% F	Ab	IVI
1	*Xylia xylocarpa*	1.2	70	1.71	46.81
2	*Mallotus philippensis*	0.3	30	1.00	18.80
3	*Grewia tiliaefolia*	1.1	80	1.38	50.20
4	*Terminalia crenulata*	0.4	40	1.00	24.87
5	*Ficus hispida*	0.3	20	1.50	12.96
6	*Albizia lebbeck*	0.4	4c	1.00	37.52
7	*Macaranga peltata*	0.2	20	1.00	23.20
8	*Flacourtia indica*	0.1	20	1.00	8.79
9	*Strychnos nux-vomica*	0.5	40	1.25	20.32
10	*Bauhinia* sp.	0.7	50	1.40	24.22
11	*Ziziphus xylopyrus*	0.4	40	1.00	16.15
12	*Calycopteris floribunda*	0.4	40	1.00	16.15

Table 7.8. **Location: Kannimangalam (Mid slope)**

Sl. No.	Name of species	D	% F	Ab	IVI
1	*Xylia xylocarpa*	1.8	*90*	2.00	61.03
2	*Haldina cordifolia*	0.6	60	1.00	42.86
3	*Terminalia bellirica*	0.3	30	1.00	21.02
4	*Aacia instia*	0.5	30	1.67	15.78
5	*Terminallia crenulats*	**0.3**	30	1.00	25.77
6	*Macaranga peltata*	0.1	10	1.00	**13.48**
7	*Tetrameles nudiflora*	0.3	*30*	1.00	23.26
8	*Bambusa* **sp.**	**0.8**	70	1.14	**30.13**
9	*Ziziphus xylopyrus*	0.2	*20*	1.00	**8.46**
10	*Strychnos nux-vomica*	0.2	20	1.00	10.56
11	*Grewia tiliaefolia*	0.2	50	1.20	**35.03**
12	*Calycoptereis floribunda*	**0.3**	30	1.00	12.45

Table 7.9. Location: Kannimangalam (Upper slope)

sl. No.	Name of species	D	% F	Ab	IVI
1	*Tectona qrandis*	0.9	*80*	1.13	44.83
2	*Lagerstroemia microcarpa*	*0.8*	*60*	1.33	36.79
3	*Ficus hispida*	*0.3*	*30*	1.00	16.51
4	*Grewia tiliaefolia*	*0.7*	*60*	1.17	39.51
5	*Zizyphus xylopyrus*	*0.3*	*30*	1.00	13.13
6	*Terminalia bellirica*	*0.5*	*50*	1.00	36.48
7	*Albizia lebbeck*	0.3	*30*	1.00	26.25
8	*Terminalia crenulata*	*0.2*	20	1.00	17.91
9	*Xylia xylocarpa*	0.8	*70*	1.14	30.23
10	*Calycopteris floribunda*	*0.6*	40	1.50	19.80
11	***Cassia** fistula*	0.1	10	1.00	6.40
12	*Macaranga peltata*	0.1	10	1.00	12.16

Table 7.10. Location: Near KFDC (Plantation)

Sl. No.	Name of species	D	% F	Ab	IVI
1	*Tectona grandis*	0.8	70	1.14	41.88
2	*Terminalia crenulata*	0.4	40	1.00	26.68
3	**Cassia** *fistula*	0.4	40	1.00	24.42
4	*Xylia xylocarpa*	1.5	80	1.88	52.88
5	*Albizia* **sp.**	0.4	40	1.00	34.93
6	*Alstonia* ***scholaris***	0.3	30	1.00	28.25
7	*Macaranga peltata*	0.3	30	1.00	18.70
8	*Ziziphus xylopyrus*	1.1	80	1.38	36.28
9	*Calycopteris floribunda*	0.3	30	1.00	14.03
10	*Pambusa* **sp.**	0.6	50	1.20	21.24

Table 7.11. Location: Pandupara (Mid slope)

Sl. No.	Name of species	D	% F	Ab	IVI
1	*Tectona grandis*	0.7	*60*	1.17	42.30
2	*Albizia* **sp.**	0.4	40	1.00	35.18
3	*Ficus hispida*	0.5	40	1.25	24.37
4	*Xylia xylocarpa*	1.0	80	1.25	53.99
5	*Grewia tiliaefolia*	0.6	50	1.20	45.05
6	*Acacia instia*	0.4	40	1.00	21.12
7	*Alstonia scholaris*	0.3	*30*	1.00	27.83
8	*Lagerstroemia microcarpa*	0.2	*20*	1.00	16.72
9	*Gmelina arborea*	0.1	10	1.00	10.22
10	*Artocarpus hirsutus*	0.2	20	1.00	23.00

