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Developing Strategies for Bio-cultural Restoration, Conservation and Management of Lateritic Biotopes in North Kerala

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Project Summary

Project Number	KFRI-RP- 652/2012
Title	Developing Strategies for Bio-cultural Restoration, Conservation and Management of Lateritic Biotopes in North Kerala
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Co-investigators	Dr. V. B. Sreekumar Dr. T. V. Sajeev Dr. S. Sandeep Dr. T. K. Hrideek (Co-ordinator) Dr. Amruth M.
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Objectives	• Identification, systematic documentation and characterization of biodiversity and ecological processes within the mosaics of microhabitats and the ecological linkages among these elements within the landscape. • To understand the role of various factors such as edaphic, climatological and human interaction in determining the character of the unique ecosystems and landscape elements. • To identify the threats to the laterite landscapes and unique habitat types to evolve a protocol for the bio-cultural restoration, conservation and management of lateritic biotope. • Influence conservation and land management policies through extension and outreach by initiating an informed policy process.
Duration	3 years
Funding Agency	KFRI Plan Grant

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Contents

Summary

The lateritic biotopes of Northern Kerala along with its different ecological subunits and microhabitats were studied to document its biodiversity, and land use change over the years. Being a human dominated landscape this system facing various threats which were identified and analyzed. Lateritic hillocks, Sacred Groves, Kaanams and Kuthiru were the major ecosystems documented during the study which are abodes of biodiversity and provide various valuable ecosystem services. A total of 80 Sacred Groves, two Kaanams and 16 Kuthiru were documented and mapped during the study. A total of 970 species of angiosperms belonging to 138 families were identified and listed, out of which 138 are endemic, 4 are endangered and 14 are vulnerable species and one critically endangered species were also documented. In lower fauna, 112 species of spiders, 25 species of grasshoppers, 42 species of odonates, 140 species of butterflies and 321 moth species were documented. Among higher group of animals, 215 birds (3 vulnerable, 5 near threatened under IUCN), 27 reptile species (one near threatened), 20 amphibians (one endangered), 68 fish species(one near threatened) and 25 mammal species were documented. Among these, seven species of reptile are new report to lateritic biotope. Among different ecological sub units, lateritic hillock was richer in floral and faunal component. This exhaustive documentation of biodiversity is the scientific validation against the prevailing 'waste land' concept on lateritic hillock.

The presence of rich biodiversity and its interactions with the landscape elements provide valuable ecosystem services to the society. The hillock serves as a water holding unit which recharges ground water and there is perennial water flows associated with kaanam as a part of lateritic hillock. Mass blooming of the plants on the rocky plateaus offers abundant food supply for the pollinators, which are supporting various crops and homestead plants of various adjoining ecological units. The presence of different pollinator groups such as Lepidoptera, Orthoptera, Aves and Chiroptera in turn facilitates the crop production. On the other hand, larger animals including birds have a major role in seed dispersal. Seed dispersers play critical roles in the natural regeneration of vegetation and maintaining biodiversity. Hence the lateritic hillock and associated ecological subunits are interacting with each other and support the society by providing various ecosystem services such as recharging ground water, increasing agriculture/crop productivity, provision for food, nutrient cycling, carbon sequestration etc.

The landuse and land cover pattern indicated that around 40% of the paddy cultivated areas were converted for infrastructure development and mixed cultivation. 60% of the lateritic biotopes were converted for other purposes such as infrastructure, monoculture plantations and laterite mines. 84% of the cashew cultivated area was replaced by rubber plantations and infrastructures. There is also a considerable increase in the mining area during last three decades.

Population pressure is the root cause of the depletion of natural resources and degradation of ecosystems services. Increase in population and high population density leads to over exploitation of natural resources and change in traditional land use pattern, and lead to a drastic change in land use and structure. Most of the lateritic exposed area and wetlands were converted into industrial and residential area. Infrastructure developments lead to mining and extraction of more lateritic hills and the soil from the mining were used to fill wetland and paddy field which again utilized for building and infrastructure development. This series of events in turn seriously affected the natural environment of the lateritic biotopes in Northern Kerala. The conversion of biodiversity rich biotopes for infrastructure development, mines and monoculture plantations adversely affected the landscape. By enlisting and understanding the severe threats faced by the lateritic biotope, human centric restoration and conservation strategies were also suggested.

1. Introduction

Buchanan while on a journey through Mysore, Canara and Malabar (Buchanan, 1807; Narayanaswamy, 1992) came across a type of weathered substance which he described and termed as laterite. This substance used in building material, consisted of indurated clay, full of cavities and pores. This unique geological formation is reported to occur from Karnataka, Kerala, Madhya Pradesh, the Eastern Ghats regions of Orissa, Maharashtra and parts of Assam and more (Raychaudhuri, 1981). Furthermore, the laterite of Buchanan's type area in Angadipuram has been found to vary in composition from limonitic hematite to argillaceous or siliceóus limonite (Scrivenor, 1937). Chemical analyses of laterite of this area were reported by Chacko (1919) and later by Fox (1936). Lake (1933) also described a series of lateritic occurrences. Gopalaswamy and Nair (1975) worked out the micro morphological aspects of Kerala laterites. Studies on mineralogy, geochemistry, genesis and relationship to landform evolution have been attempted by many workers (Gopalakrishnan and Nair, 1976; Sinha Roy, 1979; Subramaniyan *et al.*, 1980,1981; Karunakaran and Sinha Roy, 1981; Mallikarjuna *et al.*,1981; Nair and Thomas Mathai, 1981; Raghavan Nambiar *et al.*, 1981; Sambandam and Prasad, 1981; Ghosh, 1982a, 1982b, 1983; Ghosh and Narayanaswamy, 1982; Soman, 1982; Sambandam and Nair, 1982; Ghosh, 1986; Narayanaswamy,1986; Narayanaswamy and Ghosh, 1987; Rajendran and Narayanswamy, 1987; Soman and Slukin, 1987).

Regional floristic studies have reported the occurrence of many narrow-niched endemic and habitat specialist angiosperms from lateritic plateaus (Bachulkar, 1983; Deshpande *et al.*, 1993; Yadav and Sardesai, 2002) throughout the Western Ghats. Some of the new species discovered from laterite ecosystem in India include *Rotala malabarica, Nymphoides krishnakesara, Justicia ekakusuma, Lepidagathis keralensis, Rotala khaleeliana,Eriocaulon sivarajanii, E.kannurense, E. madayiparnese* and *Lindernia madayiparense* (Joseph 1990; Pradeep 1990, 1991; Ansari and Balakrishnan (2009); Madhusoodanan and Singh 1992; Ansari 2009; Swapna 2012; Swapna *et al.* (2012); Narayanan 2012; Sunil *et al.* (2012); Narayanan *et al.* (2012); Sunil *et al.* (2013) and Pradeep *et al.* (2013).This indicates the potential importance of lateritic hills in floral diversity. Though many endemic and new species have been reported from the lateritic hills of Northern Kerala, floral inventory of these lateritic hills is limited (Jayarajan 2004; Balakrishnan *et al.* 2010).

Faunal diversity of the midland laterite hills is amazing. Butterflies which are the bio-indicators of nature are abundantly present in these hills. As they cannot be seen in polluted lands, their presence indicates the virginity and versatility of these hills. Diversity of plants, habitats, topography and climate influence the distribution, diversity and abundance of butterflies (Vidya, 1996) and they are good biological indicators of habitat quality as well as general environmental health (Kunte *et al.*, 1997)

The environment of Northern Kerala is governed by its peculiar geographic features. A unique feature of this region is the presence of lateritic hillocks which give fascinating undulations for the midland terrain in particular. Such hillocks are present up to Malappuram district towards south and they are spread to South Karnataka towards North. These lateritic biotopes are large scale ecological units, which contains ecological units such as lateritic vegetation, agro-ecological units with varying slope management systems, ephemeral flush vegetation, seasonal pools, stream banks, and shelter belts, grasslands, kanams, sacred groves which are interacting with each other. Many of the above mentioned microhabitats are unique in character, poorly documented and figured significantly in the conservation literature and policy documents. Rocky surfaces, grass lands and green patches of laterite hills are rich and diverse habitats accommodating vast varieties of flora and fauna.

This study is a part of collating baseline information to highlight the ecological significance of the lateritic hills of Northern Kerala. The elements in these landscapes and their cross linkages studied in the current and socio-historical milieu that shaped them and continue to reshape them would throw crucial insights on the possible management and policy making for conservation and restoration of human impacted landscapes in the region.

2. Study Area

The present study was carried out in the lateritic hills of Kavvayi River Basin and Madayipara in Northern Kerala located between $12^{0}05'$ to $12^{0}15'$North latitudes and $75^{0}05'$ to $75^{0}20'$ East longitude and 12°2' North latitude and 75°16' East longitude.

Kavvayi River Basin

Kavvayi River is typical among the 14 mid-land originated rivers of Kasaragod and Kannur Districts. It has a watershed area confined to midland hillocks and their valleys. Hillocks are situated along its basin up to the western boundary of the mid-land. Initially Kavvayi River opened into the Lakshadweep Sea at the North-West point of Ezhimala. But later the river mouth became closed with sand barrier. As a result, the direction of the flow changed. It flows seventeen kilometers north parallel to the sea and opens into the sea at Thaikkadappuram. Samad *et al.,* (1996) gives a comprehensive description of Kavvayi watershed as follows.

Location

The Kavvayi watershed is located between 12°05' to 12°15' North latitudes and 75°05' to 75°20' East longitudes. It is spread over the districts of Kannur and Kasargod. The boundary is formed by Hosdurg Taluk of Kasaragod in the North, Kannur and Taliparamba Taluk in the South, Hosdurgand Taliparamba in the East and the Lakshadweep Sea in the west. The watershed has a total area of 164.76 square km, covering 14 villages spread over 9 local bodies in the two districts.

Kannur District:

- Payyanur Municipality
- Karivellur-Peralam Pachayath
- Kankole-Alapadamba Panchayath

Kasaragod District:

- Pilicode Panchayath
- Cheruvathur Panchayath
- Kayyur-Cheemeni Panchayath

- Padne Panchayath
- Trikaripur Panchayth
- Valiyaparamba Panchayth.

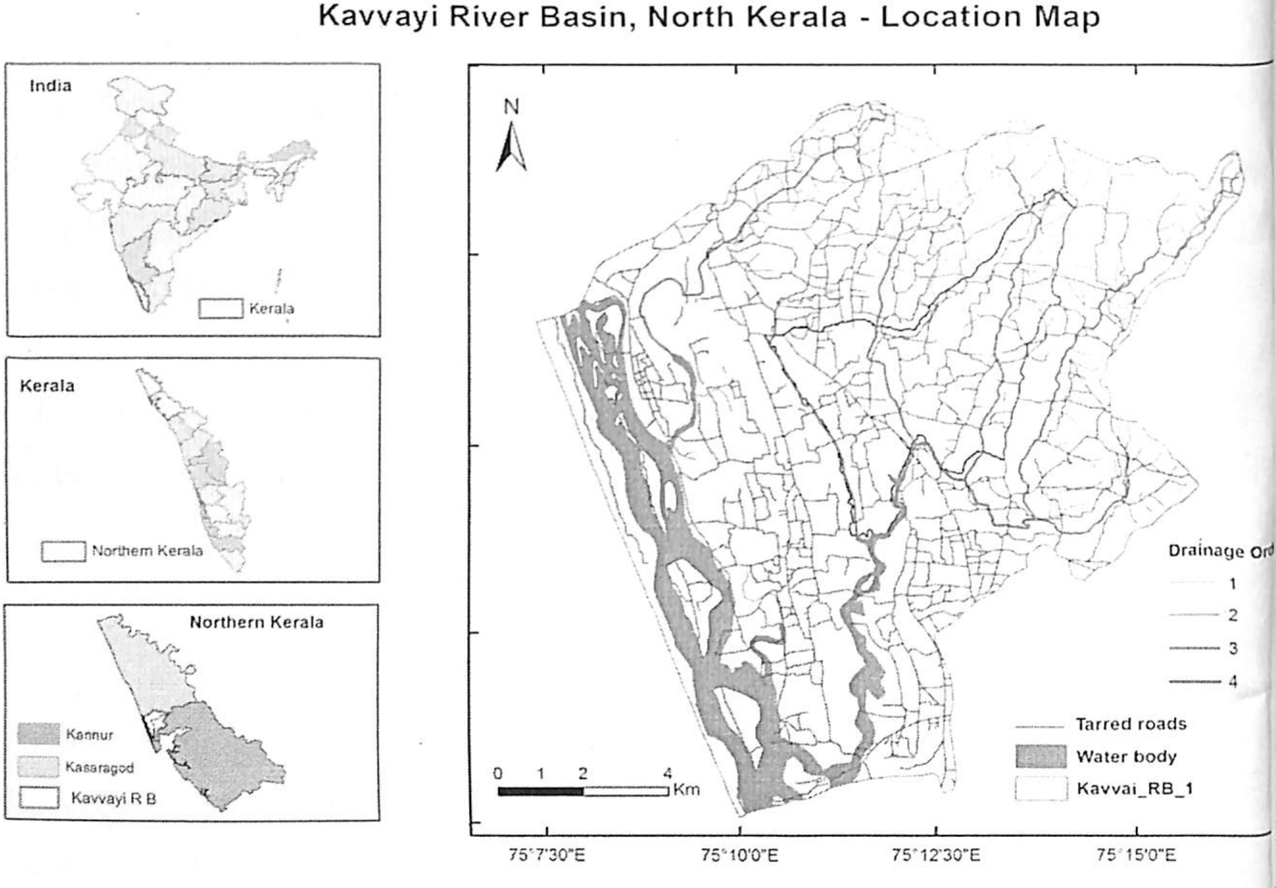


Fig. 2.1: Map of Study Area

3. Methodology

3.1 Identification and mapping of landscape elements

Kavvayi river basin boundary delineated from the geo-refernced 1: 50000 SOI toposheets 48P/4 and 48 P/8 and rectified using digital elevation model of the area. Arc GIS version 9.3 were used for this process. The different land classes in the study area identified and hand sketches representation of the surveyed area and geographical locations were marked during the GPS field survey. The hand held GPS Garmin eTrex 30 were used for the geographical location identification. The personal interactions with the local inhabitants and personal interviews with the local experts the present land use and land utilisation history were noted.

The survey GPS locations and identified primary land classes were consolidated and brought in to the QGIS (Quantum GIS version 1.8) platform in the next step. Using QGIS Open layer plug-in and Google satellite images dated February – March 2014 Land use/ land cover pattern of Kavvayi river basin identified and vectorised primarily through desktop visual interpretation after cross refereeing with the field survey data. Potentiality of Google satellite image which are basically visual representation of high resolution satellite images of Quick bird and ICONOS were proved in large scale land classification studies (Hu et al. 2013). After a detailed review on existing land use classification schemes and discussion with the experts, an 18 folded and locally specific land classification scheme was adopted for the finalization and further vectorisation of the landscape of the present study. Depending up on this land classification scheme the land use / land cover of the river basin of the year 2014 were prepared at 1: 2500 mapping scale. WGS 1984 spatial projection is followed in the vectorisation process and the shape files are reprojected to WGS 1984, 43 N at the time of calculation. Final map where prepared using Arc GIS 9.3 version.

3.2 Analysis of land use change:

Land use land cover map of the study area of the year 1986 prepared using aerial photographs of the study area. The GIS and Remote sensing department of KFRI is one of the repositories of the aerial photographs of Kerala. The scanned aerial photos of the region were georeferenced and vectorised using Arc GIS 9.3 software. Area specific and land class specific land use land cover change of the study area from 1986 to 2014 calculated and maps were prepared by comparing the land use/ land cover of the study area 1986 and 2014. For this purpose Arc GIS analysis tools like Intersection, Attribute selection, Delineation, Area calculation, Projection, etc. were used.

3.3 Edaphic and Physical degradation factors

By studying soil profiles up to bedrock at the selected sites by using standard procedures. Morphological features of soils were studied following the methods of Soil SurveyManual (Soil Survey Division Staff, 1995). Particle size distribution was determined by the pipette method after removal of organic carbon and frees iron oxides. Sand (2000–50μm), silt (50–2 μm) total clay (<2 μm) fractions were separated according to the procedure of Jackson (1979). The pH, organic carbon, CEC, and extractable bases were determined on the total fine earth fraction (<2 mm) by standard methods. (Jackson 1973). Extractable acidity was determined by BaCl2-TEA method (Peech *et al.* 1947). The powder mounts of the soil fractions were X-rayed using a Bruker AXS D8 Advance diffractometer with Ni-filtered, Cu-Kα radiation at a scanning speed of 2°2θ/min. Identification of clay minerals in different fractions was done following the criteria laid down by Jackson (1979).

3.4 Inventory of Ecosystems

A list of different types of ecosystems in the study area associated with lateritic biotopes was identified by field observation, using toposheets and available literatures and consultation with the local people. These units were mapped using GPS.

3.5 Inventory of Biodiversity:

3.5.1 Floral inventory

A checklist of angiosperms in the study site has been prepared through continuous field visit. Field identifications were confirmed with the aid of regional flora (Gamble 1935 Hooker (1872 – 1897); Ramachandran and Nair, 1988; Sasidharan, 2004). The collected plant specimens were processed using standard herbarium techniques, and deposited at the Kerala Forest Research Institute. The prepared checklist follows the Bentham and Hooker system of classification.

3.5.2 Faunal Inventory

Separate methodologies were carried out for different group of fauna. Continuous field survey was done during study period to document the fauna in the study area.

Spiders

Sampling was taken in morning section between 7.00am to 11.00am and 16.00pm to 18.00pm. Sampling was done at different microhabitats including rolled or folded leaves, plant branches, leaf litter, tree trunks, rock surface and grass blades. The collection techniques used were hand collection, litter sampling and sweep netting. Standard sampling techniques such as pitfall sampling and semi-quantitative sampling (Coddington, 1996) were also employed to collect the spiders from the selected areas. The mature specimens were identified up to the species level with the help of stereo zoom microscope (Leica-MS5) and also with available literatures (Tikader, 1987; Barrion and Litsinger, 1992; Sebastian and Peter, 2009).

Grasshoppers

Grasshoppers were collected from Kavvayi River Basin by using sweep net. The collected specimens were transferred in to killing bottles that contains cotton soaked with ethyl acetate. Insects were preserved as dry specimens and pinned. Grasshoppers were identified by comparing with Museum Type specimens of Natural History Museum London (BNHM, UK), Natural History Museum Madrid Spain (MNCN MADRID) and Natural History Museum Paris France (MNHN PARIS). Taxonomy and nomenclature have been updated after Orthoptera Species File (OSF)

Butterflies

Direct visual count method was used to observe butterflies. Observations were taken in the morning by conducting field visit at regular intervals. Butterflies were photographed and identified with standard texts like Kunte (2000), Issac (2008), Kunte *et al.,* (2012)

Moths

Most of the moths are nocturnal in habit; some are active in day and evening. The main moth sampling and collection method employed for this study was moth sheet methods, the other sampling method like field survey, rearing of larvae and insect net collection were also employed.

The collection of nocturnal moths was undertaken with the help of Moth sheet. For the Moth sheet a white sheet/dhoti was hanged between two vertical poles above a height of 1m and a light source was allowed to hang in such a way that the whole sheet brightly reflected the light. , 20 Watt UV and fluorescent tube light working with battery power were used as the light source. Moths were collected from six various locations of study area during 6.00 PM to 6.00 AM at different seasons during the study period. The moths collected and photographed in this study were identified by reference to literature or by referring to insect collection lab, KFRI.

Birds

Direct visual count (with binocular) was used to enumerate birds. Observations were taken in the morning (7.00-11.00) and evening time (4.00-7.00) by conducting field visit at regular intervals. Birds were sighted using 8×40 binocular and identified with the help of Birds of Southern India (Grimmet & Inskipp, 2005) and The Book of Indian Birds (Salim Ali, 2002).

Reptiles

Sightings of reptiles were done using quadrate survey and visual encounter survey. Quadrate survey (10mX10m) and visual encounter survey was carried out for the reptilian fauna (Heyer *et al.*, 1994; Campbell & Christman, 1982).

Quadrate survey

Quadrates of 10mX10m will be laid based on the spatial replication method and sampled for the presence of Reptiles (Heyer *et al.*, 1994; Bhupathy, 2011).

Visual encounter survey

The diversity of reptiles were sampled using visual encounter survey (VES) method, involving searching for reptiles in each of the micro-habitats recording all the animals encountered on the route. The underside of rocks, stones, leaf litter and fallen branches/wood will be examined for elusive species that might take refuge among them. The details of microhabitats (boulders/leaf litter/bark/crevices/burrows) and behavior at the time of observation (basking, resting or moving) were also being noted (Campbell & Christman, 1982).

Amphibians

For estimating the species diversity and ecology of the study area, a combination of methods like quadrat sampling, scan searches, night surveys, call surveys (acoustic sampling) and patch sampling were used (Heyer *et al.*, 1994; Sutherland, 2006).

Quadrate sampling:

Quadrates of 10mX10m were laid based on the spatial replication method i.e. maximum number of quadrates laid in the field and thoroughly searching those squares for amphibians. This spatial replication helped to reduce the chance of sighting the same individual once again and the sample size was sufficiently large. General characteristic features/parameters of the plots such as GPS reading, presence of streams/marshes, humidity, temperature, presence of boulders were also recorded (Heyer *et al.*, 1994; Sutherland, 2006).

Scan searches

The scan searches were conducted by random walk in the field thoroughly searching for the frogs. The scan searches were best conducted at night, using torches, when the animals are most active (Cooke & Arnold, 2003; Sutherland, 2006). This method was most useful for the frogs that aggregate at breeding sites.

Night surveys

Night surveys, the scan searches done in the night or the time constraint survey done in the night time. This method was helpful to find out the nocturnal species richness and to study the ecology.

Call surveys

Call recording procedure was done for the species determination and clarification by using microphone and voice recorder. The frog calls are species specific which enables easy identification (Bee *et al.,* 2013).

Patch sampling

It was preferably done in pre-monsoon and post-monsoon times as many species are encountered in leaf litter, below the rocks, wooden logs and in reed culms (Sutherland, 2006).

Fishes

The specimens collected were identified using the identification keys of Day (1875-1878), Talwar & Jhingran (1991), Jayaram (1981) and Easa and Shaji (2003).

Mammals

Census methods for mammals depend critically on the size of the species and its natural history (Krebs, 2006). Total counts were done for large mammals in the study area (Bookhout, 1994).

Bats: Bats were counted at the roost site or as they emerge from the site (O'Shea *et al.,* 2003).

Hibernation-site monitoring: Counts are made of all species encountered at a range of sites selected, typically caves, mines and cellars. Hibernating bats are identified and counted without disturbance. Photos were taken with minimum disruption to colonies.

3.6 Ecosystem Dynamics

3.6.1 Vegetation Dynamics

The microhabitats in lateritic hillocks were classified based on edaphic properties, water availability and species composition. All existing classifications attempted in other rocky plateues of Western Ghats and other regions were referred while classifying microhabitats (Seine *et al.*, 1998; Porembski and Barthlott, 2000; Jacobi *et al.*,2007; Watve, 2010; Lekhak and Yadav, 2012). But the present classification is site specific and does not suits exactly to any existing systems since there are factors especially species composition which are peculiar to these habitats. But the current and all the above microhabitat classifications on the rocky plateaus are limited by the fact that there is no clear physical demarcation between the microhabitats and many of them are seasonal too. The microhabitats classified were further analyzed for their similarity in species composition by Sorensen's Similarity index.

In order to compare two communities we calculated the Sorensen's Similarity index is suggested by Sorensen (1948)

Sorensen's Similarity index $S=2C/(A+B)$

Where S= Similarity index; A= number of species in sample; B= number of species in sample; C=number of species in sample common to A and B both.

Diversity index were calculated for diversity and species richness was determined by using Shannon-Wiener diversity index (1963) and Menhinick's species richness index (1964) as:

Species diversity index (H) = $-\sum [(ni/N) \log_2 (ni/N)]$

Where, H is Shannon –Weiner index, calculated to the base 2 of species diversity; ni= number of individual of a species i; N= total number of individual of all species in the community.

Species richness index (R) = $S/\sqrt{N}$

Where, R= Menhinick's index of species richness; S= Number of a species in a collection; N= Number of individuals collected.

The index of dominance of the community was calculated by Simpson's index (Simpson, 1949)

Index of dominance (C) = $\sum [ni/N]^2$

Where, C= Simpson's index of dominance; ni = number of individuals of species i; N= total number of individuals of all species in the community.

3.6.2 Host-Butterfly Interaction

Host-butterfly interactions were observed in the lateritic hillocks. The lateritic biotopes were rich in vast varieties of flora, which in turn leads to the rich number of butterfly species. In the present study the host plant-butterfly interaction were carried out on the basis of field observation and available literatures.

3.6.3 Influence of Weather Parameters on Species Richness in Laterite Microhabitats

The species composition and dynamics may depend on abiotic factors including weather parameters. The sample plots established in Madayipara were selected for the study for the influence of weather parameters on species richness. The seasonal floral inventory and weather datas such as temperature, rainfall and humidity were collected during 2013 and 2015 for the study.

4. Results and Discussion

4.1 Identification and mapping of landscape elements

The lateritic biotopes in Northern Kerala consist of different landscape elements. Secondary Data Collection (Toposheets (SOI and Drainage map), and primary data collection from field were done.

- Detailed GPS field survey and ground data collection
- Vectorisation of Web GIS (Google Earth, Bing Map) Satellite image using FOSS GIS(QGIS 2.8, Arc GIS 9.3) software
- Detailed Ground truthing
- Land use map finalization

4.1.1 Elevation class of Kavvayi River Basin

Kavvayi river basin was divided into 7 different elevation classes (Table 4.1). 50% of the area in Kavvayi river basin has an elevation below 25m. Only 2.5 % of the area is at an elevation above 100m. The map of the elevation class is given below (Fig 4.1).

Table 4.1 Elevation class of Kavvayi River Basin

SI No	Elevation in m	Area (Ha.)	% to total area
1	< 5	756.50	4.92
2	5 – 10	3403.40	22.12
3	10 -25	3936.69	25.59
4	25 – 50	2106.78	13.69
5	50 – 75	2425.40	15.76
6	75 – 100	2564.26	16.67
7	> 100	191.68	1.25
	Total	15384.71	100.00

4.1.2 Slope class of Kavvayi River Basin

The study area were divided into 5 different slope classes, flat, gently undulating, undulating, rolling and moderately steep (Table 4.2). In the study site 40% of the area is the slope class flat, which constitutes 6276 ha, and 33% of the area is gently undulating having 5095 ha. The map of the elevation class is given below (Fig 4.2).

Table 4.2 Slope class of Kavvayi River Basin

Sl No	Slope class	Area (Ha.)	% to total area
1	Flat	6276.90	40.80
2	Gently undulating	5095.30	33.12
3	Undulating	2410.92	15.67
4	Rolling	1502.78	9.77
5	Moderately steep	98.82	0.64
	Total	15384.71	100.00

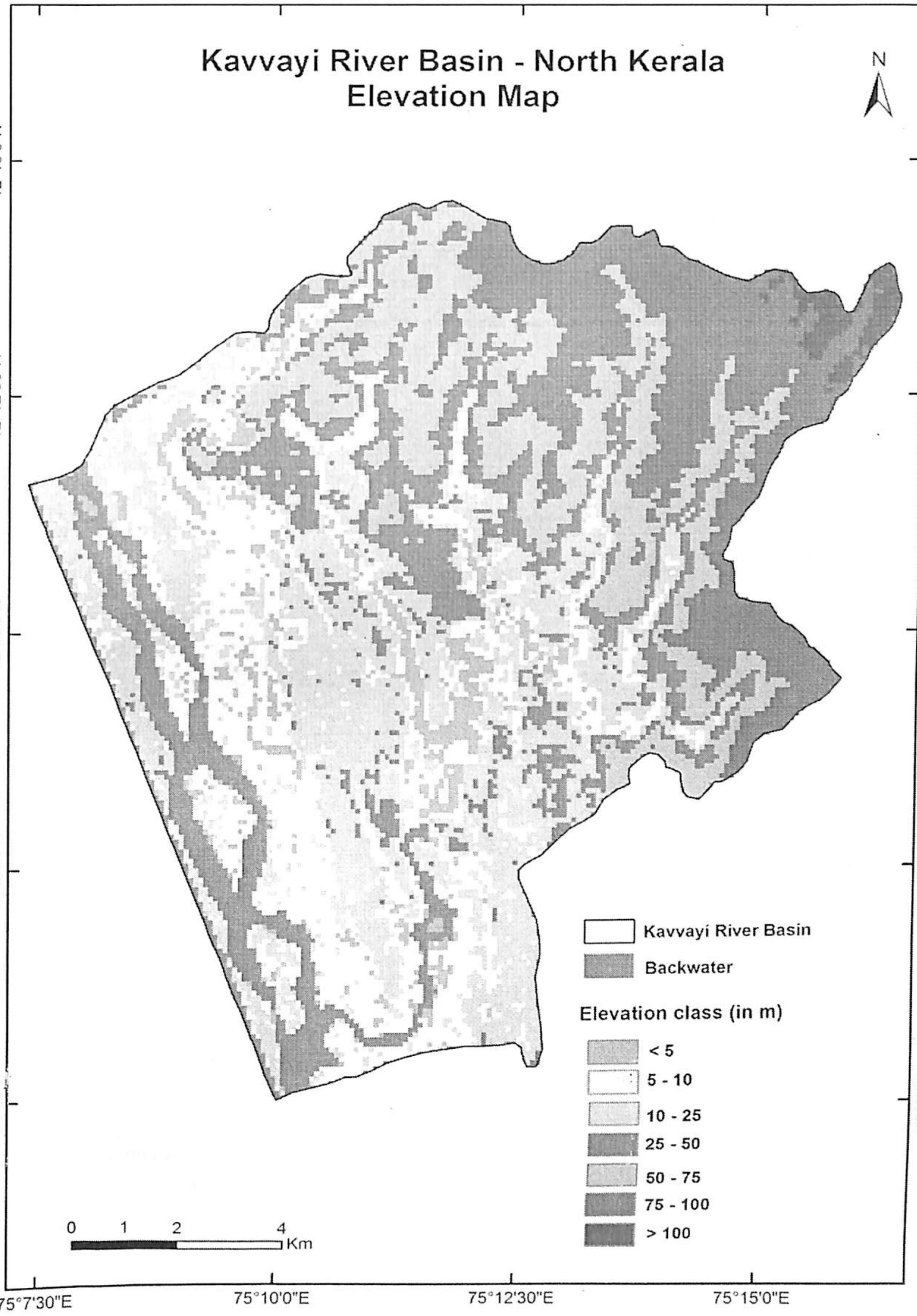


Fig. 4.1Elevation of the Study Area

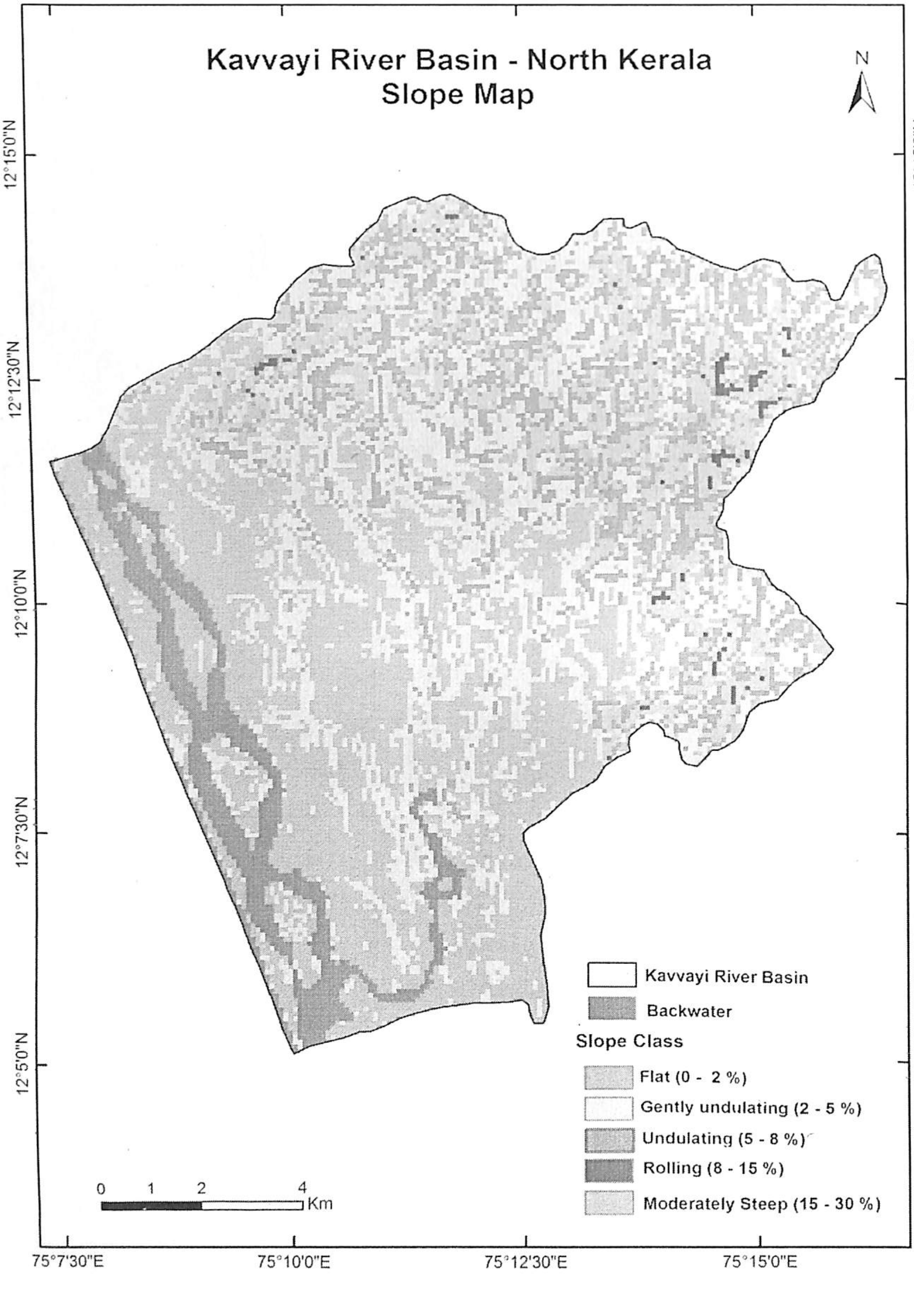


Fig. 4.2 Slope of the Study Area

4.1.3 Mapping of landscape elements

The Lateritic hillocks, Sacred Groves, Kaanams and Kuthiru were identified and mapped with the help of field data and softwares (Fig 4.3a, Fig 4.3b and Fig 4.3c)

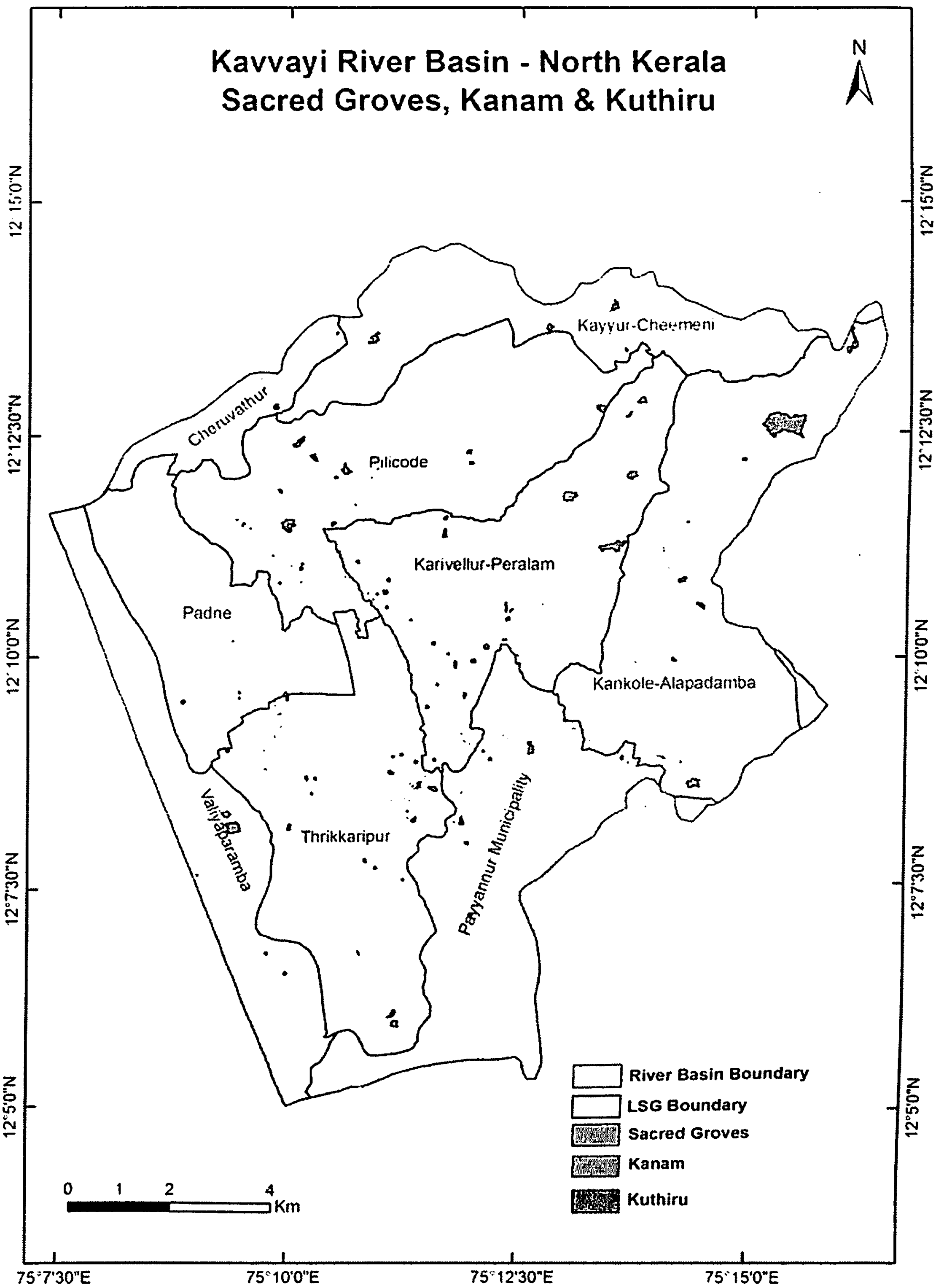


Fig. 4.3a: Distribution of Sacred Groves, Kaanams and Kuthiru in Kavvayi River Basin

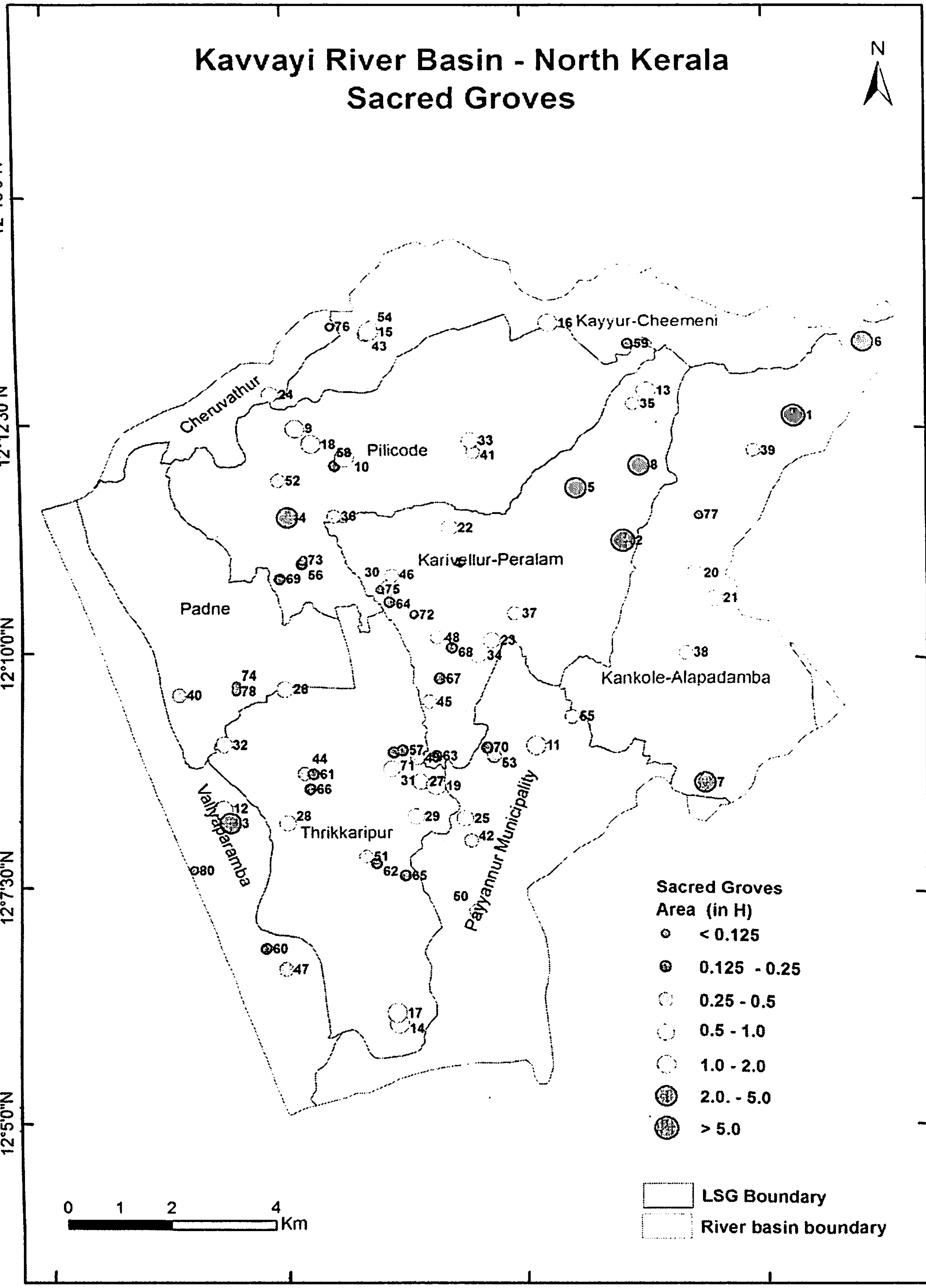


Fig. 4.3b: Distribution and extent of Sacred Groves in Kavvayi River Basin

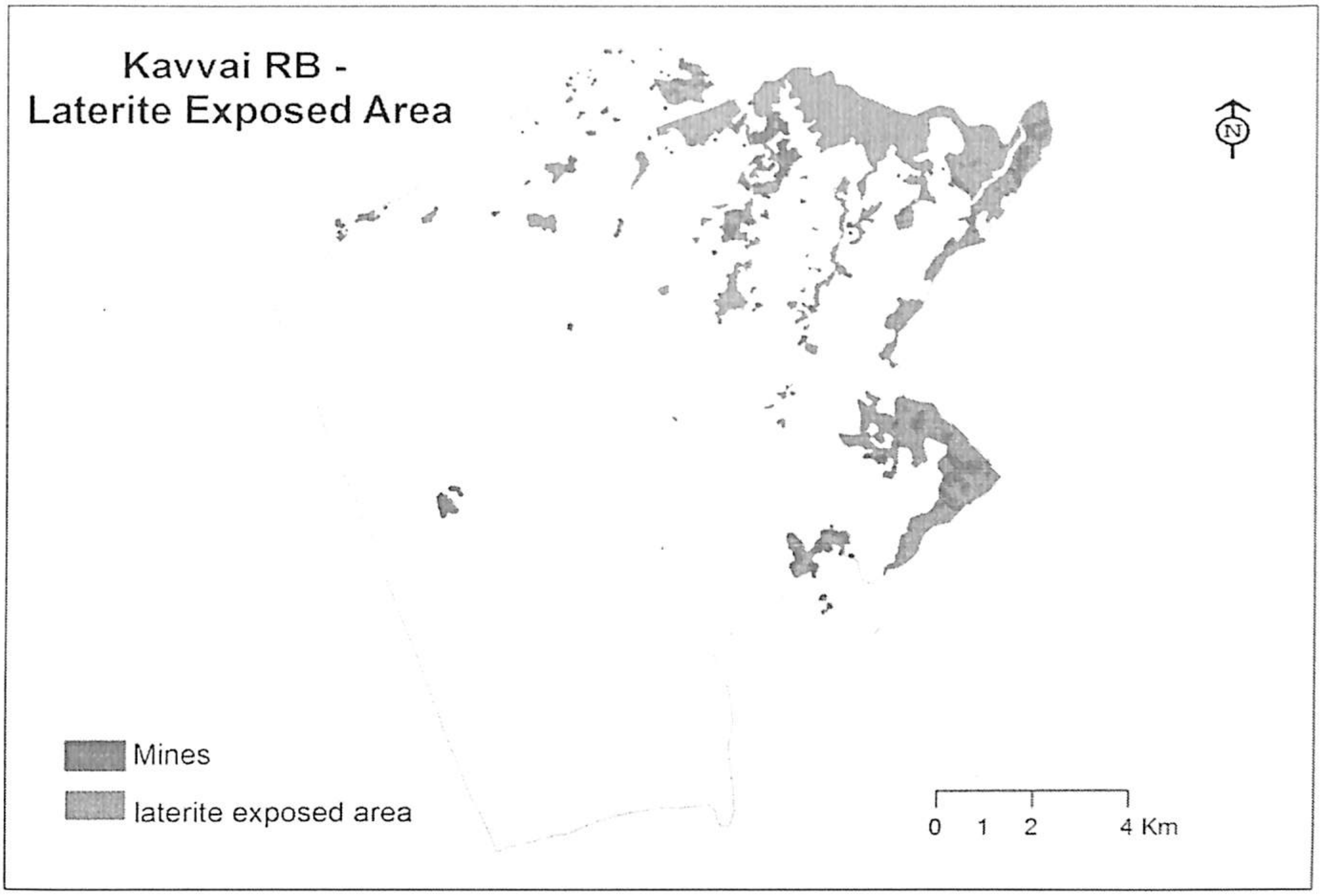


Fig. 4.3c: Laterite exposed area and mines in Kavvayi River Basin

4.2 Analysis of Landuse Change

For the landuse change study land cover change of the year 1986 and 2014 were compared.

4.2.1 Landuse change in Kavvayi River Basin

Land cover is divided into 18 different types such as Homestead with mixed cultivation, Urban built-up, Temple/ School ground, Paddy cultivation, Mixed cultivation, Rubber cultivation, Coconut cultivation, Cashew cultivation, Sacred groves, Mangroves/ Marsh, Laterite exposed area, Kuthiru, Kaanam/ other natural vegetation, Backwater, Mines, Roads/Railway, River/ Pond and Others. From the analysis of landuse/ land cover map, it is evidenced that homestead and mixed cultivation were increased from 16 % to 30% of total area. Other major findings from the analysis are the paddy cultivation and laterite exposed area decreased from 16.48% to 9.97% and 19.23% to 8.27% of the total area respectively.

The cashew cultivation area was also decreased from 3.83% to 2.27%. Laterite mines were increased from 0.05% to 1.35% of the total area (Table 4.4 and Table 4.5). Graphical representations of the landuse change were provided (Fig. 4.4 and Fig. 4.5). The conversion of land for homesteads and other cultivation are the major cause for the drastic decrease in the area of paddy fields (Table 4.6). Laterite exposed area converted for rubber cultivation, homesteads and mines (Table 4.7). Cashew cultivated area was replaced with homesteads, rubber and other mixed crops (Table 4.8). The graphical representation of the changes in paddy fields, laterite exposed area and cashew cultivated area are given below (Fig. 4.6, Fig 4.7 and Fig. 4.8).

Table 4.4: Landuse/ Land cover of Kavvayi River Basin in 1986

Sl No	Land cover type	Area (Ha.)	% to total area
1	Homestead with mixed cultivation	2769.58	16.69
2	Urban Built-up	156.67	0.94
3	Temple /School ground	90.46	0.55
4	Paddy cultivation	2734.70	16.48
5	Mixed cultivation	3174.01	19.14
6	Rubber cultivation	106.10	0.64
7	Coconut cultivation	1732.00	10.44
8	Cashew cultivation	635.58	3.83
9	Sacred groves	89.88	0.54
10	Mangroves/ Marsh	117.26	0.71
11	Laterite Exposed	3190.28	19.23
12	Kuthiru	9.68	0.06
13	Kanam / Other natural vegetation	101.71	0.61
14	Backwater	1070.07	6.45
15	Mines	8.13	0.05
16	Roads/ Railway	257.58	1.55
17	River / ponds	235.07	1.42
18	Others	59.64	0.36
	Total	16587.71	100

Table 4.5: Landuse/ Land cover of Kavvayi River Basin in 2014

Sl No	Land cover type	Area (Ha.)	% to total area
1	Homestead with mixed cultivation	5058.75	30.50
2	Urban Built-up	330.25	1.99
3	Temple /School ground	117.19	0.71
4	Paddy cultivation	1653.39	9.97
5	Mixed cultivation	2112.01	12.74
6	Rubber cultivation	1331.48	8.03
7	Coconut cultivation	1809.57	10.91
8	Cashew cultivation	377.08	2.27
9	Sacred groves	92.07	0.56
10	Mangroves/ Marsh	165.43	1.00
11	Laterite Exposed	1372.04	8.27
12	Kuthiru	8.48	0.05
13	Kanam / Other natural vegetation	65.34	0.39
14	Backwater	1074.44	6.48
15	Mines	223.82	1.35
16	Roads/ Railway	381.98	2.30
17	River / ponds	233.46	1.41
18	Others	180.96	1.09
	Total	16587.71	100

Table 4.6: Changes in Paddy Cultivated area 1986-2014

Sl No	Land cover type	Area (Ha.)	% to total area
1	Homestead with mixed cultivation	311.49	11.39
2	Urban Built-up	9.33	0.34
3	Temple /School ground	7.05	0.26
4	Paddy cultivation (No change)	1631.19	59.64
5	Mixed cultivation	205.59	7.52
6	Rubber cultivation	3.14	0.11
7	Coconut cultivation	472.55	17.28

8	Mangroves/ Marsh	31.28	1.14
9	Kuthiru	1.24	0.05
10	Roads/ Railway	22.67	0.83
11	Others	39.37	1.44
	Total	2734.90	100

Table 4.7: Changes in Laterite exposed area 1986-2014

Sl No	Land cover type	Area (Ha.)	% to total area
1	Homestead with mixed cultivation	345.16	10.82
2	Urban Built-up	4.42	0.14
3	Temple /School ground	6.81	0.21
4	Mixed cultivation	229.73	7.20
5	Rubber cultivation	737.53	23.12
6	Coconut cultivation	32.28	1.01
7	Cashew cultivation	240.28	7.53
8	Laterite Exposed (No change)	1329.54	41.67
9	Kaanam / Other natural vegetation	10.92	0.34
10	Mines	203.32	6.37
11	Roads	31.62	0.99
12	Others	17.89	0.58
	Total	16587.71	100

Table 4.8: Changes in Cashew cultivated area 1986-2014

Sl No	Land cover type	Area (Ha.)	% to total area
1	Homestead with mixed cultivation	102.28	16.09
2	Temple /School ground	0.51	0.08
3	Mixed cultivation	66.12	10.40
4	Rubber cultivation	314.57	49.50
5	Coconut cultivation	6.01	0.95
6	Cashew cultivation (No change)	110.60	17.40
7	Laterite Exposed	23.47	3.69
8	Mines	2.96	0.47
9	Roads	4.36	0.69
10	Others	5.51	0.73
	Total	635.58	100.00

The population pressure leads to depletion in natural ecosystems in the lateritic biotopes in North Kerala over last three decades. The biodiversity rich biotopes are converted for infrastructure development, mines and monoculture plantations. The laterite exposed area and paddy cultivated areas are the most affected in the study area. Around 40% of the paddy cultivated areas were already converted for infrastructure development and mixed cultivation. 60% of the lateritic biotopes were converted for other purposes such as infrastructure, monoculture plantations and laterite mines. 84% of the cashew cultivated area is replaced by rubber plantations and infrastructures.

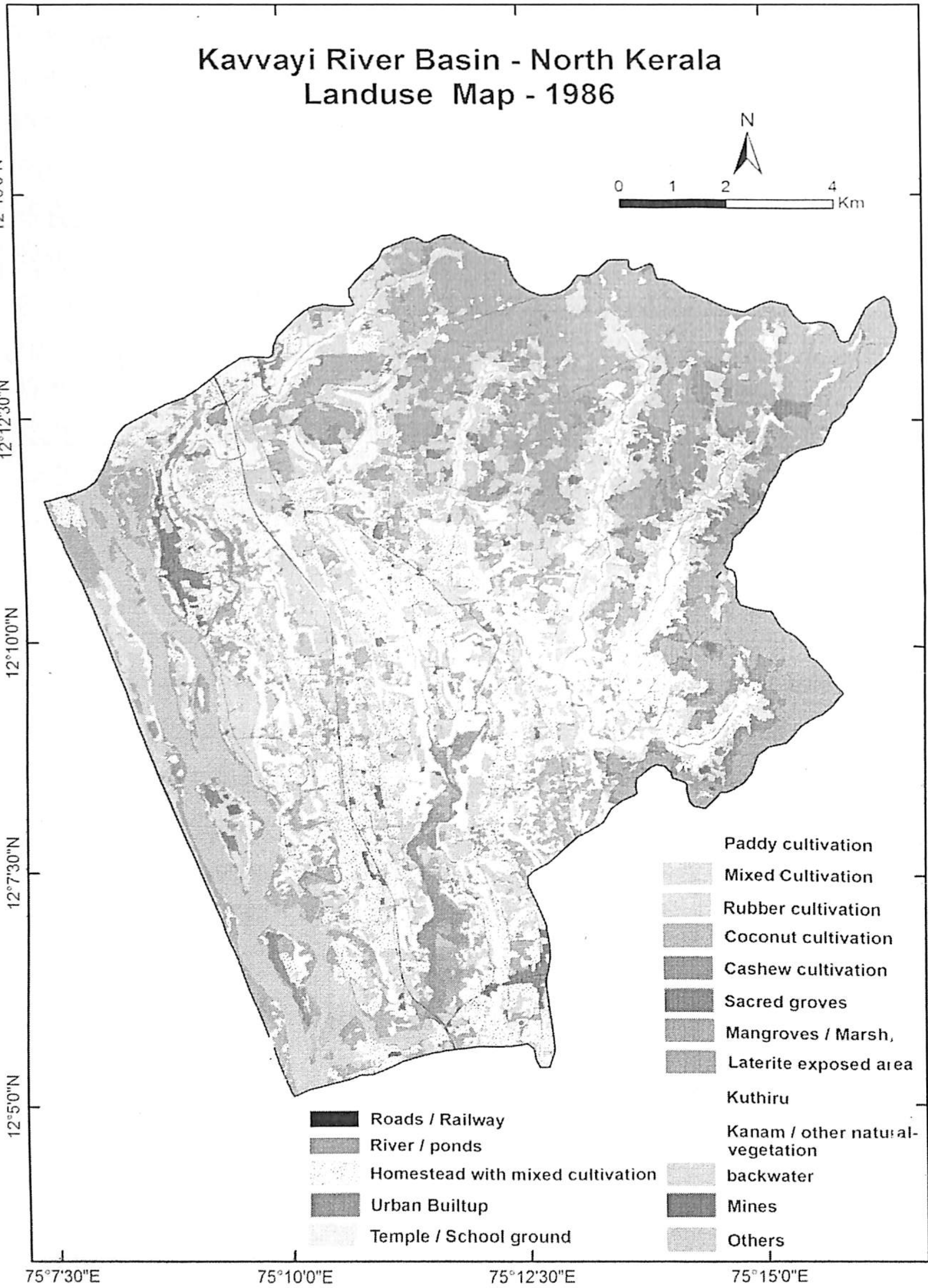


Fig. 4.4: Landuse/ Land cover of Kavvayi River Basin in 1986

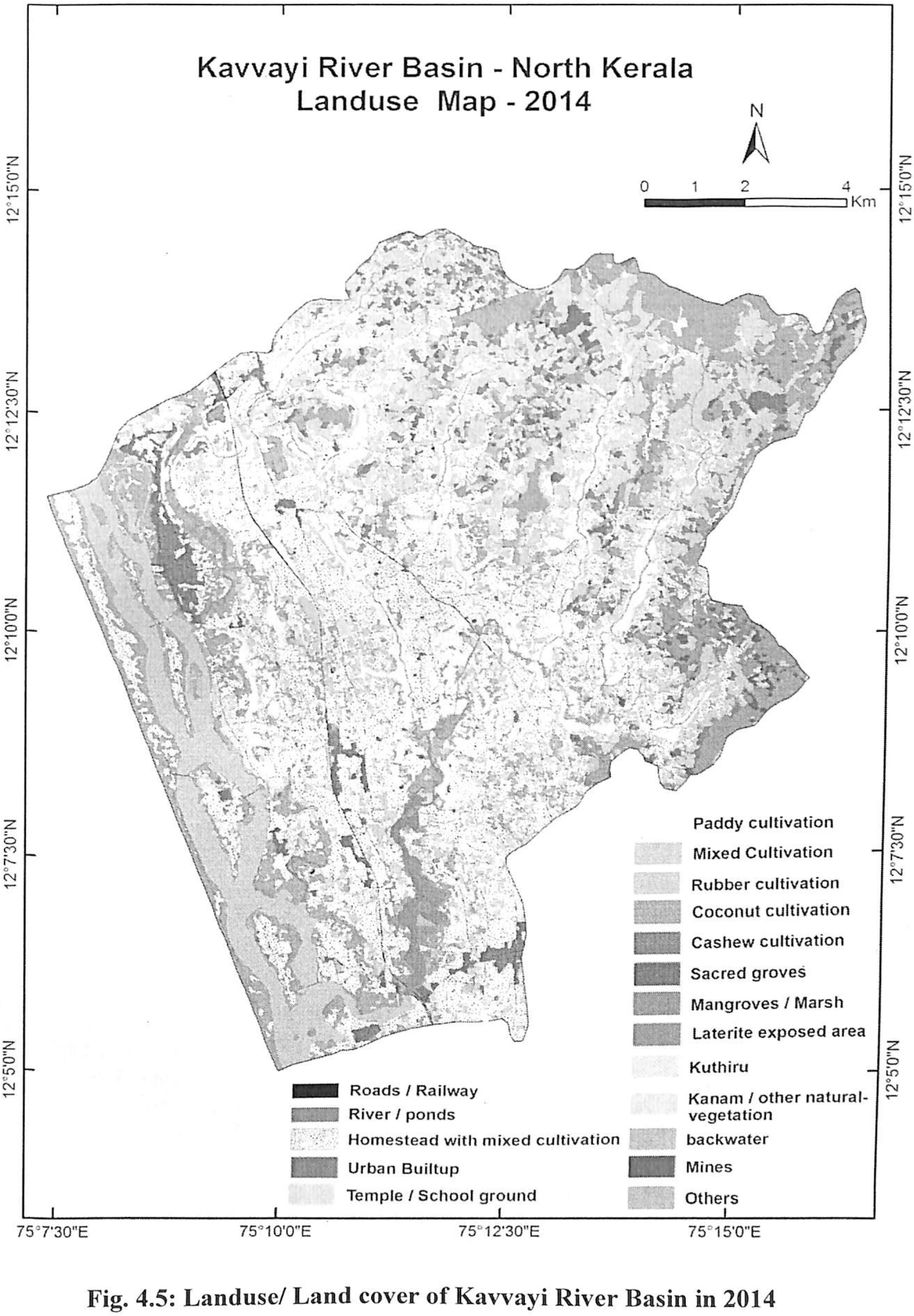


Fig. 4.5: Landuse/ Land cover of Kavvayi River Basin in 2014

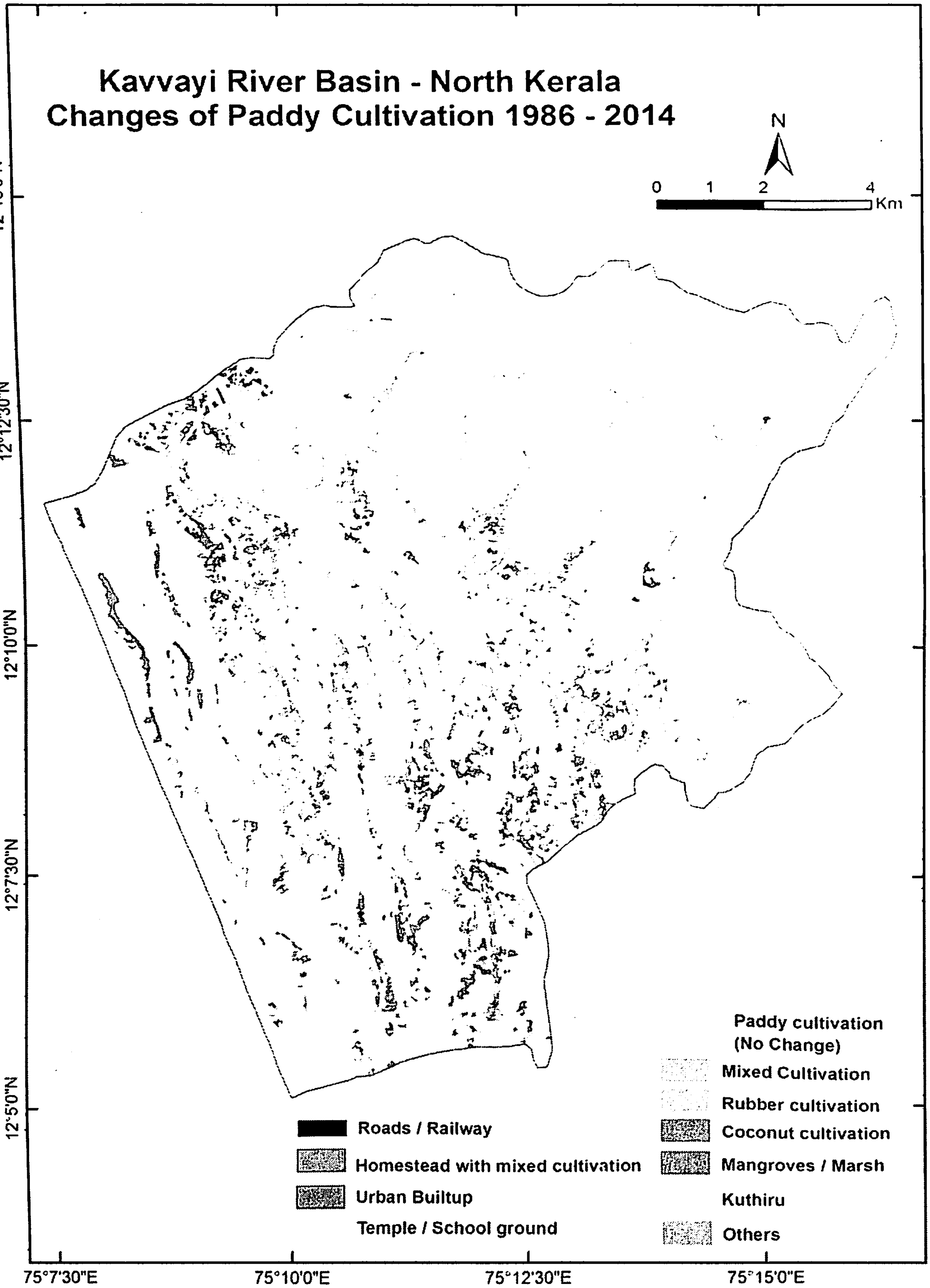


Fig. 4.6: Changes in Paddy Cultivated area 1986-2014

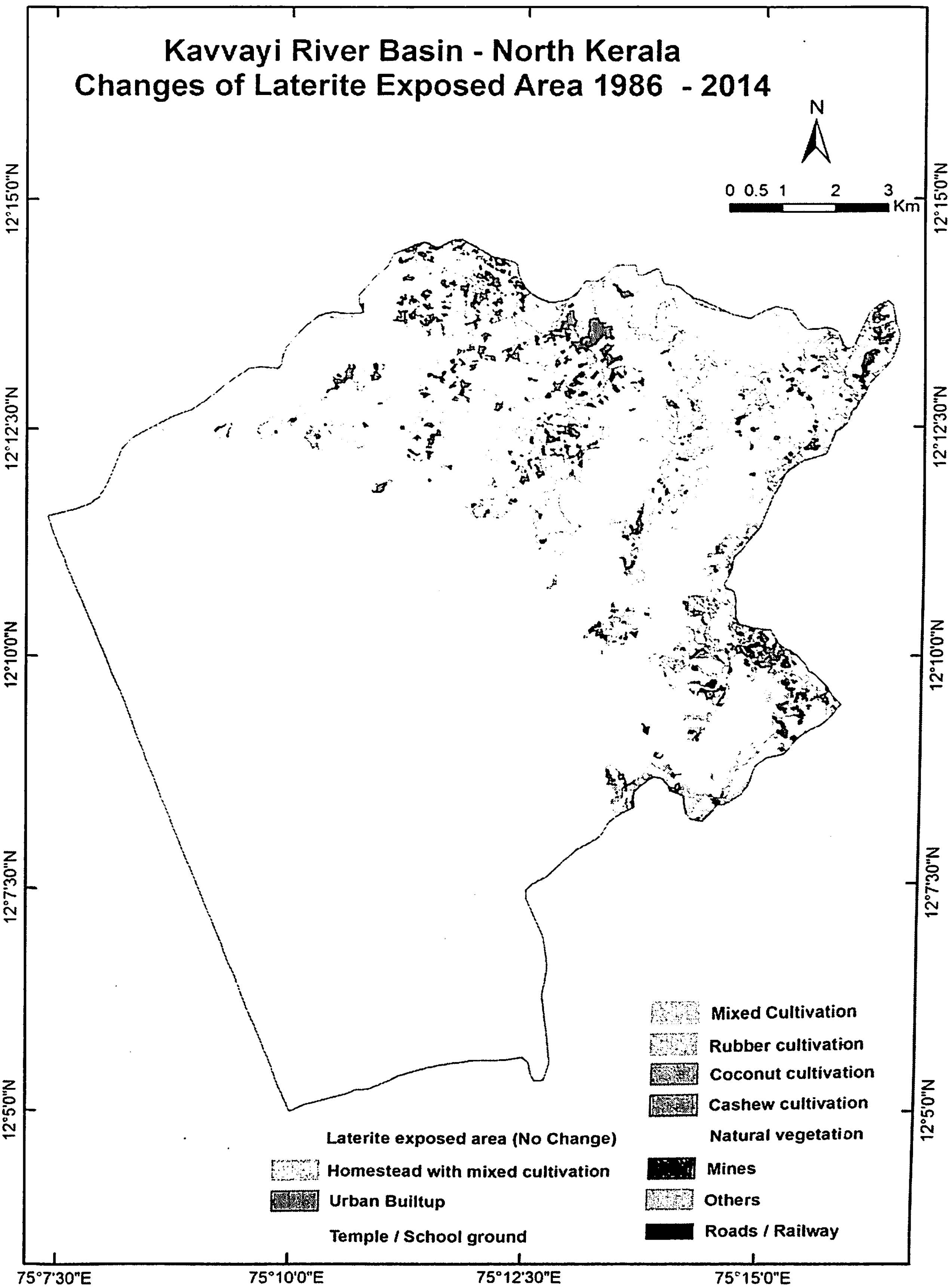


Fig. 4.7: Changes in Laterite Exposed area 1986-2014

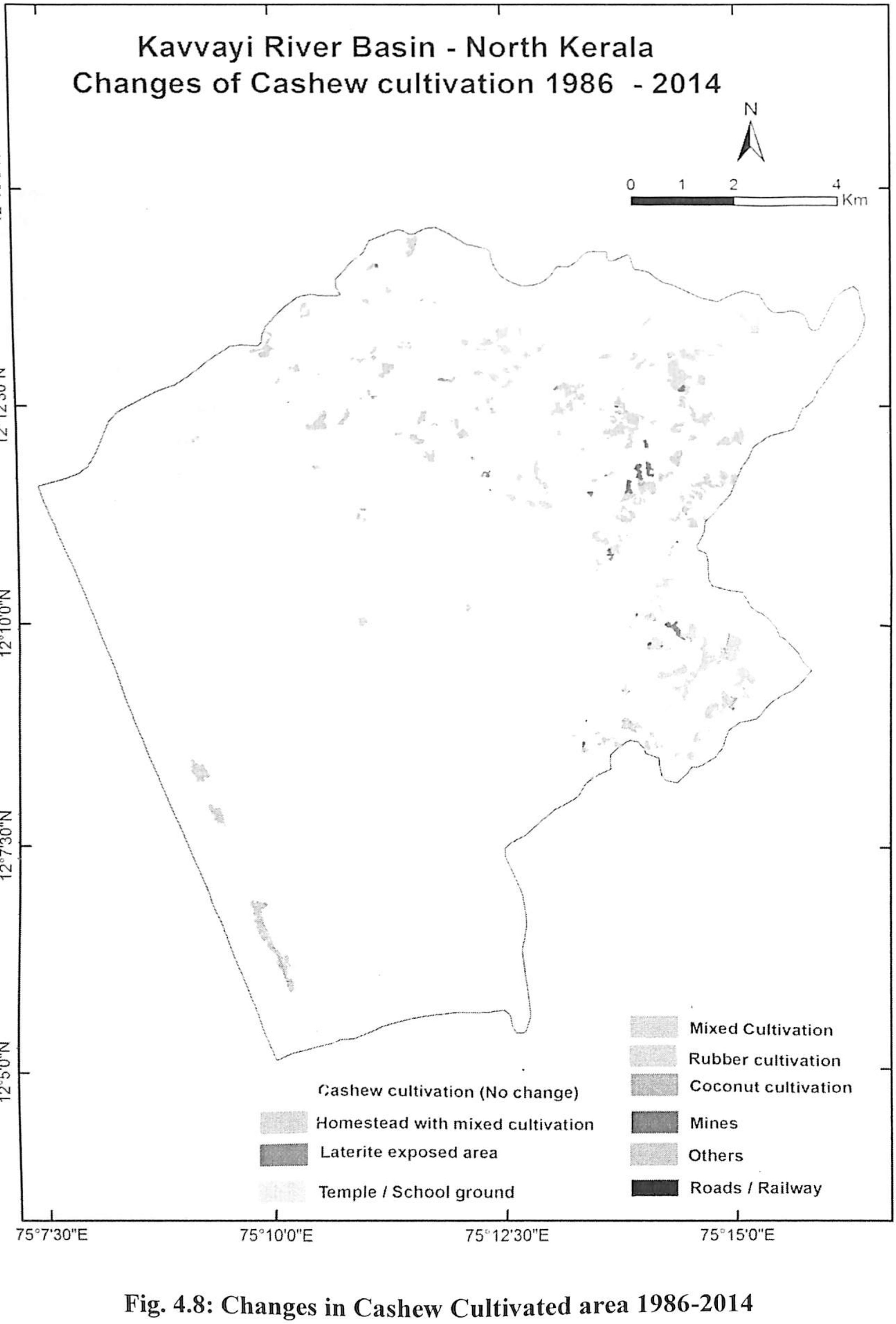


Fig. 4.8: Changes in Cashew Cultivated area 1986-2014

4.2.2 Panchayath-wise Landuse change in Kavvayi River Basin

Panchayath-wise landuse change in Kavvayi River Basin was studied in detail. The 9 constituencies, Thrikkarippur, Karivellur-Peralam, Padne, Pilikode, Kankol-Alappadamba, Valiyaparamba, Kayyur-Cheemeni panchayaths and Payyannur municipality were studied for their landuse change.

4.2.2.1 Landuse change in Thrikkarippur Panchayath

In Thrikkarippur Panchayath, the major change from 1986 to 2014 was the increase in percentage area of Homestead with mixed cultivation from 29.78% to 43.19% (Table 4.9 and Table 4.10). Besides this urban built-up was also increased from 0.63% to 2.86%, while paddy cultivation was decreased from 20.79% to 11.49% and mixed cultivation decreased from 22.82 % to 11.52%. Another important change was the disappearance of cashew cultivation. 40% of the paddy cultivation area were converted to homestead with mixed cultivation, coconut cultivation and mixed cultivation during the period of 1986-2014 (Table 4.11). The graphical representation of landuse change in Thrikkarippur Panchayath is given below as image (Fig 4.9, Fig 4.10 and Fig 4.11).

Table 4.9: Landuse/Land cover pattern in Thrikkarippur Panchayath, 1986

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	684.65	29.78
2	Urban Built-up	14.51	0.63
3	Temple /School ground	21.27	0.93
4	Paddy cultivation	477.98	20.79
5	Mixed cultivation	524.66	22.82
6	Coconut cultivation	323.06	14.05
7	Cashew cultivation	2.79	0.12
8	Sacred groves	8.82	0.38
9	Mangroves/ Marsh	15.74	0.68
10	Kuthiru	1.75	0.08
11	Riverine vegetation	5.30	0.23
12	Backwater	101.12	4.40
13	Roads/ Railway	45.44	1.98
14	River / ponds	64.45	2.80
15	Others	7.23	0.31
	Total	2298.78	100.00

Table 4.10: Landuse/Land cover pattern in Thrikkarippur Panchayath, 2014

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	992.61	43.19
2	Urban Built-up	65.62	2.86
3	Temple /School ground	32.11	1.40
4	Paddy cultivation	264.11	11.49
5	Mixed cultivation	264.78	11.52
6	Coconut cultivation	374.46	16.30
7	Sacred groves	9.07	0.39
8	Mangroves/ Marsh	38.34	1.67
9	Kuthiru	1.30	0.06
10	Riverine vegetation	1.74	0.08
11	Backwater	97.39	4.24
12	Roads/ Railway	60.09	2.61
13	River / ponds	65.49	2.85
14	Others	31.54	1.37
	Total	2298.65	100.00

Table 4.11: Changes in Paddy cultivated area, Thrikkarippur Panchayath, 1986-2014

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	67.30	14.08
2	Urban Built-up	0.71	0.15
3	Paddy cultivation (No change)	257.25	53.82
4	Mixed cultivation	30.30	6.34
5	Coconut cultivation	101.41	21.22
6	Mangroves/ Marsh	4.25	0.89
7	Roads	4.46	0.93
8	Others	12.30	2.57
	Total	477.98	100.00

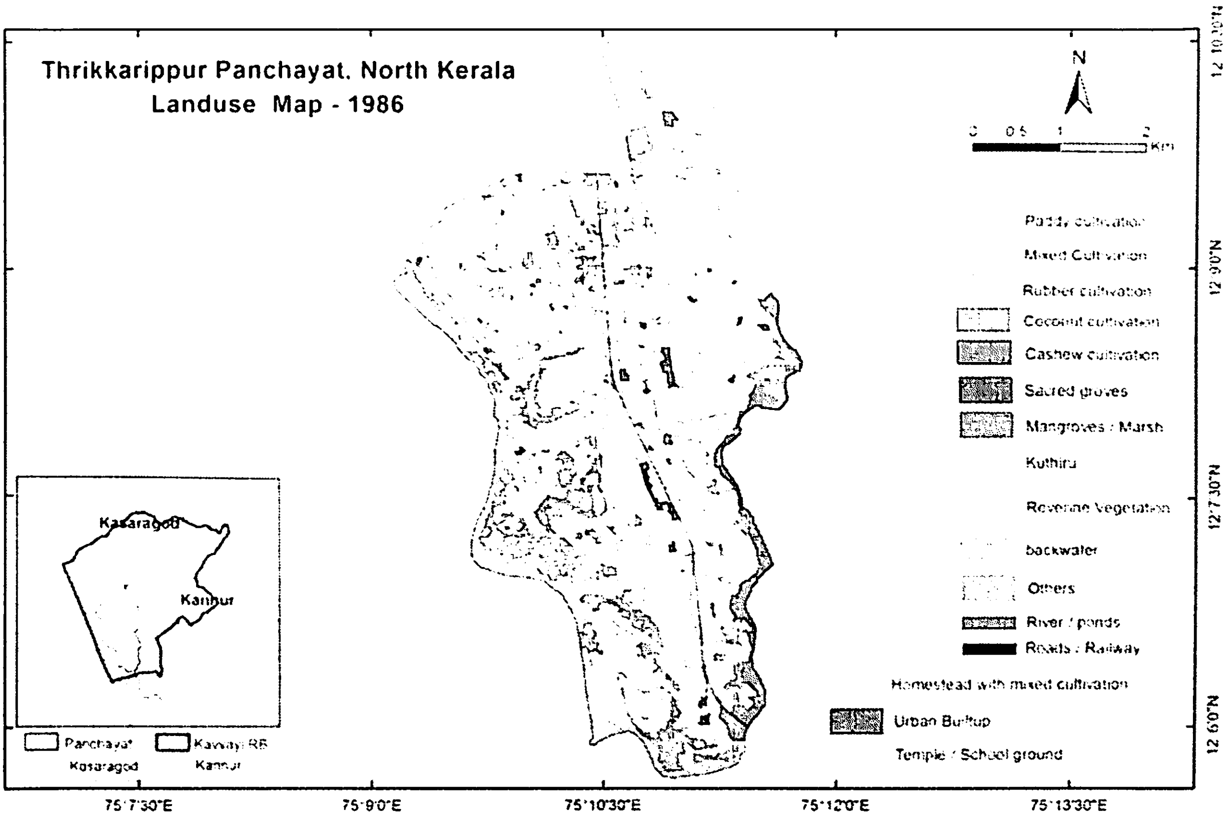


Fig. 4.9: Landuse/Land cover pattern in Thrikkarippur Panchayath, 1986

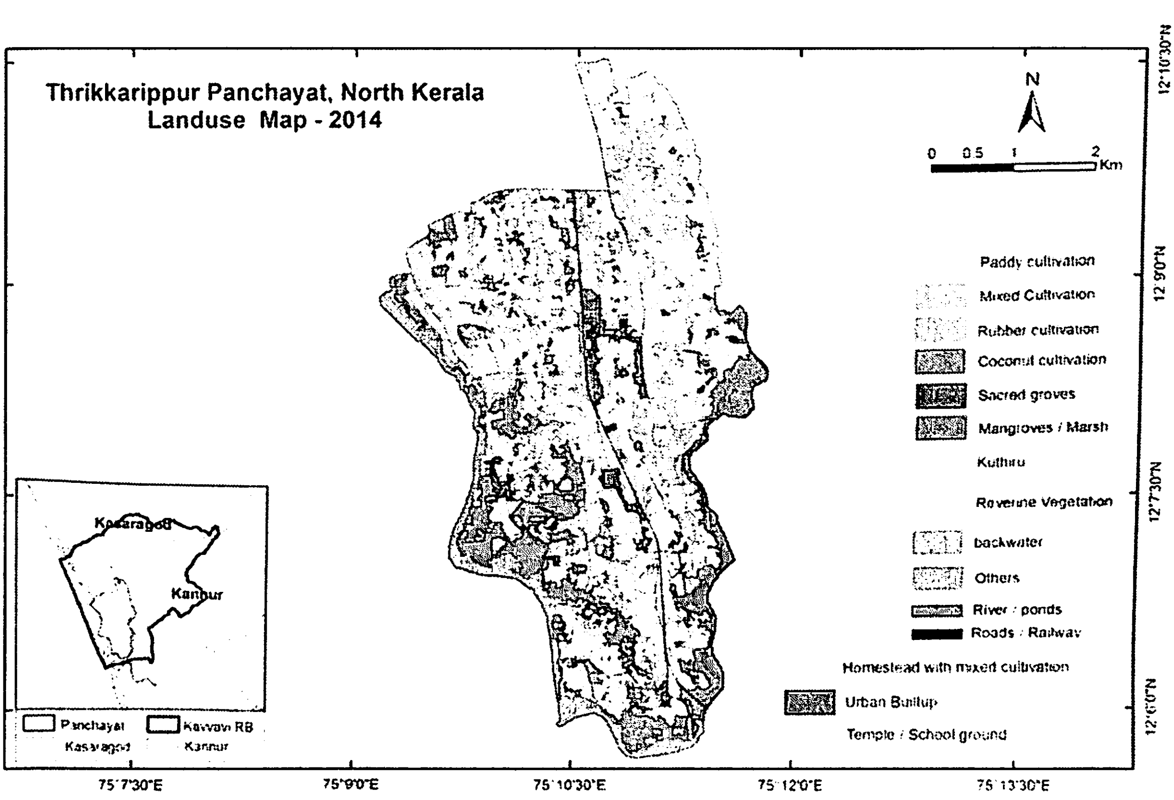


Fig. 4.10: Landuse/Land cover pattern in Thrikkarippur Panchayath, 2014

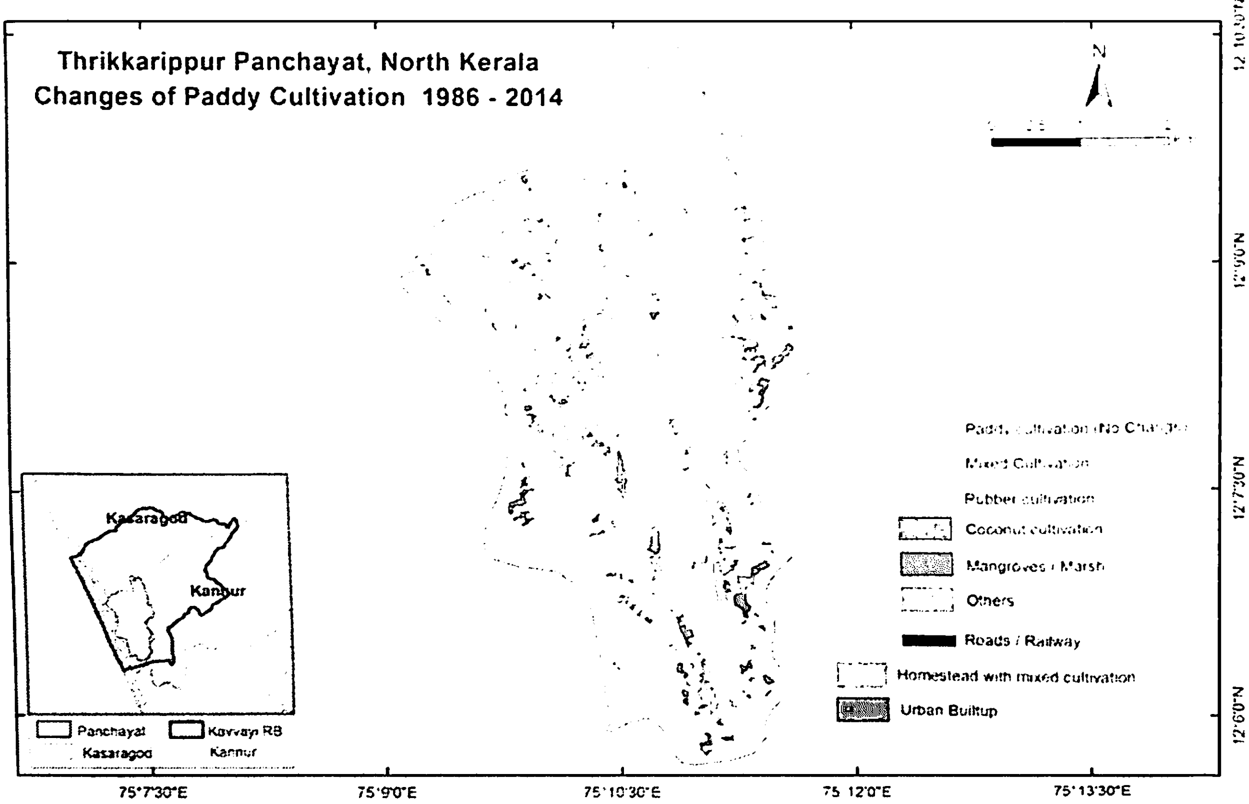


Fig. 4.11: Changes in Paddy cultivated area, Thrikkarippur Panchayath, 1986-2014

In Thrikkaripur Panchayat, due to the infrastructure development the area of padd and mixed cultivation decreased drastically. 44% of the paddy cultivated area is no converted to infrastructures, coconut cultivation and mixed cultivation.

4.2.2.2 Landuse change in Karivellur-Peralam Panchayath

In Karivellur- Peralam Panchayath the major landuse change noticed was the increas of the area of homestead with mixed cultivation from 22% to 40.17%. Paddy cultivatio decreased from 22.84% to 17.69%, mixed cultivation decreased from 23.68% to 13.43% cashew cultivation decreased from 3.44% to 1.52% and laterite exposed area were decrease from 11.53% to 4.55%. On the other hand, Rubber cultivation was increased by 10 time from 0.82% area to 8.52% (Table 4.12 and Table 4.13). Almost 20% of the paddy cultivate areas were converted to homesteads, mixed cultivation and coconut during these years (Tabl 4.14). 55% of the laterite exposed areas were converted to rubber cultivation, homestead mixed cultivation, cashew, mines, etc (Table 4.15). Only 38% percent of the laterite expose areas were remaining in the Panchayath. The map showing the landuse change in Karivellur-Peralam Panchayth is given below (Fig 4.12, Fig 4.13, Fig 4.14 and Fig 4.15).

Table 4.12: Landuse/Land cover change in Karivellur-Peralam Panchayath in 1986

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	508.07	22.00
2	Temple /School ground	16.39	0.71
3	Paddy cultivation	527.40	22.84
4	Mixed cultivation	546.84	23.68
5	Rubber cultivation	18.90	0.82
6	Coconut cultivation	216.28	9.37
7	Cashew cultivation	79.44	3.44
8	Sacred groves	17.44	0.76
9	Mangroves/ Marsh	13.69	0.59
10	Laterite Exposed	266.24	11.53
11	Kuthiru	3.80	0.16
12	Kanam / Other natural vegetation	9.11	0.39
13	Mines	2.65	0.11
14	Roads/ Railway	45.73	1.98
15	River / ponds	35.36	1.53
16	Others	1.88	0.08
	Total	2309.21	100.00

Table 4.13: Landuse/Land cover change in Karivellur-Peralam Panchayath in 2014

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	927.74	40.17
2	Urban Built-up	1.42	0.06
3	Temple /School ground	15.10	0.65
4	Paddy cultivation	408.56	17.69
5	Mixed cultivation	310.14	13.43
6	Rubber cultivation	196.82	8.52
7	Coconut cultivation	158.59	6.87
8	Cashew cultivation	35.04	1.52
9	Sacred groves	17.44	0.76
10	Mangroves/ Marsh	9.70	0.42
11	Laterite Exposed	105.14	4.55
12	Kuthiru	4.28	0.19
13	Kaanam / Other natural vegetation	2.22	0.10
14	Mines	11.07	0.48
15	Roads/ Railway	60.30	2.61
16	River / ponds	34.18	1.48
17	Others	11.54	0.50
	Total	2309.21	100

Table 4.14: Changes in Paddy cultivated area, Karivellur-Peralam, 1986-2014

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	42.40	8.04
2	Paddy cultivation (No change)	406.36	77.05
3	Mixed cultivation	26.25	4.98
4	Coconut cultivation	44.98	8.53
5	Kuthiru	0.74	0.14
6	Roads	3.21	0.61
7	Others	3.38	0.64
	Total	527.40	100

Table 4.15: Changes in Laterite exposed area, Karivellur-Peralam, 1986-2014

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	25.91	9.73
2	Mixed cultivation	15.68	5.89
3	Rubber cultivation	85.19	32.00
4	Cashew cultivation	20.00	7.51
5	Laterite Exposed	102.94	38.66
6	Mines	10.43	3.92
7	Roads	1.81	0.68
8	Others	4.28	1.61
	Total	266.24	100.00

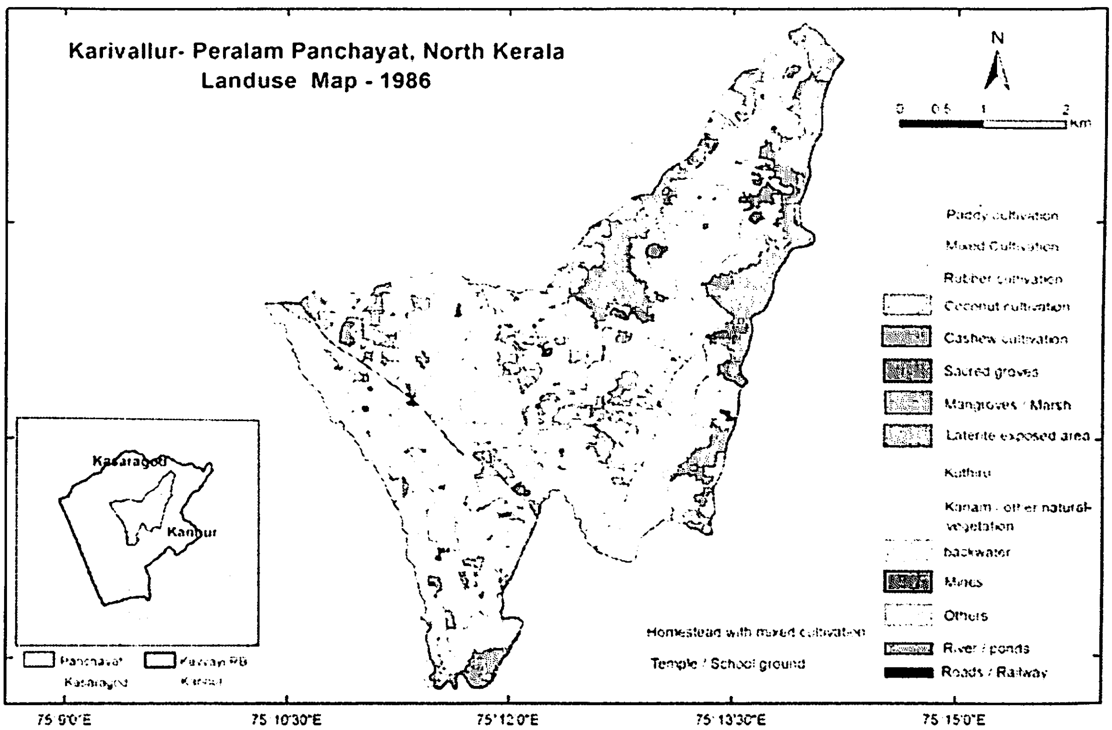


Fig. 4.12: Landuse/ Land cover change in Karivellur-Peralam Panchayath, 1986- 2014

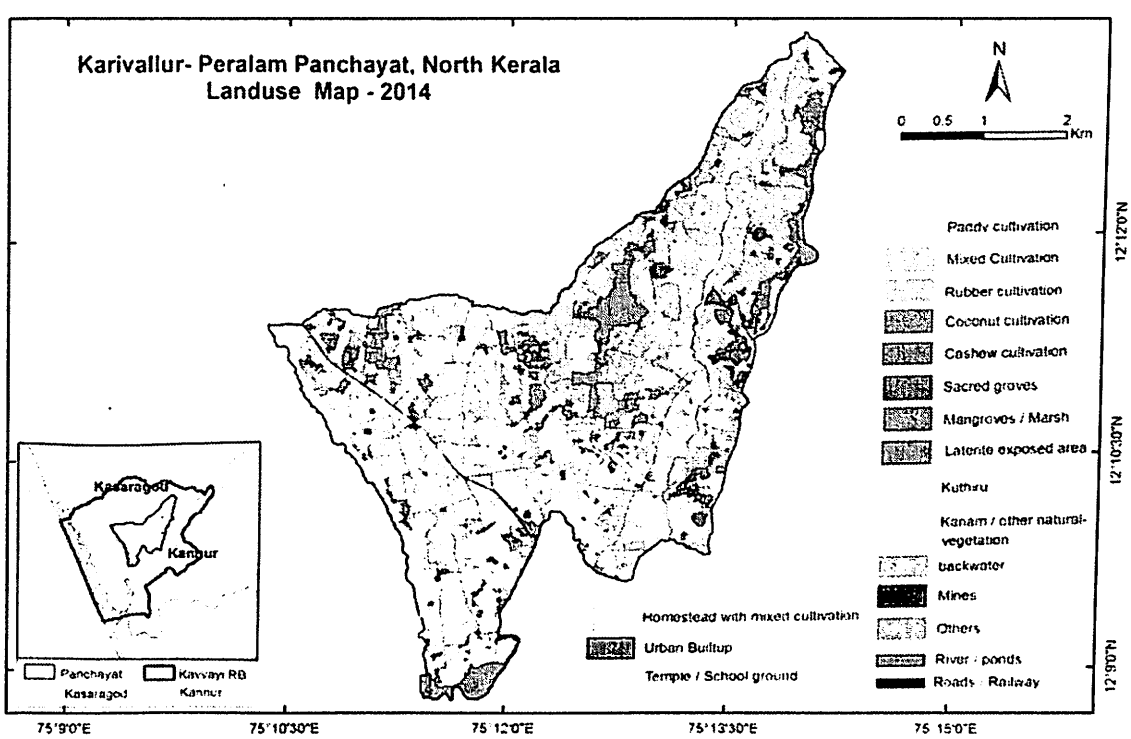


Fig. 4.13: Landuse/ Land cover change in Karivellur-Peralam Panchayath, 1986-2014

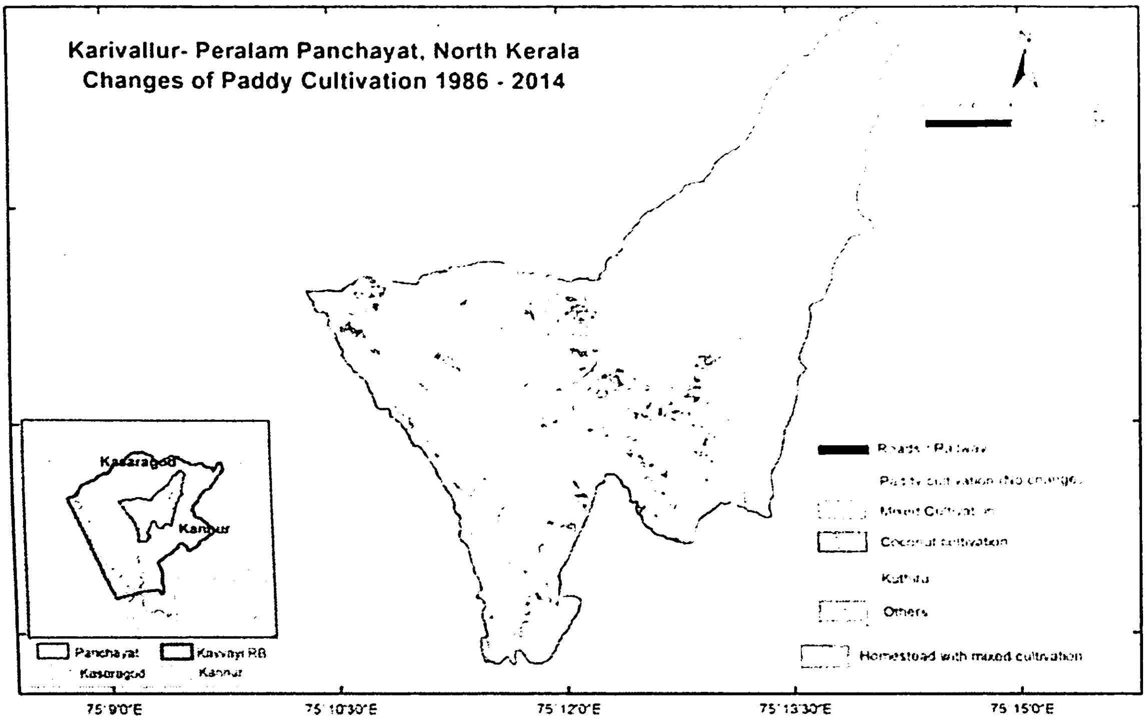


Fig. 4.14: Changes in Paddy cultivated area, Karivellur-Peralam Panchayath, 1986-2014

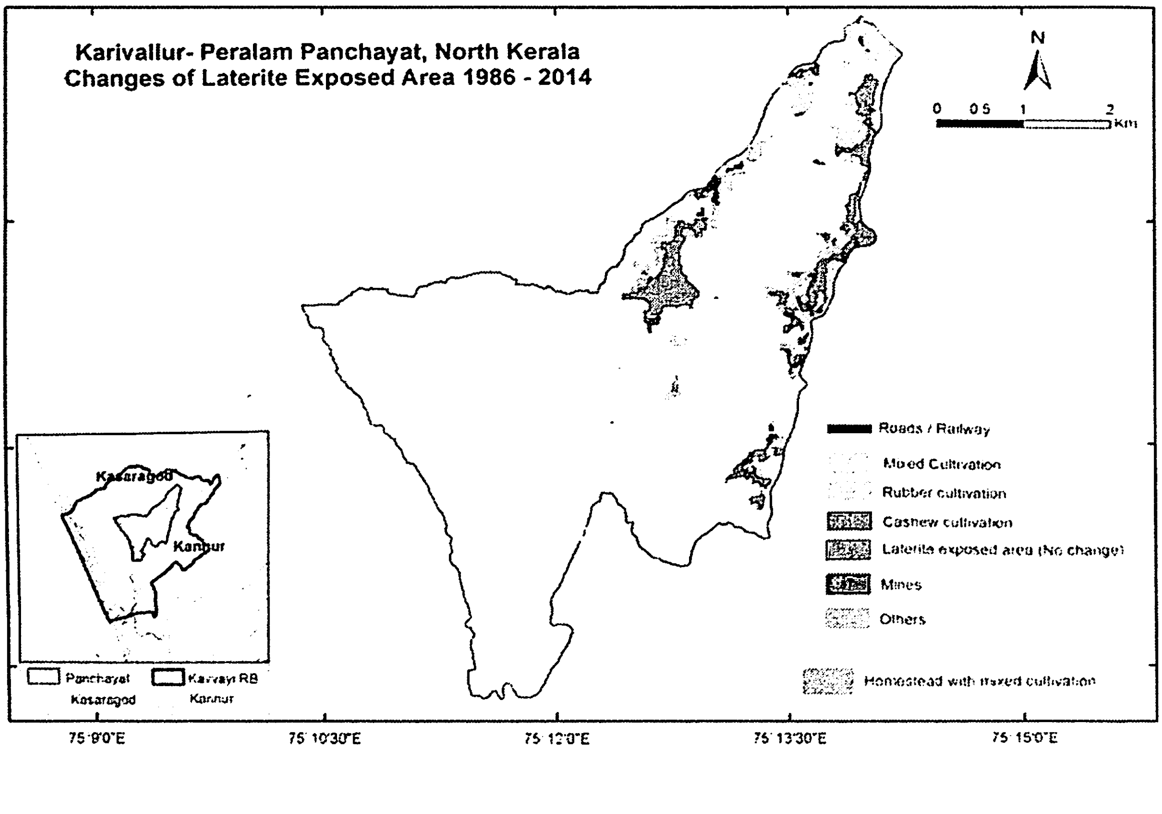


Fig. 4.15: Changes in Laterite exposed area, Karivellur-Peralam Panchayath, 1986-201

The increased rate of urbanization leads to the depletion of laterite exposed areas, paddy cultivated areas and mixed cultivated areas. The areas of mines are also increased in the Panchayath over 3 decades. 23% of the paddy cultivated areas are converted for homestead, coconut cultivation and mixed cultivation. 61% of the laterite exposed area is now converted to infrastructure development, rubber cultivation, monoculture plantations and mines.