Table 7.12. Location: Illithodu

Sl. No.	Name of species	D	% F	Ab	IVI
1	*Tectona grandis*	1.0	70	1.43	42.88
2	*Terminalia crenulata*	0.4	30	1.33	20.57
3	*Xylia xylocarpa*	0.5	40	1.25	24.84
4	*Dalbergia sissoides*	0.5	50	1.00	26.03
5	*Flacourtia indica*	0.5	50	1.00	22.28
6	*Swietenia mahagoni*	0.7	60	1.17	58.10
7	*Albizia procera*	0.4	40	1.00	26.82
8	*Pterocarpus marsupium*	0.4	40	1.00	22.84
9	*Ficus hispida*	0.4	40	1.00	19.17
10	*Haldina cordifolia*	0.2	20	1.00	36.44

Table 7.13. Location: Kurishumudi (South)

sl. No.	Name of species	D	% F	Ab	IVI
1	*Terminalia crenulata*	0.8	70	1.14	46.77
2	*Albizia lebbeck*	0.4	40	1.00	28.58
3	*Ficus hispida*	0.6	40	1.50	24.73
4	*Haldina cordifolia*	0.5	50	1.00	54.68
5	*Alstonia scholaris*	0.5	50	1.00	37.74
6	*Calycopteris floribunda*	0.6	40	1.50	23.95
7	*Grewia tiliaefolia*	0.4	40	1.00	28.94
8	*Gmelina arborea*	0.1	10	1.00	11.72
9	*Strychnos nux-vomica*	0.2	20	1.00	14.78
10	*Ziziphus xylopyrus*	0.3	30	1.00	15.72
11	*Bambusa* sp.	0.3	20	1.50	12.68

Table 7.14. **Location: Pandupara (Upper slope)**

Sl. No.	Name of species	D	% F	Ab	IVI
1	*Terminalia crenulata*	***0.7***	70	1.00	47.35
2	*Lannea coromandelica*	0.3	***30***	1.00	21.71
3	*Acacia instia*	0.3	30	1.00	16.97
4	*Grewia tiliaefolia*	0.5	40	1.25	32.44
5	*Xylia xylocarpa*	***0.3***	30	1.00	24.61
6	*Albizia lebbeck*	0.4	40	1.00	44.66
7	*Calycopteris floribunda*	0.3	***30***	1.00	16.46
8	*Bambusa* sp.	***0.5***	***50***	1.00	26.79
9	*Terminalia be11irica*	0.4	30	1.33	53.63
10	*Dalbergia sissoides*	0.2	20	1.00	15.20

Table 7.15. Image interpretation key for land cover mapping using panchromatic black and white aerial photographs

sl. No.	Cover type	Tone	Texture	Pattern/Remarks
1	Evergreen forests	Black	Fine	Smooth
2	Moist deciduous forests	Greyish	Medium	Medium
3	Dry deciduous forests	Black	Coarse	Rough
4	Scrub	Grey	Coarse	Rough
5	Plantation (Rubber)	Black	Fine	Smooth
6	" (Teak)	Light grey	Nedium	Arrangements seen in young plantations
7	" (Eucalyptus)	Greyish	Medium	Medium
8	" (Cashew)	Dark grey	Medium	Arrangements seen
9	" (Mixed)	Grey mixed	Medium	Medium
10	Agriculture	Whitish grey	--	Shape, size, ion, association, etc. considered
11	Forest blank	Whitish	--	"
12	Exposed rock	Light grey	--	"
13	Habitation	White	--	"
14	Water bodies	Black	--	"

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APPENDIX I

FORMULAE USED

$$\text{Density (D)} = \frac{\text{Total number of individuals}}{\text{Total number of quadrat studied}}$$

$$\text{Abundance (Ab)} = \frac{\text{Total number of individuals}}{\text{No. of quadrats of occurrence}}$$

$$\text{\% Frequency (\%F)} = \frac{\text{No. of quadrats of occurrence}}{\text{Total number of quadrats studied}} \times 100$$

$$\text{Relative density (RD)} = \frac{\text{No. of individuals of the species}}{\text{No. of individuals of all species}} \times 100$$

$$\text{Relative frequency (RF)} = \frac{\text{No. of occurrence of the species in the quadrat}}{\text{No. of occurrence of all species,}} \times 100$$

$$\text{Relative basal area (RBA)} = \frac{\text{Basal area of the species}}{\text{Basal area of all species}} \times 100$$

Important Value Index = Relative Density + Relative Frequency + Relative Basal Area