4.2.2.3 Landuse change in Padne Panchayath

The notable change in this Panchayath was the increase in homestead and urban built-up, first one increased from 11.52% to 19.26% and the later one from 5.85% to 10.20%. Paddy cultivation and mixed cultivation decreased from 17.43% to 8.36% and 20.35% to 8.21% respectively (Table 4.16 and Table 4.17). The Kuthiru ecosystem, which has an area of 0.06% in 1986 were completely vanished in 2014 and 50% of the paddy filed were converted to coconut cultivation, homestead, mixed cultivation, etc (Table 4.18). The map of landuse change is given below (Fig 4.16, Fig 4.17 and Fig 4.18).

Table 4.16: Landuse/Land cover change in Padne Panchayath in 1986

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	163.31	11.52
2	Urban Built-up	82.99	5.85
3	Temple /School ground	3.15	0.22
4	Paddy cultivation	247.08	17.43
5	Mixed cultivation	288.48	20.35
6	Coconut cultivation	285.81	20.16
7	Sacred groves	0.93	0.07
8	Mangroves/ Marsh	16.42	1.16
9	Kuthiru	0.83	0.06
10	Backwater	282.65	19.94
11	Roads/ Railway	19.97	1.41
12	River / ponds	15.45	1.09
13	Others	10.4	0.73
	Total	1417.47	100.00

Table 4.17: Landuse/Land cover change in Padne Panchayath in 2014

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	272.95	19.26
2	Urban Built-up	144.60	10.20
3	Temple /School ground	7.36	0.52
4	Paddy cultivation	118.51	8.36
5	Mixed cultivation	116.41	8.21
6	Coconut cultivation	369.73	26.08
7	Sacred groves	0.93	0.07
8	Mangroves/ Marsh	39.46	2.78
9	Backwater	274.62	19.37
10	Roads/ Railway	27.70	1.95
11	River / ponds	15.63	1.10
12	Others	29.38	2.09
	Total	1417.46	100

Table 4.18: Changes in Paddy cultivated area, Padne Panchayath, 1986-2014

Sl No	Land cover type	Area (Ha.)	area %
1	Homestead with mixed cultivation	18.89	7.65
2	Urban Built-up	1.26	0.51
3	Paddy cultivation	116.09	46.98
4	Mixed cultivation	10.07	4.08
5	Coconut cultivation	76.16	30.82
6	Mangroves/ Marsh	15.38	6.22
7	Roads/ Railway	1.26	0.51
8	Others	7.97	3.23
	Total	247.08	100.00

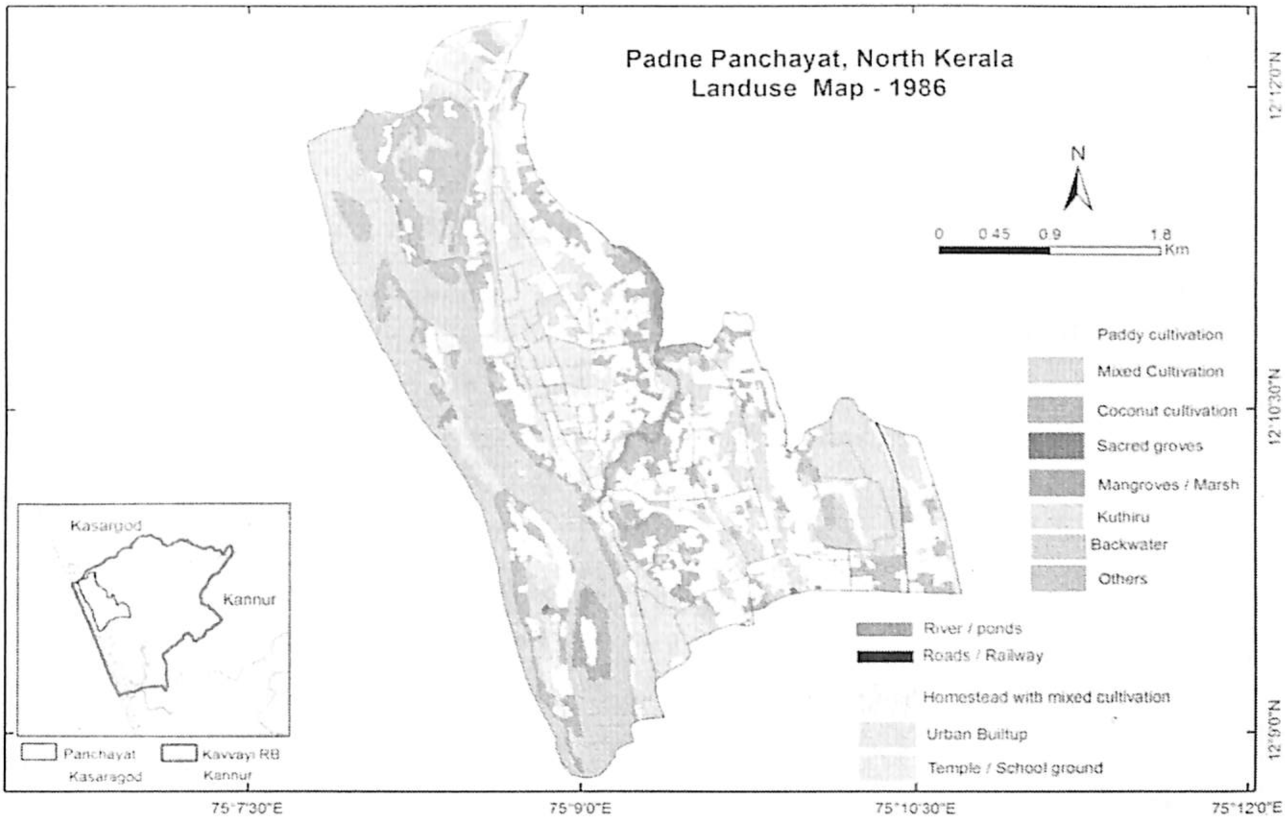


Fig. 4.16: Landuse/Land cover change in Padne Panchayath in 1986

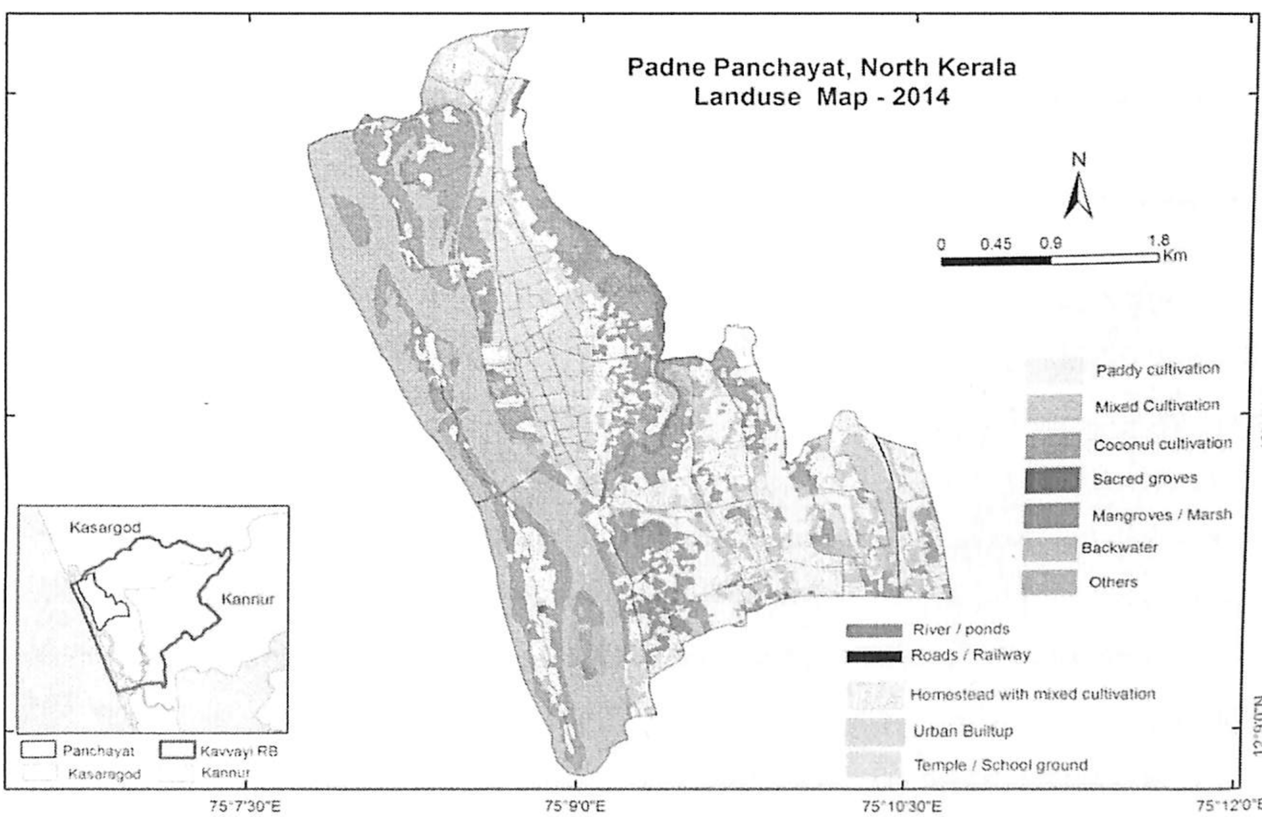


Fig. 4.17: Landuse/Land cover change in Padne Panchayath in 2014

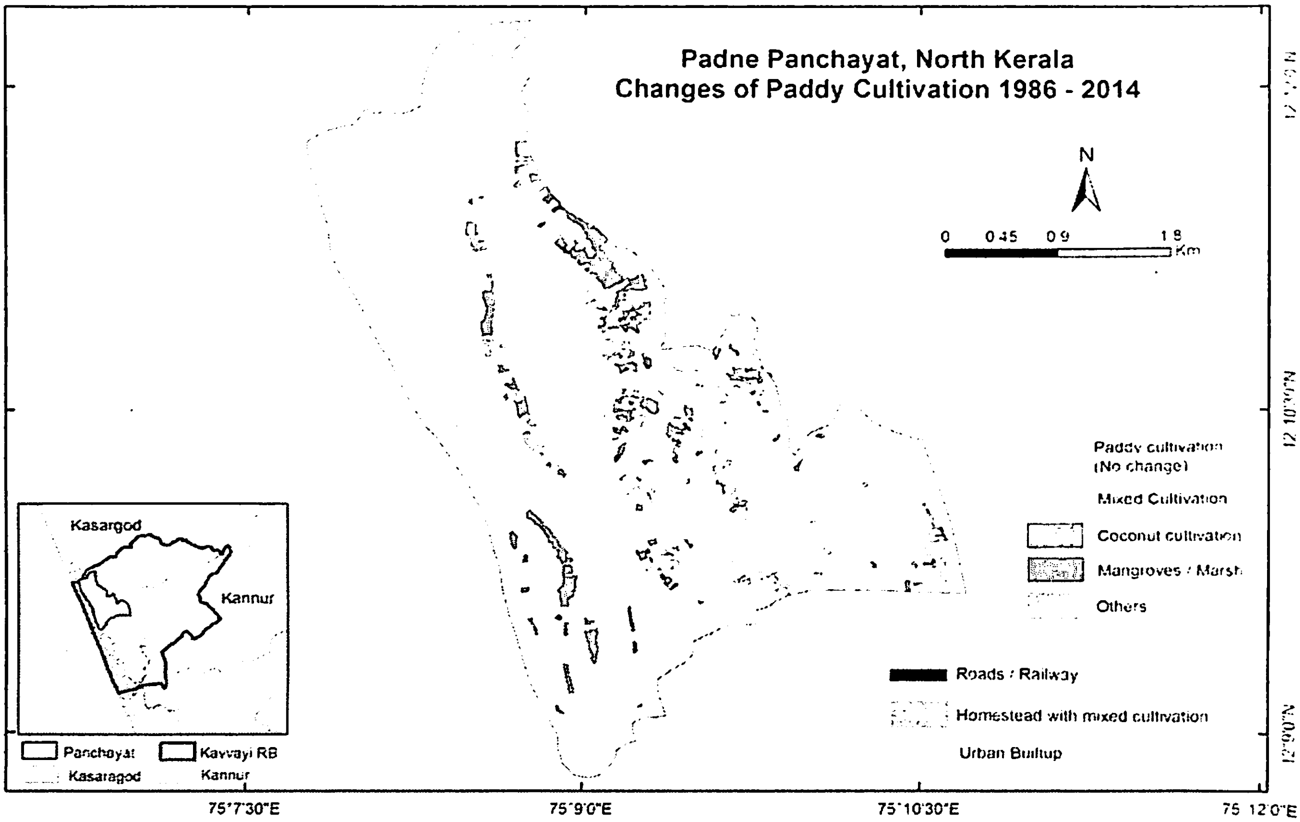


Fig. 4.18: Changes in Paddy cultivated area, Padne Panchayath, 1986-2014

Padne Panchayath's 54% of the paddy cultivation was converted to coconut cultivation and infrastructure development over 30 years.

4.2.2.4 Landuse change in Pilikkode Panchayath

In this Panchayth, homesteads and rubber cultivation were increased from 14.19% to 32.18% and 0.52% to 10.57% respectively. Paddy cultivation, mixed cultivation and laterite exposed area were decreased from 15.79% to 12.05%, 25.13% to 20.90% and 27.54% to 6.58% respectively (Table 4.19 and Table 4.20). Another important change was that 1.87% of total the area was converted into mines in 2014. Almost 20% of the paddy cultivated areas were converted into homesteads, mixed cultivation and coconut cultivation (Table 4.21) and 70% of the laterite exposed areas were converted to rubber cultivation, homesteads, mixed cultivation, cashew and mines (Table 4.22). The map of the landuse change in Pilikkode Panchayath is given below (Fig 4.19, Fig 4.20, Fig 4.21 and Fig 4.22)

Table 4.19: Landuse/Land cover change in Pilikkode Panchayath in 1986

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	365.25	14.19
2	Urban Built-up	1.08	0.04
3	Temple /School ground	21.47	0.83
4	Paddy cultivation	406.43	15.79
5	Mixed cultivation	646.66	25.13
6	Rubber cultivation	13.48	0.52
7	Coconut cultivation	189.25	7.35
8	Cashew cultivation	118.06	4.59
9	Sacred groves	11.69	0.45
10	Mangroves/ Marsh	2.44	0.09
11	Laterite Exposed	708.67	27.54
12	Kuthiru	1.31	0.05
13	Kaanam / Other natural vegetation	17.72	0.69
14	Roads/ Railway	46.80	1.82
15	River / ponds	13.56	0.53
16	Others	9.28	0.36
	Total	2573.17	100.00

Table 4.20: Landuse/Land cover change in Pilikkode Panchayath in 2014

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	828.02	32.18
2	Urban Built-up	10.71	0.42
3	Temple /School ground	24.03	0.93
4	Paddy cultivation	309.97	12.05
5	Mixed cultivation	537.92	20.90
6	Rubber cultivation	271.92	10.57
7	Coconut cultivation	155.43	6.04
8	Cashew cultivation	93.88	3.65
9	Sacred groves	11.37	0.44
10	Mangroves/ Marsh	2.75	0.11
11	Laterite Exposed	169.20	6.58
12	Kuthiru	1.10	0.04
13	Kaanam / Other natural vegetation	12.19	0.47
14	Mines	48.03	1.87
15	Roads/ Railway	66.57	2.59
16	River / ponds	13.48	0.52
17	Others	16.66	0.65
	Total	2573.23	100.00

Table 4.21: Changes in Paddy cultivated area, Pilikkode Panchayath, 1986-2014

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	30.05	7.44
2	Temple /School ground	1.44	0.36
3	Paddy cultivation (No change)	307.52	76.16
4	Mixed cultivation	31.40	7.78
5	Rubber cultivation	1.87	0.46
6	Coconut cultivation	24.86	6.16
7	Roads/ Railway	2.43	0.60
8	River / ponds	0.61	0.15
9	Others	3.24	0.89
	Total	403.76	100.00

Table 4.22: Changes in Laterite exposed area, Pilikkode Panchayath, 1986-2014

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	107.23	15.13
2	Urban Built-up	4.07	0.57
3	Temple /School ground	3.84	0.54
4	Mixed cultivation	103.48	14.60
5	Rubber cultivation	183.69	25.92
6	Coconut cultivation	17.19	2.43
7	Cashew cultivation	66.52	9.39
8	Laterite Exposed	163.91	23.13
9	Kaanam / Other natural vegetation	1.49	0.21
10	Mines	45.32	6.40
11	Roads/ Railway	7.52	1.06
12	Others	4.40	0.62
	Total	708.67	100.00

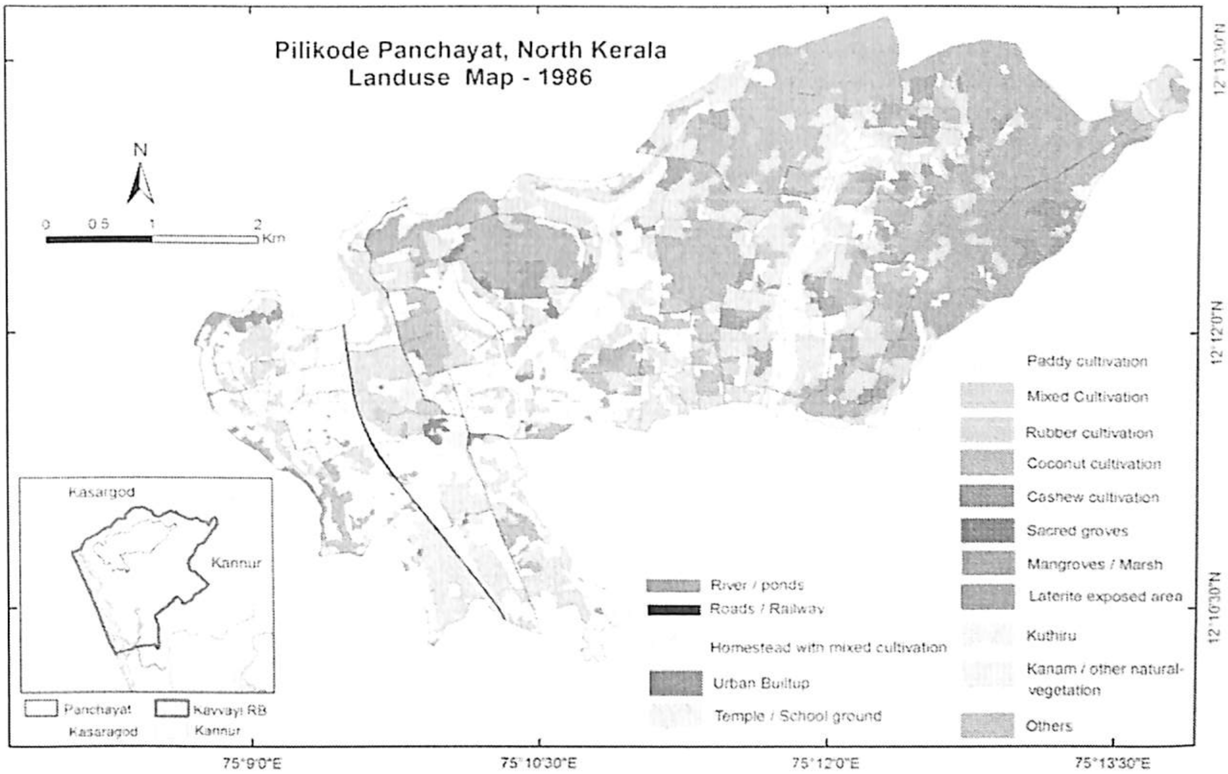


Fig. 4.19: Landuse/Land cover change in Pilikkode Panchayath in 1986

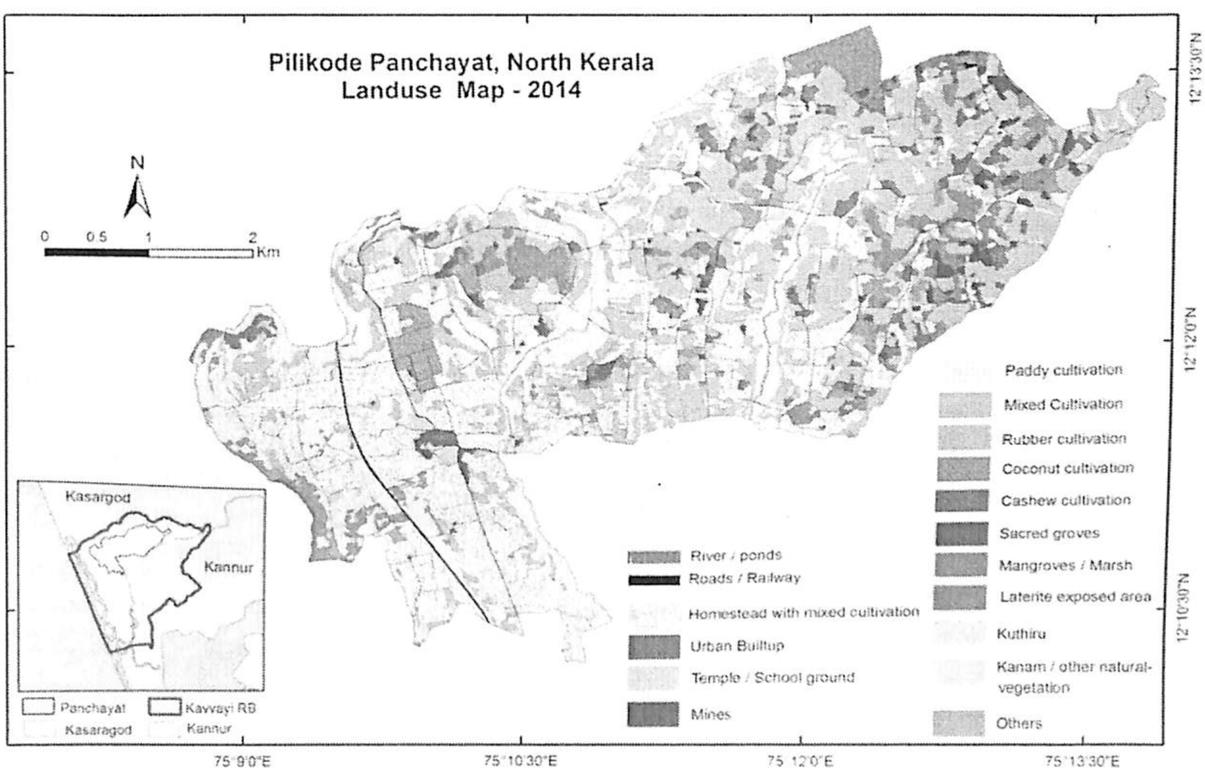


Fig. 4.20: Landuse/Land cover change in Pilikkode Panchayath in 2014

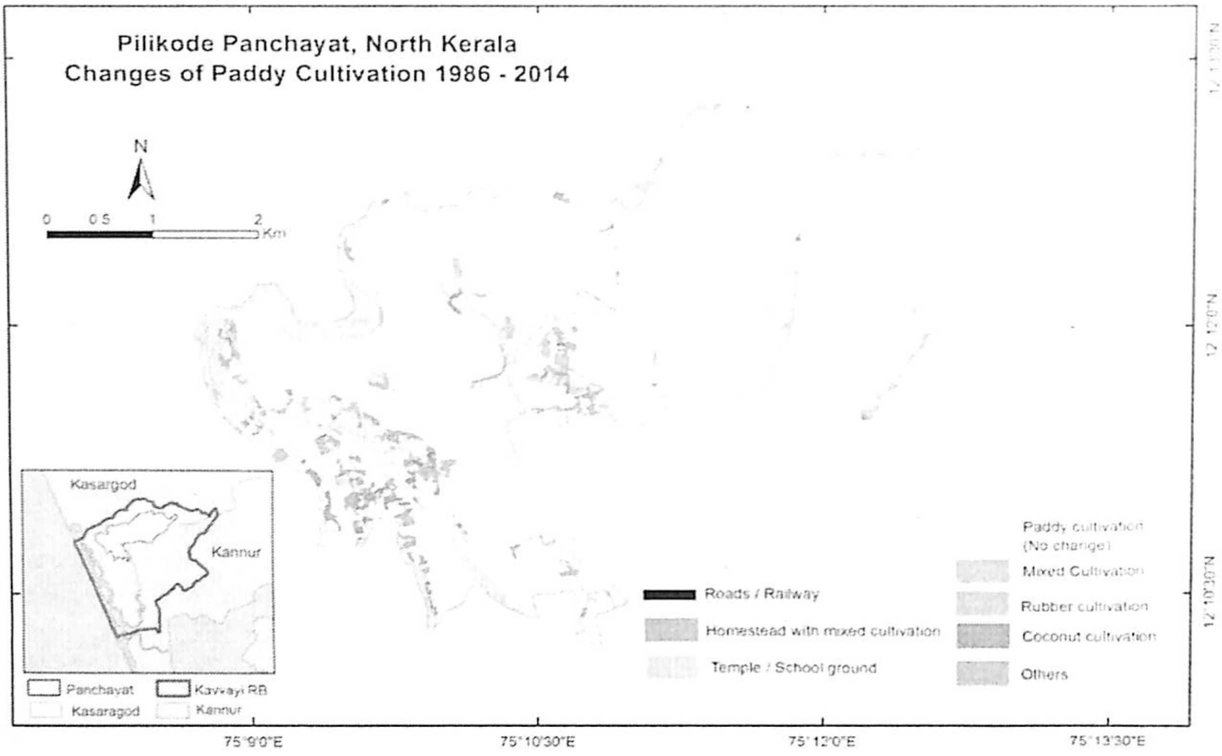


Fig. 4.21: Changes in Paddy cultivated area, Pilikkode Panchayath, 1986-2014

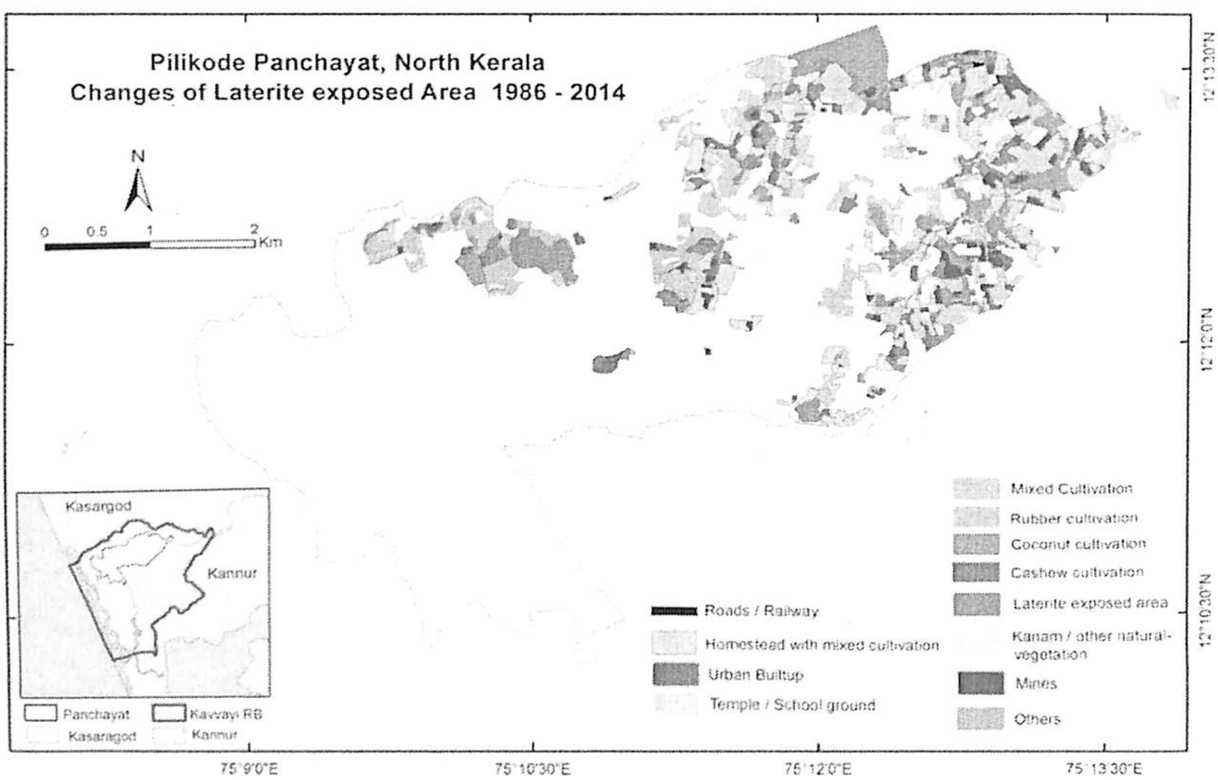


Fig. 4.22: Changes in Laterite exposed area, Pilikkode Panchayath, 1986-2014

Pilikkode Panchayth is also facing serious threat of natural resource depletion because of the infrastructure development and monoculture plantations. 23% of the paddy fields are converted to infrastructures and mixed cultivation. 74% of the laterite exposed area was converted for infrastructure development, monoculture plantations and mines.

4.2.2.5 Landuse change in Payyannur Municipality

In Payyannur municipality the homestead area was increased from 25.65% to 45.58%. Paddy cultivation, Mixed cultivation and coconut cultivation were decreased to 8.78% from 21.68%, 12.76 % from17.89% and 11.47% from 17.06 respectively and 0.09% of area is under mining activity (Table 4.23 and Table 4.24) and 60% of the paddy cultivated area is now converted into homesteads, mixed cultivation, coconut cultivation and roads/ railways (Table 4.25). The landuse map of Payyannur municipality is given below (Fig. 4.23, Fig 4.24 and Fig 4.25).

Table 4.23: Landuse/Land cover change in Payyannur Municipality in 1986

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	548.13	25.65
2	Urban Built-up	44.39	2.08
3	Temple /School ground	13.02	0.61
4	Paddy cultivation	463.21	21.68
5	Mixed cultivation	382.31	17.89
6	Rubber cultivation	1.05	0.05
7	Coconut cultivation	364.63	17.06
8	Cashew cultivation	15.30	0.72
9	Sacred groves	4.10	0.19
10	Mangroves/ Marsh	39.39	1.84
11	Laterite Exposed	50.47	2.36
12	Kuthiru	1.34	0.06
13	Kaanam / Other natural vegetation	8.58	0.40
14	Backwater	75.98	3.56
15	Roads/ Railway	34.11	1.60
16	River / ponds	84.60	3.96
17	Others	6.36	0.30
	Total	2136.97	100.00

Table 4.24: Landuse/Land cover change in Payyannur Municipality in 2014

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	974.11	45.58
2	Urban Built-up	71.68	3.35
3	Temple /School ground	15.60	0.73
4	Paddy cultivation	187.72	8.78
5	Mixed cultivation	272.68	12.76
6	Rubber cultivation	4.56	0.21
7	Coconut cultivation	245.12	11.47
8	Cashew cultivation	13.24	0.62
9	Sacred groves	4.00	0.19
10	Mangroves/ Marsh	46.26	2.16
11	Laterite Exposed	33.51	1.57
12	Kuthiru	0.91	0.04
13	Kaanam / Other natural vegetation	9.46	0.44
14	Backwater	85.99	4.02
15	Mines	1.97	0.09
16	Roads/ Railway	56.18	2.63
17	River / ponds	83.97	3.93
18	Others	30.02	1.40
	Total	2136.97	100.00

Table 4.25: Changes in Paddy cultivated area, Payyannur Municipality, 1986-2014

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	102.03	22
2	Paddy cultivation	182.93	39.45
3	Mixed cultivation	58.17	13
4	Coconut cultivation	66.70	14
5	Mangroves/ Marsh	0.33	0.05
6	Kaanam / Other natural vegetation	2.06	0.5
7	Roads/ Railway	45.08	10
8	Others	4.72	1
	Total	463.20	100.00

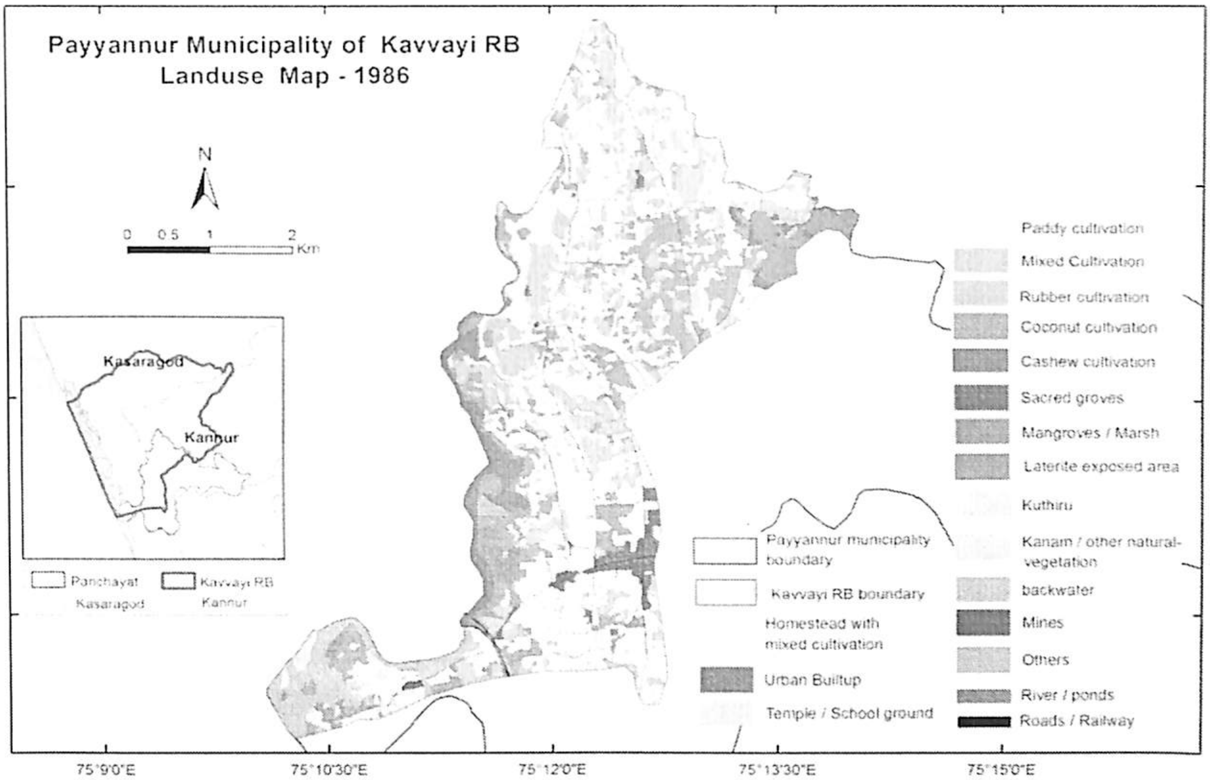


Fig. 4.23: Landuse/Land cover change in Payyannur Municipality in 1986

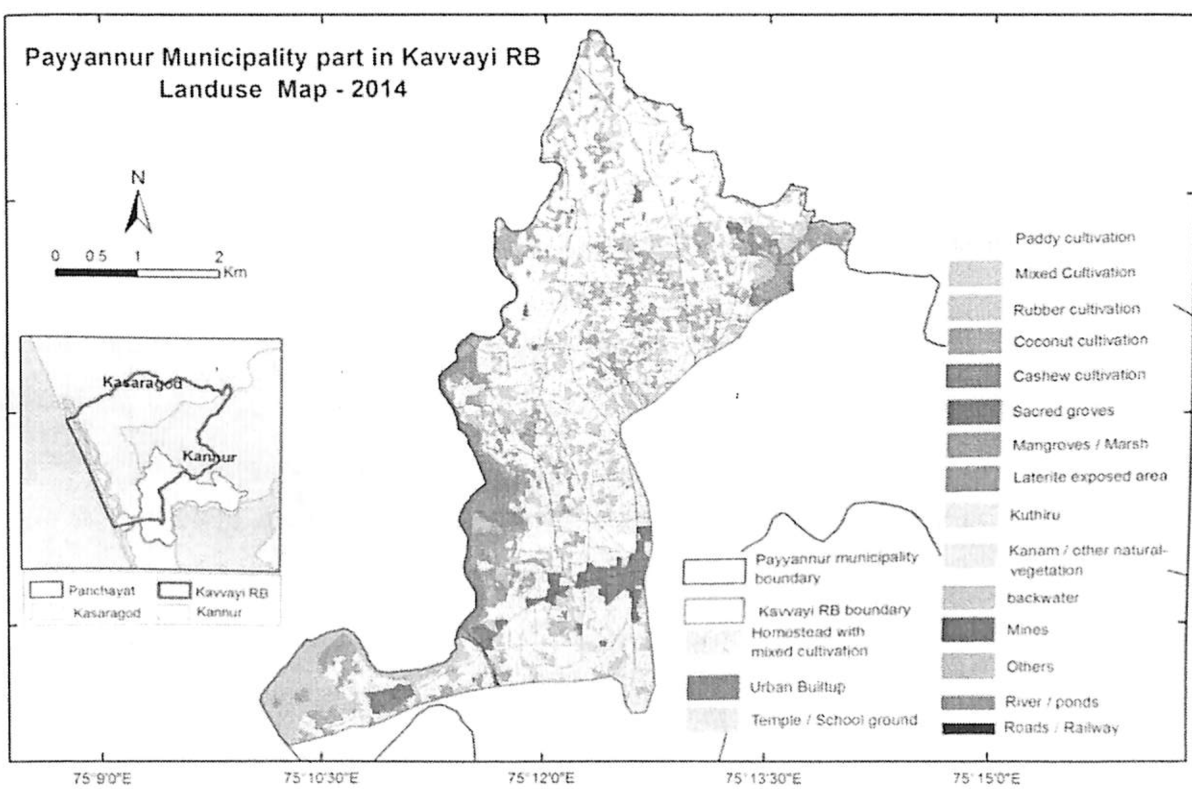


Fig. 4.24: Landuse/Land cover change in Payyannur Municipality in 2014

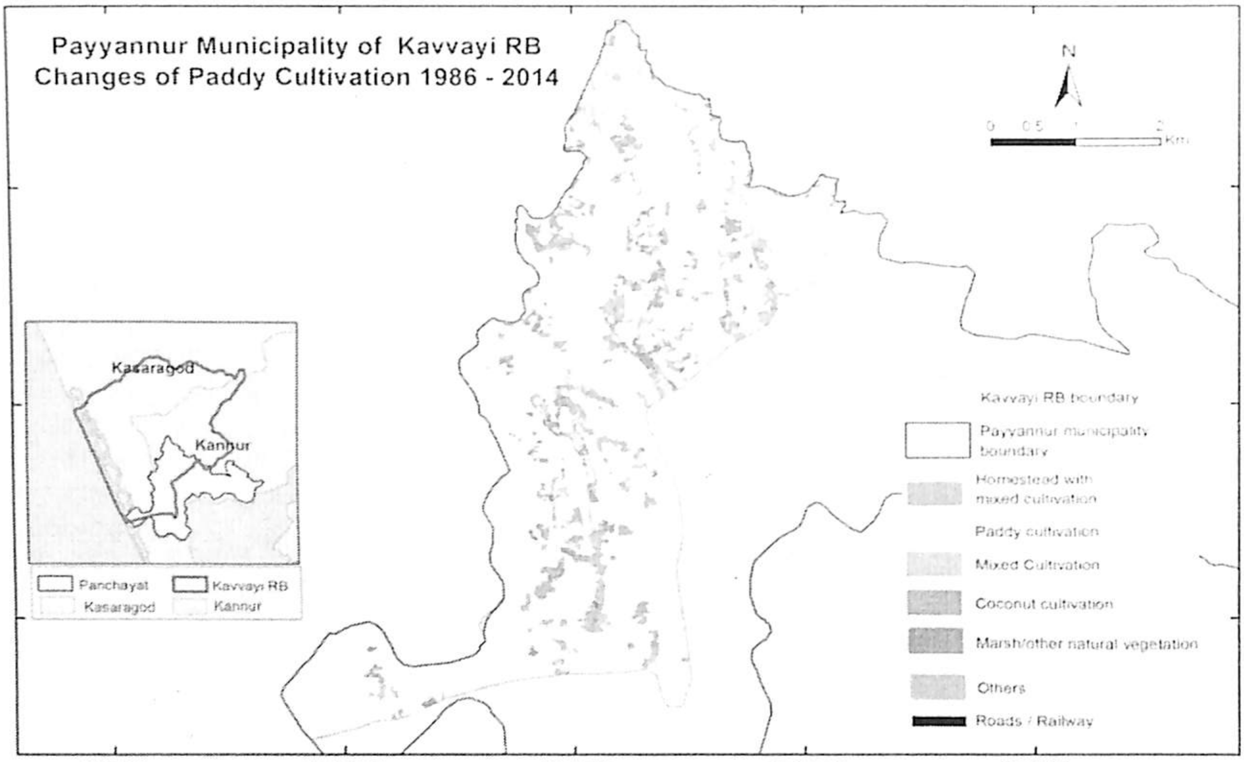


Fig. 4.25: Changes in Paddy cultivated area, Payyannur Municipality, 1986-2014

Payyannur municipality is facing industrialization and urbanization at a high rate. 65% of the paddy cultivation is replaced by infrastructures and mixed cultivation.

4.2.2.6 Landuse change in Kankole- Alappadampa Panchayath

In Kankole- Alappadampa Panchayath, the homestead and rubber cultivation increased from 11.13% to 18.26% and 0.48% to 20.29% respectively. But in the case of paddy cultivation, laterite exposed area and cashew cultivation the area is decreased from 12.38% to 8.73%, 43.66% to 23.32 and 12.53% to 4.81% respectively (Table 4.26 and Table 4.27). Another major change was 3.91% of the area is now converted into mines. Almost 50% of the laterite exposed area is converted to rubber cultivation, homestead, mines, mixed cultivation and cashew cultivation (Table 4.28). Landuse change map of Kankole – Alappadampa Panchayth is given below (Fig 4.26, Fig 4.27 and Fig 4.28)

Table: 4.26 Landuse/Land cover change in Kankole-Alappadampa in 1986

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	286.32	11.13
2	Temple /School ground	11.85	0.46
3	Paddy cultivation	318.51	12.38
4	Mixed cultivation	322.29	12.53
5	Rubber cultivation	12.40	0.48
6	Coconut cultivation	83.46	3.24
7	Cashew cultivation	322.33	12.53
8	Sacred groves	34.86	1.36
9	Laterite Exposed	1122.98	43.66
10	Kuthiru	0.58	0.02
11	Kaanam / Other natural vegetation	5.70	0.22
12	Roads/ Railway	36.65	1.42
13	River / ponds	14.24	0.55
	Total	2572.18	100.00

Table 4.27: Landuse/Land cover change in Kankole-Alappadampa in 2014

Sl No	Land cover type	Area (Ha.)	Area%
1	Homestead with mixed cultivation	469.85	18.26
2	Temple /School ground	13.49	0.52
3	Paddy cultivation	224.65	8.73
4	Mixed cultivation	319.97	12.44
5	Rubber cultivation	521.89	20.29
6	Coconut cultivation	77.92	3.03
7	Cashew cultivation	123.72	4.81
8	Sacred groves	36.50	1.42
9	Mangroves/ Marsh	2.83	0.11
10	Laterite Exposed	599.85	23.32
11	Kuthiru	0.78	0.03
12	Kaanam / Other natural vegetation	10.99	0.43
13	Mines	100.58	3.91
14	Roads/ Railway	56.74	2.21
15	River / ponds	11.80	0.46
16	Others	0.87	0.03
	Total	2572.45	100.00

Table 4.28: Changes in Laterite exposed area, Kankole-Alappadampa, 1986-2014

Sl No	Land cover type	Area (Ha.)	Area%
1	Homestead with mixed cultivation	104.69	9.32
2	Temple /School ground	1.36	0.12
3	Mixed cultivation	38.43	3.42
4	Rubber cultivation	230.2	20.50
5	Coconut cultivation	6.0	0.53
6	Cashew cultivation	56.3	5.01
7	Laterite Exposed area (No change)	579.65	51.62
8	Mines	91.72	8.17
9	Roads	12.85	1.14
10	Others	1.78	0.16
	Total	1122.98	100.00

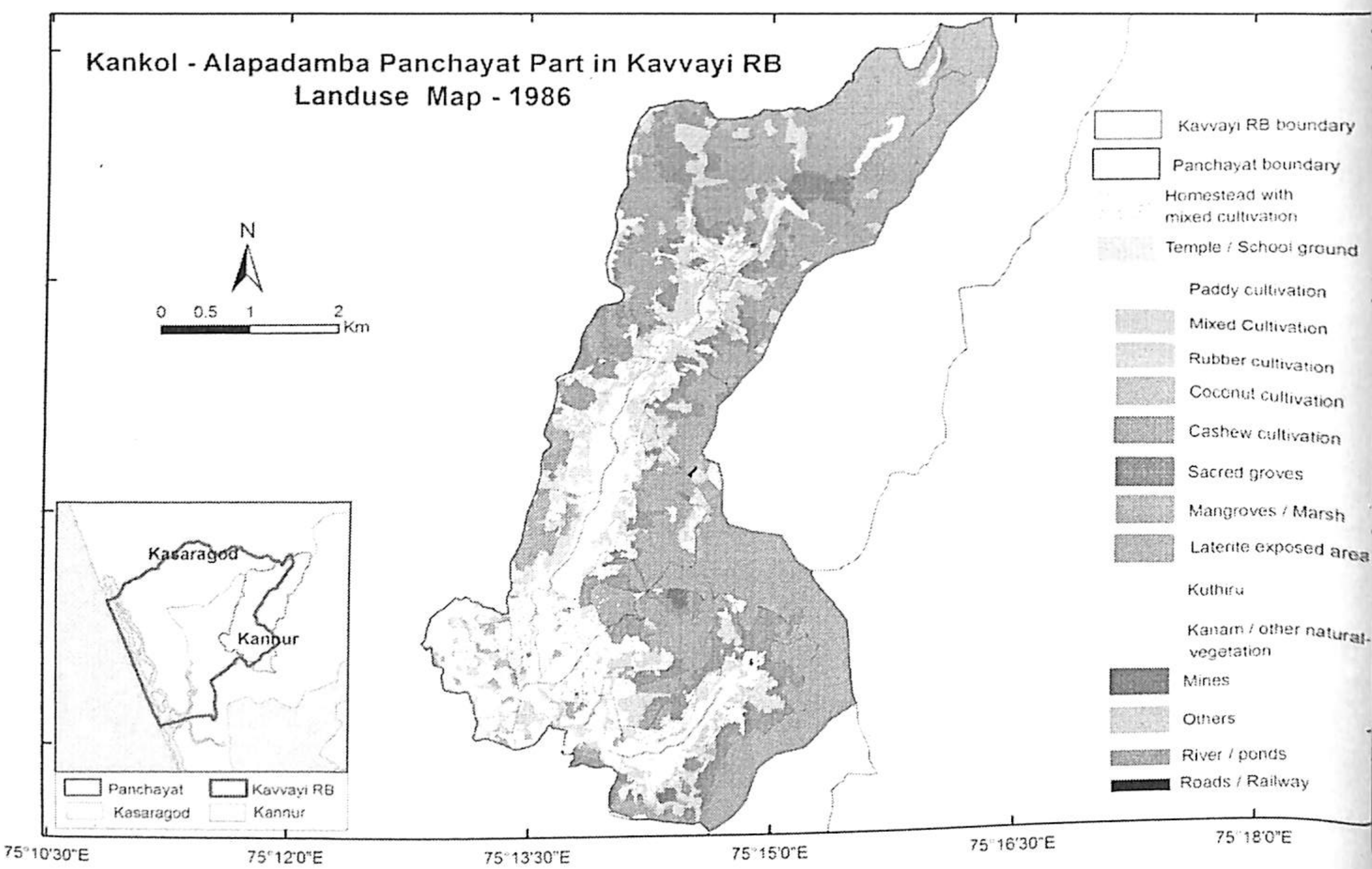


Fig. 4.26: Landuse/Land cover change in Kankole-Alappadampa Panchayath in 1986

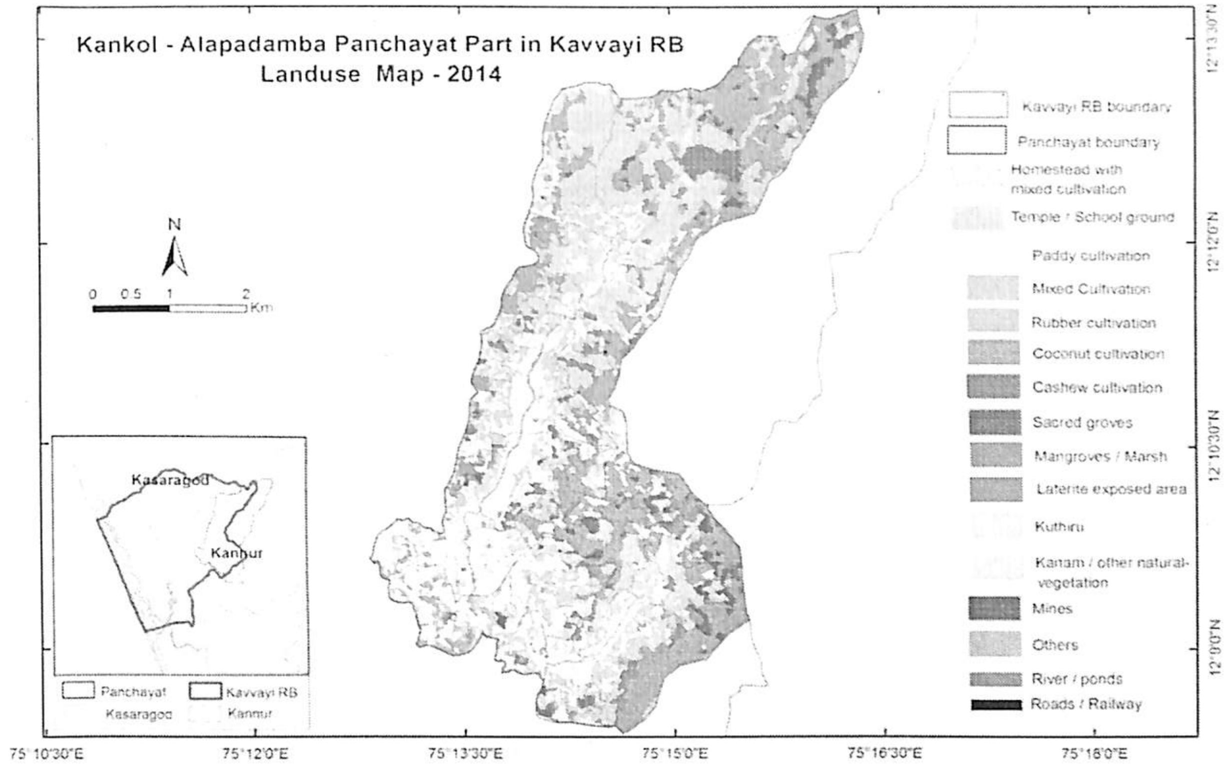


Fig. 4.27: Landuse/Land cover change in Kankole-Alappadampa, 2014

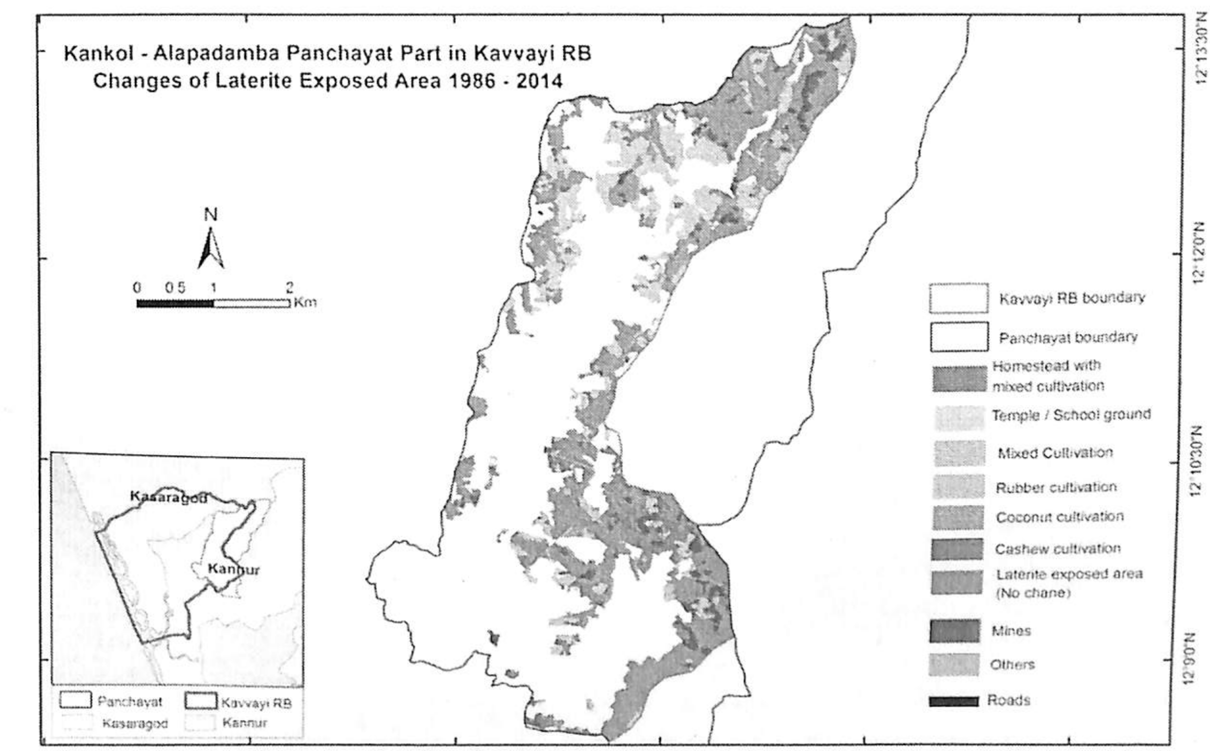


Fig. 4.28: Changes in Laterite exposed area, Kankole-Alappadampa Panchayath, 1986-2014

The 48% of the lateritic exposed area is converted infrastructure development, monoculture plantations and mines over the last three decades.

4.2.2.7 Landuse change in Valiyaparamba Panchayath

In Valiyaparamba Panchayath, the homestead and coconut cultivation were increased from 3.63% to 18.47% and 2.66% to 26.47%. But the paddy and mixed cultivation were decreased from 7.15% to 1.34% and 14.72% to 1.39% (Table 4.29 and Table 4.30). The landuse change map of Valiyaparamba Panchayath is given below (Fig 4.29 and Fig 4.30).

Table 4.29: Landuse/Land cover change in Valiyaparamba Panchayath in 1986

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	48.58	3.63
2	Temple /School ground	1.30	0.10
3	Paddy cultivation	95.57	7.15
4	Mixed cultivation	196.84	14.72
5	Coconut cultivation	35.53	2.66
6	cashew cultivation	48.75	3.65
7	Sacred groves	5.10	0.38
8	Mangroves/ Marsh	39.88	2.98
9	Backwater	608.98	45.54
10	Roads/ Railway	204.69	15.31
11	shore (backwater / sea)	48.37	3.62
12	Others	3.77	0.28
	Total	1337.38	100

Table 4.30: Landuse/Land cover change in Valiyaparamba Panchayath in 2014

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	247.09	18.47
2	Temple /School ground	3.95	0.30
3	Paddy cultivation	17.88	1.34
4	Mixed cultivation	18.63	1.39
5	Coconut cultivation	354.09	26.47
6	cashew cultivation	2.14	0.16
7	Sacred groves	6.90	0.52
8	Mangroves/ Marsh	10.09	0.75
9	Backwater	615.04	45.98
10	Roads/ Railway	12.61	0.94
11	Shore (backwater / sea)	44.26	3.31
12	Others	4.96	0.37
	Total	1337.59	100.00

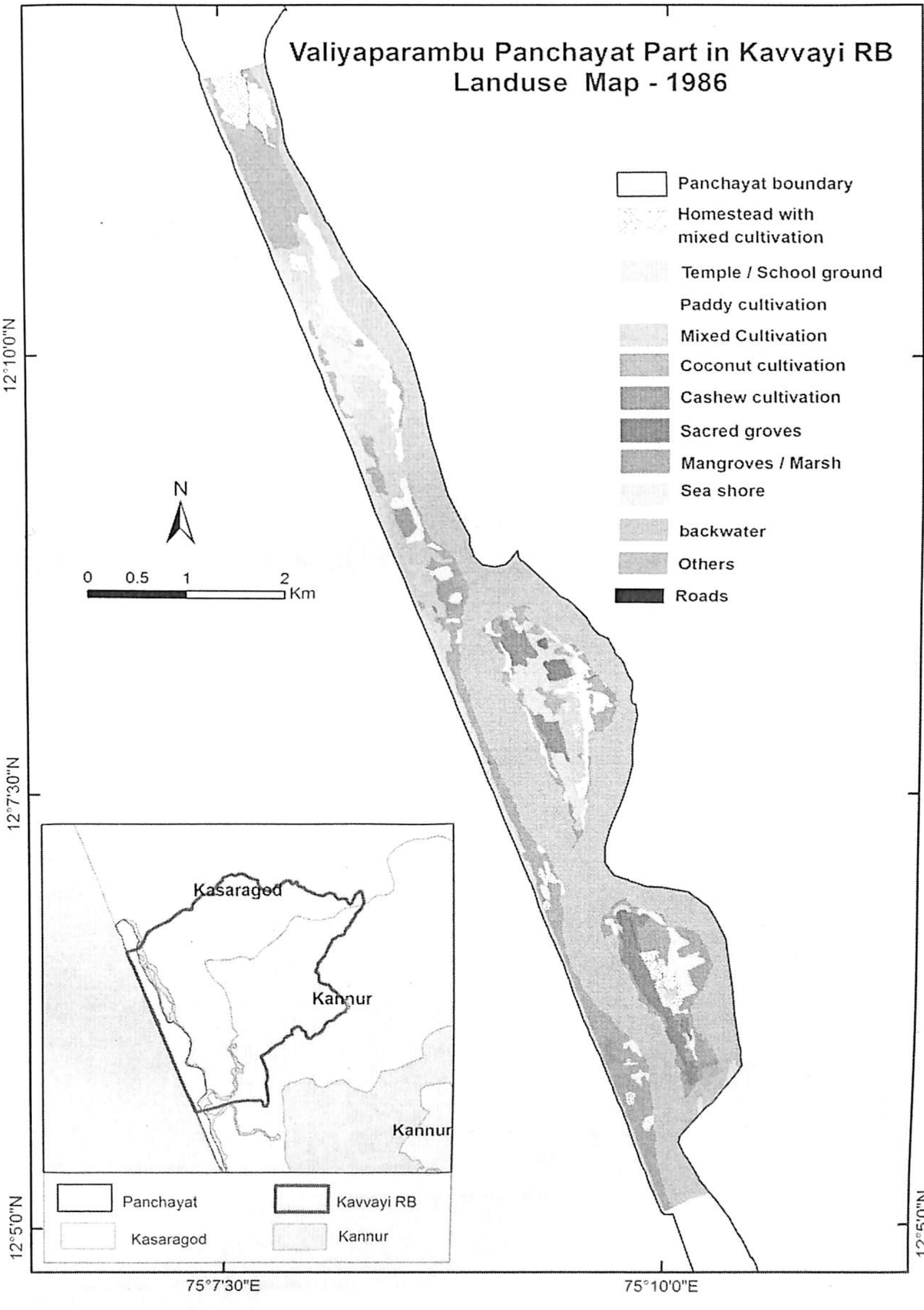


Fig. 4.29: Landuse/Land cover change in Valiyaparamba Panchayath in 1986

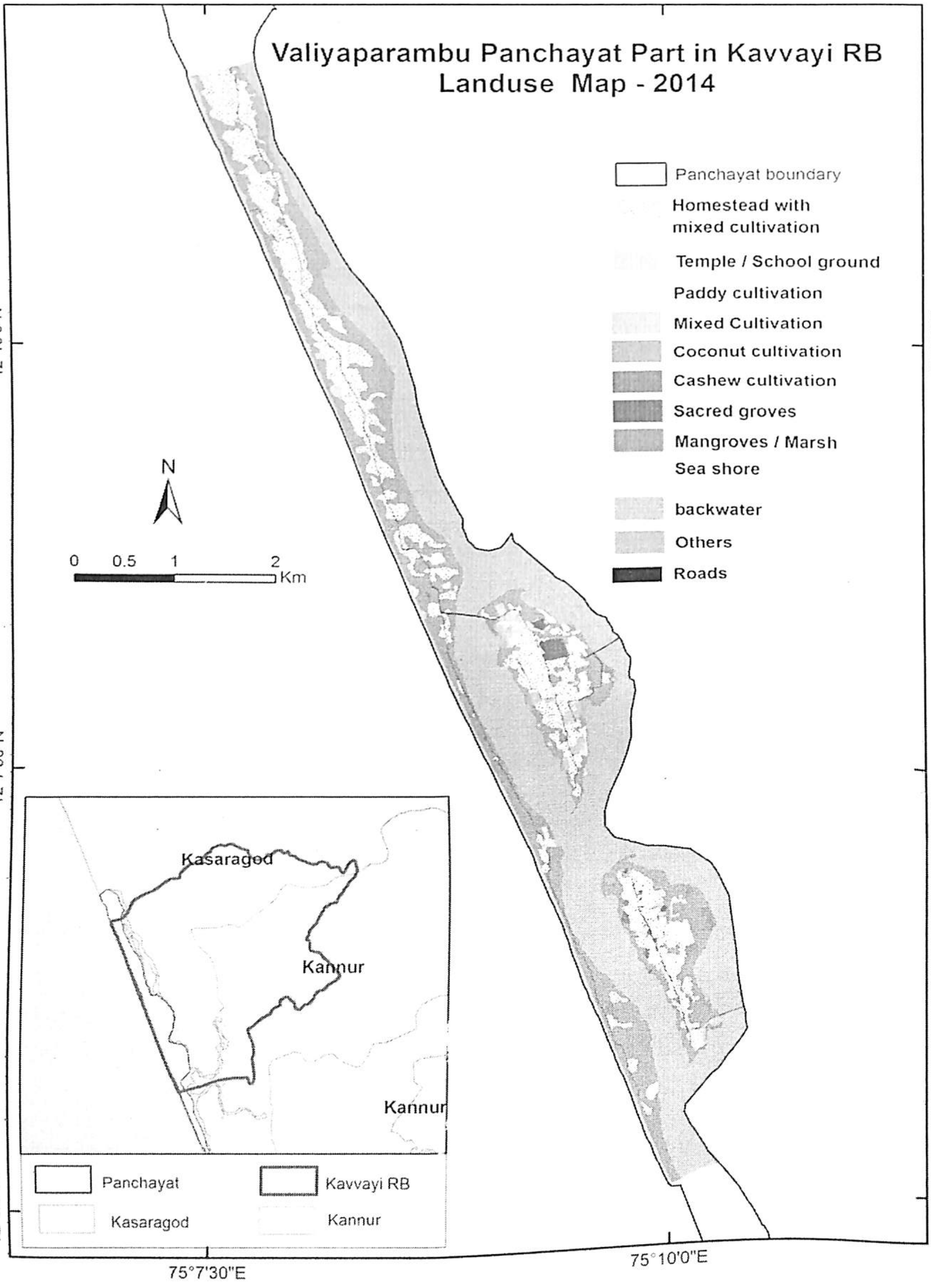


Fig. 4.30: Landuse/Land cover change in Valiyaparamba Panchayath in 2014

In Valiyaparamba Panchayath the coconut cultivation replaced with mixed cultivation and the infrastructure development is at a high rate, doubled over last three decades.

4.2.2.8 Landuse change in Cheruvathur Panchayath

In Cheruvathur Panchayath, the homestead, urban built-up and coconut cultivation were increased from 18.76% to 27.94%, 2.37% to 7.15% and 8.46% to 10.92% respectively. The paddy cultivation and laterite exposed area were decreased from 37.90% to 21.60% and 3.89% to 1.91% respectively (Table 4.31 and Fig 4.32). The landuse change map of Cheruvathur Panchayath is given below (Fig 4.31 and Fig 4.32).

Table 4.31: Landuse/Land cover change in Cheruvathur Panchayath in 1986

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	82.55	18.76
2	Urban Built-up	10.44	2.37
3	Temple /School ground	2.57	0.58
4	Paddy cultivation	166.77	37.90
5	Mixed cultivation	54.35	12.35
6	Coconut cultivation	37.22	8.46
7	Cashew cultivation	16.04	3.65
8	Sacred groves	0.93	0.21
9	Mangroves/ Marsh	8.53	1.94
10	Laterite Exposed	17.12	3.89
11	Kaanam / Other natural vegetation	26.07	5.93
12	backwater	1.40	0.32
13	Roads/ Railway	10.21	2.32
14	River / ponds	5.31	1.21
15	Others	0.42	0.10
	Total	440.00	100.00

Table 4.32: Landuse/Land cover change in Cheruvathur Panchayath in 2014

Sl No	Land cover type	Area (Ha.)	Area %
1	Homestead with mixed cultivation	122.95	27.94
2	Urban Built-up	31.47	7.15
3	Temple /School ground	2.89	0.66
4	Paddy cultivation	95.02	21.60
5	Mixed cultivation	55.35	12.58
6	Rubber cultivation	3.11	0.71
7	Coconut cultivation	48.06	10.92
8	Cashew cultivation	9.25	2.10
9	Sacred groves	0.93	0.21
10	Mangroves/ Marsh	15.64	3.55
11	Laterite Exposed	8.42	1.91
12	Kaanam / Other natural vegetation	17.09	3.88
13	backwater	1.40	0.32
14	Roads/ Railway	13.04	2.96
15	River / ponds	5.28	1.20
16	Others	10.09	2.29
	Total	439.99	100.00

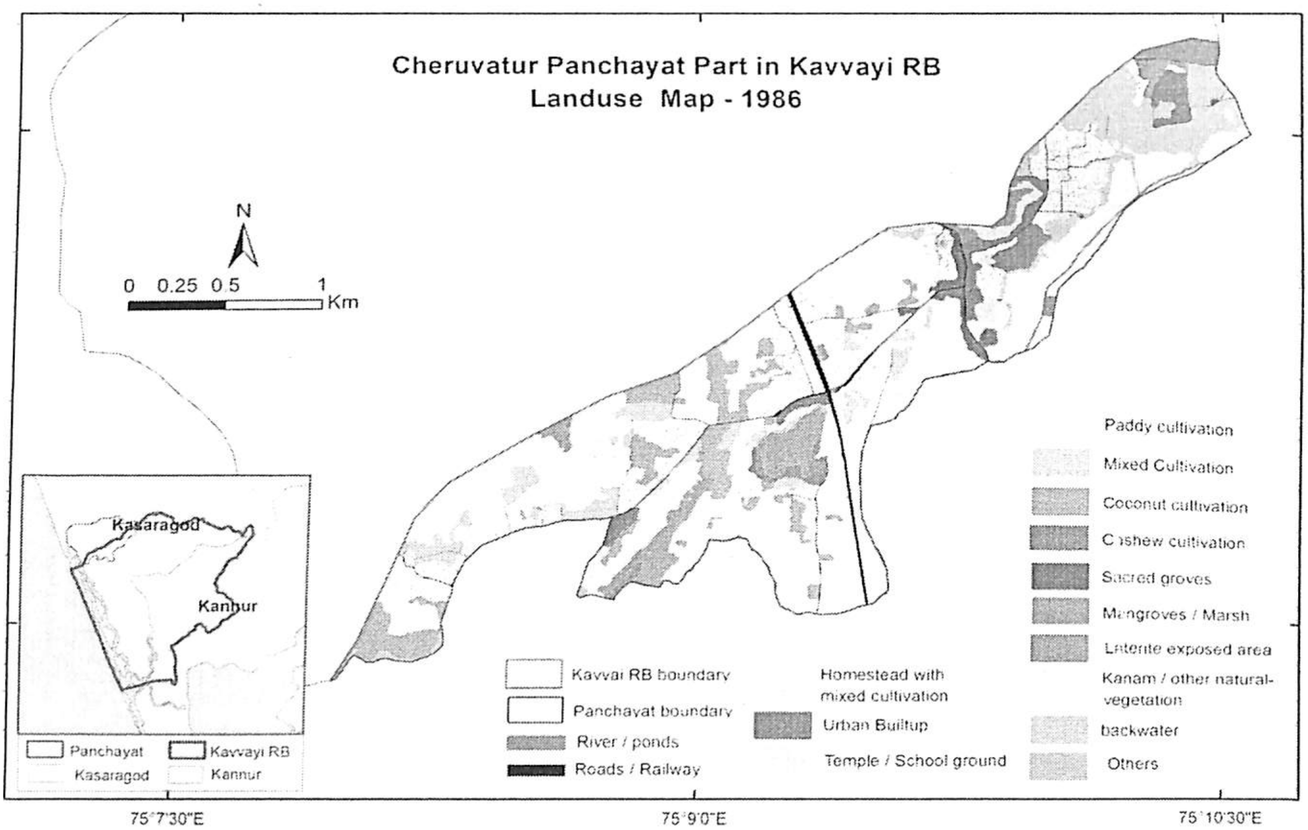


Fig. 4.31: Landuse/Land cover change in Cheruvathur Panchayath in 1986

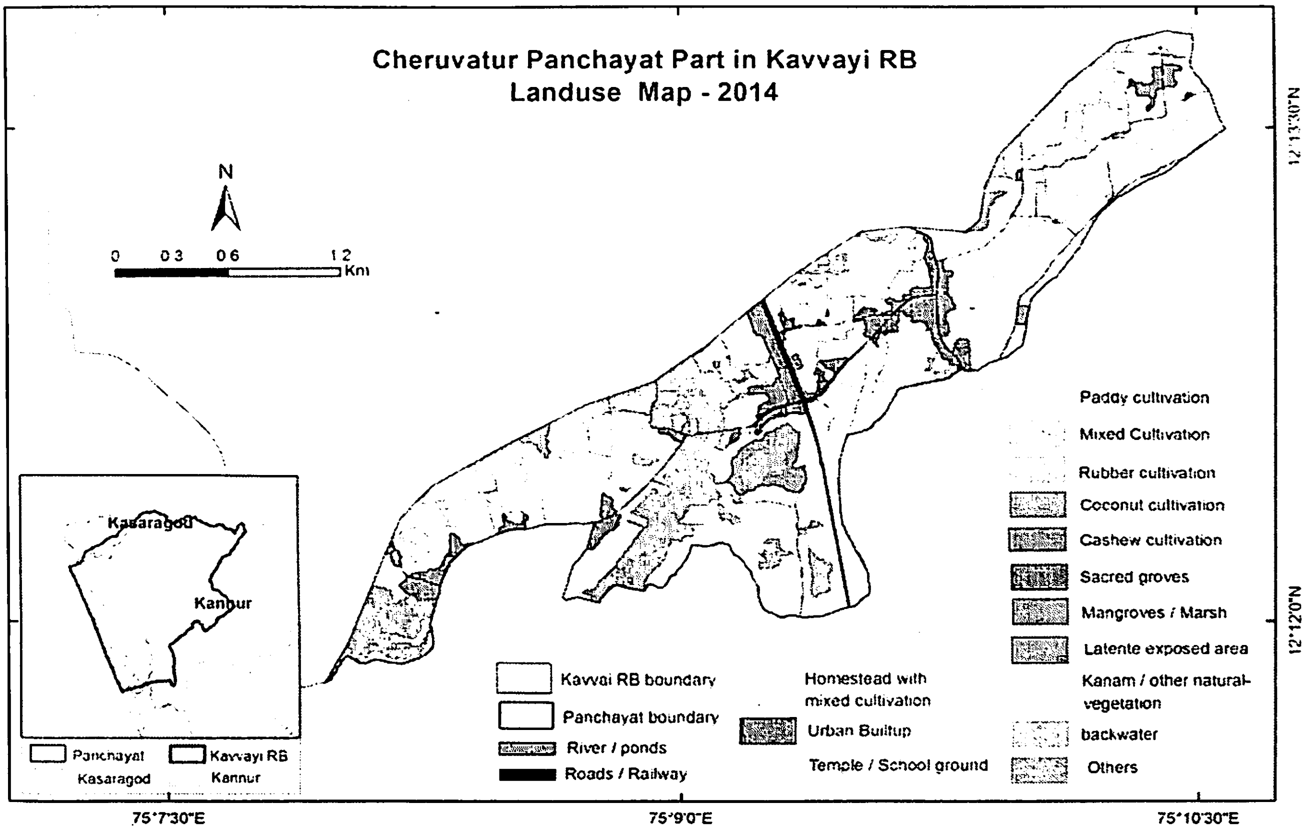


Fig. 4.32: Landuse/Land cover change in Cheruvathur Panchayath in 2014

Cheruvathur Panchayath also facing depletion in paddy cultivated area and laterite exposed areas because of the infrastructure development.

4.2.2.9 Landuse change in Kayyur-Cheemeni Panchayath

In Kayyur- Cheemeni Panchayath, the homestead, rubber cultivation and cashew cultivation were increased from 5.70% to 15.09%, 2.22% to 22.89% and 2.30% to 6.85% respectively. But in the case of laterite exposed area there is a drastic decrease from 67.05% to 28.95%. Another important change is 3.98% of area is now under mining activity (Table 4.33 and Table 4.34). Almost 58% of the laterite exposed area was converted to rubber cultivation, homesteads, mixed cultivation, cashew cultivation and mines (Table 4.35). The landuse change map of Kayyur- Cheemeni Panchayath is given below (Fig 4.33, Fig 4.34 and Fig 4.35).

Table 4.33: Landuse/Land cover change in Kayyur-Cheemeni in 1986

Sl No	Land cover type	Area (Ha.)	Area%
1	Homestead with mixed cultivation	81.54	5.70
2	Built-up	1.94	0.14
3	Temple /School ground	0.76	0.05
4	Paddy cultivation	34.41	2.41
5	Mixed cultivation	232.28	16.24
6	Rubber cultivation	31.80	2.22
7	Coconut cultivation	18.79	1.31
8	Cashew cultivation	32.85	2.30
9	Sacred groves	2.93	0.20
10	Laterite Exposed	959.30	67.05
11	Kaanam / Other natural vegetation	14.01	0.98
12	Roads/ Railway	16.69	1.17
13	River / ponds	2.77	0.19
14	Others	0.58	0.04
	Total	1430.65	100.00

Table 4.34: Landuse/Land cover change in Kayyur-Cheemeni in 2014

Sl No	Land cover type	Area (Ha.)	Area%
1	Homestead with mixed cultivation	215.95	15.09
2	Built-up	4.76	0.33
3	Temple /School ground	1.91	0.13
4	Paddy cultivation	26.97	1.89
5	Mixed cultivation	213.33	14.91
6	Rubber cultivation	327.47	22.89
7	Coconut cultivation	23.50	1.64
8	Cashew cultivation	97.98	6.85
9	Sacred groves	3.15	0.22
10	Laterite Exposed	414.23	28.95
11	Kaanam / Other natural vegetation	11.57	0.81
12	Mines	56.90	3.98
13	Roads/ Railway	27.26	1.91
14	River / ponds	3.33	0.23
15	Others	2.36	0.16
	Total	1430.67	100.00

Table 4.35: Change in Laterite exposed area in Kayyur-Cheemeni in 1986-2014

Sl No	Land cover type	Area (Ha.)	Area%
1	Homestead with mixed cultivation	97.75	10.19
2	Built-up	0.35	0.04
3	Temple /School ground	0.86	0.09
4	Mixed cultivation	65.69	6.85
5	Rubber cultivation	230.99	24.08
6	Coconut cultivation	7.22	0.75
7	Cashew cultivation	86.20	8.99
8	Laterite Exposed	402.11	41.92
9	Kaanam / Other natural vegetation	8.88	0.93
10	Mines	49.62	5.17
11	Roads/ Railway	8.75	0.91
12	Others	0.88	0.09
	Total	959.30	100.00

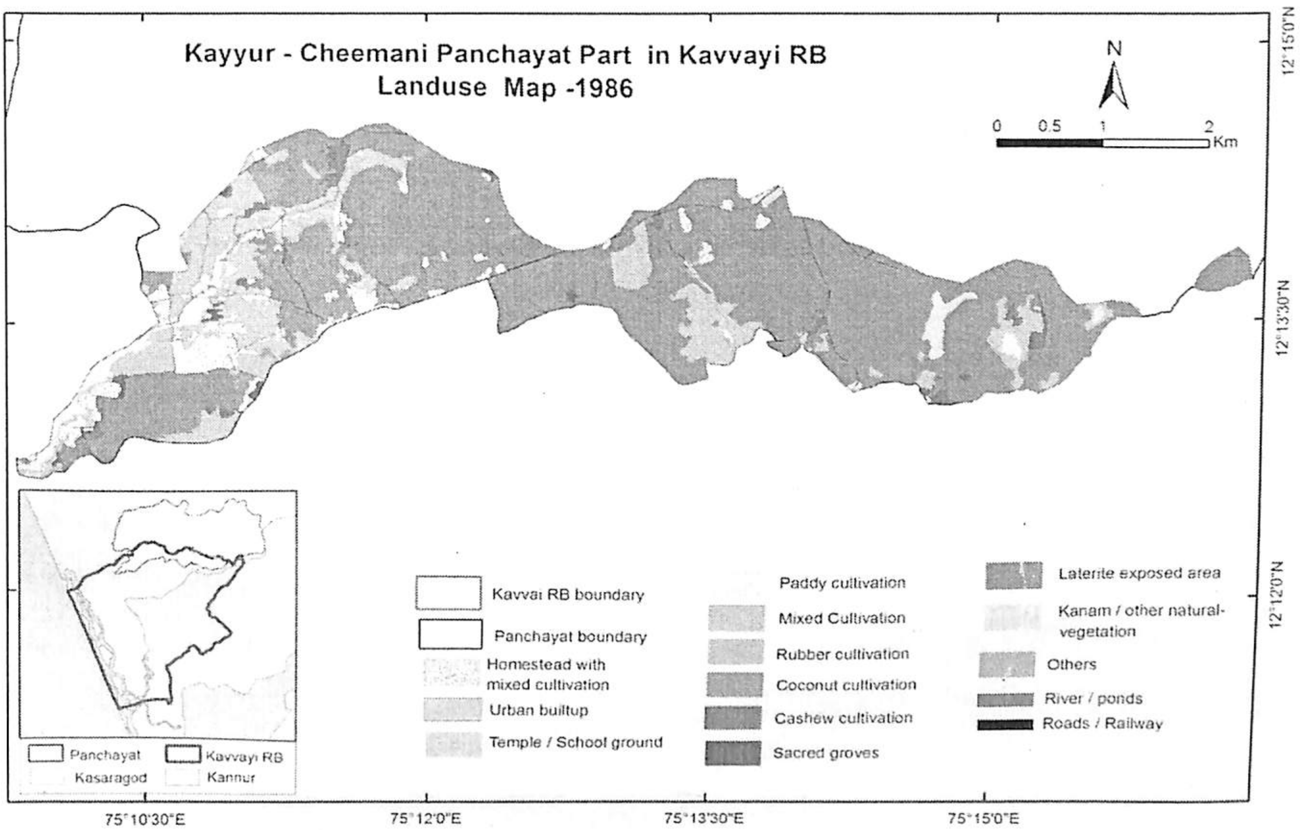


Fig. 4.33: Landuse/Land cover change in Kayyur-Cheemeni in 1986

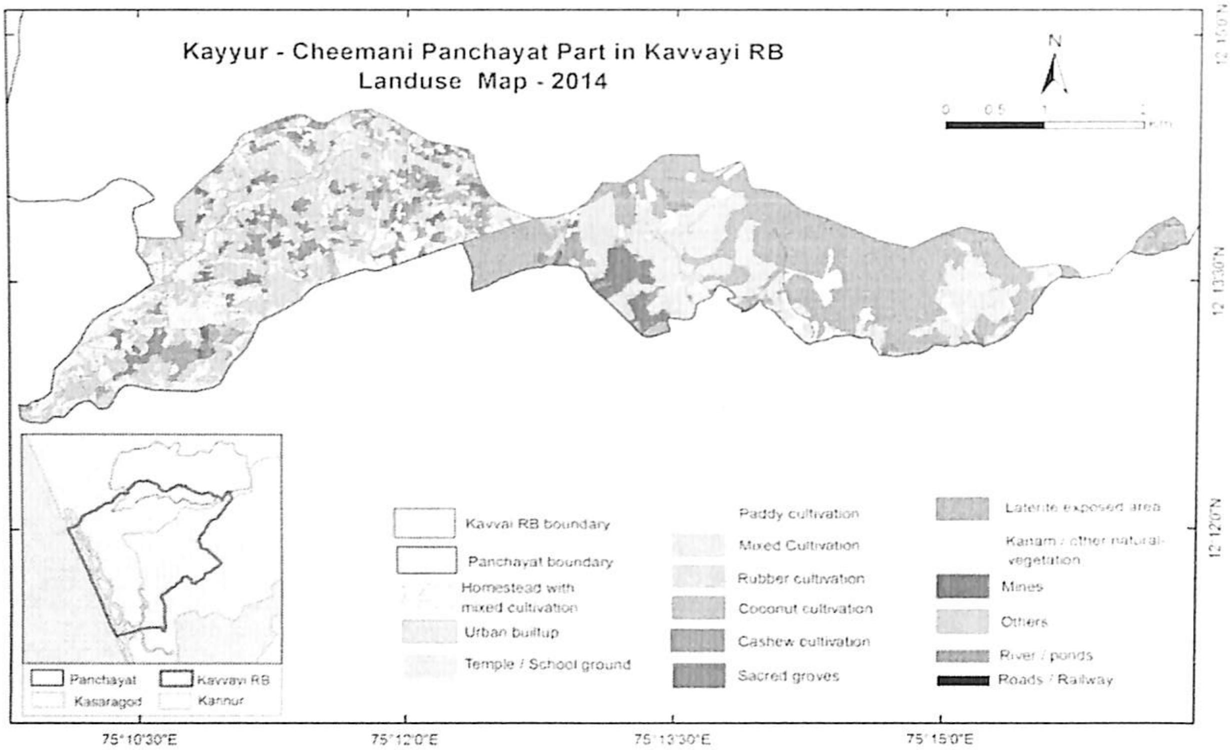


Fig. 4.34: Landuse/Land cover change in Kayyur-Cheemeni in 2014

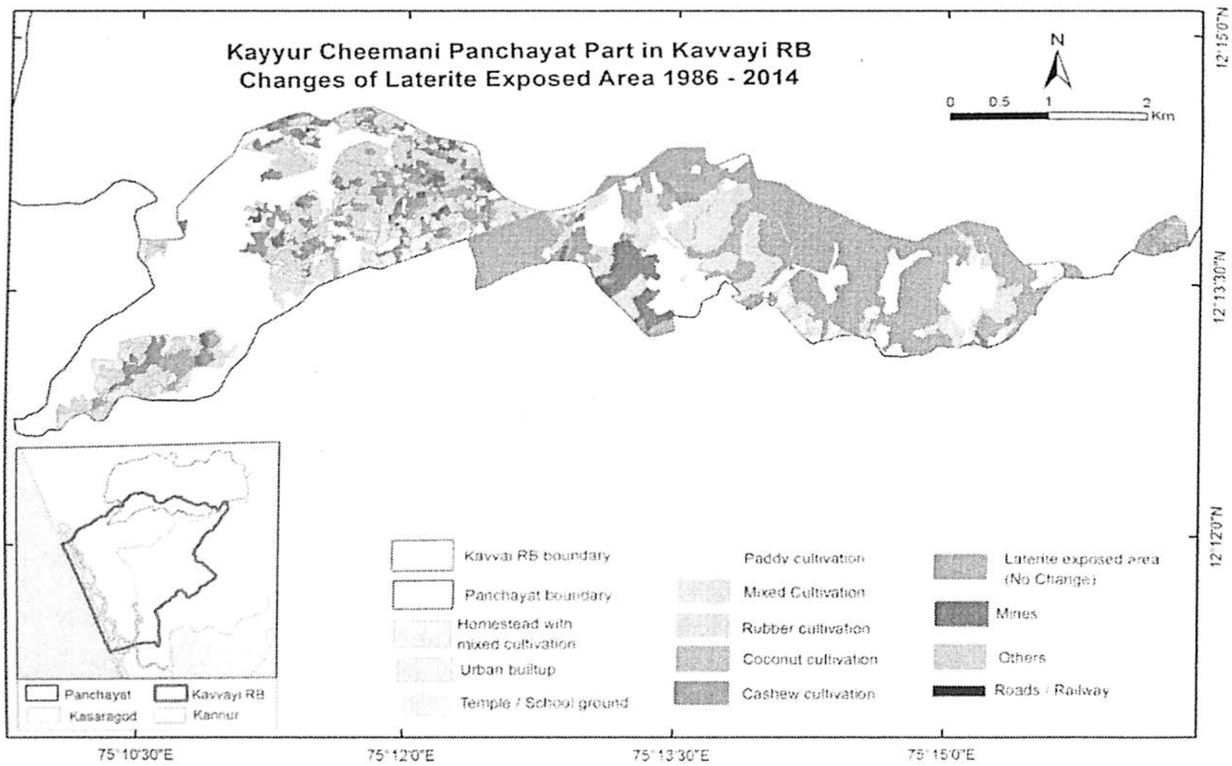


Fig. 4.35: Change in Laterite exposed area in Kayyur-Cheemeni Panchayath in 1986-2014

Kayyur-Cheemeni Panchayth is facing the depletion of lateritic exposed area in a high rate. Sixty percent of the lateritic exposed areas are converted to infrastructures, monoculture plantations and mines.

Population pressure is the main driver of the depletion of ecosystems in the study area. Population density leads to change in landuse pattern and inturn infrastructure expansion and agriculture land converted into industrial and residential area. Due to this wetland and paddy field reclamation took place and laterite mines were expanded for soil. This series of events in turn seriously affected the natural environment of the lateritic biotopes in Northern Kerala.

4.3 Edaphic and Physical Factors

Kerala State, located in south-western part of India, is known in earth science literature as the '*type locality*' of 'laterite', a name first coined by Francis Buchanan in 1800 at the Angadipuram of Malappuram district of the State. The midlands and highlands of Kerala (Western Ghats) have been subdivided into central Sahyadri, the Nilgiris, and southern Sahyadri (Krishnan *et al.,* 1996). Sporadic uplift of the Western Ghats during the Miocene–Pliocene periods is thought to be responsible for the development of the recent landscape. The study area belongs to the Archaean system which is dominated by low grade metamorphic and gneissic rocks. Capping of indurated laterite is widespread on crystalline and sedimentary rocks at places.

Kerala experiences a humid tropical climate with high rainfall (3500 mm) with bimodal pattern. Mean annual air temperature is about 27°C. The difference in mean summer and winter soil temperature is <6°C, which qualifies for isohyperthermic temperature regime (Soil Survey Staff, 1999). Laterites are the major soils covering >50% of the total surface area (Krishnan *et al.,* 1996; Anon, 1999) particularly in the hills and mounds. A representative Benchmark Ultisol was selected in the study area.

Geomorphic features ranging from coastal beaches of negligible relief in the west to the high hills with conspicuous relief (>600m) in the east are discerned in the area. Comparing geology and morphologic units, it can be observed that the eastern and south-eastern parts are dominated by undulating terrain. hills, and mountains. All the above lithounits are lateritised and in a number of places hard crust- mesa like landforms have been developed. Earlier studies in the region have showed extensive laterites mesa -like landforms in the northern parts, underlain by granulites, schists and sedimentaries (Vaidyanadhan, 1967; Karunakaran and Sinha Roy, 1981; Narayanswamy, 1992). Geochemical features of laterites over these rock units indicate more of iron-enrichment trends, facilitating to the formation of hard crust. The river valleys that mostly follow the lineaments cutting across the laterite are narrow, steep but flat bottomed. This indicates the dominance of scarp retreat in landform development and is possible only due to the presence of hard laterite cap at the top and soft clayey material below it (Narayanswamy, 1992; Brook and Twidale, 1984).

The drainage lines are largely controlled by lineament pattern except in the coastal plain. The distribution of existing mesas parallel to the channels in a linear fashion can be taken as a structurally controlled feature. Narrow width of the basin in the mesa dominated areas also indicates structural control.

The soils in the study region are non-calcareous and their texture varies from sandy loam to sandy clay. The soils have clay skins identified in the field just below the Ap horizons. The soils are well drained, with colours varying from dark reddish brown to dark red. Moderate medium sub-angular blocky structure was prevalent in the soils. The surface layers in many cases are either removed or mixed up with the Bt horizons. Therefore, in many cases an exposed argillic horizon was observed in the surface. In such cases, the criterion for clay requirement of a subsurface horizon to qualify as an argillic horizon as per Soil Taxonomy (Soil Survey Staff, 1975, 1999) was not fulfilled. Thus, on stable landscapes such as that of Kerala, clay argillans identified in the subsurface horizons are considered for identification of Bt horizon.

The soils are acidic due to high rainfall (>3500 mm) and leaching of bases. The KCl pH values of soils (Table 4.36) were close to or greater than pH values in water for the lower horizons of some soils, indicating the presence of gibbsite and/or amorphous materials (Smith 1986). A negative/zero/positive ΔpH value indicates the presence of variable charge minerals such as gibbsites and/or sesquioxides (Uehera and Gillman 1980; Bhattacharyya et al. 1994). The organic carbon content in the profile varied from 2.83% in the surface Ap horizon to 0.65% in Bt3 (0.70 – 0.85 m) indicating that the surface layers are high in organic carbon content. This high organic carbon may be possibly due to the addition of litter from the ephemeral vegetation and will play a major role in soil water retention in the profile.

Table 4.36: Selected physical and chemical properties of soil

Horizon	Depth	pH	pH	ΔpH	Org. C	Sand	Silt	Clay
	(m)	(H20)	(KCl)		(%)	(%)	(%)	(%)
Ap	0-0.10	5.07	4.3	-0.77	2.83	70.00	10.00	20.00
Bt1	0.10-0.42	5.15	4.3	-0.85	2.22	45.00	15.00	40.00
Bt2	0.42-0.70	5.30	4.3	-1.00	0.93	61.93	10.78	27.29
Bt3	0.70-0.85	5.11	4.3	-0.81	0.65	36.57	18.92	44.51
R	0.85+	Hard lateritic material						

CEC and base saturation values ranged from 5.9 to 8.2 cmol(+)/kg and 7.8 to 10.8 percent, respectively, in the profile (Table 4.37). The CEC was found to reduce down the profile whereas base saturation followed a reverse trend. The soils in the humid tropics are subjected to intense leaching wherein the bases are leached from the upper to the lower layers. Although the extractable acidity by 1M KCl was low, the same obtained through $BaCl_2$-TEA was very high (Table 6.44). Low KCl-extractable aluminium and high total extractable acidity were also reported for highly weathered Oxisols of Puerto Rico (Beinroth, 1982). This shows that large amounts of Al3+ released during tropical weathering are held in the interlayer of soil clays and are not easily extractable by 1M KCl solution. This reaction prevents the weathering of minerals such as vermiculites and thus these soils are not impoverished with weatherable minerals. In these lateritic soils the process of desilication no longer operates in present day conditions because the pH of the soils is well below the threshold of ~9 (Millot, 1970). Thus, these soils qualify for Ultisols (Soil Survey Staff, 1999). The formation of Ultisols on granite-gneiss under humid tropical weathering conditions appears to be a common occurrence in Indian subcontinent as evidenced in the present study and elsewhere (Bhattacharyya *et al.*, 2000).

Table 4.37: Exchange characteristics of soil

Horizon	Depth (m)	Extr. bases	Extr. acidity			CEC	BS
		NH_4OAc	$BaCl_2$-TEA	KCl (M)		NH_4OAc	
				H+	Al3+		
Ap	0-0.10	0.71	20.7	0.29	1.49	8.2	8.6
Bt1	0.10-0.42	0.53	17.1	0.23	1.31	7.5	7.1
Bt2	0.42-0.70	0.55	13.4	0.23	1.12	6.1	9.0
Bt3	0.70-0.85	0.64	6.2	0.14	0.98	5.9	10.8

XRD patterns of sand fraction show the presence of gibbsite (0.48 nm peak), a 1.2 nm peak of 1.0–1.4 nm mixed layer minerals, and quartz along with some feldspars (Fig. 4.51). The sharpness of the peak at 0.48 nm indicates that gibbsites are well crystallised. Earlier studies by Chandran *et al.* (2005) show that gibbsite in the lateritic soils of Kerala are pseudomorphs.

The ferruginous soils of Kerala, developed under tropical acid weathering conditions, have been considered as highly weathered soils with dominant proportions of gibbsite and kaolin minerals and insignificant amounts of weatherable minerals. But the results of the present study indicate the presence of significant amounts (>10%) of weatherable minerals by the presence of mixed layer minerals and micas in both the sand and silt fractions of the soils, hence could sustain very specific floral species. Kaolin and gibbsite were the dominant minerals in the clay fractions. The occurrence of mixed layer minerals and micas in the sand and silt fraction and their absence in the clay fractions indicates that 2:1 type of minerals in the sand and silt fractions has been transformed with weathering to form clay sized fractions. Earlier studies have reported that the Al3+ released during tropical weathering is adsorbed in the interlayer of vermiculites to form mixed layer minerals and further probably to kaolin or kaolin –interlayered minerals (Pal*et al.*,1989; Bhattacharyya *et al.*,1993), and such interstratified minerals are common inthe ferruginous soils of India (Pal *et al.*,1989; Bhattacharyya *et al.*,1997).

a. *b.*

c.

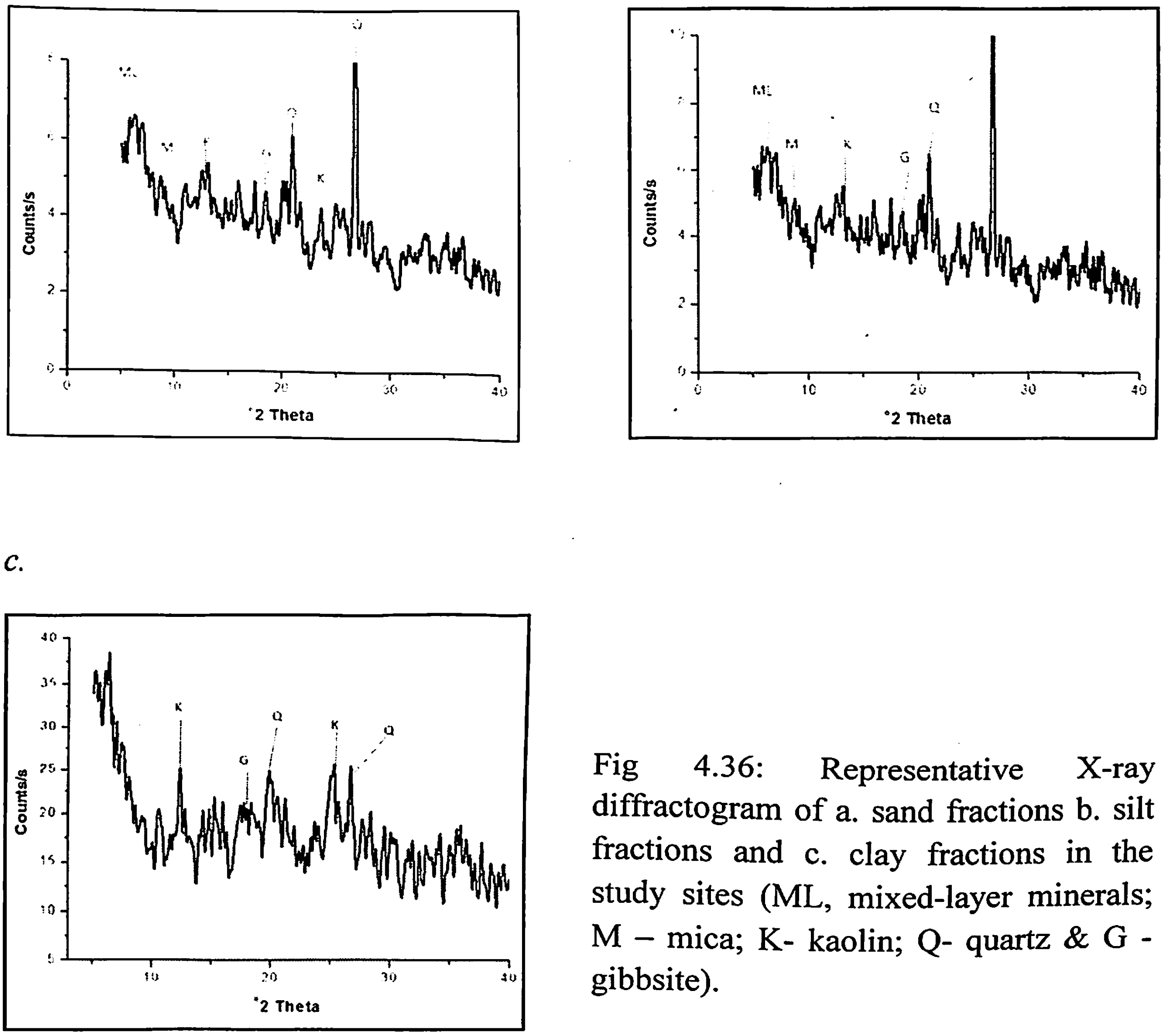


Fig 4.36: Representative X-ray diffractogram of a. sand fractions b. silt fractions and c. clay fractions in the study sites (ML, mixed-layer minerals; M – mica; K- kaolin; Q- quartz & G - gibbsite).

The soils are acidic with the presence of gibbsite and/or amorphous materials. The surface soils were rich in organic matter and the CEC values varied from 5.9 to 8.2 cmol(+)/kg. Kaolin and gibbsite were the dominant minerals in the clay fractions. The ferruginous soils of Kerala, developed under tropical acid weathering conditions, have been considered as highly weathered soils and insignificant amounts of weatherable minerals. But the results of the present study indicate the presence of significant amounts (>10%) of weatherable minerals by the presence of mixed layer minerals and micas in both the sand and silt fractions, hence could sustain very specific floral species.

4.4 Inventory of Ecosystems

Lateritic biotopes contains large scale ecological units such as lateritic hillock, Kanams, Kuthiru and Sacred groves and Paddy fields which are interacting with each other. Lateritic hills are one among the most imposing but extremely threatened topographical, floristic and faunistic features of Northern Kerala (Sreejith *et al.*, 2014). Inventory of the different types of ecosystems associated with lateritic biotopes were documented by using Toposheets, available literatures from the study area and field visits. The documented ecosystems were mapped. Lateritic Hillocks, Sacred Groves, Kaanams and Kuthiru were the major ecosystems documented.

4.4.1 Lateritic Hillocks

Lateritic hillocks occur principally as a cap over the summits of hills and plateaus and are the characteristic feature of tropical monsoon regions. Vast stretches of laterite-capped hillocks are characteristic features of Kannur-Kasaragod Districts of Kerala.

From the study area five such lateritic hillocks, Ariyittapara, Cherupara, IT Park, Kookkanam and Madayipara, were identified and documented. These five lateritic hillocks comprise an area of 553.8ha.

4.4.2 Sacred Groves

Sacred grove is an age-old tradition where a patch of forest is dedicated to local deities and none is allowed to cut plants or to harm animals or any form of life (Gaikwad *et al.*, 2004). India is well known for its diverse cultures and traditions. Nature worship has been an important aspect of cultural practices in different regions in India. These sites are often seats of religious and cultural ritual that have been maintained through community conservation and are refugia of biodiversity; in fact, there is a significant network of large "shadow" conservation sites that are protected because of their sacredness (Dudley, *et al.*,2009). These groves are significant repositories of regional biodiversity, serve as stepping stones for dispersal through unsuitable habitat (Lal *et al.*, 1990) and are known to retain viable populations of rare and endangered species (Godbole, 1996). Sacred groves, in contrast to nature reserves, are also an integral part of rural social systems. Because of this, many sacred groves host rich biodiversity, particularly when compared to adjacent areas managed in other ways, or even to protected forests (Bhagwat *et al.*, 2005a). The groves are also sources of important ecosystem services for local communities, including provisioning (e.g. water, medicinal plants or ornamental resources) and regulating (e.g. pollination or water purification) services (Harsha *et al.,* 2002; Waghchaure *et al.,* 2006; Sukumaran and Raj, 2010).

A total of 80 Sacred Groves were documented and mapped from the Kavvayi River basin. Among these, Theyyottu Kavu is the larger one with an area of 27.05 ha and the Valiyaparambu Kalichan Kavu is the smaller one with an area of 0.06 ha. There were 20 sacred groves present in the Kavvayi River Basin having an area of one hectare or above. Majority of the sacred groves present in the study area were seen associated with the lateritic biotopes.

4.4.3 Kaanam

When the evergreen forests receded from the midland hillocks of North Kerala, allowing in encroachers, it left behind these green patches, with rich flora and fauna and home to atleast one virgin stream, a wonderful ecosystem of immense value. These small groves found on the slopes of midland laterite hills, widely known as Kanams, are fast disappearing, affecting a bang on the unique and fragile ecosystem caught in the midst of human habitats which is not documented scientifically so far. These Kanams lie unattended as revenue wasteland in lateritic hills of Kannur and Kasaragode Districts. No authentic statics as such available on its number, area and biodiversity. Kannur and Kasaragode districts together boast of 19 out of the total 44 rivers in the state. All rivers except four or five among them originate from Kanams, they also account for several small rivulets. This system is conserved by local community without any associated belief/ritual or enforced law but primarily due to the ecological significance/service provided by the system, especially in terms of hydrology.

A total of two Kaanams were documented from the study area namely, Vannathi Kaanam and Vattapoyil Kaanam, which comprises a total area of 4.61ha. Both Kaanams home for streams which nourishes the Kavvayi River. There was water bodies present in both Kaanams and the biodiversity of these Kaanam were also documented during this study.

4.4.4 Kuthiru

This is another unique ecosystem which is not documented so far. Kuthiru is an elevated land in the center or corner of paddy fields having natural vegetation formed by the deposition of extra soils during the old traditional paddy filed leveling practices. During this study, Kuthiru present in Karivellur-Peralam Panchayath were studied in detail. There were 16 Kuthiru in the Panchayath comprising an area of 4.6ha.

4.5 Inventory of Biodiversity

In tropical climates biota (especially organic matter) in the soil plays a much larger role than it does in temperate regions. One reason behind this fact is that soils in humid tropical zones are subject to severe rates of weathering and leaching. Soil organic matter (SOM) impacts soils because they act as holding sights for nutrients. In humid tropical soils, up to 80% of the P located in the soil, is stored in the organic matter. (This is as opposed to 20-50% in temperate regions.) Further, up to 95% of the N and S in soil solution are contained in SOM. The soil itself holds very little of the nutrients. Therefore, when biota is removed from these soils, the leaching of nutrients is rapid and uncontrollable. As the soil organic matter begins to decompose and is not replaced, the soil becomes progressively less nutrient rich (Duxbury *et al.*, 1989, van Wambeke 1992). One of the major differences between natural and agricultural ecosystems on laterite soils are the "synchronicity between plant growth and microbial activity" (Duxbury *et al.*, 1989). Plants and microbes in natural ecosystems have been through millions of years of natural selection. Their relationship is symbiotic, as each creates an environment which is helpful for the other. Another effect of the removal of vegetation from laterite soils (and the effect for which this type of soil is best known) is the drying out, and hardening of the upper horizons, leading to an impenetrable crust which reduces the soils ability to absorb water, and makes an almost impenetrable barrier for roots (Nahon, 1986; van Wambeke, 1992). This hardening is virtually irreversible and drastically affects the sustainablility of farming practices in the tropics.

Rocky surfaces, grass lands and green patches of laterite hills are rich and diverse habitats accommodating vast varieties of flora and fauna. The age old biological activities have transformed these areas into bio-rich realms which are the nature's gifts. Different ecological units associated with these lateritic hillocks, such as Sacred Groves, Kaanams, Kuthirus, Agro-ecological units, etc adds biodiversity to the system. The sacred groves and

Kaanams are the naturally existent floral centers supporting various groups of butterflies, birds and other animals, of which some are endemic to these habitats. Biodiversity of hillocks has been studies along with sociological and ecological importance. Padmanabhan *et al.*, (2002) gives a comprehensive description of the historical, geological and ecological aspects of the hillocks. Jaffer (1998) made a study of species diversity of Madayipara. The studies available on wetlands (Nalini Naik *et al.*, 2002) and that of sacred groves of this region (Jayarajan *et al.*, 2003) documented the relation of these habitats with hillocks. The study of biodiversity of Kalliassery (Sreedharan, 2001) gives an idea of the mid-land habitat.

4.5.1 Floral Inventory

Floristic studies in lateritic plateaus have reported occurrence of many endemic species and habitat specialist flora (Bachulkar 1983; Deshpande 1993; Yadav and Sardesai 2002) throughout the Western Ghats, India. Some of the new species discovered from laterite ecosystem in India include *Rotala malabarica, Nymphoides krishnakesara, Justicia ekakusuma, Lepidagathis keralensis, Eriocaulon sivarajanii, Eriocaulon kannurense, Eriocaulon madayiparnese* and *Lindernia madayiparense* (Joseph, 1990; Pradeep, 1990, 1991; Madhusoodanan and Singh, 1992; Ansari, 2009; Swapna, 2012; Narayanan, 2012; Sunil, 2013).

These new flora reports highlight the potential importance of lateritic hills in floral diversity. Though many endemic and new species have been reported from the lateritic hills of Northern Kerala, floral inventory of these lateritic hills is limited (Jayarajan, 2004; Balakrishnan *et al.*,2010). Hence, this study presents a checklist of the flora of the lateritic hills of North Kerala in an effort to contribute to the documentation of floristic composition of the area and to highlight the significance of lateritic hills as a centre of floral diversity.

The floral diversity is astounding with different species of shrubs, herbs, trees and creepers growing at the surfaces and in the slopes of the hills. Midland hills are characteristic with large varieties of grasses, some of which are medicinally important. Candhium, Figs, Alstonia, Indian Coral tree, Indian Iron wood, Semicarpus, Neem, Pterocarpus etc. are invariably present in midland hills. Holorrhena, Terminalia, Ixora spp. Vinea, Gnetum, Calycopteris, Vitis and Lianas represent some of the highly important and rare plants having commercial and economic importance.

In total, we recorded 970 species belonging to 138 families from the lateritic hillocks in the northern Kerala (Appendix II). 10 predominant Families (i.e. with number of species ≥ 20 in each family), namely Fabaceae (88 species), Poaceae (77 species), Euphorbiaceae (54 species), Rubiaceae (49 species), Acanthaceae (39 species), Asteraceae (36 species), Convolvulaceae (26 species), Malvaceae (25 species), Commelinaceae (21) and Verbenaceae (20) were listed. Families with greatest number of genera included the following: Fabaceae (47 genera), Poaceae (42 genera), Euphorbiaceae (26 genera), Acanthaceae (22 genera), Asteraceae (25 genera) and Rubiaceae (24 genera).

The herbaceous species were predominant among the flora of lateritic hills of North Kerala (414 species: 43% of the total), followed by trees (216 species, 22% of the total), shrubs (190 species, 19%) and climbers (150 species, 16%). 138 endemic species were documented from the study area. Among them, 81 species are endemic to Western Ghats, 14 species to southern India, four to South west India, 28 to Peninsular India and 11 species to India. Of the 970 species reported, *Zehneria maysorensis* (Wight & Arn.) Arn.in Hook's, *Impatiens dasysperma* Wight., *Asparagus fysonii* Macbr. and *Holigarna beddomei* Hook. f. are the only four species listed by IUCN as Endangered category. 14 species, *Cayratia pedata* (Lam.) A. Juss.ex Gagnep. var. *glabra* Gamble, *Murdannia crocea* (Griff.) Faden, *Murdannia lanuginosa* (Wall. ex Clarke) Brueck., *Impatiens herbicola* Hook. f., *Sonerila elegans* Wight var. *beddomei* Giri & M.P. Nayar., *Cyanotis burmanniana* Wight., *Ixora malabarica* (Dennst.) Mabb., *Capparis rheedei* DC., *Hopea parviflora* Bedd., *Hydnocarpus macrocarpa* (Bedd.) Warb. in Engl. & Prantl., *Pterospermum reticulatum* Wight & Arn., *Dalbergia latifolia* Roxb., *Saraca asoca* (Roxb.) de Wilde and *Aglaia lawii* (Wight) Saldanha in Saldanha & Nicolson are listed as Vulnerable (IUCN 2015), one species, *Syzygium travancoricum* Gamble is listed as critically endangered and one species, *Diospyros ebenum* Koenig listed as data deficient (Table 4.38).

The alteration in wet and dry spells creates unique microhabitats that support the varied biota on lateritic hillock. Most of the lateritic flora is adapted to the various microhabitats and each microhabitat is unique in its edaphic properties, water availability and species composition. This makes such floristic studies ecologically significant. Floral inventories such as provided here contribute to understanding and highlighting the ecological significance of the landscape. The current inventory adds to the floristic knowledge of lateritic biotope.

Floral inventory of different ecosystems present in the study area were also done during the study period. The study recorded 550 species of angiosperms from 375 genera belonging to 118 families from lateritic hillocks. Out of this 550 species, 79 are endemic species. 43 species are endemic to Western Ghats, 12 species to southern India, two species to South west India, 16 species to Peninsular India and 6 species to India. One endemic taxa, *Asparagus fysonii*, falls into IUCN category Endangered.

Recorded 389 species from the sacred groves belonging to 273 genera and 98 families. Out of this 389 species, 65 species were endemic. 45 species are endemic to Western Ghats, 3 species to southern India, 3 species to South west India, 9 species to Peninsular India and 5 species to India. 8 endemic species falls into the IUCN category Vulnerable, one into Endangered and one into Critically Endangered.

452 species belonging to 306 genera and 87 families were documented from the two Kaanams. 56 species documented were endemic, 35 species are endemic to Western Ghats, 2 species to southern India, 14 species to Peninsular India, 4 species to India and one species is data deficient. In this 5 endemic species falls into the IUCN category Vulnerable and 2 into Endangered.

145 species of plants belonging to 128 genera and 60 families were documented from Kuthiru ecosystem. Out of this 145 species 26 were endemic species. 14 species are endemic to Western Ghats, 2 species are endemic to India and 10 species are endemic to Peninsular India. One endemic species falls into the IUCN category Vulnerable.

Table 4.38: IUCN categorized plants in Lateritic Hillocks of Kavvayi River Basin

SI No	Scientific Name	IUCN Status
1	*Aglaia lawii* (Wight) Saldanha in Saldanha & Nicolson	Tree*[VU]
2	*Asparagus fysonii* Macbr.*	Shrub*[W,EN]
3	*Capparis rheedei* DC.	Shrub*[W,VU]
4	*Cayratia pedata* (Lam.) A. Juss. *ex* Gagnep. var. *glabra* Gamble	Climber*[SW,VU]
5	*Cyanotis burmanniana* Wight	Herb*[W,VU]
6	*Dalbergia latifolia* Roxb.	Tree*[VU]
7	*Diospyros ebenum* Koenig	Tree*[DD]
8	*Holigarna beddomei* Hook. f.	Tree*[SW,EN]
9	*Hopea parviflora* Bedd.	Tree*[SW,VU]

10	*Hydnocarpus macrocarpa* (Bedd.) Warb. in Engl. & Prantl	Tree*SW.VU
11	*Impatiens dasysperma* Wight	Herb*W.EN
12	*Impatiens herbicola* Hook. f.	Herb*SW.VU
13	*Ixora malabarica* (Dennst.) Mabb.	Shrub*SW.VU
14	*Murdannia crocea*(Griff.) Faden	Herb*PI. VU
15	*Murdannia lanuginosa* (Wall. ex Clarke) Brueck.	Herb*PI. VU
16	*Pterospermum reticulatum* Wight & Arn.	Tree*SW.VU
17	*Saraca asoca* (Roxb.) de Wilde	Tree* VU
18	*Sonerila elegans* Wight var. *beddomei* Giri & M.P. Nayar	Herb*SW.VU
19	*Syzygium travancoricum* Gamble	Tree*SW.CE
20	*Zehneria maysorensis* (Wight & Arn.) Arn. in Hook.'s	Climber*SW,EN

4.5.2 Faunal Inventory

Lateritic biotopes in Northern Kerala support a vast variety of fauna also. A few of these are endemic to such restricted geographical areas. The diversity of ecosystem and microhabitat is responsible for the high species diversity in lateritic biotopes. Unlike flora, faunal species have the ability to move away from one habitat to another hence seasonal studies were done to assess the complete faunal diversity.

4.5.2.1 Spiders

Spiders are the most abundant diverse predators on earth comprising amongst the largest portions of invertebrate fauna in any habitat (Coddington and Levi, 1991). They rank seventh in total species diversity among all other groups of organisms. About 45,741 species of spiders belonging to 3,965 genera and 114 families are known to science (World Spider Catalog, 2015). They are distributed on every continent except Antarctica and have adapted to all known ecological environments except air and open sea (Foelix, 1996). In terrestrial habitats, spiders are a dominant group of predators that, in their role as generalist feeders, often play a strong part in influencing community structure (Nentwig, 1986; Wolff, 1990). Many spiders are pre-adapted to habitats with large spatial and temporal variability (Wise, 1993) and constitute an abundant and widespread group of polyphagous predators in ephemeral and disturbed habitats, including cultivated land. Spiders find everywhere at every time and they are abundant in both natural as well as agriculture habitat (Turnbull, 1973; Nyfeller and Benz, 1987).

India being a mega-diverse country is rich in both flora and fauna. Spiders form one of the most ubiquitous and diverse groups of organisms existing in India. Previous conservation efforts in India have focused on the larger vertebrates while invertebrates were largely ignored and were only incidentally conserved in existing parks and protected areas (Hore, 2009). The spider fauna of India has never been studied in its entirety despite contributions by many arachnologists since Stoliczka (1869). Tikader (1980, 1982), described spiders from India. Out of 45,741species (World Spider Catalog, 2015) a total of 1685 species of spiders belonging to 438 genera and 60 families have been listed from Indian region (Keswani *et al.*, 2012). Spiders are clearly integral parts of the global biodiversity since they play an important role in ecosystems as predators and source of food for other creatures. The spiders are the bio-indicators, indicating the richness of biodiversity. As spiders are insectivorous, helps to keep the population of insect under control, therefore, can be used as a natural insecticide in an agro-ecosystem; so from the study area we recorded the fauna of spiders. They are suitable biological indicators of ecosystem changes and habitat modifications due to their small body size, short generation time, high sensitivity to temperature and moisture changes (Kremen *et al.*, 1993).

There is now growing needs to conserve all species and not only the larger vertebrates (Samways, 1990). Surveys of invertebrates fauna especially spiders have therefore become more important, mainly in conserved areas where conservation strategies are already in place, because they play an important role in ecosystem as stabilizing agents or as regulators of insect population. Kerala one of the smallest states lying in the southernmost part of India, is abundantly blessed with flora and fauna. The present study is carried out in Kavvayi River Basin, which is in Northern Kerala. Kavvayi River Basin consists of Lateritic biotopes, Sacred Groves, Kanams and Agro-ecosystems.

The spider fauna of the entire regions of Kavvayi river basin has never been documented or summarized. The only reported study from this area on spiders was carried out by Palot and Balakrishnan (2014), who listed 17 species of spiders from Madayipara, a typical lateritic biotope of Kavvayi river basin. The present study covers the entire ecosystems of Kavvayi river basin and it resulted in the documentation 112 species of spiders. The study emphasizes that the spider fauna of Kavvayi river basin is qualitatively rich. This area holds a wide range of unique habitats and these varied habitats provide a greater array of microhabitats, microclimatic features, alternative food sources, retreat sites and web attachment sites. The rich floral and faunal diversity is the key to building microhabitats for a variety of spiders. All of which probably favors the colonisation and establishment of a high number of spider species in the study area.

A total of 112 species belonging to 81 genera and 21 families were identified from Kavvayi River Basin. The result of the present study shows that great variety of spider species exist in this area. Salticidae and Araneidae were found as most abundant families which represented 22 families each.

Functional Groups: The identified specimens can be divided in to eight functional groups or guilds based on their foraging behavior in the field (Uetz, *et al.*, 1999). The major functional groups found in the study area are Stalkers, Orb web builders, Ambushers, Foliage runners, Space web builders Ground runners, Wandering sheet weavers and Sheet web weavers. The dominant group was orb weavers that constitute 32% of the total population, which was followed by stalkers with 28%, ambushers with 12%, space web builders with 12%, ground runners with 7%, foliage runners with 6%, wandering sheet weavers with 2% and sheet web weavers with 1% (Fig4.37)

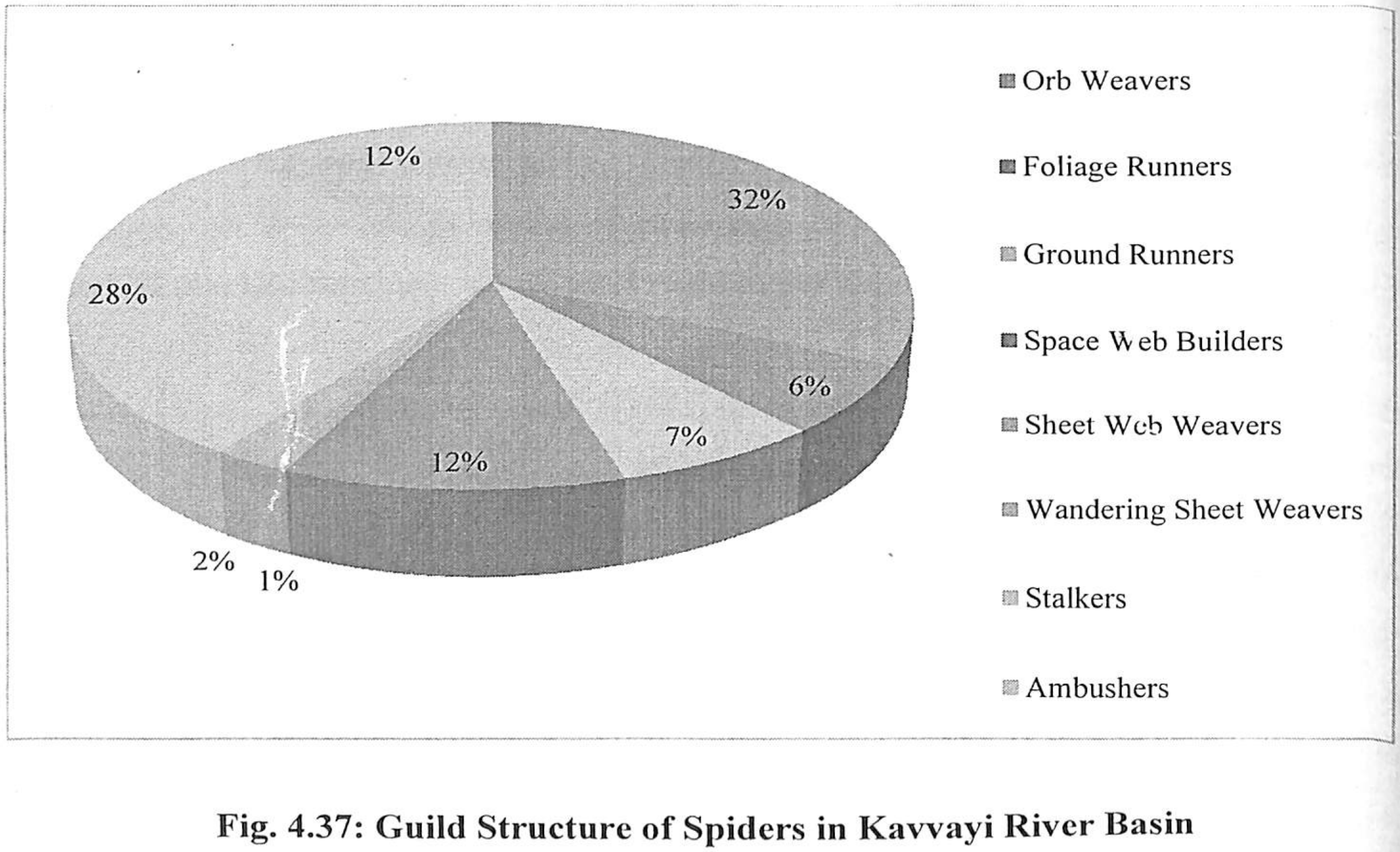


Fig. 4.37: Guild Structure of Spiders in Kavvayi River Basin

The genera such as Oxyopes and Neoscona show high diversity. The most dominant family for the web-builders is Araneidae, which includes 22 species of the total collection. The most abundant among the non-web builders is represented by the family Salticidae with 22 species (Fig 4.38)

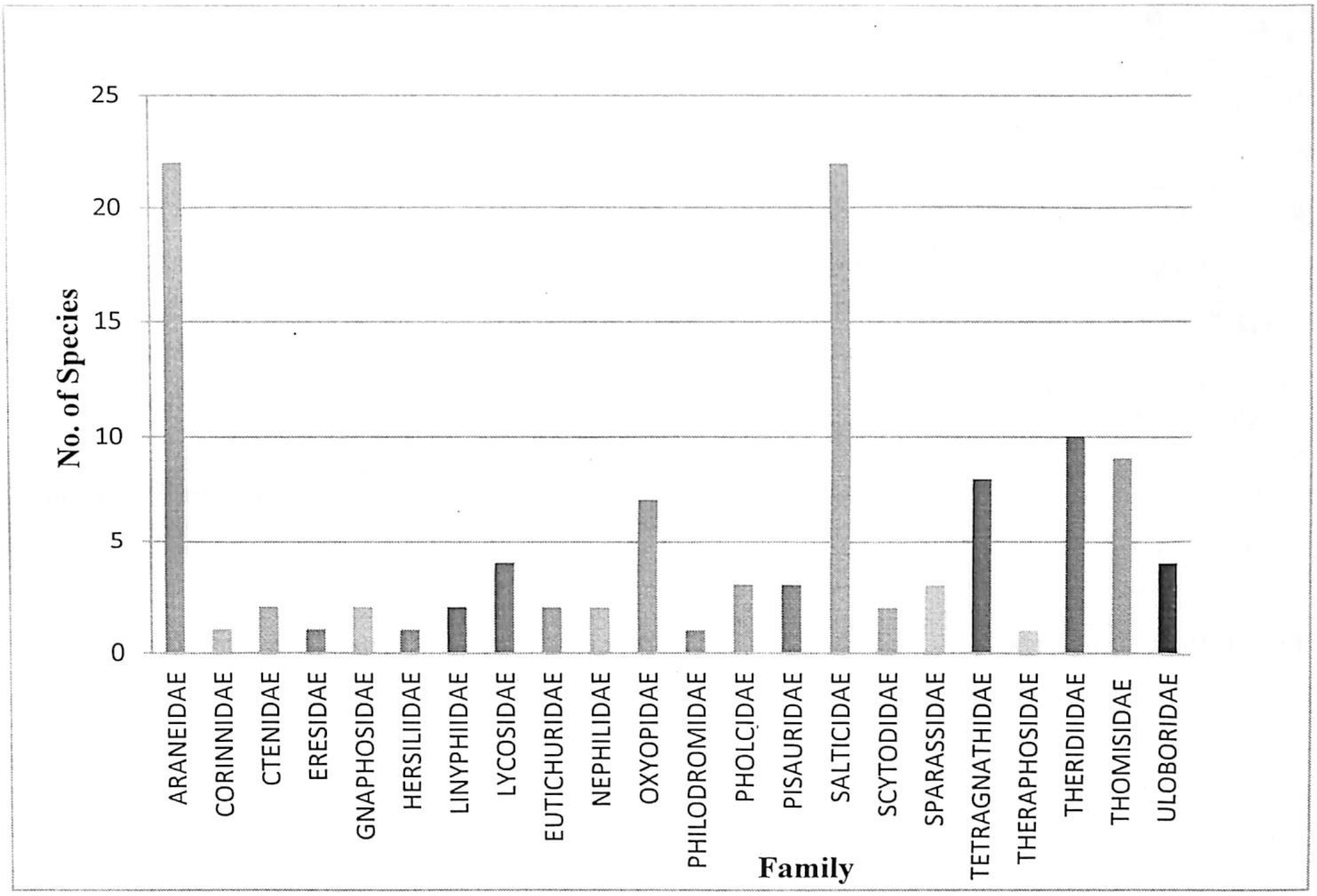


Fig. 4.38: Species Diversity of Spiders in Different Families from Kavvayi River Basin

Out of the 438 genera recorded from Indian region (Keswani *et al.*, 2012), 81 genera are reported in Kavvayi River Basin (Fig 4.39). Maximum generic diversity was found in families like Salticidae (18), Araneidae (12), Theridiidae (9) and Thomisidae (8).

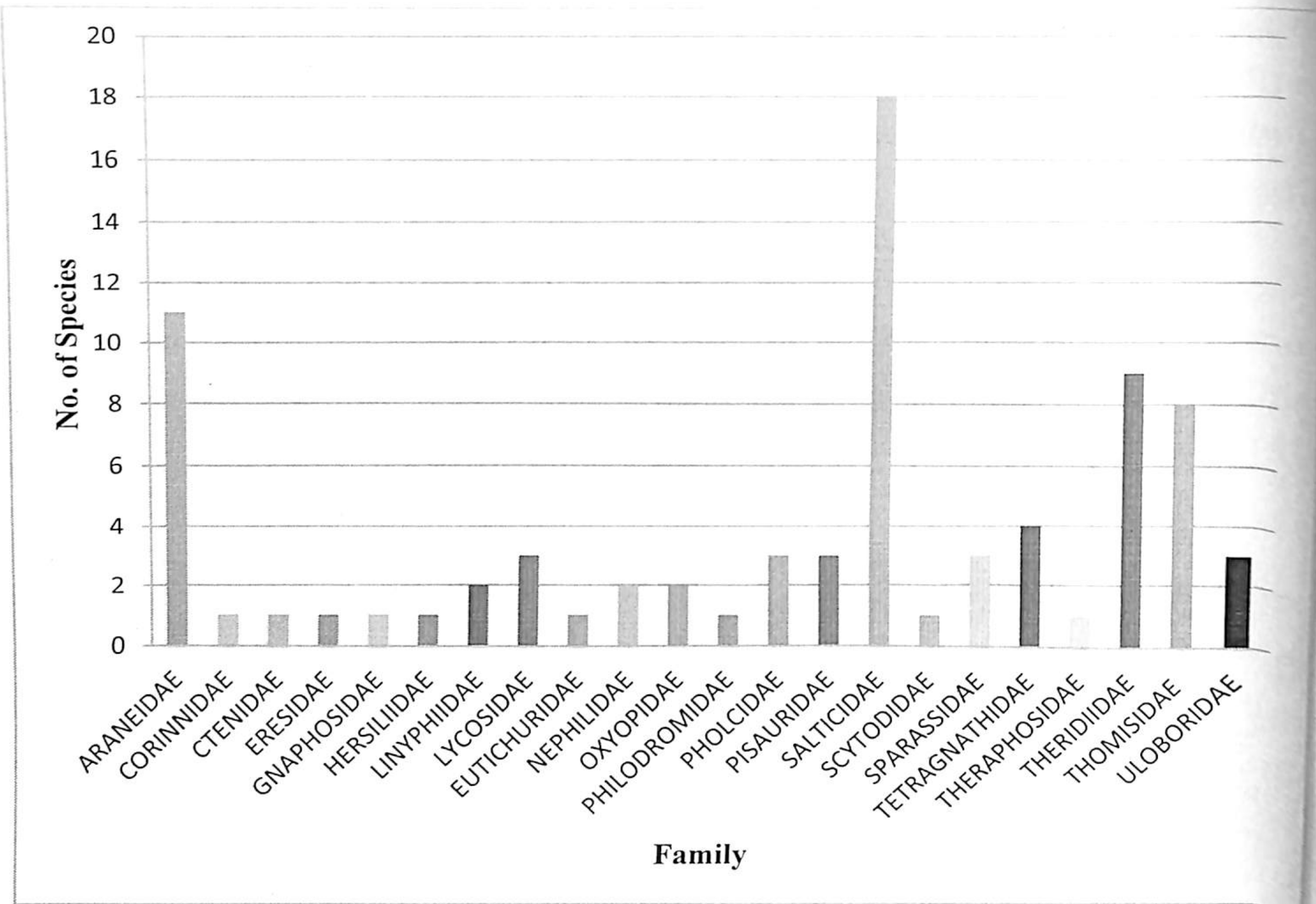


Fig. 4.39: Generic diversity of Spiders in Different Families from Kavvayi River Basin

A total of 22 spider families are present in Kavvayi River Basin, which represent 36.6% compared to Indian continental region which having 60 spider families. Salticidae and Araneidae were the most dominant families with 22 species from 18 and 12 genera respectively and each constituting 19.5% of total spider population. Second dominant family was Theridiidae represented by 10 species from 9 genera constituting 8.8% of the total population. This was followed by Thomisidae (7.9%), Tetragnathidae (7.1%) and Oxyopidae (6.2%). The relative species abundance of various families recorded during the study can be represented as Salticidae= Araneidae> Theridiidae> Thomisidae> Tetrgnathidae> Oxyopidae> Lycosidae= =Uloboridae> Pholcidae= Sparassidae= Pisauridae> Ctenidae= Gnaphosidae= Linyphiidae= Eutichuridae= Nephilidae= Scytodidae> Corinnidae= Eresidae= Hersiliidae= Philodromidae= Theraphosidae.

4.5.2.2 Orthoptera

Orthoptera fauna of Indian subcontinent is one of the least explored insects group, even though it belongs to the most species-rich areas on earth. Taxonomic and ecological studies on Indian Orthoptera are still under a dormancy period. Orthoptera is actually considered to be a pest that causes serious damages to the agricultural field. More than 20000 Orthoptera are known to Science till now. India has 1750 species, which contributes to almost 9 % of the global Orthoptera diversity (Tandon and Hazra, 1998). Out of 1750 species/subspecies belonging to 398 genera and 21 families, 563 species/subspecies under 19 families are endemic. The Indian subcontinent is still capable of contributing a lot to the order Orthoptera. Zoological Survey of India (ZSI) has contributed some basic information on Indian Orthoptera. The only published checklist to Indian Orthoptera is by Chandra *et al.* (2007, 2013). Bhowmik (1993) reported 256 species of Acrididae from India, which included 148 endemic species. However, Ghosh (1996) included 900 species of Orthoptera from India. Total 790 species belonging to 329 genera are reported in 'Faunal Diversity in India', by Tandon and Hazra (1998). Kumar and Usmani (2012a, b) have conducted some studies in the Northern States of India. Orthoptera diversity of Kerala still remains as a neglected area of research.

The only published diversity-related work in Kerala was by Priya and Narendran (2003) "A key and a checklist of the genera of short-horned grasshoppers (Orthoptera: Acridoidea) of Kerala". This study had recorded 41 species under 32 genera from the families Acrididae and Pyrgomorphidae. This is the only recent publication on Orthoptera diversity from Kerala. There is also some general diversity documentation (Mathew and Mohandas, 2001; Mathew *et al.*, 1998, 2003, 2004, 2005, 2007).

A total of 25 species grasshoppers representing 22 genera belonging to 4 families of infraorder Acrididea (Orthoptera) were recorded from the lateritic biotopes of Kavvayi River basin. Six of them are endemic to India. With 17 species of grasshoppers, Acrididae (65%) are the most diverse Orthoptera family from Kavvayi River Basin (Fig 4.40), followed by 5 species of pyrgomorphidae (20%), 2 species of Chorotypidae (8%) and 1 species of Tetrigidae (4%).The diverse ecosystem of Kavvayi river basin has a decent number of Orthoptera. Orthoptera is distributed in all the terrestrial habitats except permanently ice-covered area. Micohabitats of Kavvayi river basin provides a favourable environmental condition to the diversity of Orthoptera. Insects like grasshoppers are more likely to be observed in disturbed habitats, diversity of Orthoptera in sacred grooves and Kanams were comparatively lesser than that of lateritic-grassy hilltops such as Madayipara and Ariyittapara. This indicates the human disturbances on lateritic hillocks.

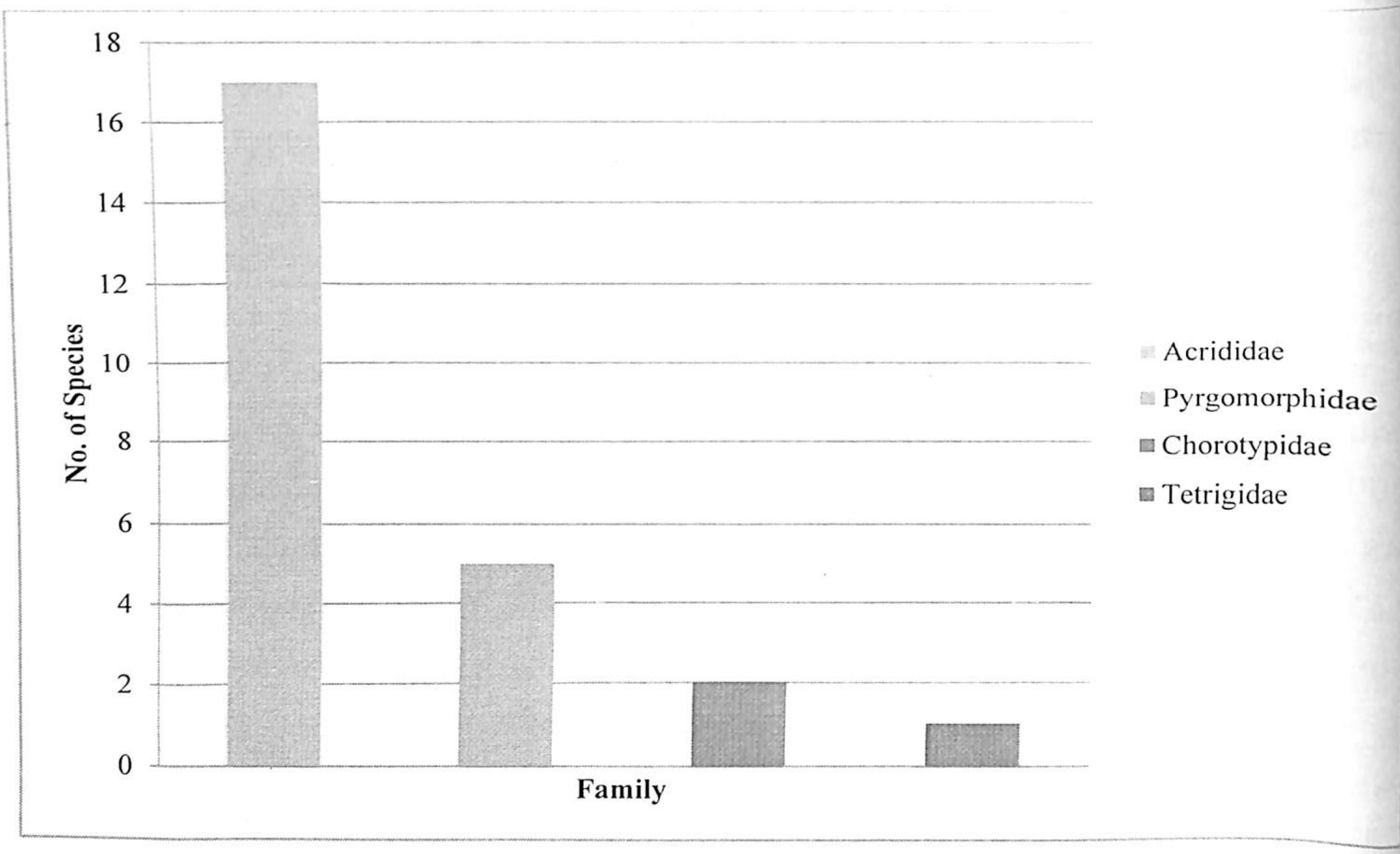


Fig. 4.40: Family wise distribution of Grasshoppers in Kavvayi River Basin

4.5.2.3 Odonates

Dragonfly nymphs (Order: Odonata) are the most dominant insects to be found in the ponds and temporary wetlands. Mature dragonflies are aerial predators feeding on flying insects, while the nymphal stages are aquatic and prey on aquatic insects, small crustaceans and other small animals. Dragonfly nymphs are known for their voraciousness and no doubt they exert a significant influence in the ponds where they occur.

A total of 42 species of Odonates belonging to two suborder, Anisoptera and Zygoptera, and 7 families were identified from the study area. The highest number of species is from family Aeshnidae with 26 species, followed by Gomphidae with 8 species, Platycnemididae, Calopterygidae and Lestidae families has 2 species each and Family Libellulidae and Coenagrionidae are having only one species each.

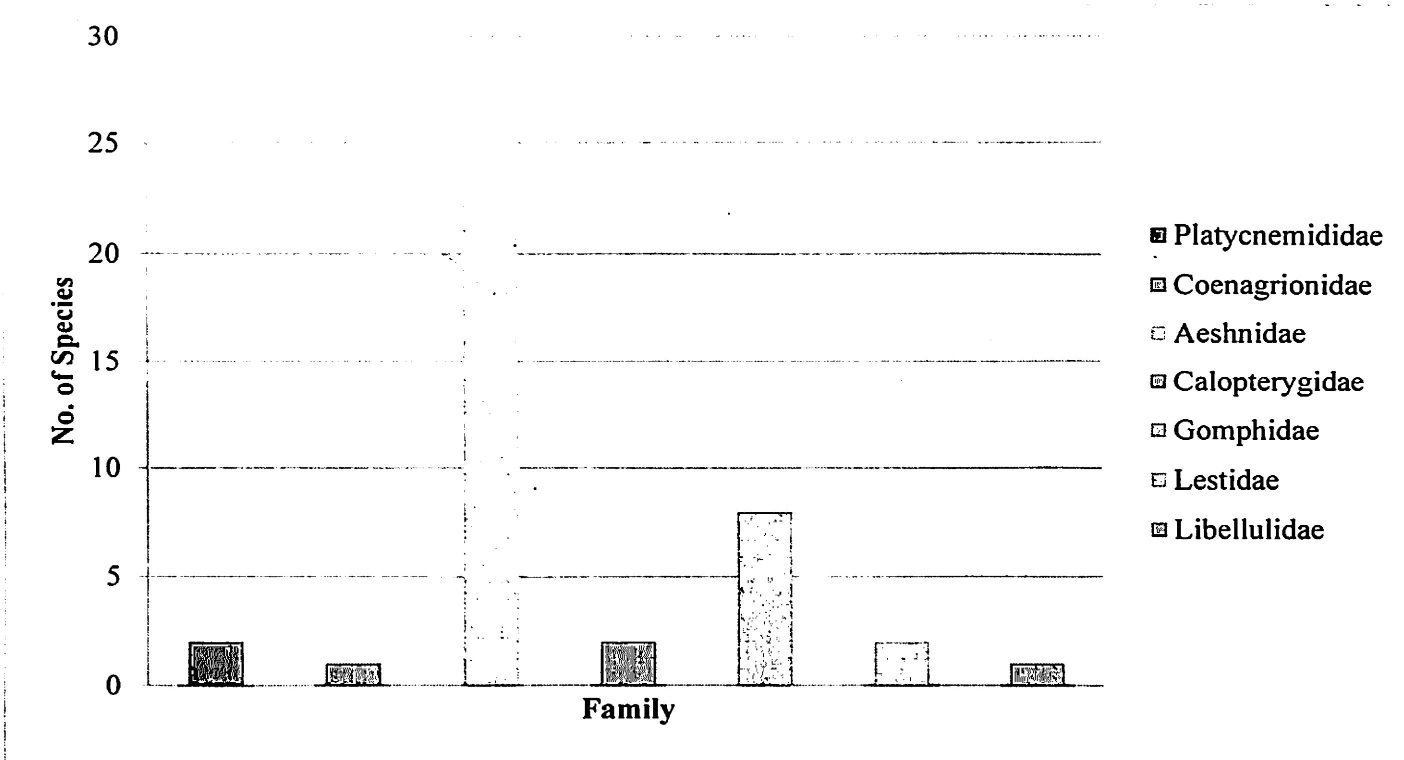


Fig. 4.41: Family wise distribution of Odonates in Kavvayi River Basin

4.5.2.4 Butterflies

The diversity of plants, habitats, topography and climates influence distribution, diversity and abundance of butterflies and they are good biological indicators of habitat quality as well as general environmental health. Butterflies play a major role in the ecosystem as they interact with the environment as pollinators, seed dispersers, herbivores, predators and prey. Out of the 334 reported butterfly species of Western Ghats, 316 species of butterflies were recorded from Kerala. As per the review of literature, a large number of studies on diversity and distribution of butterflies were done in the protected areas of Kerala includes; For instance Mathew & Rahmathulla (1993) who reported 100 species from Silent Valley National Park, Sudheendrakumar *et al.*,(2000) reported of 124 species from Parambikulam Wildlife Sanctuary, Shamsudheen and Mathew (2010) reported 73 species Shendurney Wildlife Sanctuary, Mathew*et al.*,(2005) reported 71 species from Peechi - Vazhani Wildlife Sanctuary, Mathew (2002) reported 53 species from Neyyar Wildlife Sanctuary. Other than protected areas, human dominated non-protected natural habitats like sacred groves, home gardens, and countryside city gardens are also important in terms of butterfly diversity as Kunte (2000) recorded 104 butterfly species from Pune city along with the human impact gradient, and recently Gaude and Janarthanam(2015) reported 33 species of butterflies from four selected sacred groves of Goa. As far as Kerala is concerned, Aneesh *et al.*, (2013) reported 139 species of butterflies from Kerala Agricultural University Campus, Prasad *et al.*, (2010) recorded 52 species from Kerala University campus, Palot (1998) studied butterflies from Calicut university campus. There is very little information available on the ecology and biodiversity of laterite hills in which Palot and Radhakrishnan (2005) reported 111 species of butterflies from Madayipara. The current study focused on butterfly diversity of Midland laterite biotope of Kavvayi river basin, North Kerala. This landscape includes lateritic hills, sacred groves, mangroves, riparian vegetation and locally conserved vegetation such as Kaanam.

The rich diversity of flora is the main reason for the variety in butterflies and many of these plants are food plants of butterflies at larval stage. A total of 140 species butterflies were recorded from the study area, among which the highest number species were from the family Nymphalidae (48 species), followed by Hesperiidae (32 species), Lycaenidae (27 species), Papilionidae and Pieridae with 16 species each and 1 from the family Riodinidae. Among different ecosystems in the study area number of species were more in Laterite biotopes (127), followed by sacred grove (106). Kanams and Riparian ecosystems have the same number of butterfly species (100). Richness in the diversity of butterflies highlights the significance of the lateritic biotopes and associated ecosystems. Most abundant butterfly species among the six families include *Troides minos*, *Pachliopta hector*, *Papilio helenus*, *Papilio polymnestor* and *Graphium sarpedon* (Papilionidae), *Delias eucharis*, *Catopsilia pyranthe pyranthe*, *Eurema brigitta* and *Eurema hecabe* (Pieridae), *Castalius rosimon*, *Jamides celeno*, *Talicada nyseus*, *Loxura atymnus atymnus* and *Rathinda amor* (Lycaenidae), *Abisara echerius* (Riodinidae), *Danaus chrysippus*, *Tirumala limniace*, *Danaus genutia*, *Euploea core*, *Cupha erymanthis*, *Phalanta phalantha*, *Junonia lemonias*, *Hypolimnas misippus*, *Acraea terpsicore*, *Mycalesis perseus* and *Ypthima huebneri* (Nymphalidae), *Tagiades gana silvia*, *Tagiades litigiosa*, *Iambrix salsala*, *Notocrypta curvifascia* and *Psolos fuligo* (Hesperiidae).

Species such as *Pachliopta hector, Papilio clytia clytia, Papilio liomedon, Castalius rosimon, Hypolimnas misippus, Cepora nerissa, Cepora nadina, Appias lyncida, Euchrysops cnejus, Lampides boeticus, Parthenos Sylvia, Tanaecia lepidea* and *Prioneris sita* are protected under various schedules (I, II, IV) of the Indian Wildlife (Protection) Act, 1972.

Butterflies depend largely on plant species as their food plants to complete their entire life cycle, hence high diversity in butterfly community is also an indication of the virginity of the landscape and the floral and faunal wealth of the area. The distribution of butterflies in different ecosystem, places and the family-wise distribution is given in the figures 4.42, 4.43 and 4.44 respectively. The endemic and the species coming under WPA were given in the table 4.39.

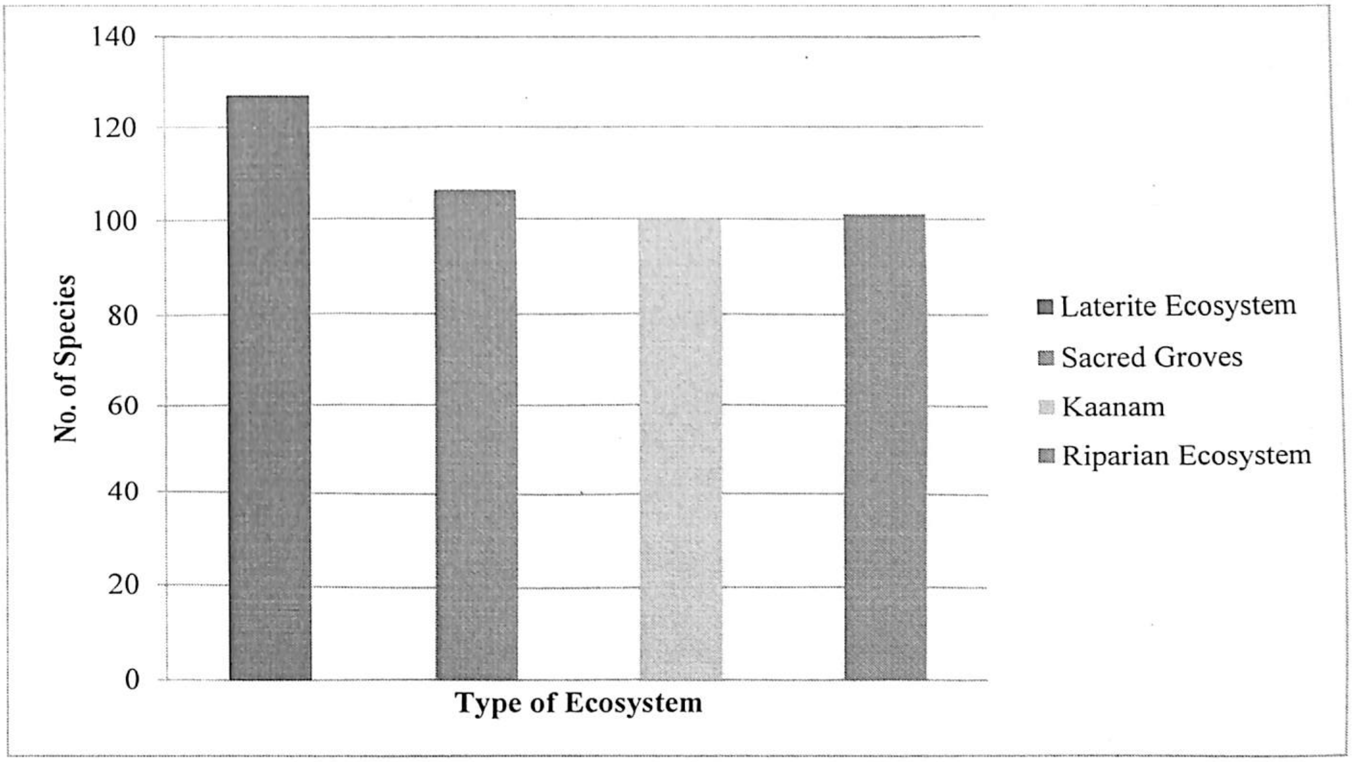


Fig. 4.42: Distribution of Butterflies in different ecosystems of Kavvayi River Basin

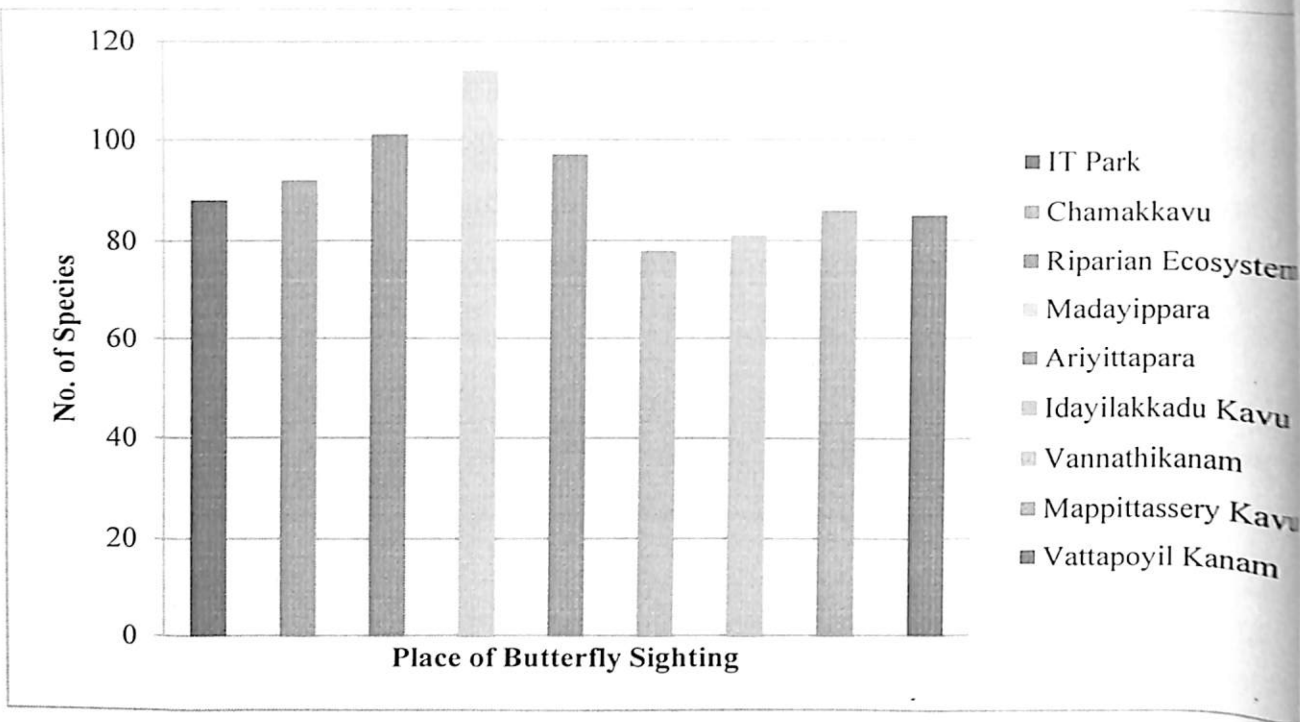


Fig. 4.43: Distribution of Butterflies in selected places of Kavvayi River Basin

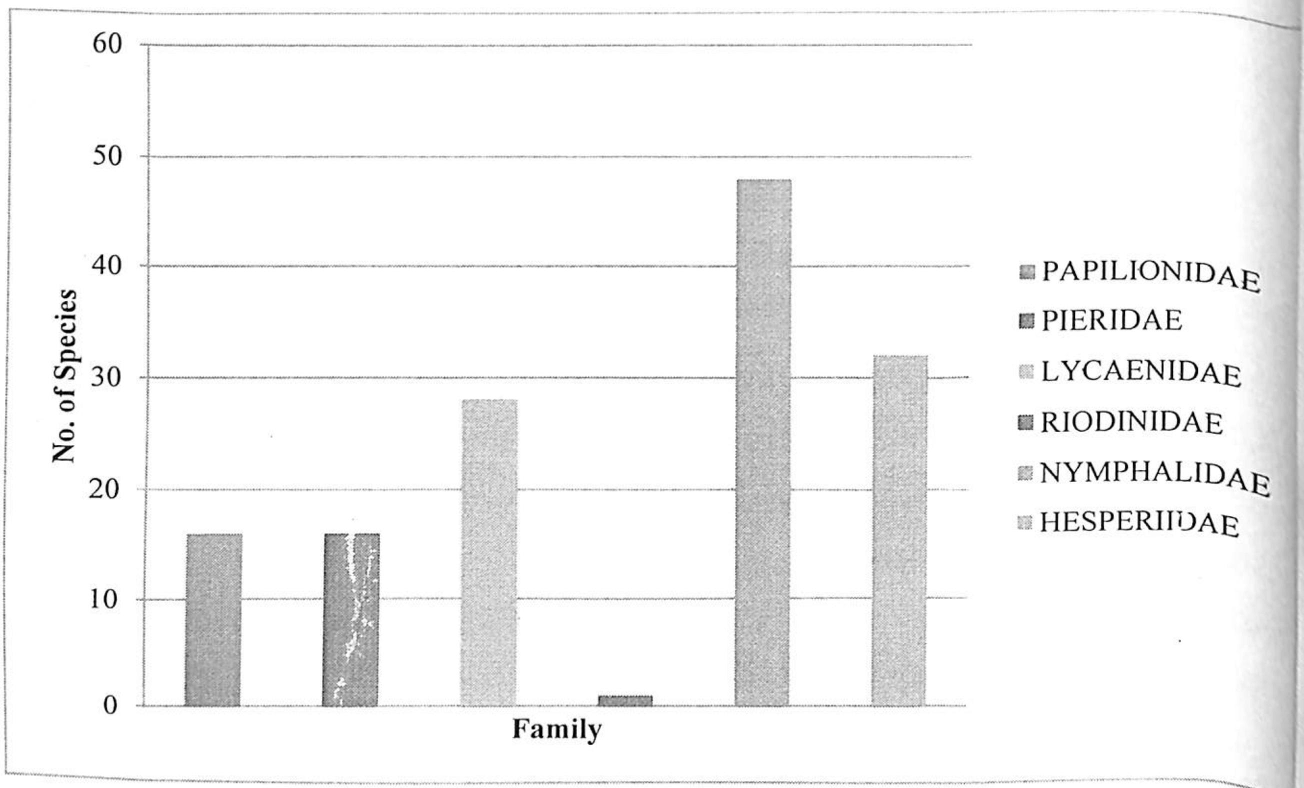


Fig. 4.44: Species distribution of Butterflies in families from Kavvayi River Basin

Table 4.39: Endemic and WPA listed Butterflies from Kavvayi River Basin

SI No.	Scientific name	Common name	Status
1	*Pachliopta pandiyana*	Malabar Rose	E
2	*Pachliopta hector*	Crimson Rose	Sch I
3	*Papilio clytia clytia*	Oriental Common Mime	Sch I
4	*Papilio liomedon*	Malabar Banded Swallowtail	Sch I
5	*Prioneris sita*	Painted Sawtooth	Sch IV
6	*Cepora nerissa*	Common Gull	Sch II
7	*Cepora nadina*	Lesser Gull	Sch II
8	*Appias lyncida*	Chocolate Albatross	Sch II
9	*Castalius rosimon*	Common Pierrot	Sch I
10	*Euchrysops cnejus*	Gram Blue	Sch II
11	*Lampides boeticus*	Pea Blue	Sch II
12	*Curetis siva*	Shiva Sun Beam	E
13	*Cirrochroa thais*	Tamil Yeoman	E
14	*Hypolimnas misippus*	Danaid Eggfly	Sch I
15	*Kallima horsfieldi*	Sahyadri Blue oakleaf	E
16	*Parthenos sylvia*	Sahyadri Clipper	Sch II
17	*Tanaecia lepidea*	Grey Count	Sch II
18	*Mycalesis junonia*	Malabar Glad-eye-Bushbrown	E

4.5.2.5 Moths

Insects, as the most diverse group of fauna, which add substantial variety and diversity to the extraordinary rare veneer of life on our biosphere. Lepidoptera, as 'Ambassadors of biodiversity', fall unevenly into three major functional groups: 'butterflies', 'macromoths', 'microlepidoptera', about 160,000 described Lepidoptera and an estimated 500,000 species that may exist all over the world (Kristensen *et al.*,2007). As same as the world perspective in India also the butterfly taxonomy and distribution have been relatively well studied whereas moth study lacks significant additions since the work of Hampson, Bell and Scott in their "Fauna of British India" series (1892-1937) and Cotes and Swinhoe's "A Catalogue of Moths of India" (1887), they were recorded 5277 and 4438 moth species respectively which shows India is gifted with rich fauna of moths. Moths are cosmopolitan in distribution occurring in every conceivable habitat from plains to deserts, forest and valley of hills and mountains. They act as a good bio indicator of particular vegetation as they are host specific (Gurule *et al.*, 2011). There are about 140 families of moths & 7 families of butterflies in the world. The reliable estimates report over 1, 27,000 species of moths from all over the world (Alfred *et al.*, 1998). Of which over 12,000 species are recorded from Indi (Chandra and Nema, 2007).

Lepidoptera play a vital role in pollination, source of food for birds & other predators. Among insects, the Lepidoptera are economically very important being the primary consumers in the ecosystem. They are very diverse in their habits and are adapted to a variety of conditions. Being highly sensitive to changes in the environment they are easily affected by even relatively minor perturbations in the habitat so much so they have been considered as indicators of environmental quality (Rosenberg *et al.,* 1986) .

About 500 species of moths were collected in this study. Of these, the identity of 321 of moths was confirmed (Appendix VII). The moths identified in this study belonged to 32 families and 232 genuses. Altogether 321 species could be identified. The families Crambidae (71), and Erebidae (66) containing maximum number of species followed by Geometridae (44) and Noctuidae (42). This study has indicated that the moth diversity of Kavvayi River Basin is rich and diversified. The distribution of moths in families with more than one species was given in the figure 4.45.

Moth diversity studies in Kerala were mainly conducted by KFRI as part of the insect fauna diversity assessment of selected protected forest areas. The Lepidopteron diversity assessed by these studies are concluded in the table 4.40

Table 4.40: Moth diversity studies in Kerala

Sl No	Year of Study	Location	Number of Reported Moth sp. (family in bracket)	Reference
1	1999	Amarambalam Reserve	202 (11)	Sharma, *et al.* (20
2	1998	Nellyampathy RF	204 (14)	Mathew (1998)
3	1990	Silent valley NP	318 (17)	Mathew *et al.* (19
4	2002	Peppara WLS	87 (7)	Mathew, *et al.* (2
5	2002	Shendurney WLS	129 (12)	Mathew, *et al.* (2
6	2003	Peechi Vazhani WLS	113 (23)	Mathew,*et al.* (20

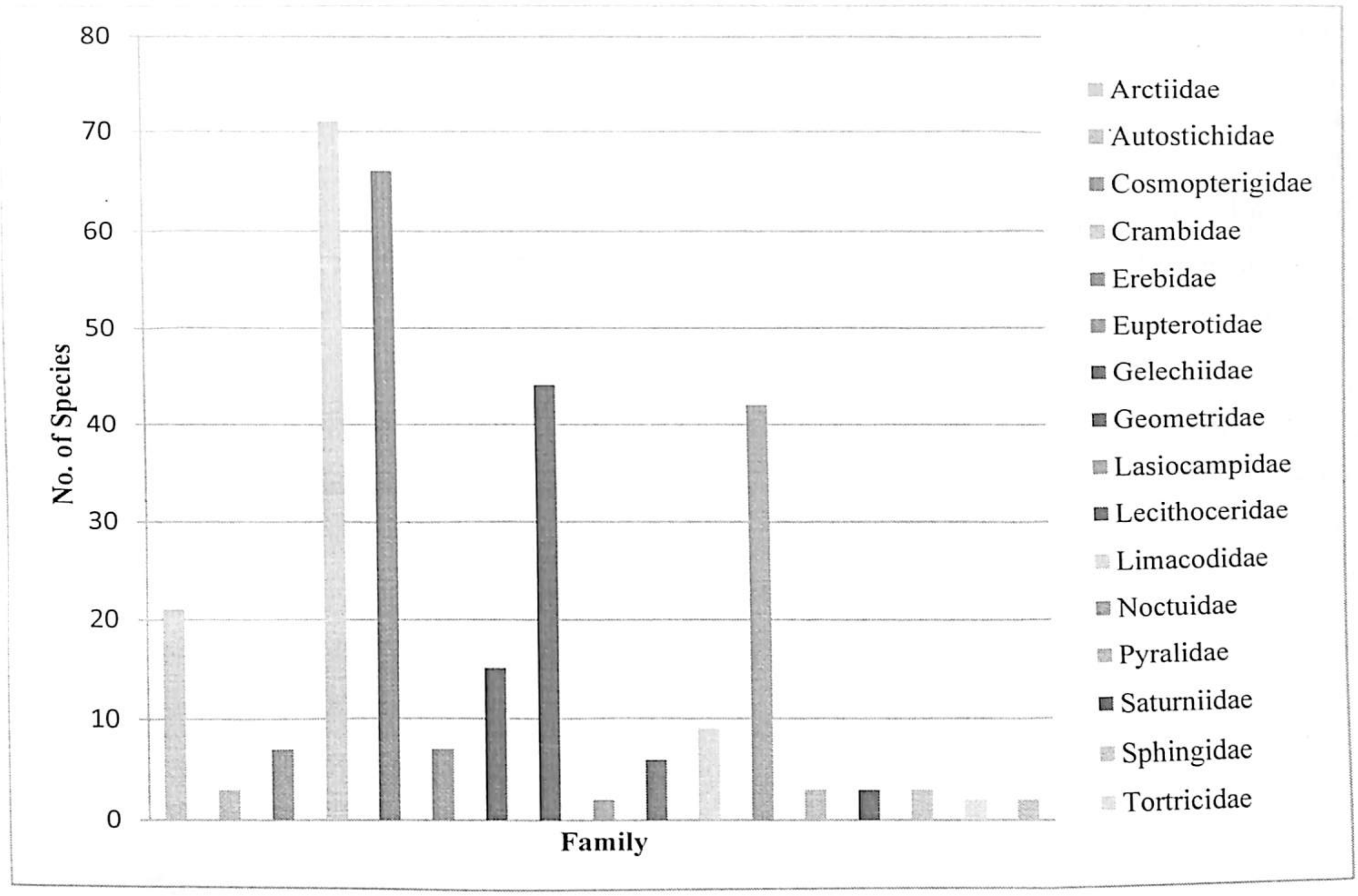


Fig.4.45: Family wise distribution of Moths in Kavvayi River Basin

4.5.2.6 Birds

The lateritic hillocks of the northern Kerala have its own characteristic vegetation, dominated by scrub jungles, grasslands and semi aquatic vegetation on the hilltops. Birds use this as their feeding, roosting and breeding places. Most of the studies on birds of Lateritic hill ecosystems were from Madayipara, Kannur (Palot and Radhakrishnan, 2002; Palot and Radhakrishnan, 2005; Palot and Balakrishnan, 2014), which reported 181 species of birds.

The present study reports a total of 215 species of birds to 18 Orders and 60 families from different lateritic biotopes in Northern Kerala (Appendix VIII). Order Passeriformes was the most represented order with 28 families and 82 species. In this 215 species, three species Greater Spotted Eagle *Clanga clanga*, Indian Spotted Eagle *Aquila hastate* and Woolly-necked Stork *Ciconia episcopus* coming under vulnerable category and Oriental Darter *Anhinga melanogaster*, Black-headed Ibis *Thresikornis melanocephalus,* Eurasian Curlew *Numenius arquata,* River Tern *Sterna aurantia* and Pallid Harrier *Circus macraurus* are under Near Threatened category based on IUCN. Two species, Malabar Grey Hornbill

Ocyceros griseus griseus and Rufous Babbler *Turdoides subrufus subrufus* are Endemic to Western Ghats (Table 4.41). Several ecological units are associated with this landscape like sacred groves, kaanams, agro-ecosystems and wetlands. Out of the 215 species of birds, 170 species from lateritic hillocks, 153 species from sacred groves and 106 species from kaanams were observed. The orderwise distribution of birds and distribution of birds in different ecosystems were given in figure 4.46 and 4.47.

Sacred groves and kaanams associated with these lateritic landscapes provide diverse habitats for birds having small pockets of green patches of vegetation. Many of the forest birds such as Grey Jungle Fowl, Emerald Dove, Eurasian Blackbird, Forest Wagtail, Indian Pitta, etc. were breeding in these ecosystems (Sashikumar, 2004). Some of the resident birds such as Ashy-crowned finch Lark, Bush Lark, Eastern Skylark, Malabar Crested Lark, Paddy field Pipit, Pied Bush Chat, Red-wattled Lapwing, Yellow-wattled Lapwing and the Stone Curlew were use this plateau as breeding ground vehicles (Palot and Radhakrishnan, 2005). The unique topographic setting of these lateritic hillocks, an elevated table like plateau surrounded by wetlands has been a very distinct land mark for the migratory birds coming from far beyond Himalaya and from Palaearctic countries. In these lateritic biotopes, migratory birds start arriving mostly in late August and most of them leave the hill in late October (Palot and Radhakrishnan, 2005). During the monsoon period these lateritic hills forms a good feeding ground for the birds including several migratory birds. Resident species like larks, pipits and lapwings use these ground as their nesting ground. The presence of high percentage of birds shows the importance of the system. Laterite hill ecosystems with a variety of microhabitats (Sreejith *et al.,* 2014) support a variety of birds and many other organisms and at the same time are under severe threat of poaching, habitat degradation due to mining, pollution, roads and other developmental activities. Habitat modification in vast stretches leading to shrinkage and fragmentation of these hillocks and consequent loss of biodiversity leads to the decline in the number of resident birds. The breeding success of the ground nesting birds is highly affected by mining, overgrazing and uncontrolled movement of vehicles (Palot and Radhakrishnan, 2005).

Table 4.41: IUCN listed Birds of Kavvayi River Basin

SI No	Common Name	Species name	IUCN
1	Woolly-necked Stork	*Ciconia episcopus*	VU
2	Black-headed Ibis	*Threskiornis melanocephalus*	NT
3	Oriental Darter	*Anhinga melanogaster*	NT
4	Eurasian Curlew	*Numenius arquata*	NT
5	River Tern	*Sterna aurantia*	NT
6	Indian Spotted Eagle	*Clanga hastata*	VU
7	Greater Spotted Eagle	*Clanga clanga*	VU
8	Pallid Harrier	*Circus macrourus*	NT

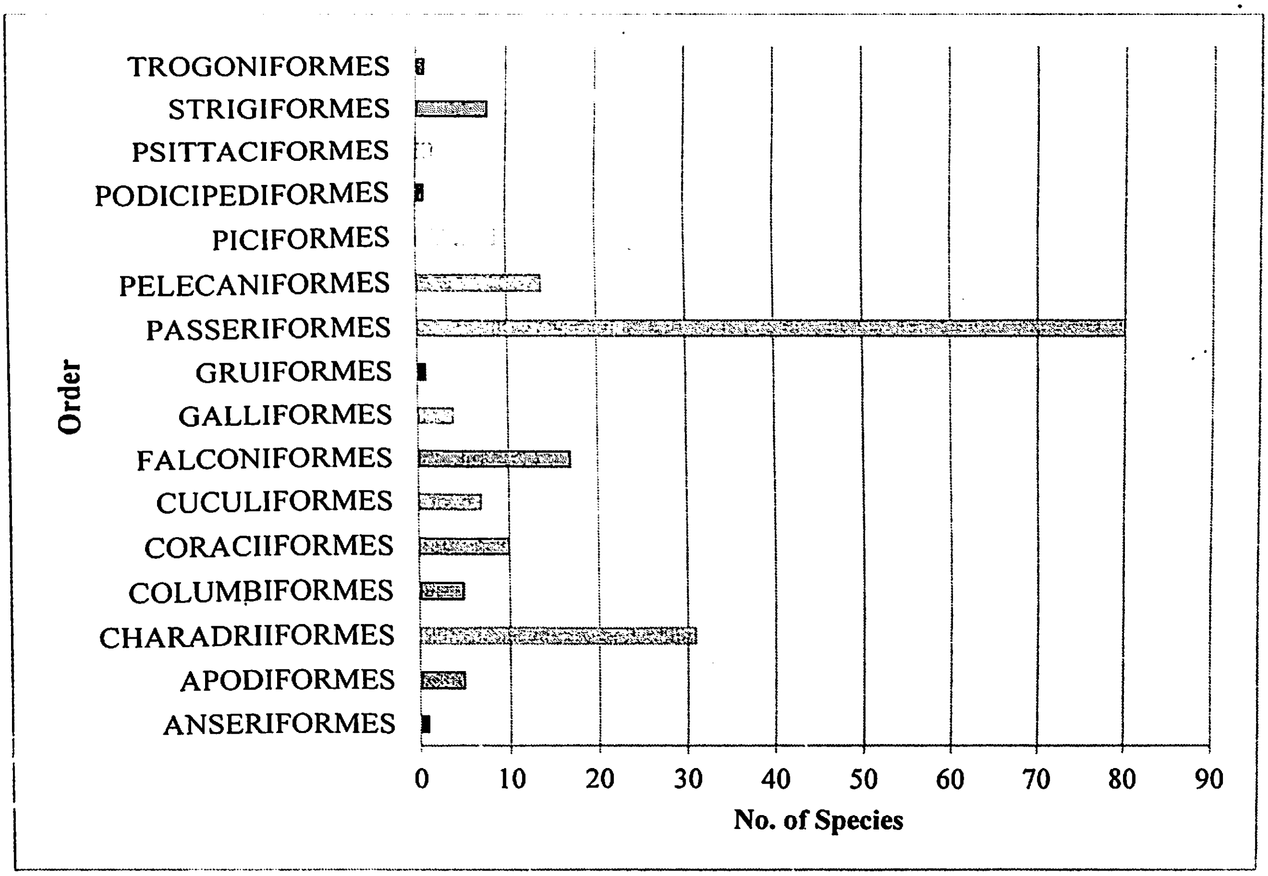


Fig. 4.46: Order wise distribution of Birds in Kavvayi River Basin

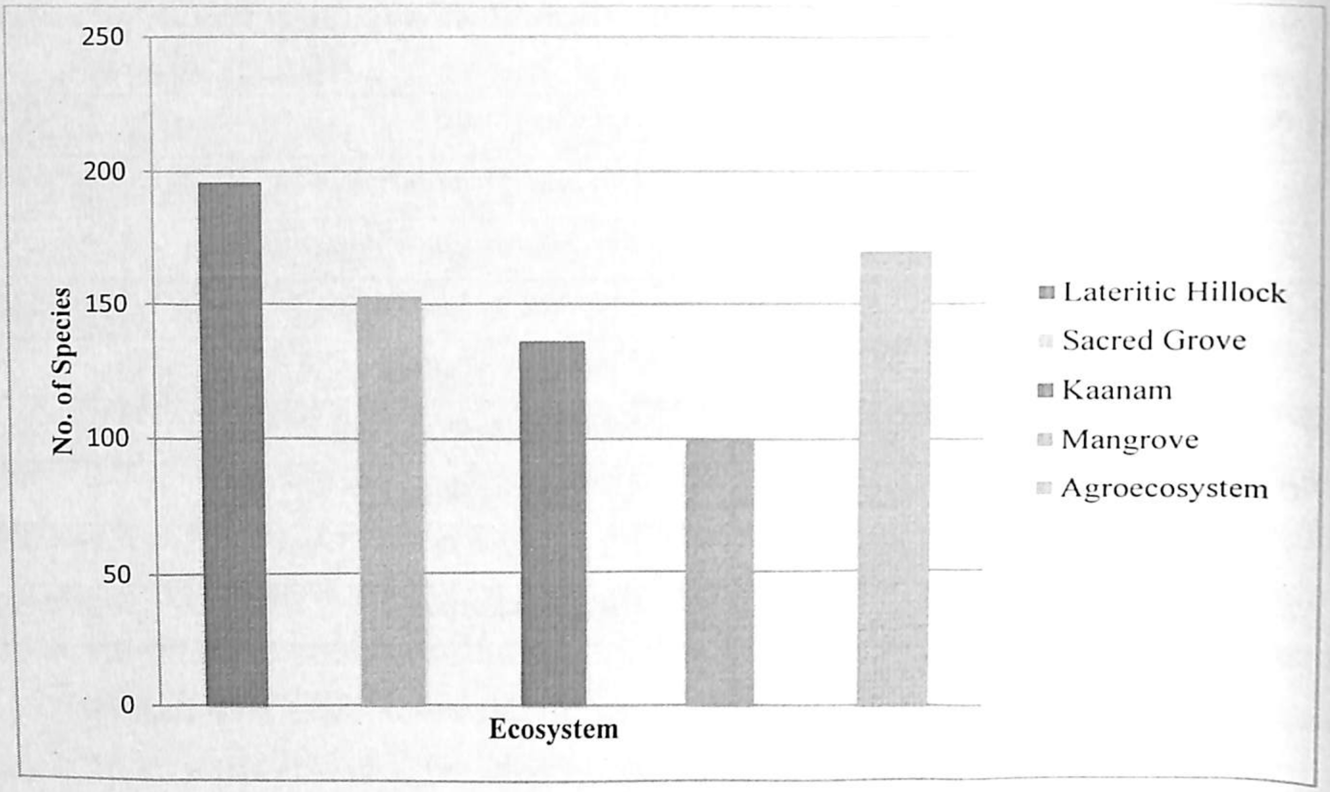


Fig. 4.47: Distribution of Birds in different ecosystems of Kavvayi River Basin

4.5.2.7 Reptiles

The reptilian fauna of lateritic ecosystems comprises a total of 27 species belonging to two orders, 14 families and 25 genera (Appendix IX). Out of this 27 species, seven species *Calotes rouxi*, *Ophisops beddomei*, *Eutropis macularia*, *Lygosoma punctata*, *Oligodon taeniolatus*, *Echis carinatus* and one species of Ristella were new to the lateritic ecosystem. One species, *Melanochelys trijuga*, is coming under the IUCN category Near Threatened, 10 species were least concern category and 16 species were not evaluated. Out of the 27 reptilian species, three species, *Lissemys punctata*, *Varanus bengalensis* and *Python molurus* were coming under the Scheduled category I under the Indian Wildlife Protection Act, 1972. Five species, *Ptyas mucosa*, *Xenochrophis piscator*, *Cerberus rynchops*, *Naja naja* and *Daboia russelii* were in Scheduled category II and 11 species, *Indotyphlops braminus*, *Grypotyphlops acutus*, *Eryx conicus*, *Oligodon arnensis*, *Oligodon taeniolatus*, *Dendrelaphis tristis*, *Lycodon aulicus*, *Ahaetulla nasuta*, *Boiga trigonata*, *Bungarus caereleus* and *Echis carinatus* were in Scheduled category IV. The list of reptiles under IUCN and WPA category was given in table 4.42 and the distribution of reptiles in different ecosystems was given in figure 4.48.

Table 4.42: Reptiles under IUCN and WPA category from Kavvayi River Basin

SI No.	Scientific Name	Common Name	IUCN	WPA
1	*Melanochelys trijuga* (Schweigger)	Indian Pond Terrapin	NT	
2	*Lissemys punctata* (Lacépède, 1788)	Indian Flap-shelled Turtle		Sch. I
3	*Varanus bengalensis* (Daudin,1802)	Indian Monitor Lizard		Sch. I
4	*Indotyphlops braminus* (Daudin,1803)	Common Blind Snake		Sch. IV
5	*Grypotyphlops acutus* (Dumeril & Bibron,1844)	Beaked Blind Snake		Sch. IV
6	*Python molurus* (Linnaeus, 1758)	Indian Rock Python		Sch. I
7	*Eryx conicus* (Schneider, 1801)	Common Sand Boa		Sch. IV
8	*Ptyas mucosa*(Linnaeus,1758)	Indian Rat Snake		Sch.II
9	*Oligodon arnensis* (Shaw,1802)	Common Kukri Snake		Sch.IV
10	*Oligodon taeniolatus* (Jerdon, 1853)	Russell's Kukuri Snake		Sch.IV
11	*Dendrelaphis tristis* (Daudin,1803)	Common Indian Bronze-back		Sch.IV
12	*Lycodon aulicus* (Linnaeus,1754)	Common Wolf Snake		Sch.IV
13	*Ahaetulla nasuta* (Bonnaterre,1790)	Green Vine Snake		Sch.IV
14	*Boiga trigonata* (Schneider, 1802)	Common Cat Snake		Sch.IV
15	*Xenochrophis piscator* (Schneider,1799)	Checkered Keelback		Sch.II
16	*Cerberus rynchops* (Schneider, 1799)	Dog-faced water snake		Sch.II
17	*Bungarus caereleus* (Schneider)	Common Krait		Sch.IV
18	*Naja naja* (Linnaeus,)	Indian Kobra		Sch.II
19	*Daboia russelii* (Shaw & Nodder, 1797)	Russel's Viper		Sch.II
20	*Echis carinatus* (Schneider, 1801)	Saw-scaled Viper		Sch.IV

WPA: Wildlife Protection Act, 1972
NT: Near Threatened, Sch: Schduled category under WPA

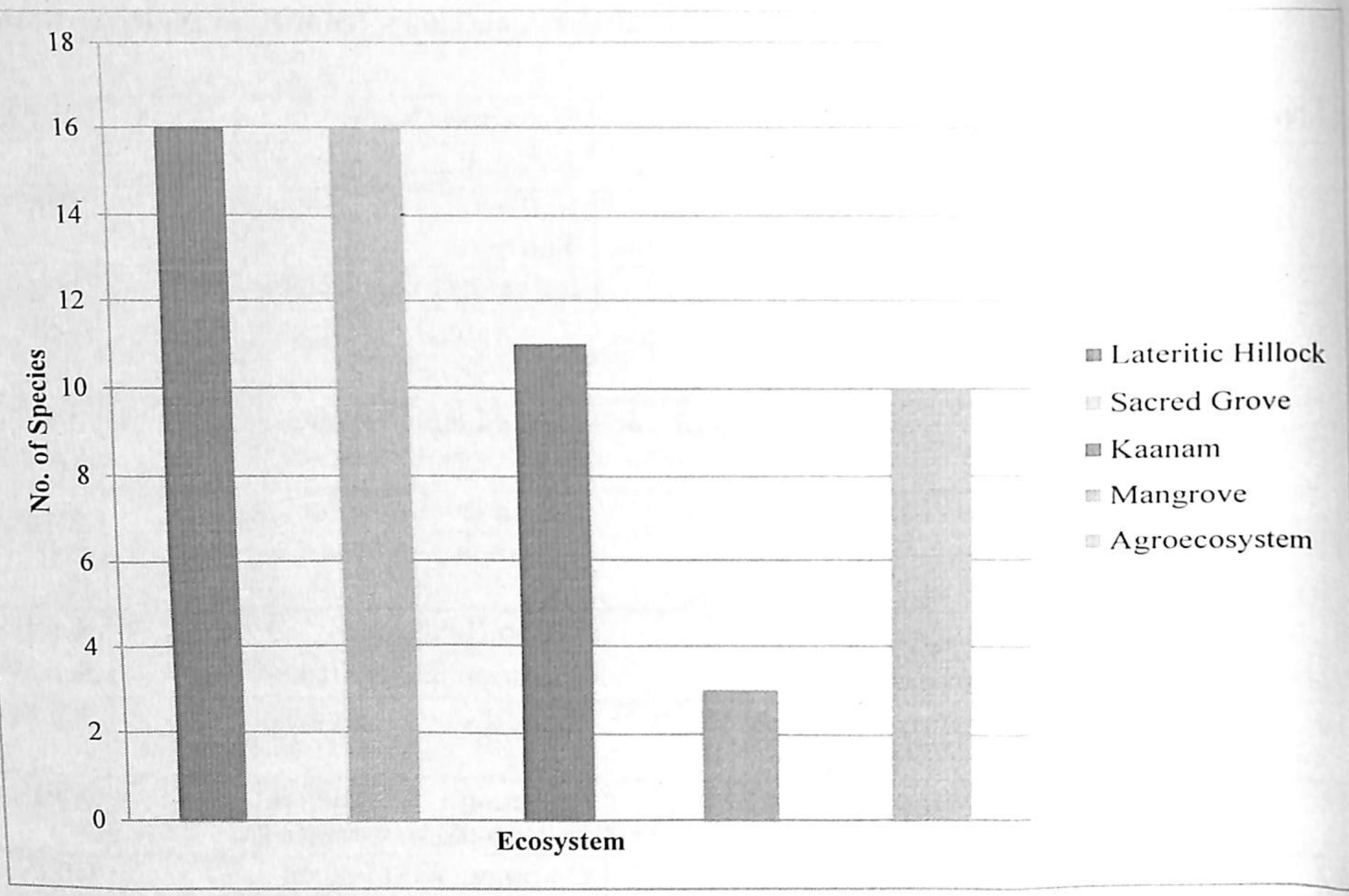


Fig. 4.48: Distribution of Reptiles in different ecosystems of Kavvayi River Basin

4.5.2.8 Amphibians

The alternation of very wet and dry conditions creates an unusual ecological situation and varying microhabitats which support unique biota especially smaller vertebrates including amphibians and reptiles. The permanent and temporary water bodies found in these lateritic biotopes and the various microhabitats harbor different species of amphibians. The current study focused on the amphibian diversity of laterite ecosystems of the Kavvayi River basin.

The lateritic hill ecosystems have a total of 20 species of amphibians in two Orders, Anura (19 species) and Gymnophiona (1 species) belonging to 6 different families under 14 Genera (Appendix X). Dicroglossidae family was the most represented family with 8 species followed by Microhylidae (5 species), Rhacophoridae (4 species) and 1 species in Bufonidae, Ranidae and Ichthyophidae. *Fejervarya rufescens* a laterite specialist and the only IUCN red data list endangered species in the study area. *Fejervarya sahyadris* were well represented throughout the study area. Amphibian species under IUCN and WPA were given in table 4.43 and the distribution of species in different ecosystems were given in fig 4.49.

Laterite hill ecosystems with a variety of microhabitats (Sreejith *et al.,* 2014) supports a variety of amphibians and many other organisms at the same time they under severe threat of habitat degradation due to mining, pollution, roads and other developmental activities. Almost all Laterite hill ecosystems sampled had roads cutting through the landscape acting as death sites for amphibians moving towards and away from water bodies during breeding seasons. Amphibian road kills were also found in temporary pools among roads created during rainy seasons. Uncontrolled mining and destructive activities without a check can easily wipe out these sensitive creatures from laterite ecosystems.

Table 4.43: Amphibians under IUCN and WPA category from Kavvayi River Basin

SI No.	Scientific Name	Common Name	IUCN Status	WPA
1	*Euphlyctis cyanophlyctis* (Schneider, 1799)	Dicroglossid frog	LC	Sch.IV
2	*Euphlyctis hexadactylus* (Lesson, 1834)	Indian green frog	LC	Sch.IV
3	*Hoplobatrachus tigerinus* (Daudin, 1803)	Indian bullfrog	LC	Sch.IV
4	*Fejervarya sahyadris* (Dubois, Ohler & Biju, 2001)	Sahyadri rain-pool Frog	EN, WG	
5	*Fejervarya rufescens* (Jerdon, 1853)	Rufescent Burrowing Frog	LC, WG	Sch.IV
6	*Fejervarya brevipalmata* (Peters, 1871)	Short-webbed frog	DD, WG	Sch.IV
7	*Microhyla ornata* (Dumeril & Bibron, 1841)	Ornate narrow-mouthed frog	LC, WG	
8	*Polypedates occidentalis* (Das & Dutta, 2006)	Charpa Tree Frog	DD, WG	
9	*Pseudophilautus wynaadensis* (Jerdon,1854)	Dark-eared Bush Frog	EN, WG	
10	*Rhacophorus malabaricus* (Jerdon, 1870)	Malabar gliding frog	LC, WG	

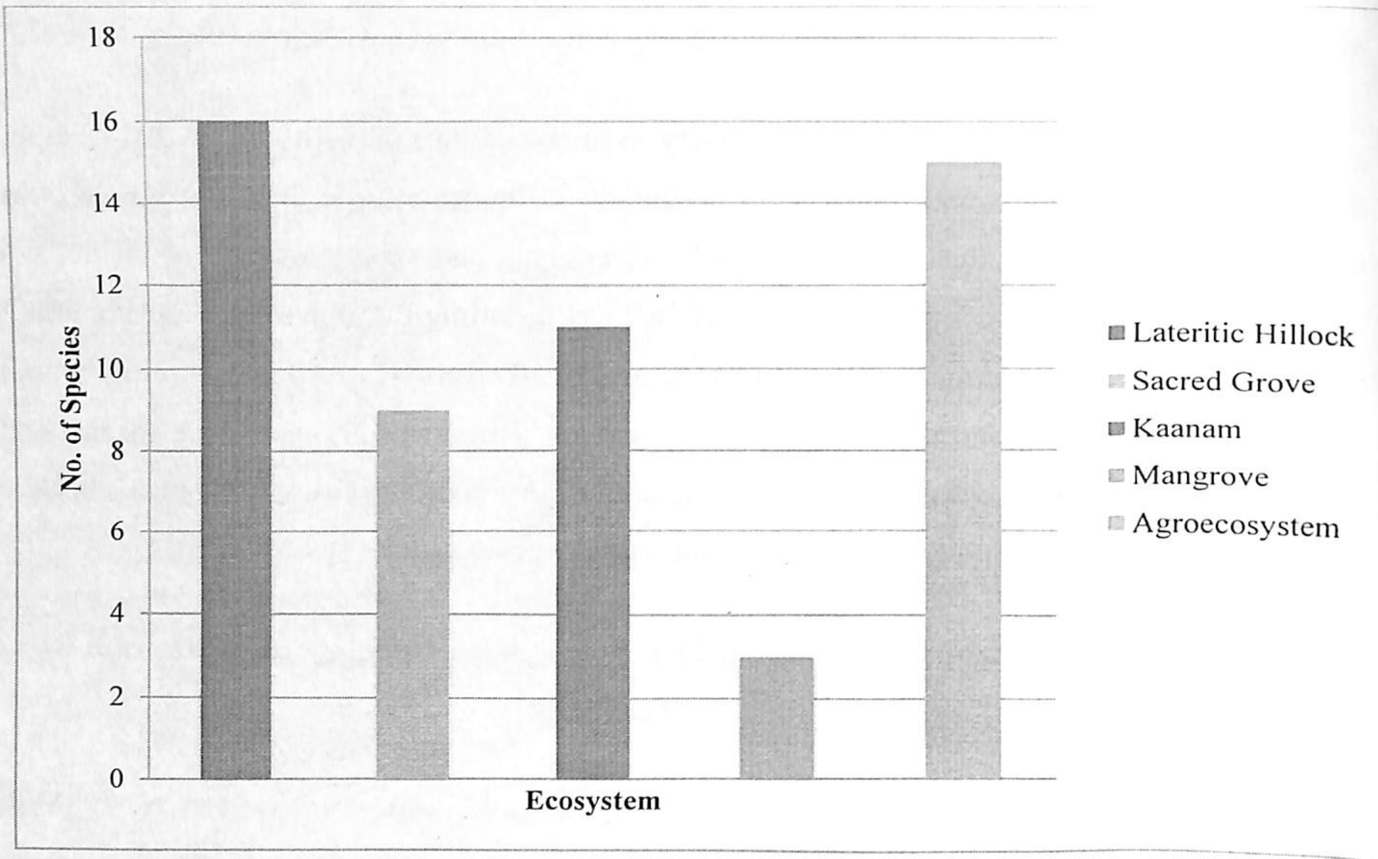


Fig 4.49: Amphibian distribution in different ecosystems of Kavvayi River Basin

4.5.2.9 Fishes

The lateritic hillocks in the Kavvayi River Basin having five major streams, Kuniyan stream, Mattalayi stream, Kuppithodu stream, Vannathichal stream and Kankol stream, which nourishes the Kavvayi river. Besides these streams many seasonal pools and ponds were present in the lateritic hillocks and associated ecosystems. Most of the Sacred Groves and the Kanams are having water bodies. Most of these water bodies having different species of fishes.

A total of 68 species of fishes belonging to 16 orders and 42 families were listed from the water bodies in Kavvayi river basin (Appendix XI). Out of this 68 species one species, *Oreochromis mossambica* (Peters, 1852), is coming under the IUCN category Near Threatened. 63 species were least concern, 18 species were not evaluated and 6 species were data deficient. Out of the 68 species listed 27 species belongs to the order Perciformes, followed by Cypriniformes (9), Tetraodontiformes (6) and Siluriformes (4). Order Clupeiformes, Beloniformes, Mugiliformes, Synbranchiformes and Pleuronectiformes having three species each. Cyprinodontiformes having two species and Anguilliformes, Batrachoidiformes, Scorpaeniformes, Atheriniformes and Lophiformes are with one species each.

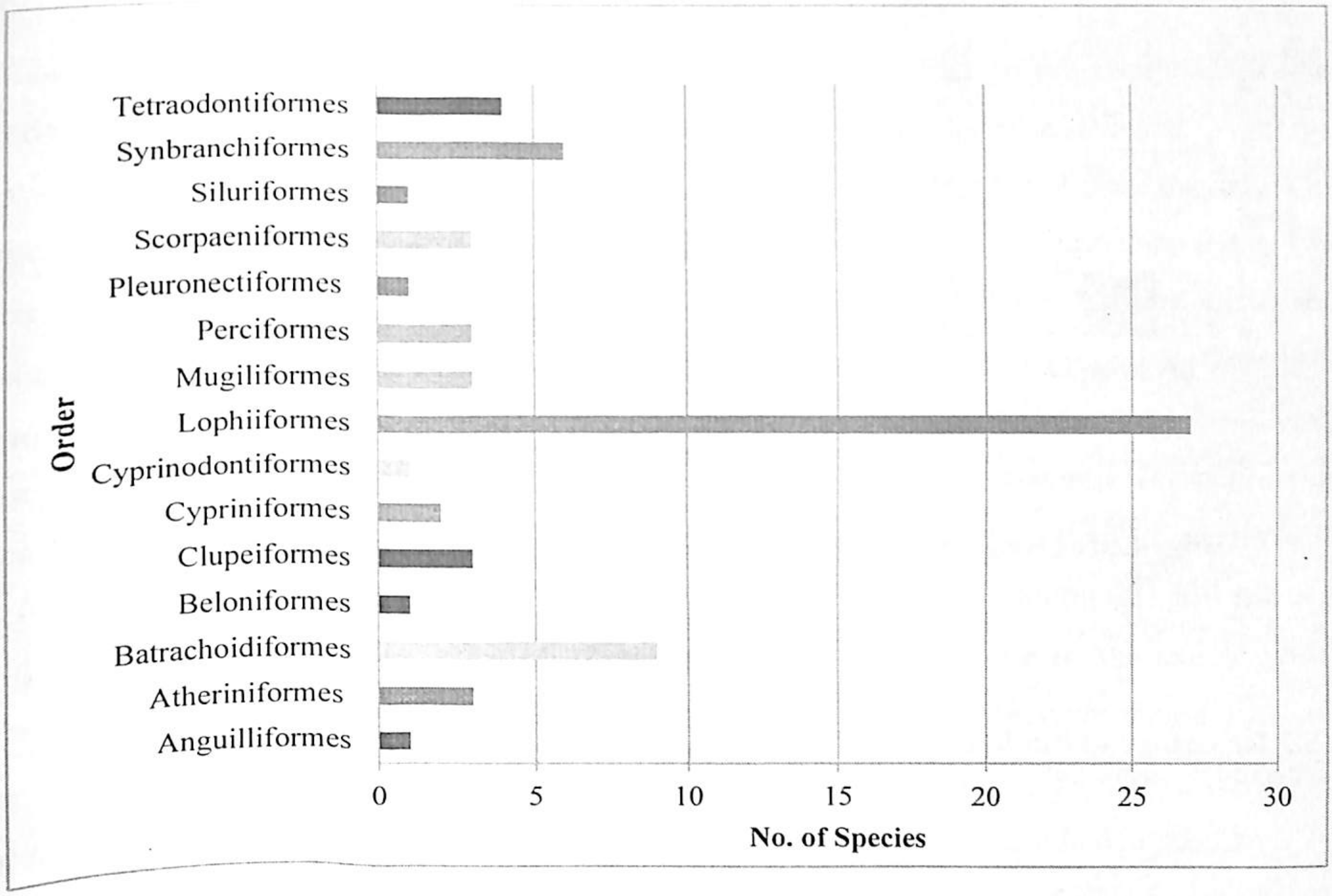


Fig. 4.50: Order wise distribution of fishes in Kavvayi River Basin

4.5.2.10 Mammals

Out of the 93 mammalian species found in Kerala, 25 belonging to five order 14 families and 22 genera were present in this lateritic ecosystem (Appendix XII). Jackal, *Canis aureus* is the most common mammal seen in these lateritic hillocks. An orderwise distribution map was prepared from the list. Out of the 25 species 9 species belongs to the order Chiroptera, 8 belongs to Rodentia, 6 belongs to Carnivora and Eulipotyphla and Lagomorpha orders having one species each.

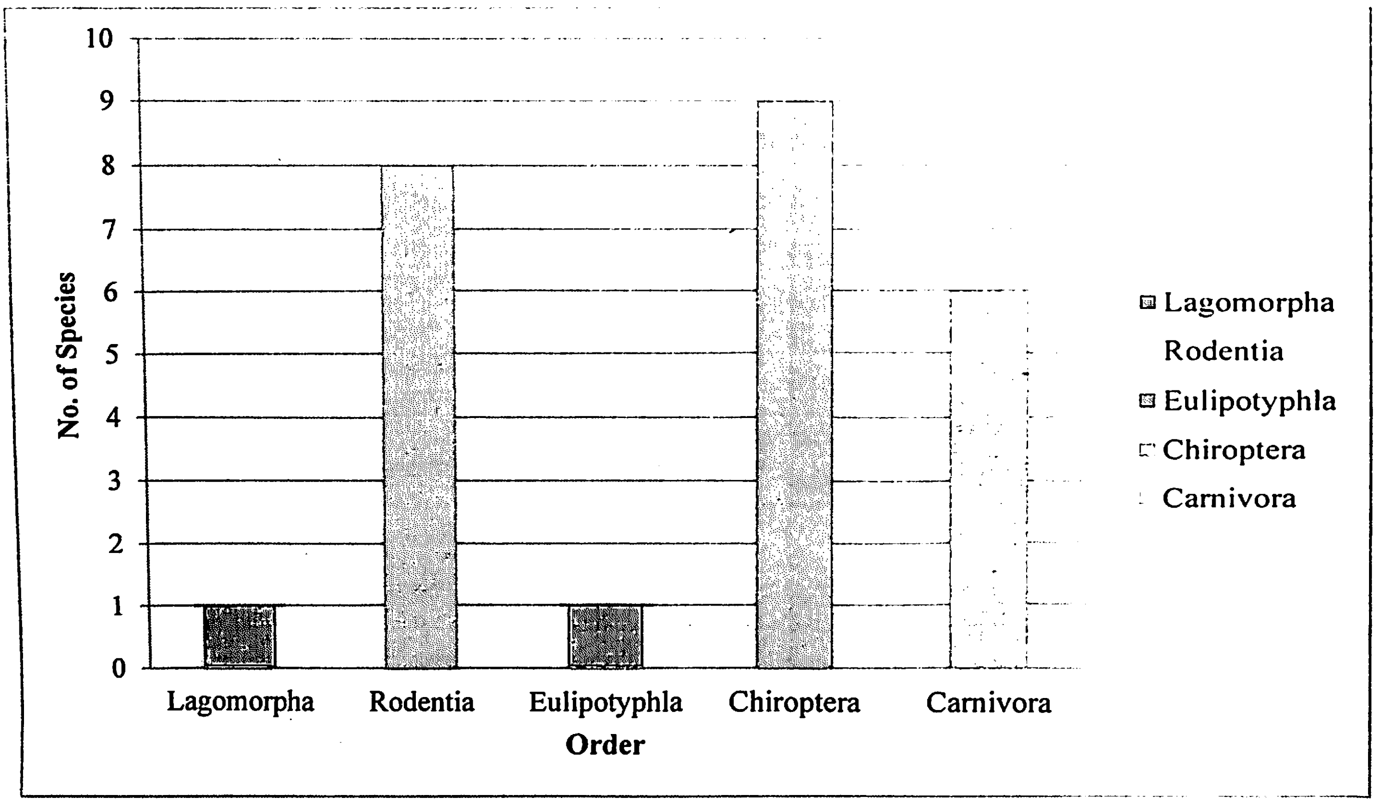


Fig. 4.51: Order wise distribution of Mammals in Kavvayi River Basin

4.5.3 Inventory of biodiversity in Local Ecosystems of Kavvayi River Basin

Local ecosystems are took a major role in the enrichment of biodiversity in the lateritic biotopes. These ecosystems are interlinked through ecosystem services. Ecosystems such as sacred groves, Kaanams and Kuthirus were taken for the inventory. Kuniyan wetland ecosystem is also taken for study because of its rich diversity of birds.

4.5.3.1 Biodiversity of Sacred groves

A total of 80 sacred groves present in associated with lateritic biotopes, which are protected because of its sacred value. These sacred groves altogether constitutes 389 species of angiosperms belonging to 98 families. Out of the 389 species, 5 were endemic to India, 18 were endemic to Southern Western Ghats, 27 were endemic to Western Ghats, 9 were endemic to Peninsular India, 3 were endemic to South India and 3 were endemic to South West India. Among them 8 species, *Cayratia pedata, Ixora malabarica, Hopea parviflora, Hydnocarpus macrocarpa, Pterospermum reticulatum, Dalbergia latifolia, Saraca asoca* and *Aglaia lawii* were coming under Vulnerable, one species, *Syzygium travancoricum* is coming under Critically Endangered and one species, *Holigarna beddomei* is coming under Endangered category of IUCN. Among the 153 species of birds observed belonging to 16 orders and 51 families, *Ciconia episcopus* and *Clanga hastate* Vulnerable and *Threskiornis melanocephalus* is Near Threatened of IUCN.

4.5.3.2 Biodiversity of Kaanam

Two Kaanams, Vannathi Kaanam and Vattapoyil Kaanam, which comprises a total area of 4.61 ha, were studied from the Kavvayi river basin for the floral and faunal inventory. A total of 452 species of angiosperms belonging to 87 families were listed from the area. Out of these one species is endemic to India, 14 species are endemic to Peninsular India, two species were endemic to South India, 7 species were endemic to Southern Western Ghats and 26 species were endemic to Western Ghats. Among the 452 species, one species, *Diospyros ebenum* is Data Deficient, two species *Zehneria maysorensis* and *Impatiens dasysperma* were endangered and five species, *Impatiens herbicola, Sonerila elegans, Pterospermum reticulatum, Dalbergia latifolia* and *Saraca asoca* were Vulerable under IUCN category. 136 species of birds were found belonging to 48 families and 14 orders. Among this 136 species, *Threskiornis melanocephalus* is Near Threatened and *Clanga hastate* is Vulnerable under IUCN category. 17 species of amphibians belonging to 5 families were found in these Kaanams. Out of these, 7 species *Fejervarya sahyadris, Fejervarya rufescens, Fejervarya brevipalmata, Microhyla ornate, Polypedates occidentalis, Pseudophilautus wynaadensis* and *Rhacophorus malabaricus* were endemic to Western Ghats. Two species *Fejervarya sahyadris* and *Pseudophilautus wynaadensis* are endangered under IUCN category and five species, *Euphlyctis cyanophlyctis, Euphlyctis hexadactylus, Hoplobatrachus tigerinus, Fejervarya rufescens* and *Fejervarya brevipalmata* are coming under Schedule IV of Indian Wildlife Protection Act, 1972. A total of 27 species of reptiles belonging to two orders and 14 families were found in these ecosystems. Among them, one species *Melanochelys trijuga* is coming under Near Threatened category of IUCN. Three species, *Lissemys punctata, Varanus bengalensis* and *Python molurus* are under Schedule I, four species, *Ptyas mucosa, Xenochrophis piscator, Naja naja* and *Daboia russelii* are under Schedule II and 10 species, *Indotyphlops braminus, Grypotyphlops acutus, Eryx conicus, Oligodon arnensis, Oligodon taeniolatus, Dendrelaphis tristis, Lycodon aulicus, Ahaetulla nasuta, Boiga trigonata* and *Bungarus caereleus* are under Schedule IV of Indian Wildlife Protection Act, 1972.

4.5.3.3 Biodiversity of Kuthiru

16 Kuthiru from Karivellur - Peralam panchayat were taken for its biodiversity inventory. A total of 142 angiosperm species belonging to 60 families could find from the selected Kuthirus. Among them two species are endemic to India, 10 species were endemic to Western Ghats and 10 species were endemic to South West of India and one species, *Sonerila elegans* is under Vulnerable category of IUCN. 15 species reptiles belonging to two orders and 10 families were found in these ecosystems. Among them one species, *Melanochelys trijuga* is coming under Near Threatened category of IUCN. Three species, *Lissemys punctata, Varanus bengalensis* and *Python molurus* were Schedule I, four species, *Ptyas mucosa, Xenochrophis piscator, Naja naja* and *Daboia russelii* were Schedule II and four species, *Dendrelaphis tristis, Lycodon aulicus, Ahaetulla nasuta* and *Bungarus caereleus* were Schedule IV of Indian Wildlife Protection Act, 1972. A total of 13 species of amphibians belonging to four families were observed from Kuthiru. Among them one species, *Fejervarya sahyadris* is endangered category of IUCN and four species, *Euphlyctis cyanophlyctis, Euphlyctis hexadactylus, Hoplobatrachus tigerinus* and *Fejervarya rufescens* were under Schedule IV of Indian Wildlife Protection Act, 1972. Three species, *Fejervarya sahyadris, Fejervarya rufescens* and *Microhyla ornate* were endemic to Western Ghats.

4.5.3.4 Birds of Kuniyan Wetland Ecosystem

Kuniyan is having several ecological units including paddy fields, seasonal marshes, riparian vegetation and mangroves. A total of 153 species belonging to 15 orders and 52 families were recorded during the study. Among them, 59.2% species of the total are residents, 19.1% species are local migrants and 21.7% species are winter visitors. In the avian fauna recorded, one species *Ciconia episcopus*, coming under vulnerable and 5 species *Anhinga melanogaster, Numenius arquata, Sterna aurantia, Circus macrourus* and *Threskiornis melanocephalus* are coming under Near Threatened category of IUCN. The most abundant family was found to be Scolopacidae (10.5%) and the most abundant species reported were Little Egret, Cattle Egret, Median Egret, Pond Heron and Purple Moorhen. Indian Cormorant, Darter, Western Marsh Harrier, Dunlin and Indian Pitta were the occasional visitors to the study area. The availability of food materials and diversity of microhabitats attracts a large number of bird species including many migrants.

4.5.4 Endemic and Threatened Species in Lateritic Biotopes

The geographical and climatical features made laterite hillock system in supporting a unique assemblage of species. It is the home of some unique and sparsely distributed endemic plants such as *Nymphoides krishnakesara* (Joseph and Sivarajan, 1990), *Rotala malabarica* (Pradeep *et al.*, 1990), *Justicia ekakusuma* (Pradeep *et al.*, 1991) and *Lepidagathis keralensis* (Madhusoodanan and Singh, 1992). *Nymphoides krishnakesara* is a small water lilly appear during the wet phase in the small pools and ponds on the plateau. *Rotala malabarica* is a semi-aquatic plant seen largely in the temporary pools. *Justicia ekakusuma* (Pradeep *et al.*, 1991), aptly named because of its nature of flower, is rare and seen in the rocky edges of the plateau. *Lepidagathis keralensis* (Madhusoodanan and Singh, 1992) described for the first time from this locality and flowers during the dry phase. It is observed that the number of *Justicia ekakusuma* has been declining drastically over the years, while other newly described species remain uniformly distributed. *Chamaesyce katrajensis* (which now includes *Euphorbia katrajensis* var. *kasaragodensis*), is an endemic species originally described from the similar habitats of Katraja hills of Maharashtra. The beautiful small yellowish to pinkish flowers of this species is seen during the wet phase. This plant is poorly distributed and individuals of the species can be seen on the elevated portions of rocks. *Curuma oligantha* is another characteristic plant seen in the laterite habitats during the wet phase. It now includes plants described by Ansari *et al.* (1982) as *Curcuma cannanorensis* var. *cannanorensis* and var. lutea. Besides, the abundance of insectivorous plants such as *Drosera indica* and *Utricularia* spp. are worth mentioning. 138 endemic species were documented from the study area. Among them, 81 species are endemic to Western Ghats, 14 species to southern India, four to South west India, 28 to Peninsular India and 11 species to India. The presence of endemic species belonging to various threat categories such as *Hopea ponga*, *Capparis rheedei*, *Eriocaulon cuspidatum* and *Neanotis rheedei* are also indicate the conservation significance of the area.

Out of the 140 species of butterflies listed five species, *Pachliopta pandiyana*, *Curetis siva*, *Cirrochroa thais*, *Kallima horsfieldi* and *Mycalesis junonia* were endemic to Western Ghats. 5 species, *Pachliopta hector*, *Papilio clytia*, *Papilio liomedon*, *Castalius rosimo* and *Hypolimnas misippus* were Schedule I, 7 species, *Cepora nerissa*, *Cepora nadina*, *Appias lyncida*, *Euchrysops cnejus*, *Lampides boeticus*, *Parthenos sylvia* and *Tanaecia lepidea* were

Schedule II and one species, *Prioneris sita* is Schedule IV of Indian Wildlife Protection Act, 1972.

Out of the 27 reptile species documented, seven species, *Calotes rouxii, Ophisops beddomei, Eutropis macularia, Lygosoma punctate, Ristella spp., Oligodon taeniolatus* and *Echis carinatus*, are new to the lateritic hillocks of Northern Kerala. One species, *Melanochelys trijuga*, is coming under the IUCN category Near Threatened, 10 species were least concern category and 16 species were not evaluated. Out of the 27 reptilian species, three species, *Lissemys punctata, Varanus bengalensis* and *Python molurus* were coming under the Scheduled category I under the Indian Wildlife Protection Act, 1972. Five species, *Ptyas mucosa, Xenochrophis piscator, Cerberus rynchops, Naja naja* and *Daboia russelii* were in Scheduled category II and 11 species, *Indotyphlops braminus, Grypotyphlops acutus, Eryx conicus, Oligodon arnensis, Oligodon taeniolatus, Dendrelaphis tristis, Lycodon aulicus, Ahaetulla nasuta, Boiga trigonata, Bungarus caereleus* and *Echis carinatus* were in Scheduled category IV.

Fejervarya rufescens a laterite specialist and the only IUCN red data list endangered species in the study area. 7 species, *Fejervarya sahyadris, Fejervarya rufescens, Fejervarya brevipalmata, Microhyla ornata, Polypedates occidentalis, Pseudophilautus wynaadensis* and *Rhacophorus malabaricus* were endemic to Western Ghats. 5 species, *Euphlyctis cyanophlyctis, Euphlyctis hexadactylus, Hoplobatrachus tigerinus, Fejervarya rufescens* and*Fejervarya brevipalmata* were coming under the Scheduled category IV of Indian Wildlife Protection Act, 1972.

The lateritic biotopes of Northern Kerala harbor a vast variety of flora and fauna. Many of them rare, endangered and endemic species whose presence signifies the ecological importance of the region. Some faunal species occurring in this region are highly endemic and featuring in Red List of IUCN and are also protected by the Schedules of Indian Wildlife Protection Act (1972).

4.6 Ecosystem Dynamics

An ecosystem is a complex system of interconnected living organisms together with its environment. It is characterized by abundance of individual species populations, interspecies relationships, activity of organisms, physical and chemical characteristics of environment, flows of matter, energy and information, and the changes of these parameters with time. Ecosystem dynamics is the study of how ecosystems change over time. Ecosystems are dynamic in nature, subject to regular micro and macro disturbances, both internal and external.

The presence of rich biodiversity and its interactions with the landscape elements provide good ecosystem services to the entire landscape. Ecosystem services are the natural result of all the activities that occur in the biosphere. Owing to the hard impermeable rock surface, rocky plateaus serve as water catchments. Pollinators such as insects and nectivorous birds increase the productivity of crops by facilitating pollination. The larger animals and birds have a major role in seed dispersal also. Seed dispersers play critical roles in the regeneration and restoration of disturbed and degraded ecosystems. These landscapes and associated biodiversity and its subunits takes a major part in ecosystem services like, regulation of air, climate and natural hazards and take role in provision of food and clean water, cycling of nutrients, conversion of atmospheric carbon into biomass, the pollination of crops and natural vegetation, the balance of processes such as growth and decomposition, the provision of beauty and spirituality.

Ecosystem dynamics identifies positive and negative feedback loops as the basic mechanism through which biological creatures and whole ecosystems regulate themselves and change over time (Joss Colchester, 2016). Ecosystems are dynamic entities controlled both by external and internal factors. External factors, such as climate and the parent material that forms the soil control the overall structure of an ecosystem and the way things work within it, but are not themselves influenced by the ecosystem. While the resource inputs are generally controlled by external processes, the availability of these resources within the ecosystem is controlled by internal factors such as decomposition, root competition, or shading. Other internal factors include disturbance, succession, and the types of species present. From one year to another, ecosystems experience variation in their biotic and abiotic environments. Over-exploitation and over-use of the land have been recognized as environmental problems since the time of Plato. The basic issues are not new, what has changed in our time is the scale of the problem (Gilpin *et al.*, 1992b).

4.6.1 Microhabitat Vegetation Dynamics

Lateritic hillocks of Kerala which are often considered as 'wastelands' in remote sensing images due to devoid of vegetation were analyzed for its floral wealth and microhabitat diversity. In monsoon, the impermeable nature of the hard rock surfaces leads to water logging and creation of ephemeral wetlands (Watve, 2013). Plants species commonly seen in these areas are showing high specificity towards their microhabitat. Some species are capable of growing in very closely related microhabitats were as some are seen in two or more different microhabitats. But the species that grow in many different microhabitats having less dominance when comparing with the microhabitat specific plants. Most of the species are able to grow across a wide range of soil depths and slopes, although their dominance varies with difference in microhabitats.

A. Classification of Microhabitats

Plants on the plateaus are adapted to various microhabitats and each of these microhabitats is unique in its edaphic properties, water availability and species composition. The most common Microhabitats types on the lateritic hillock plateaus have been described along with characteristic species assemblages.

Ephemeral Flush Vegetation: It occurs on rocks where water seeps continuously through the rainy season and soil deposition is negligible. It occupies a large area on plateaus, colonized predominantly by *Desmodium heterophyllum, Desmodium triflorum, Eriocaulon cuspidatum, Drosera indica, Utricularia graminifolia*, etc. We could record 45 species in this particular microhabitat, in which 14 species specifically confined to this microhabitat

Exposed Rock Surfaces: They are flat or uneven rock surfaces, exposed to direct sunlight. They may gradually get covered by grasses during monsoon. Some common plants of the habitat are.*Polycarpaea corymbosa, Lepidagathis keralensis, Eriocaulon cuspidatum, Neanotis rheedei* etc.We could record 13 species in this particular microhabitat in which 2 species specifically confined to this microhabitat.

Rock Crevices/Fissures: They are frequently found on lateritic plateaus by providing a unique ecological niche specific to small number of species. Many species such as *Begonia* *crenata, Heliotropium marifolium. Polycarpaea corymbosa, Impatiens minor*.etc could list from this microhabitat. We could record 12 species in this particular microhabitat, in which 3 species specifically confined to this microhabitat.

Small Ephemeral Pools (SEP): They are shallow depressions which remain filled with water during monsoon. Since there is hardly any soil deposition plateau crust can be seen easily. The dominant species in this microhabitat includes *Dopatrium junceum, Rotala malabarica* and *Nymphoides krishnakesara*. We could record 16 species in this particular microhabitat in which 5 species specifically confined to this microhabitat.

Soil-filled Depressions (SFD): A specific microhabitat which are depressions that accumulate soil and water. *Eriocaulon cuspidatum, Curculigo orchioides, Utricularia graminifolia*, etc. are the most common species found here. We could record 35 species in this particular microhabitat in which 1 species specifically confined to this microhabitat.

Soil-rich Areas (SRA): These are soil-rich microhabitats with more than 20 cm soil-thickness. The gaps left between mats are mainly occupied by species *Commelina diffusa, Commelina erecta, Heliotropium marifolium*, etc. We could record 69 species in this particular microhabitat in which 9 species specifically confined to this microhabitat.

Tree Cover and Tree Associated (TCTA): This microhabitat is entirely different from the rest simply because the dominance of tree species. These are soil-rich areas of plateaus where tree could grow and survive. The covered shady areas provide a habitat which is entirely different from the harsh extreme environmental conditions prevailing on the exposed surfaces of plateaus. *Ficus arnottiana, Holigarna arnottiana, Hugonia mystax, Bridelia retusa, Benkara malabarica*, etc. are commonly found in this area. We could record 193 species in this particular microhabitat in which 156 species specifically confined to this microhabitat.

Boulders (B): They are large rocks either isolated or in groups. They are usually covered by lichens and bryophytes. Some typical angiosperm species also found to be associated with the systems which include *Begonia crenata, Begonia malabarica, Utricularia* *cecilii, Ariopsis peltata*, etc. We could record 9 species in this particular microhabitat in which 4 species specifically confined to this microhabitat.

Crust Edges or Cliffs (CEC): They are edges of the plateaus mainly inhabited species such as *Eriocaulon cuspidatum, Begonia crenata. Ariopsis peltata*.etc. We could record 10 species in this particular microhabitat.

When analyzed these communities for their similarity in species composition, the index varied from 0-0.71. A total of 36 combinations were possible when 9 communities were compared between each other for their similarity in species composition, but interestingly only 2 found to have more than 50% similarity (Table 4.44) which clearly indicates the diversity of habitats within the lateritic hillock. On the other hand, 2 microhabitats found 100% dissimilar (Table 4.44). This diversity in habitats and seasonality supports unique plant community in each habitat which further supports associated faunal elements and responsible for the high species diversity of the lateritic hills. Diversity is further supported by change in species composition and community within microhabitat due to seasonal fluctuations. Barren Rock (B) and Tree cover and Tree Associates (TCTA) were found to be the two communities which show more dissimilarity with remaining seven communities. This also indicates the succession pattern in the laterite hillock in which Barren Rock (B) represents the pioneer community and Tree cover and Tree Associates (TCTA) represent the climax community. A detailed study supported by quantitative information on each community may reveal the role and level of remaining communities in the process of succession and their role in the landscape.

The Shannon diversity index (H) is ranged from 2.11 to 3.64 (Table 4.45). The highest Shannon diversity index was recorded in Soil Rich Areas (3.64) followed by Ephemeral Flush Vegetation (3.51), Soil Filled Depressions (3.29), Small Ephemeral Pools (2.56), Exposed Rock Surfaces (2.25), Crust Edges (2.19), Rock Crevices (2.15) and Boulders (2.11). The Simpson index of dominance ranged from 0.0324 to 0.1515. The highest Simpson index was recorded in Rock Crevices (0.1515) followed by Boulders (0.1304), Exposed Rock Surfaces (0.1296), Crust Edges (0.1288), Small Ephemeral Pools (0.0951), Soil Filled Depressions (0.0489), Ephemeral Flush Vegetation (0.0380) and Soil Rich Areas (0.0324). The species richness index in different microhabitat of study area ranged from 0.0736 to 0.3369 (Table 6.5.1.2) .The highest species richness index (R) was recorded in Soil Rich Areas (0.3369) followed by Soil Filled Depressions (0.1486), Ephemeral Flush Vegetation (0.1447), Small Ephemeral Pools (0.1016), Crust Edges (0.0862), Rock Crevices (0.0809), Boulders (0.0752) and Exposed Rock Surfaces (0.0736).

Table 4.44: Similarity index value between microhabitats in a lateritic hillock, Northern Kerala

	EFV	ERS	RCF	SEP	SFD	TCTA	B	CEC	SRA
EFV		0.26	0.13	0.36	0.71[a]	0.071	0.1	0.31	0.37
ERS			0.24	0.19	0.54[a]	0.073	0.09	0.17	0.14
RCF				0.12	0.39	0.055	0.26	0.25	0.07
SEP					0.043	0.045	0.074	0.42	0.25
SFD						0.025	0.011	0.26	0.47
TCTA							0[b]	0[b]	0.26
B								0.42	0.125
CEC									0.14
SRA									

[a] microhabitats which having more than 50% similarity; [b] microhabitat which are 100% dissimilar

EFV=Ephemeral flush Vegetation, ERS=Exposed rock Surfaces, RCF=Rock crevices/fissures, SEP=Small ephemeral pools, SFD=Soil-filled depressions, TCTA=Tree cover and tree associated, B=Boulders, CEC=Crust edges or cliffs, SRA=Soil-rich Areas.

Table 4.45: Species Number, Shannon Diversity Index (H), Simpson Index (C) and Species Richness Index (R) of different microhabitats in a Lateritic Hillock, Northern Kerala

Microhabitat	No. of Species	Shannon Index	Simpson Index	Species Richness Index
EFV	45	3.51	0.0380	0.1447
ERS	13	2.25	0.1296	0.0736
RCF	12	2.15	0.1515	0.0809
SEP	16	2.56	0.0951	0.1016
SFD	35	3.29	0.0489	0.1486
SRA	69	3.64	0.0324	0.3369
B	9	2.11	0.1304	0.0752
CEC	10	2.19	0.1288	0.0862

The wetlands of the midland lateritic hillocks come under the wetland category defined by Ramsar Wetland Convention held in 1971(2013). In Northern Kerala, brackish water lakes and freshwater wetlands of midland lateritic hillocks are closely situated. These wetlands are very much active during North-West monsoon and are rich in biodiversity point of view. In the study area, we have identified three distinct types of wetland vegetation such as small ephemeral pools, seasonal ponds and permanent pools. Ephemeral flora grows gregariously and their life-cycle completes in about 40-60 days (Appendix XVIII) and ephemeral herbs increase the nutrient stability in laterite. They accumulate soil nitrogen and replenish the soil and make it available for other plants and improve nitrogen content. Climatic changes associated with each season cause dramatic changes in the appearance of seasonal ponds. The unique environment of Seasonal Ponds provides habitat for numerous rare plants and animals that are able to survive and thrive in these harsh conditions.

In general, the ephemeral plants are classified into three categories (i) Spring ephemerals-grow and reproduce in a short period of time when sufficient light is available during spring (ii) Weedy ephemerals-take advantage of open space and good soil moisture for their growth and reproduction and dies off completely leaving behind a dormant seeds for the next season (iii) Desert ephemerals- are adapted to take advantage of the short wet periods in arid climates (Nehru and Ramesh, 2001). Ephemeral herbs increase the nutrient stability in laterite by serving as a temporary sink for nutrients (Muller and Bormann, 1976). During their short life span ephemerals take up and accumulate soil nitrogen that would otherwise be lost from the ecosystem by leaching. This accumulated nitrogen replenishes the soil through microbial degradation of the ephemeral plant parts, stabilizes the soil nitrogen make it available for other plants and improves nitrogen content in water during monsoon so that the aquatic microorganisms will grow faster to support the survival of other related laterite flora and fauna. During this process ephemerals complete with other perennial herbs and accumulate more nitrogen within a short life span. The ephemeral plant communities can be used as a model system to study the effect of climate change and rain fall variation which directly influences the ecosystem stability of laterite.

B. Floral Inventory

A total of 263 angiosperm species were recorded from the study area in which 62 are endemic to Western Ghats (Appendix XIX). It is interesting and noteworthy that these species were distributed in 9 microhabitats and majority of them shows very narrow ecological niche. Four species (*Eriocaulon heterolepis*, *Utricularia cecilii*, *Eriocaulon cuspidatum* and *Impatiens minor*) found to be distributed in more than 5 microhabitats with a wide ecological niche as indicated by its presence in different microhabitats.

4.6.2 Host plant- Butterfly interaction

Butterflies and other wildlife rely on native plants for food throughout their entire lifecycle. Butterflies and skippers require both a host plant for the larvae to feed on and a place for adults to nectar. Butterflies lay their eggs on plants. These plants are called host plants. When the caterpillar hatches from its egg it will feed on its host plant. Butterflies are attracted to solid masses of color, flower fragrance, and flower shape. Some butterflies use only one kind of plant as a host whereas others use several to many different species. Adult butterflies feed on flower nectar and are not as specific about nectar plants as they are host plants. Host plants may vary greatly in quality and suitability, even over season (Nylin and Janz, 2009). Most herbivore insects appear to be specialists (Futuyma & Gould, 1979) and there are indications that specialization evolves faster than generalization does (Nosil, 2002). A large proportion of the herbivorous insects are specialized on only one or a few related hosts (Bernays and Graham, 1988). This is especially true for polyphagous species where hosts may differ in both nutritional content and chemical defences. Related host plants may present larvae with similar chemicals and larvae mid-gut needs to be able to cope with these chemicals in order for the larva to utilize a specific plant.

86 species of host plants were documented from the study area. which are used by 81 species of butterflies (Appendix XX).*Xylia xylocarpa. Pongamia pinnata. Citrus sp.* and *Barleria sp.* are the most widely used plants by butterflies. 5 species of butterflies uses thsese plants for nectar and as larval host. Four species of host plants were used by 4 different butterflies, 10 host plants were used by three butterflies. 21 plants were used by two butterflies and 47 species of host plants were used by only one specific butterfly.*Euploea core* butterfly is having a wide range of hosts with 8 plants followed by *Borbo cinnara* and *Neptis jumbah,* both having 5 host plants. 6 species of butterflies having 4 host plants, 14 species having 3 host plants, 16 species having 2 host plants. 42 species of butterflies having the narrow host range with only one host plant.

In cases of host plant use, differential gene expression depending on food would be beneficial since individuals would only need to express those that are necessary for consuming a specific plant. Food plant specificity is a corollary to strong habitat association. Some butterflies will eat a variety of plants in one family. Others are much more specialized, feeding on only one genus, or even on a single plant species. Although most butterfly caterpillars eat plant leaves, some caterpillars will only eat the flowers and fruits of the plant, and the butterfly must therefore be in the larval stage during bloom season of its host. This level of specialization is less usual, but not unknown. Those butterflies that are dependent on one food plant for larval development, or a certain food plant condition, usually have only one generation per year and these are known as univoltine species.

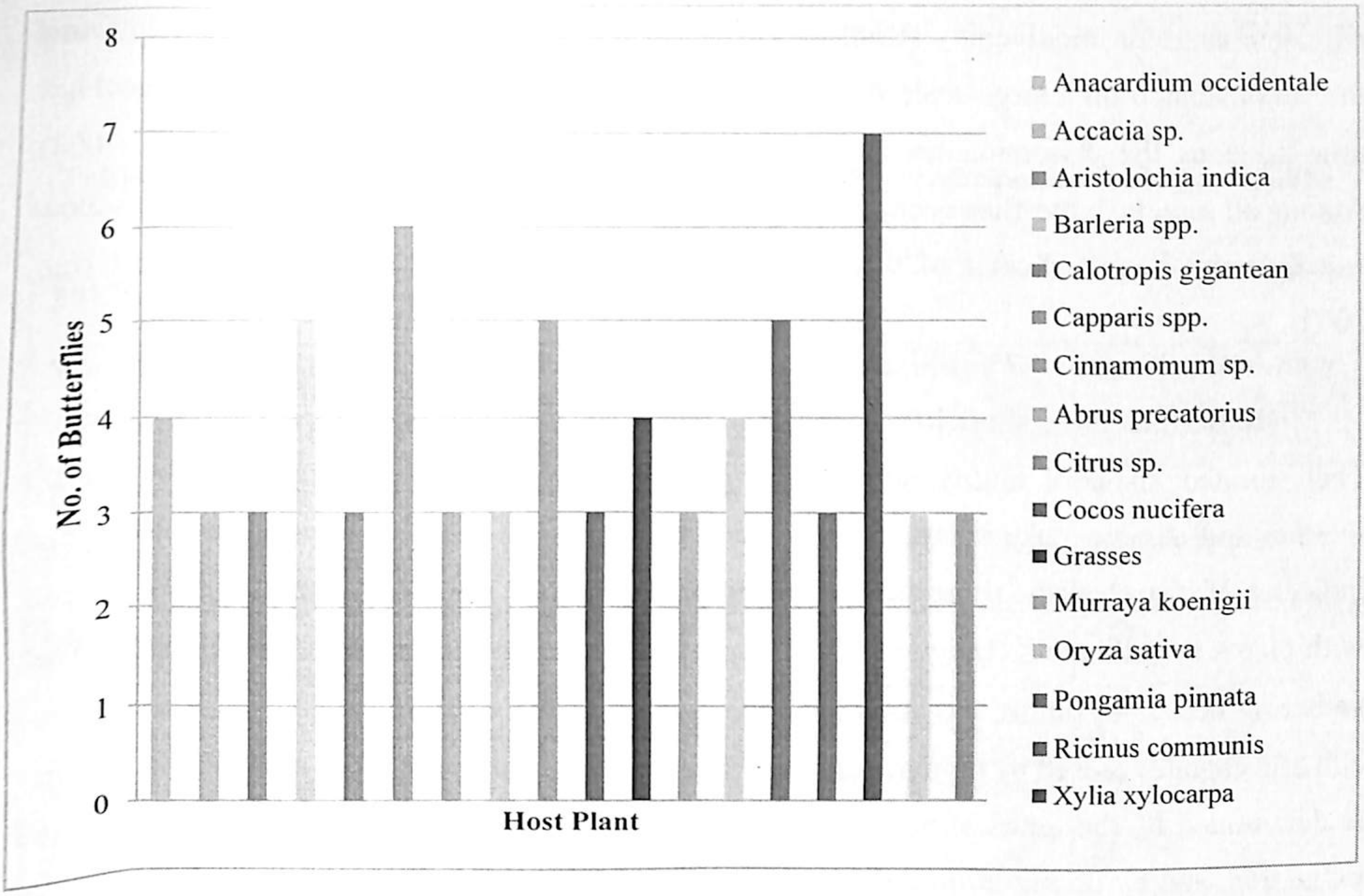


Fig.4.51: Distribution of Butterflies and their host plants in Kavvayi River Basin

Butterflies have an important role in plant pollination which is to maintain the ecosystem structure and function especially in a diverse biotope like laterite. Lepidopterian's diversity not only determined by area geographic, migration but also by plant structure, distribution, abundance and composition (Fleisman *et al.*, 2005; Cleary and Genner, 2004). Most of butterflies are nectar eater, only a small number is dirt eater. In butterfly a reproduction phase is a key element in their life. Host plant play one of critical point which are as shelter and larval host plants (Amir *et al.,* 2002). Furthermore the Interaction of insect herbivores plants is related to plant diversity. Larval host plant is the main in Lepidoptera (Tiple *et al.,* 2011). There are some factors that influence the selection of host plants such as external stimuli, environment and internal responses as well as a series of environmental barriers (Peggie and Amir, 2006). In general it can be assumed that the process of selection of host plants on insect is affected by volatile chemical signals the plant, after which the visual stimulus and then by non-volatile chemical signals (Hooks and Johnson, 2001). Diversity Lepidoptera was influenced by environmental conditions. Environmental factors that affect the altitude, temperature, humidity, intensity of light, weather and seasons (Rizal, 2007). Thus the Lepidoptera are used as bio-indicators that one can be used to measure the effect of climate change on biodiversity (Ramana *et al.*, 2011). The impact of human activities and forest conversion on a large scale is the cause of significant mass extinction in the geologic time scale as the dissemination of the distribution of organisms (Thomas *et al.*, 2004). Among all insects, butterflies occupy a vital position in the ecosystem as well as the existence and diversity is an indicator of the terrestrial environment is still awake (Aluri and Rao, 2002).

Butterflies have short life cycles and thus react quickly to environmental changes. Their limited dispersal ability, larval food plant specialization and close-reliance on the weather and climate make many butterfly species sensitive to fine-scale changes and a good indicator of disturbances. Butterflies are an important aspect of ecosystems for they interact with plants as pollinators. They are valuable pollinators when they move from plant to plant, gathering nectar. In future, the loss of biodiversity could be even more severe as a result of climatic changes caused by human activities. The number of organisms at a particular locality is determined by the types of habitat, their condition, structure and size, by speciation and extinction, and by immigration and local loss. This local biodiversity represent the result of gains and losses, which is influenced by natural and anthropogenic drivers.

4.6.3 Influence of Weather Parameters on Species Richness in Laterite Microhabitats

The species composition and dynamics may depend on abiotic factors including weather parameters especially in seasonal ecosystem. Harsh environmental conditions on the lateritic plateaus have given rise to plants with certain traits that allow them to overcome environmental adversities. These traits help the plants to overcome major environmental stresses such as drought, high temperature and light intensities and nutrient deficiency.

Results show that, species richness of Madayipara lateritic hillock was highly influenced by the weather parameters in 2013 and 2015 (Table, 6.43). The rainfall in this region is mainly from Southwest monsoon which commences during early June and normally ends by the middle of September. The average annual rainfall recorded here lies in the range of 1500-1800mm. The average annual minimum temperature is 31.5°C.Richness of species was highest during and following the monsoon season (June- December), when the weather is favorable for germination and growth of most of the species. Moisture, relative humidity and temperature were found to be optimum to sustain large number of species during this period. Increase in temperature and decrease of moisture from January onwards results in the gradual disappearance of most of the species with consequent reduction in species richness.

Table 4.46: Monthly Rainfall, Temperature, Humidity and Species Richness in 2013 and 2015

2013				
Month	**Rainfall (mm)**	**Temperature (°C)**	**Humidity (%)**	**Species Richness**
January	0	29.23	92.03	45
February	27	29.93	93.53	44
March	46.1	31.06	91.7	44
April	3.4	31.8	90.3	44
May	162.7	31.4	90.3	43
June	1457	26.85	93.3	88
July	1332	26.35	93.09	85
August	496.3	27.2	93.1	83
September	277.6	28.05	94.47	84
October	281.5	28.31	93.29	77
November	93.8	29.5	94.1	74
December	11.6	28.32	93.55	65
2015				
Month	**Rainfall (mm)**	**Temperature (°C)**	**Humidity (%)**	**Species Richness**
January	23.8	28.03	93.71	45
February	0	29.67	94.18	44
March	17.6	31.28	90.97	44
April	94	31.5	93.87	44
May	205.7	30.03	92.97	45

June	749.3	27.94	92.67	88
July	830.4	27.47	93.97	85
August	493.7	28.24	93.87	83
September	412	29.01	93.87	84
October	477.1	29.31	93.61	77
November	158	29.61	94.67	74
December	44.8	29.99	94.68	65

The graphical representation of the relation of weather parameters with species richness is given below.

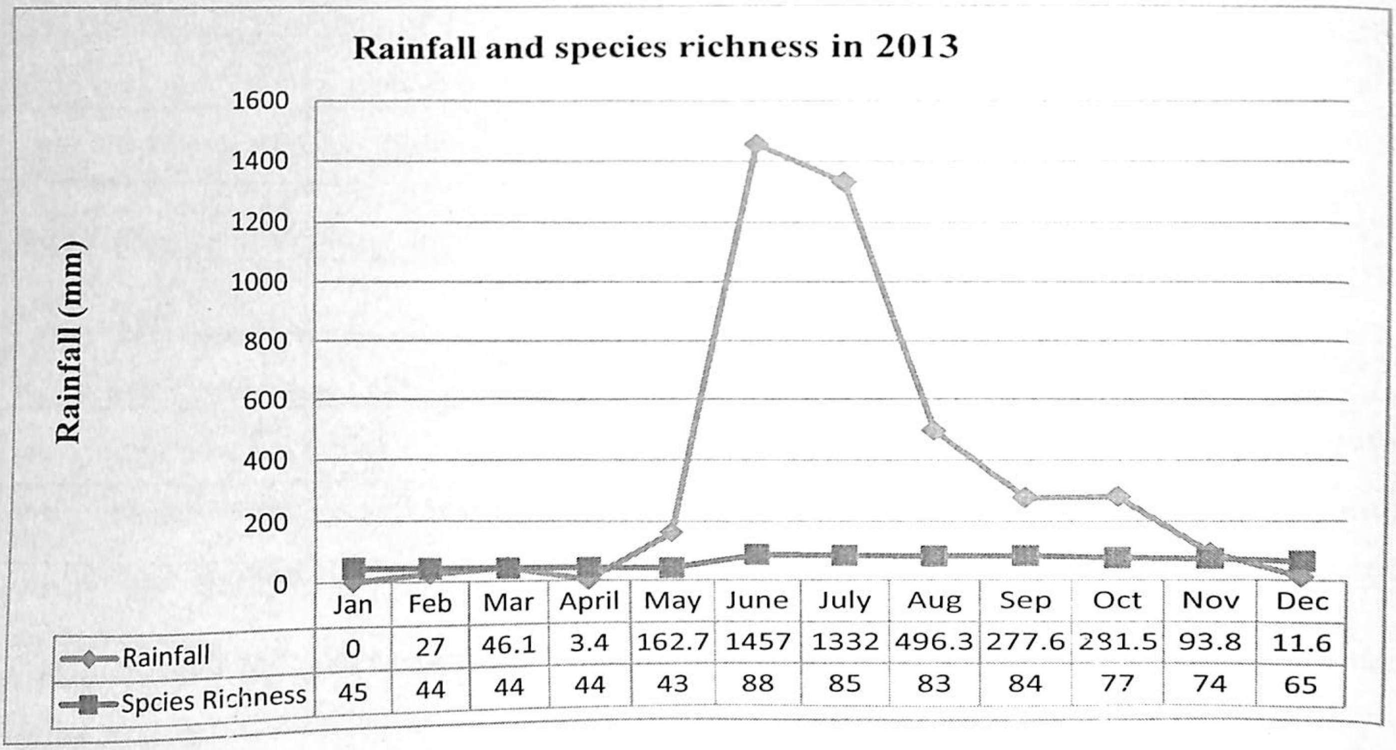
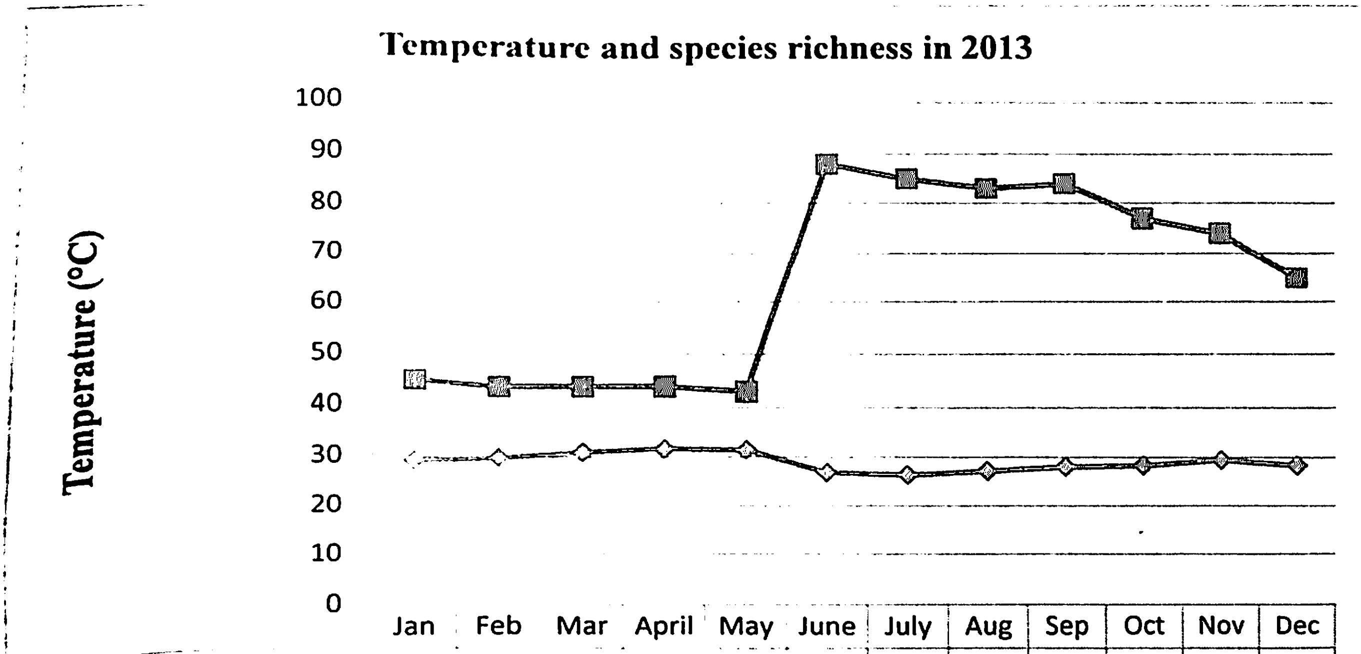
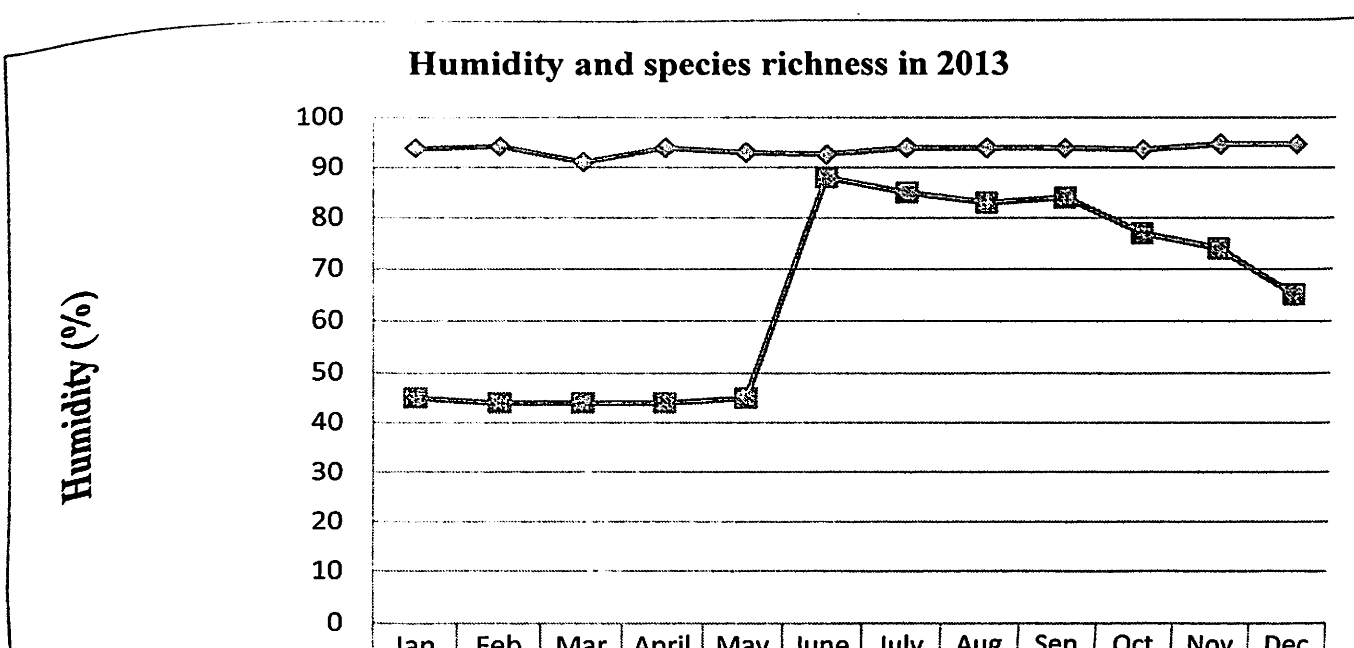


Fig 4.52: Rainfall and Species richness in 2013



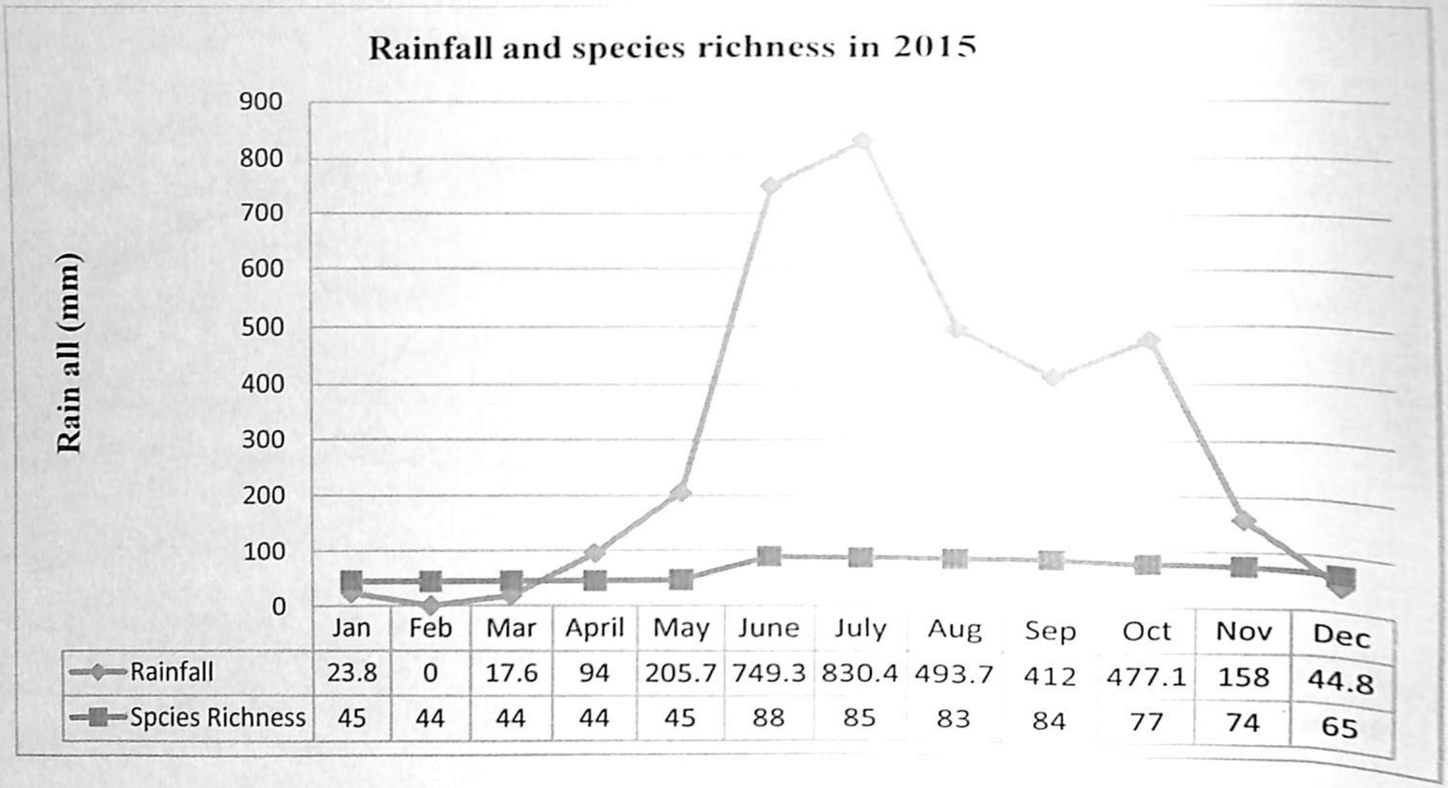
	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Temperature	29.23	29.93	31.06	31.8	31.4	26.85	26.35	27.2	28.05	28.31	29.5	28.32
Species Richness	45	44	44	44	43	88	85	83	84	77	74	65

Fig 4.53: Temperature and Species richness in 2013



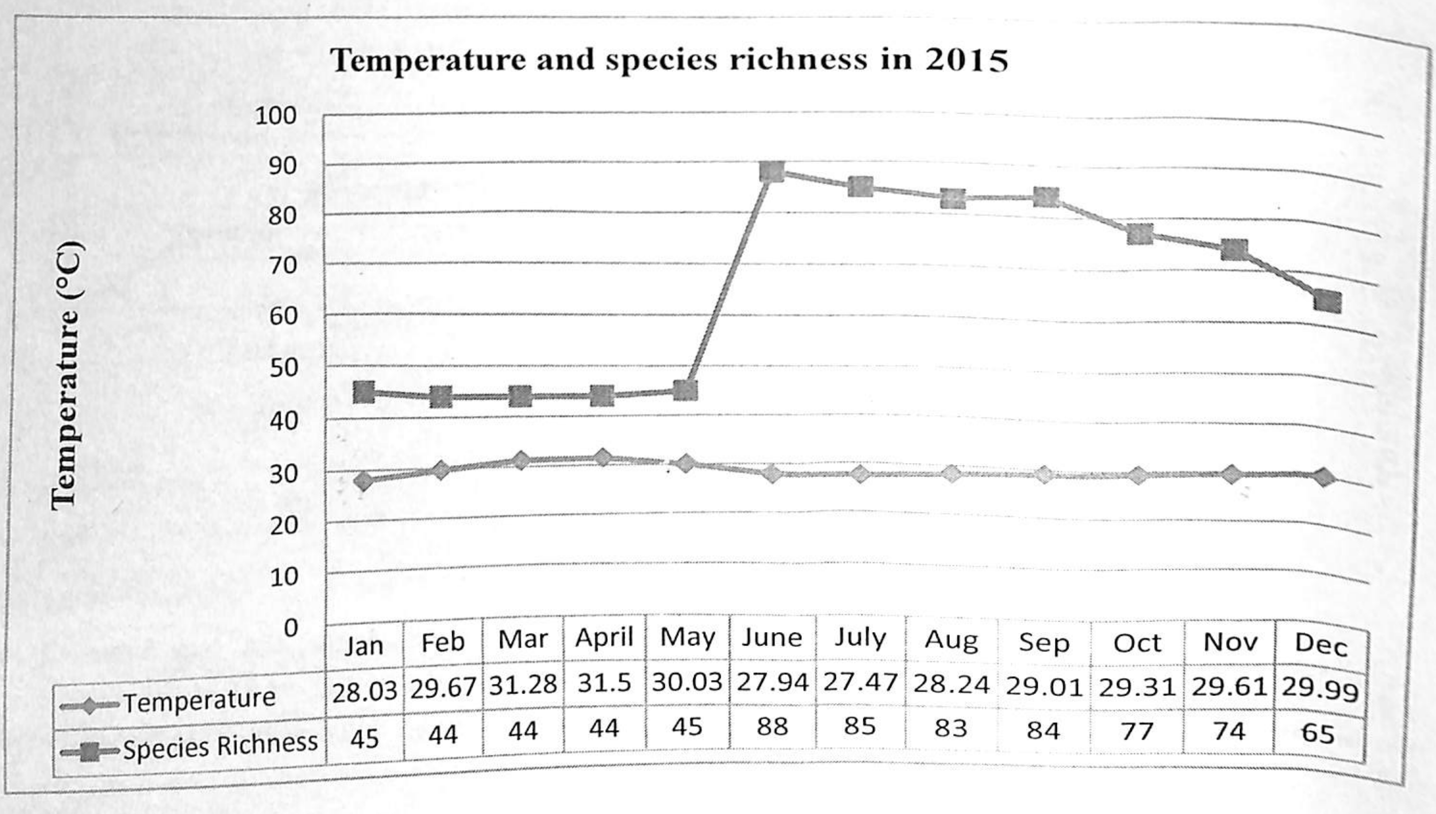
	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Humidity	93.71	94.18	90.97	93.87	92.97	92.67	93.97	93.87	93.87	93.61	94.67	94.68
Species Richness	45	44	44	44	45	88	85	83	84	77	74	65

Fig 4.54: Humidity and Species richness in 2013



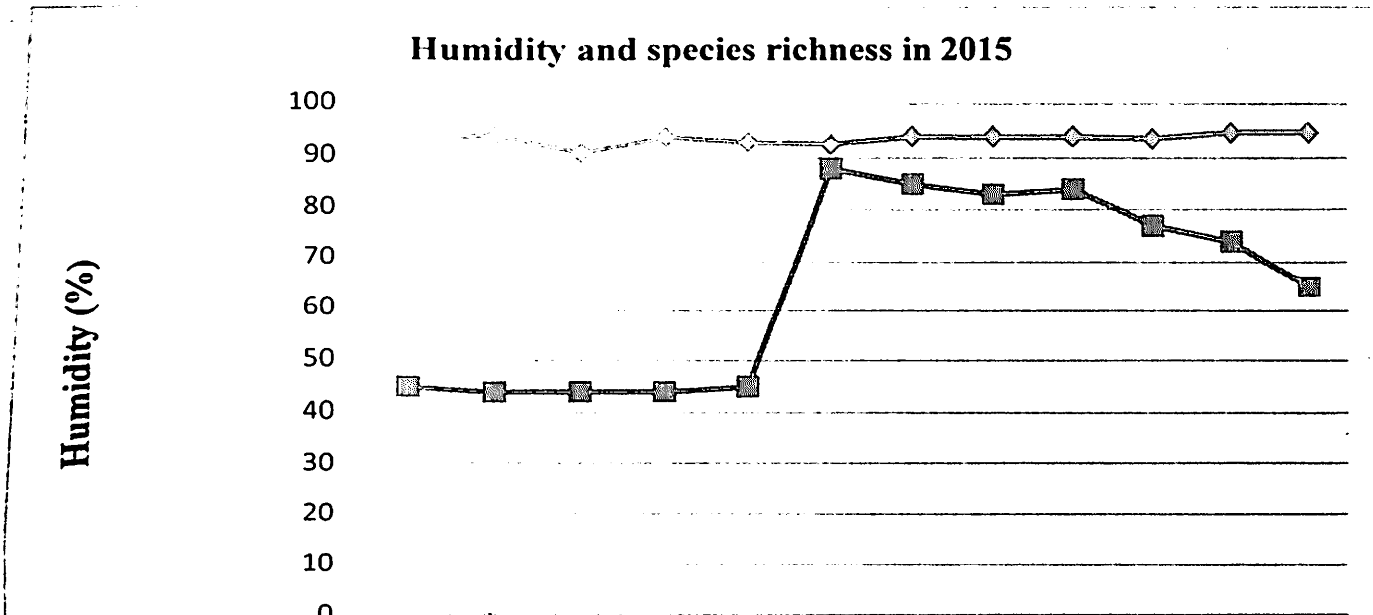
	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Rainfall	23.8	0	17.6	94	205.7	749.3	830.4	493.7	412	477.1	158	44.8
Spcies Richness	45	44	44	44	45	88	85	83	84	77	74	65

Fig 4.56: Rainfall and Species richness in 2015



	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Temperature	28.03	29.67	31.28	31.5	30.03	27.94	27.47	28.24	29.01	29.31	29.61	29.99
Species Richness	45	44	44	44	45	88	85	83	84	77	74	65

Fig 4.57: Temperature and Species richness in 2015



	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Humidity	93.71	94.18	90.97	93.87	92.97	92.67	93.97	93.87	93.87	93.61	94.67	94.68
Species Richness	45	44	44	44	45	88	85	83	84	77	74	65

Fig 4.58: Humidity and Species richness in 2015

Correlation of Species Richness with Weather Parameters during 2013 and 2015

Species richness was correlated with rainfall, temperature and humidity parameters by pooling the data of 2013 and 2015. The correlation coefficients of species richness with rainfall, temperature and humidity were high, indicating that species richness had good positive correlation with rainfall and humidity. Temperature was negatively correlated with species richness because many species dry up as temperature increases during summer period. Cheng Duan (2016) reported that the natural vegetation presents an increasing trend with the increase of rainfall. The present study also is in agreement with the above observation in case of vegetation dynamics.

According to Patricia E. Vidiella (1999), during the dry period the ephemeral species remain dormant in the soil as seeds and bulbs, respectively, and therefore are undetectable until their emergence after the rain. It has been extensively reported that temperature, as an important metric of climate change, is significantly regulated by vegetation variations at the regional scale. The enhanced canopy transpiration may provide much more moisture to the atmosphere. The increased atmospheric vapour would intensify the atmospheric downward long wave radiation and retain more energy at low levels of the atmosphere. (Xiaxiang Li, 2017). Moreover, the results also indicate that both effects are likely related to the evapotranspiration due to vegetation growth. By enhancing the canopy transpiration rate, vegetation growth may intensify the latent heat and exhibit a cooling effect during the daytime, which is consistent with the findings of Zhang *et al.*, (2013). In a recent comprehensive analysis of the depletion of rainfall in Western Australia, Andrich and Imberger (2013) state that the reduction of native vegetation from 60% to 30% of the land area in the wheat belt, between 1950 and 1970, coincided with an average 21% reduction in inland rainfall relative to coastal rainfall.

Brown (1977) reported that the availability of water was the most important environmental factor limiting growth and survival of range plants. He observed that water deficit develops in plant tissue when rate of transpiration exceeded that of water absorption. As the result shows a strong negative correlation with temperature, it indicated that water deficit condition due to increase in temperature suppresses some plants and so the vegetation in the month of February, March, April were scarce. Soon after the rainy season, the short duration plants vanished due to the unavailability of water to survive. Species richness as well as species diversity peaked at the monsoon season as most species of forbs and grasses completed their growth during this period. Seasonal vegetation is higher in this region. Short duration plants, ephemeral plants, with shallow depth are seen since the onset of the southwest monsoon, when the temperature is comparatively low and moisture content in the atmosphere is high. This favorable condition enhances the flourishing of short duration plants. The species richness as well as diversity declined again in the post monsoon (October) when most forbs withered away after completing growth and grasses dominated vegetation and reached seed dispersal stage. Only a very few annuals and perennials were seen in the winter and summer period and species richness as well as diversity were very low.

Correlation of Species Richness with Weather Parameters

The correlation study showed that the species richness is directly related to rainfall and humidity where as it was inversely with temperature. The correlations are highly significant also. In this circumstance, the regression analysis was done to make a model for prediction of richness based on various climatic conditions. Scatter plots were plotted to show the relation of species richness with the variables, rainfall, humidity and temperature.

The scatter plots of rainfall and humidity with species richness shows a positive relationship whereas, the relationship between temperature and species richness is negative.

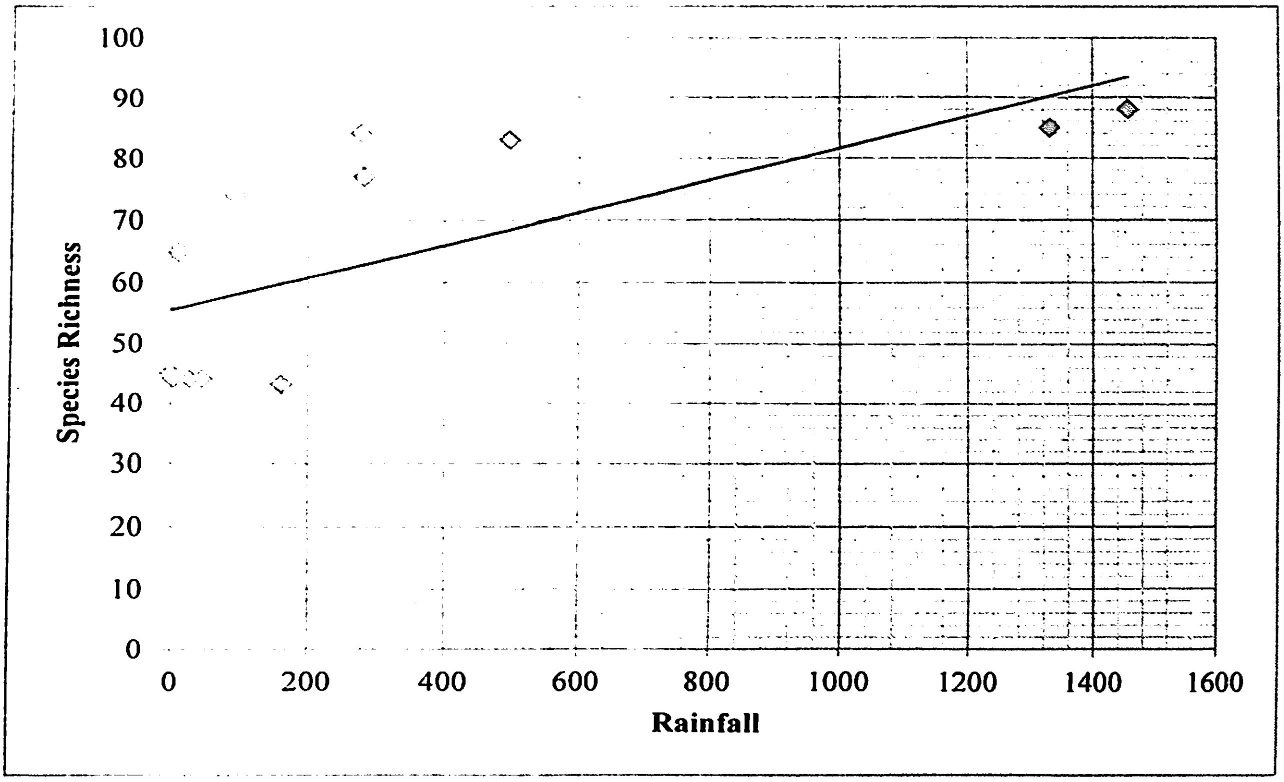


Fig 4.59: Rainfall and Species Richness

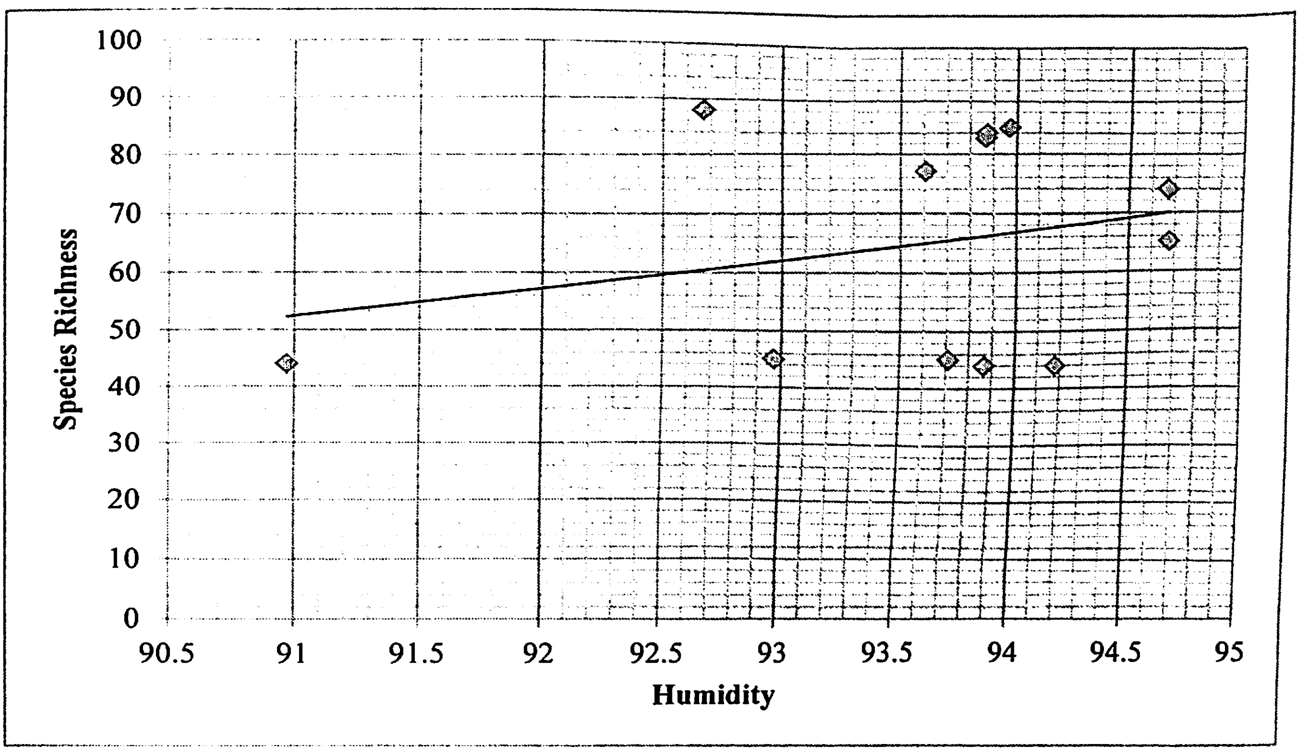


Fig 4.60: Humidity and Species Richness

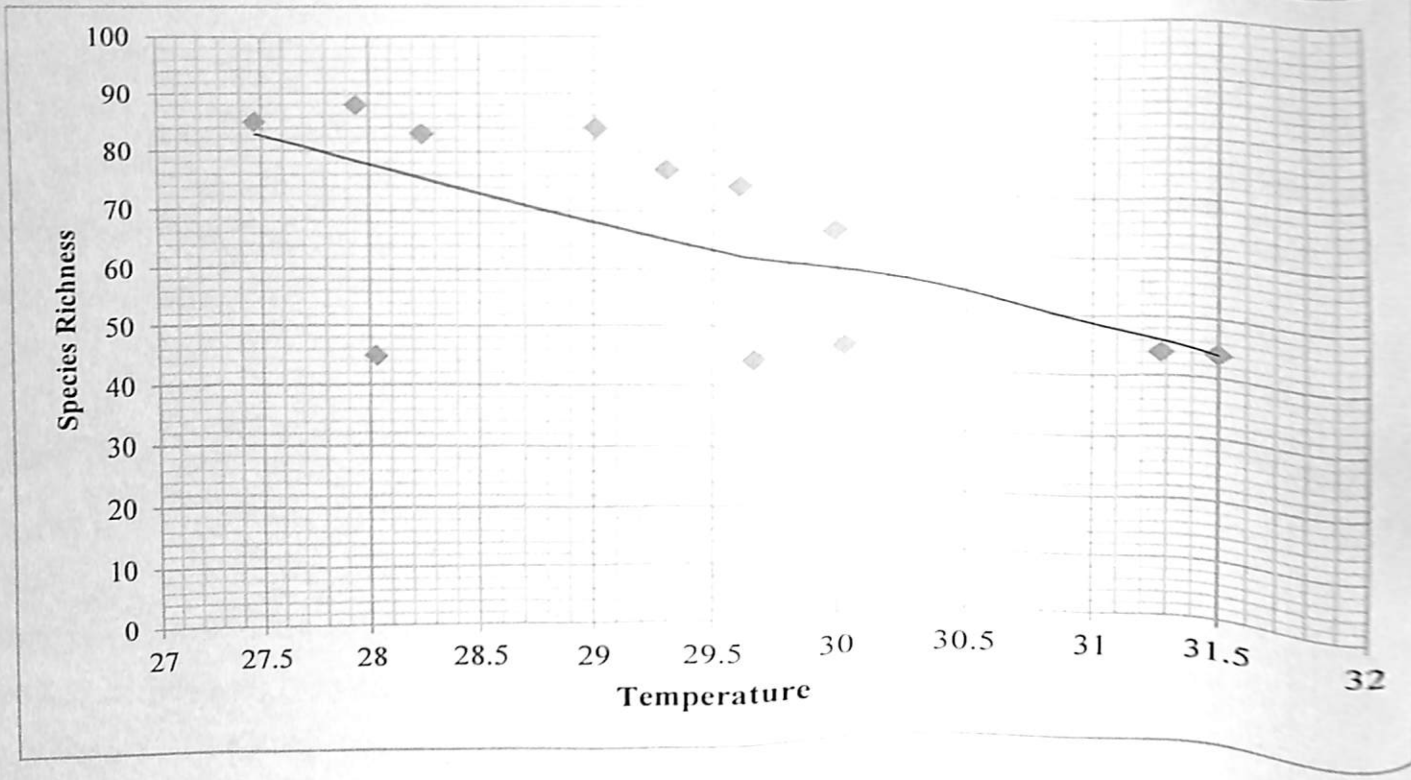


Fig 4.61: Temperature and Species Richness

Correlations were worked out with data and based on it some regression equations were developed for prediction purposes.

The model Species Richness = 0.026008*Rainfall + 55.58752 is found good for prediction of richness based on rainfall at Madayipara. Since the F in ANOVA is significant, the model is good. Also the variable rainfall is significant in the regression with high precision. R square value 0.4809 shows that the 48.09% variation in the data can be explained by rainfall itself.

R Square equals 0.4809 which shows only 48.09% of the variation in Species richness is explained by the independent variable rainfall. The closer to 1, the better the regression line (read on) fits the data.

Incorporating the variable Humidity to this model a much better regression equation is obtained. The new model is having an R square of 0.7865, indicating 78.65% variation in the data can be explained by rainfall and humidity. The model can be written as, Species Richness = 0.02087* Rainfall in mm + 8.00299* Humidity – 684

Regression Statistics	
Multiple R	0.886892305
R Square	0.78657796
Adjusted R Square	0.73915084
Standard Error	9.79354101
Observations	12

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	3181.445657	1590.723	16.584983	0.000958466
Residual	9	863.2210096	95.91345		
Total	11	4044.666667			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-684.73974	206.24113	-3.32009	0.00893
Rainfall	0.02087	0.00594	3.50963	0.00662
Humidity	8.00299	2.22916	3.59012	0.00583

By introducing Temperature, a much better regression equation with an R square of 0.8198, were obtained and it indicate 81.98% variation in the data can be explained by humidity, rainfall and temperature. The final model is written as,

Species Richness = 0.01085*Rainfall +4.53748*Humidity-4.72548*Temperature - 222.84293

Regression Statistics	
Multiple R	0.905472413
R Square	0.819880291
Adjusted R Square	0.752335399
Standard Error	9.542825741
Observations	12

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	3316.142482	1105.381	12.1383	0.002396046
Residual	8	728.5241849	91.06552		
Total	11	4044.666667			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-222.8429322	429.6809786	-0.51862	0.618059
Rainfall	0.010850847	0.010080025	1.07647	0.313105
Temperature	-4.725489808	3.885484181	-1.21619	0.258576
Humidity	4.537484669	3.582951348	1.26641	0.240994

From the present study, it is noted that the relationship between species richness with rainfall and humidity was positive and linear. From this analysis we could find that the increase in rainfall and humidity positively affect the species richness of the lateritic hillocks. The relationship between species richness and temperature was almost negative and nonlinear, which shows that the rise in temperature will adversely affect the species richness of the study area. By correlating the three climatic factors, we could predict the species richness and the regression line is;

Species Richness = 0.01085*Rainfall +4.53748*Humidity-4.72548*Temperature - 222.84293

4.7 Social and Policy Studies

4.7.1 Human impact and Threat to Lateritic Biotopes

The way by which human beings change themselves and change the surrounding environment is paced during last few decades due to the change in conservation values of society. Any anthropogenic developmental activity and extraction of natural resource will have its own impact and should be done scientifically which should further follow the restoration of landscape. Over the period, the strong concept of laterite as waste land, population growth, change in perception on environment together with emphasis on development has changed the land and landuse system of human dominated areas such as lateritic biotope of Northern Kerala. All human activities transform the landscape directly or indirectly and the land use/ land cover change testifies the first imprint of this modification. This change linked to human history initially began in a slow pace as demand for resources was limited, however with increase in population pressure and advent of industrial revolution the pace, magnitude and kind of change increased (Turner II *et al.,* 1990). Human induced change in landscape and consequences of these changes have been noted since long (Marsh, 1864; Engles, 1879). Understanding its impact and magnitude is necessary to develop conservation and restoration strategies for large scale ecological units such as lateritic biotope. The part of the human induced changes addressing landuse/landcover change is well embedded in the larger concept of global environmental change and earth system science.

In India, due to rapid increase in population, a negative growth trend was noticed in the area under forest, barren and uncultivable land, cultivable waste land, permanent pastures and grazing lands, miscellaneous trees not included in net sown area, fallow land other than current fallow (Satihal and Bhargava, 2007). But being a large country accommodating a large population of diverse characteristics, regional differences is quite often. In States like Kerala which having high population density with 859 persons per square kilometer; understanding the human impact on land cover and land use pattern to be documented for developing strategies for conservation and restoration.

The population pressure leads to the changes in land cover and land use pattern. Increase in population pressure can lead to expansion of agricultural land and intensification of cultivation and after a stage, it can cause conversion of agricultural land into residential and industrial area. To start with, the total land area in this state is divided into two major categories viz. land available for cultivation and land not available for cultivation. Unabated massive conversion of paddy fields for building houses, destruction of hillocks and the filling up of low-lying lands, paddy fields, water bodies and deforestation has been widespread in the recent past causing serious ecological and environmental problems and complex feedback effects on agricultural production. The spurt in real estate prices began taking its toll on paddy fields and lateritic hillocks.

The biodiversity rich lateritic biotopes due to its barren look marked as waste lands in government documents are more susceptible to such land use changes. Due to its wasteland status, these biodiversity rich areas are converted into laterite mines, monoculture plantations and for infrastructure development. The profit driven mindset of the people and shortage of per capita land also leads to the change in human concept of conservation. The rate of money flow is increased through the laterite quarrying and monoculture plantations like rubber over the last two or three decades. Local peoples are diverted from agriculture to mining business due to its high financial gain in short duration. These landscapes are further damaged due to poor restoration and conservation strategies. When we analyzed the extent of mining area over a period of time; there was 3190 ha area as lateritic hills during 1986 but it was reduced to 1372 ha by 2014 in the study area. When we analyze further these areas were converted to mining, monoculture plantations, infrastructure and other developmental activities.

4.7.1.1 Quarrying

Soil quarrying and leveling of hillocks have been reported from all over Kerala. Ever increasing human requirements and economic developments impose immense pressure on the natural resource base. Kerala state with an area of 38,863 Sq. Km. is one of the densely populated regions of the world having limited land and non-renewable resource availability. Indiscriminate resource extraction creates serious environmental problems which need to be tackled judiciously by striking a balance between the degree and need for development, and the extent of environmental degradation based on scientific studies. This is essential so as to utilize the natural resources to meet human needs and economic growth on one side and preserve environmental integrity, on the other. 223.82 hectares of the laterite exposed area in Kavvayi River Basin has been converted into various quarrying practices.

Soil is a key component of terrestrial ecosystem which is essential for the sustenance of life on earth. It is the end product of weathering of crustal rocks and is a heterogeneous, polyphasic, particulate, disperse and porous medium evolved through geological processes that took thousands of years (Holmes, 1976). It is the most important non-renewable resource on which agricultural prosperity depends (Tilman *et al.*, 2002). The soil categories in a region are influenced by factors like climate, geology, relief and various biotic components. A major part of Kerala is blanketed by lateritic soil, which is a product of tropical weathering of iron rich parent rocks in which several courses of transformation takes place. In recent years, excessive quantities of lateritic soils are being quarried from the residual hillocks in the lowlands and midlands of the State. This is to meet its ever increasing demand in the construction and infrastructure development. In most cases, no management plan or restoration programme is envisaged in mining areas for enhancing environmental quality and sustainability.

These mining activities have reached critical levels in the peripheral areas of the major developmental centers in the state (Maya *et al.*, 2012; Padmalal *et al.*, 2015). Although Environmental Impact Assessment studies are made to identify and evaluate the environmental effects of developmental projects, its ripple effects in the mining and quarrying sectors are often ignored and/or underestimated. This, in many of the occasions, has led to serious problems in the socio-environmental setting of the regions located close to the core developmental centers. At the same time, mining and quarrying for minerals and other natural products are inevitable for sustenance of civilization (Bradshaw, 1983; Auty and Mikesell, 1998; Sachs and Warner, 1999; MMSD, 2002). All these point to the imminent need for setting a balance between development and conservation of all our natural resources, including the soil resource, based on scientific planning and management of the environment.

Hill ecosystems are unique in several respects and offer habitat for a variety of plants and animals as we already discussed in previous chapters. Resource extraction cause significant negative impacts on flora and fauna of the affected area. The land use change due to quarrying causes loss of native/ agricultural vegetation in the area. Biotic and abiotic components of hill ecosystems operate in a balanced relationship. The top soil is the abode of many soil microorganisms which maintain the fertility of soil for plant growth. Therefore, obliteration of top soil in due course could reduce the net bio-productivity of the area. The activity leads to changes in soil profile, quality and processes detrimentally affecting the functioning of the entire ecosystem. Further, quarrying disturbs the natural habitats of certain animals inhabiting in the affected area and can even lead to habitat destruction and fragmentation. Leveling of hill ecosystems would result in significant negative impact on the biological diversity due to habitat fragmentation. Degradation of some midland laterite hills in the study area has already affected on some kaanams and sacred groves which are unique to these hills. Stripping of these hillocks along with its biological wealth is a huge loss to the society and a primary concern to be addressed.

4.7.1.2 Monoculture Plantations

Replacement of natural vegetation with various plantation crops is a global phenomenon. Rubber was introduced in Kerala as one of the plantation crops in the beginning of this century. At present it covers about 21% of total cropped area in the state (Chattopadhyay, 2015). As an estate crop it has mostly replaced natural vegetation of homestead and as small holding crop it is being raised in the places earlier given for tapioca, cashew and other mixed homesteads. Research results so far obtained from various sources indicate that there are negative environmental implications associated with rubber plantation (Chattopadhyay, 2015). However farmers will continue to grow rubber plantation due to its economic benefit. The rapid landuse change such as development of monoculture plantation in large scale ecological units has its own negative impacts on the local and regional environment. Rubber and cashew are the two major monocrops cultured in the Kavvayi River Basin. 1708 hectares area is now converted in to monoculture plantations, which are the lateritic exposed area earlier. In 1986, it was only 741 hectares of area are under monoculturing practices.

Attracted by the economic benefits and incentives to convert traditional farming areas into high value commercial crops many farmers switched to rubber cultivation. The traditional land use system evolved over a long period of time produced a unique landscape mosaic combining small agricultural plots and an array of locally adopted crops. These practices, to a great extent, were environmentally sustainable protecting the region's rich biodiversity and soil and water resources. One of the major factors driving transition to more intensive agriculture, mono-cropping and crop replacement has been population growth, including internal migration. Besides, there are infrastructural development like expansion of road network and markets making it easier for farmers to purchase agricultural inputs and to sell their crops. There are wide spread concern about environmental impact of rubber plantations among the rubber producing countries. These impacts are related to micro climate change, negative hydrological change/ drought, nutrient/ sediment run off, eutrophication and poisoning of rivers, and severe loss of species and extinction of local species. Environmental consequences of rubber plantation replacing natural vegetation and also traditional land use practices have been a matter of serious concern among the natural rubber producing countries across the World (Fox, 2014). Biodiversity loss may also lead to reduced total carbon biomass (Ziegler *et al.*, 2009) thereby impacting climate change.

Land use change is arguably the most pervasive socio-economic force driving changes and degradation of ecosystems, which is a matter of serious concern. A sustainable production system needs to internalize environmental considerations. The policy makers and government agencies involved in promotion of monoculture plantations may consider these issues for future decision making. Because of the lack of strong policy and laws to protect and conserve unique landscape like lateritic biotope, the land use changes are severe with adverse impact on environment.

4.7.1.3 Infrastructure and Developmental Activities

Infrastructure is a necessary part of the development associated with a growing human population, but it can also have devastating impacts on the environment. Nature is increasingly threatened by rapid infrastructure expansion. Expanding human development is a global conservation concern and a mounting problem in resource-rich ecosystems. Environmental concerns are not always considered during the design, planning and construction of infrastructure projects is a serious issue to be solved by the government through policy improvement.

Infrastructure expansion (Educational institutions, industries, IT parks, etc) and transport extension (including the construction of new roads) plays a critical role in the destruction of lateritic biotopes in Northern Kerala. To know the possible impact of these types of developmental activities on lateritic biodiversity, a study survey was done in the proposed IT Park at Cheemeni. From that study, it is observed that the proposed area supports vast varieties of floral and faunal groups (Appendices XIII). A total of 402 species of angiosperms are present in the proposed IT Park. Out of these 402 species, 3 were endemic to India, 9 species were endemic to South India, 2 were endemic to South West India, 29 were endemic to Western Ghats and 10 were endemic to Peninsular India. Two species *Capparis rheedei* and *Cyanotis burmanniana* are coming under the IUCN category Vulnerable. A total of 88 species of butterflies were listed. Out of this, 3 were endemic to the Western Ghats, two were coming under the Scheduled category II and 8 species coming under the Scheduled category IV of Indian Wildlife Protection Act, 1972. 15 amphibian species were observed from the area. Among this, four species are endemic to Western Ghats, two were endangered category of IUCN and 4 species were coming under Schedule IV of Indian Wildlife Protection Act, 1972. Among the 20 reptile species listed, two were Schedule I, four were Schedule II and 8 were belongs to Schedule IV of Indian Wildlife Protection Act, 1972. Out of the 115 species of birds observed two species, Indian spotted Eagle and Greater Spotted Eagle are coming under the IUCN category Vulnerable. The presence of rich diversity in the proposed IT park area shows the importance of these types of ecological units and adequate scientific study and conservation plans should be ensured while developing infrastructure in such unique ecosystems.

Mainstreaming conservation into infrastructure projects requires an appreciation for the extent of services they can provide to the environment and local communities. Since cashew and other mixed homesteads. Research results so far obtained from various sources indicate that there are negative environmental implications associated with rubber plantation (Chattopadhyay, 2015). However farmers will continue to grow rubber plantation due to its economic benefit. The rapid landuse change such as development of monoculture plantation in large scale ecological units has its own negative impacts on the local and regional environment. Rubber and cashew are the two major monocrops cultured in the Kavvayi River Basin. 1708 hectares area is now converted in to monoculture plantations, which are the lateritic exposed area earlier. In 1986, it was only 741 hectares of area are under monoculturing practices.

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Land use change is arguably the most pervasive socio-economic force driving changes and degradation of ecosystems, which is a matter of serious concern. A sustainable production system needs to internalize environmental considerations. The policy makers and government agencies involved in promotion of monoculture plantations may consider these issues for future decision making. Because of the lack of strong policy and laws to protect and conserve unique landscape like lateritic biotope, the land use changes are severe with adverse impact on environment.

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Mainstreaming conservation into infrastructure projects requires an appreciation for the extent of services they can provide to the environment and local communities. Since perhaps the beginnings of civilization, developing infrastructure and conserving biodiversity have been at odds. In the same, the conservation of biodiversity underpins all the sustainable development goals, and no long-term development can be envisaged unless the diversity of natural habitats and ecosystems are systematically included in the development, industrial and innovation policies. Safeguards policies are designed to identify and assess the potential severity of environmental and social impacts on infrastructure and design and implement plans to both prevent and reduce negative impacts and enhance the positive ones. The most important of safeguard policies relate to the scope, development and presentation of an environmental impact assessment (EIA) and its corresponding environmental management plan (EMP). It is also important to note that in most jurisdictions, it is the responsibility of the public agency deploying the project to conduct a preliminary screening during the project preparation phase, alongside the technical (engineering and financing) feasibility analyses to determine the scope of the EIA that will need to be conducted.

There needs to be more widespread recognition among policy makers, planners, businesses and financiers that green infrastructure does not necessarily provide the spatial and ecological conditions to promote biodiversity. Infrastructure planning and master planning therefore should be accompanied by: a) research to determine the biodiversity value of different green and sustainable infrastructure options; b) strategic environmental impact assessment to provide for holistic infrastructure planning and thereby increase the spatial and ecological conditions for green infrastructure to contribute to biodiversity preservation; c) environmental impact assessments that include more systematic biodiversity proofing so that the siting, design and construction of assets could be altered as needed to minimize interference to species and populations; d) environmental management plans could include express practices to ensure the same.

4.7.2 Conservation and Restoration Strategies

Humanity faces the challenge of meeting the development needs of a growing population from a shrinking natural resource base. Achieving a balance while doing this requires better understanding and recognition of conservation and development imperatives by all stakeholders, including governments, business and conservation communities. Current pressures on and losses of biodiversity are threatening to undermine these choices and adaptive responses, however. The last few years have witnessed a rapid increase in the rate at which biodiversity is being lost. As populations have grown and their consumption needs increased, so has the drive to extract more economically valuable resources more rapidly. Natural habitats that harbor some of the world's most valuable biodiversity are being lost at ever faster rates and over progressively wider areas. The laterite hillock system of Northern Kerala has been facing such serious danger of degradation over the years. Most part of the midland hillocks had been converted to plantations, building sites, mining sites, etc. The indiscriminate mining for laterite and soil demolishing the hillocks had been severely threatened the very existence of the biota, culture and also the water availability in most of the areas (Balakrishnan *et al.*, 2010). Since the study area is human dominated and having high biodiversity value, Community-based management systems for conservation are the useful which can protect locally threatened landscape units and its associated biodiversity and ecosystem services. The establishment of a system of protected areas (Community Reserves and Conservation Reserves) and a system for the protection of animals and plants through the designation of environmentally sensitive areas and environmentally sensitive species respectively is the main way to protect the lateritic biotopes from destruction. This will ensure

- Conservation and sustainable utilization of the biodiversity for the benefit of all sections of the society.
- Regular monitoring and data collection and biodiversity documentation
- Control over-exploitation of biodiversity for commercial purposes.
- Public involvement in biodiversity conservation.
- Awareness on biodiversity and its value.

In synchrony with international mechanisms, there has been an increasing focus in India to integrate local communities into biodiversity conservation (MoEF, 2010a,b) through the setup of various policies that assist communities in sustaining livelihoods without compromising biodiversity conservation (Pathak *et al.*, 2006). Conservation Reserves (IUCN Category VI) are community co-managed biodiversity rich areas, which are particularly close to existing PAs and serve as a buffer and/or corridor to establish a continuous PA network. Conservation Reserves can be declared only on government-owned lands (MoEF, 2010c). Community Reserves (IUCN Category V) on the other hand can be set up on biodiversity abundant lands that are privately or community-owned, and are managed by the individual(s)/communities in possession of the area. Both these reserves allow for extraction of natural resources, the levels of which are governed by a multi-stakeholder Reserve Management Committee (MoEF, 2010c). A Conservation Reserve Management Committee must consist of representatives from the local village Panchayat, non-governmental organisations (NGOs), and the Department of Agriculture and Animal Husbandry. Similarly, a Community Reserve Management Committee is to consist of five representatives nominated by the local Village Panchayat or the Gram Sabha, and one representative each from the State Department of Forest and Wildlife. A chairman would be elected by the committee who would also serve as a Wildlife Warden of the reserve (MoEF, 2010).

Before reserve declaration, relevant stakeholders need to be identified. Avenues for capacity building for local communities and their organizations (Panchayat) need to be opened, and empowered through the provision of opportunities. Opportunities and incentives (like ecotourism, value addition of NTFPs) need to be created for local communities to participate in the management and conservation. Local communities cannot always be expected to participate in an initiative which may not give them any benefits.

In contrast to the "traditional paradigm," in which biodiversity conservation and restoration as the responsibility of government, the "new paradigm" emphasizes cooperation among regional and local authorities, indigenous communities, private companies, and NGOs in the conservation of nature and natural resources.

While considering restoration strategies, biological reclamation technology is also suggested to improve the quality of soil. Biological reclamation technology referred to restore the soil fertility and biological production capacity. The application of biological reclamation technology could effectively improve the structure of reclaimed soil and restore the fertility of reclaimed land. Therefore, biological reclamation which included soil improvement and vegetation recovery was also considered as the continuation of engineering reclamation and an integral part of the land reclamation process. The amelioration of mycorrhizal and other microorganism on reclaimed soil achieved more and more concern, which could effectively promote vegetation recovery and will play an important role in maintaining the stability of ecosystems.

In mining sites where successional processes have been undisturbed for decades, varied grasslands as well as varied woodlands have developed. The stages of development, species composition and stand structure of these biotopes are very different. Such areas can serve as refuges for rare species or plant communities. In general successional stages of post-mining areas are characterized by a high heterogeneity in terms of substrate, soil hydrology and surface topography, often in combination with nutrient deficiency. Therefore, in order to enhance the biological diversity of the affected regions, the valuable ecological potential of the mining areas should be included in future restoration schemes.

Reclamation, rehabilitation, and restoration are all terms referring to activities that attempt to alter and improve the biological and physical conditions at a degraded site. These terms are closely linked, but they refer to distinct phases in the process of ecological recovery. Because of the high cost associated with preparation of ecologically impaired areas, an understanding of these processes and how they may complement each other is critical to success. Practiced independently, these activities will lead to different endpoints in ecological succession, and it is thus important to clearly delineate goals and objectives during the initial phase itself.

Reclamation means return the mined out land with useful life. It implies restoring the land to a form and productivity that is useful and inconformity with a prior land use. Reclamation always may not be a single-phase operation. Reclamation is the process to restore the ecological integrity of these disturbed mine land areas. It includes the management of all types of physical, chemical and biological disturbances of soils such as soil pH, fertility, microbial community and various soil nutrient cycles that makes the degraded land into productive. Management of top soil is important for reclamation plan to reduce the N losses and to increase soil nutrients and microbes.

Rehabilitation is to bring back the degraded land to a normal stage by a special treatment. It is a process of taking some mitigation measures for disturbed environmental condition created through mining activities. Rehabilitation is most similar to restoration in that rehabilitation planning uses preexisting ecological conditions as models or references. Rehabilitation seeks to recreate ecosystem processes, productivity, or services, but does not emphasize the establishment of preexisting species composition and diversity. Specifically, rehabilitation does not attempt to return the landscape to its prior baseline state or, in this case, does not attempt to reestablish pre-mining ecosystems.

Restoration is the process of returning the mined out land being fit to an acceptable environmental condition. However, the general acceptable meaning of the term is bringing the disturbed land to its original form. Restoration is often used to indicate that biological properties of soil are put back to what they were. Restoration is the process of returning an ecosystem to a close approximation of its historical or pre-mining condition prior to physical or chemical disturbance (National Research Council, 1992). Therefore, pre-mining conditions are the ideal starting point. Although an injured ecosystem may never return to conditions identical to those in the past, it can recover to conditions that are functionally equivalent to those of the previous environment. The underlying goal of restoration is ecological recovery. This goal must be realistic given the geologic, hydrologic, and biologic characteristics of the ecosystem. Therefore, in an area affected by historical mining, an understanding of pre-mining conditions is required.

Revegetation constitutes the most widely accepted and useful way to reduce erosion and protect soils against further degradation. The plant species must be selected on the basis of their ability to survive and regenerate in the local environment, and on their ability to stabilize the soil structure. Revegetation facilitates the development of N-fixing bacteria and mycorrhizal association, which are fundamental for maintaining the soil quality by mediating the processes of organic matter turnover and nutrient cycling. (Sheoran *et al.*, 2010). Hence Mine restoration efforts sometimes focused on N-fixing species of legumes, grasses, herbs, and trees. Metal tolerant plants can be effective for acidic and heavy metals bearing soils. Reclamation of abandoned mine land is a very complex process. Once the reclamation plan is complete and vegetation has established, the assessment of the reclaimed site is necessary to evaluate the success of reclamation. Evaluation of reclamation success focuses on measuring the occurrence and distribution of soil microflora community which is regulated by interactions between C and nutrient availabilities. Reclamation success also measures the structure and functioning of mycorrhizal symbiosis and various enzymatic activities in soil. Nutrient cycling is very closely linked to soil microbe activity. It is the process by which carbon, nitrogen, and phosphorus are reused within an ecosystem due to the metabolic activity of plants and soil microbes. Carbon and nitrogen cycles in particular are disrupted as soil microbe populations decline and must be re-established during reclamation. Grasses are considered as a nurse crop for an early vegetation purpose.

The excavations should be controlled by the local governing body and directed towards the total well-being of the local people. As with 'polluter pays' policy, the damaged land should be restored, by the people undertaking the excavation.

- Mining and quarrying should be restricted to meet the bare minimum requirement and that too following well defined measures, leaving least environmental damages. The activity of mining requires vigilance to ensure that the heritage of future generations – the biological as well as cultural heritage – is not adversely affected by the activities of today. (IUCN and ICMM, 2004).

- Environmental Impact Assessment (EIA) by competent agencies prior to the allocation of sites for mining and quarrying activities should be mandatory.

- Strict implementation of regulations for mining and quarrying in compliance with pollution control mechanism ensuring minimal disturbance to the environment.

- Restoration of the mined and abandoned areas should be the basic responsibility and adherence by those who are doing mining

- Implement Environment Management Plans approved by the appropriate authorities like the Pollution Control Board concurrently with the ongoing mining operations to ensure adequate ecological restoration of the affected areas.

- Identification and promotion of alternative construction material and ecofriendly construction models and methods to avoid pressure on natural resources.

- Environmentally safe disposal of the bye-products and wastes of all mining operations.

- Mining areas are to be rehabilitated to its original landscape, followed by providing adequate vegetal cover. These provisions are to be insisted up on while contractor's leasing.

- Afforestation and protection of existing vegetation cover is needed.
- In some areas, which are poor in biodiversity, the gravel bed could be removed so as to expose the underlying fine silty material that can be used for cultivation. At present such fine sediment is accumulated in the intervening valleys whose narrow flood plains are cultivated.
- Some pits in consolidated lateritic beds at lower elevations could be turned into the storage tanks that would hold back the water of monsoon rains to be used in dry season. This could help in ground water recharging. Trees could be planted successfully on the edges of these tanks.
- Some pits can be used as landfills for non-hazardous municipal or industrial wastes or mining overburden. Thereby the area could be leveled and given a soil veneer. Such land can be used for planting, recreation, or construction.
- Additional organic matter can be added to the veneer so as to promote future soil development and vegetal growth.
- The present regulatory system of controlling laterite mining is to be improved. Panchayat institutions should take more responsibility as a local environment.
- Drilling should be prohibited especially in inhabited areas. In unique spots mining shall not be allowed. Due weightage should be given to estimate ecological and economic services of the land before the land is leased out for mining.
- Quarrying can be restricted in such hillocks where agricultural productivity has been proved very low or areas with little vegetation cover/biodiversity value/ecosystem value.
- In densely populated areas manual mining can be recommended subject to certain environmental safe guards. Even in the case of manual mining, sprinkling of water over the laterites will bring down the quantum of suspended particulate matters in the air that will reduce air and noise pollution considerably.

- Most of these unique lateritic biotopes in the study area are private owned. So by only providing economic incentives to private landowners the protection of these landscapes could be done. This should be done by; promoting traditional multispecies homestead agroforestry system with incentives.

Public participation and involvement of local people is the basis of any success stories in restoration and conservation programmes. In this regard,

- Strategy to involve local non-governmental organizations from the planning stage itself is needed
- Ensure participation of residential associations and non-governmental organizations at the District, Block and Panchayat levels.
- Local bodies shall ensure such participation for the successful implementation of the project with least disturbance to the environment.
- Important to set up Environmental Information Centres, with the cooperation of NGOs and local Panchayat, containing information on the local resources and environmental conditions and also different systems of healthy environmental management practices.
- The environmental information shall also be disseminated through all possible ways.

6. Conclusion and Recommendations

1. Current study could reveal the significance of the study area in terms of its biodiversity and ecosystem services and could document the ecosystem diversity, microhabitat diversity and species level diversity.
2. Detailed landuse mapping and change detection indicates that a shift in landuse pattern in the study area where biodiversity rich lateritic hills were largely converted into mines, monoculture plantations etc.
3. The system facing threat due to prevailing concept of lateritic hillock as wasteland followed by mining, infrastructure development, change in traditional agricultural practice, lack of conservation and restoration strategies and lacuna in policy to support.
4. An urgent intervention from concerned authorities to formulate and implement strict guidelines and policies to conserve the species rich lateritic biotope and to evolve and implement site specific restoration and conservation strategies are suggested. Since these are human dominated landscapes, their involvement and contribution should be ensured during this process.

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Appendix I

List of Sacred Groves in Kavvayi River Basin

SI No.	Name of the Sacred Grove	Area in Hectare
1	Theyyottu Kavu	27.05
2	Varikkara Kavu	5.77
3	Edayilakkad Kavu	4.89
4	Karakka Kavu	4.00
5	Kaduvakkulam Kavu	3.98
6	Velichamthodu Kavu	3.31
7	Konginichal Kavu	3.18
8	Pacheny Kavu	2.33
9	Mappittissery II Kavu	2.00
10	Mappittissery Kavu	1.91
11	Chama Kavu	1.85
12	Edayilakkad_II Kavu	1.40
13	Kottyam Veedu Kavu	1.39
14	Olavara Mundya Kavu	1.31
15	Sastham Kavu I	1.15
16	Sulappu Kavu	1.14
17	Olavara II Kavu	1.08
18	Mappittissery Mundya Kavu	1.05
19	Cherukanam II Kavu	1.03
20	Nilayara Kavu	1.00
21	Dharmasastha Kavu	0.98
22	Paliyeri Mookambika Kavu	0.95
23	Karivallur Siva Kavu	0.84
24	Poomala Bhagavthy Kavu	0.83
25	Annur Kavu II	0.78
26	Udinoor Kshethra Palaka Kavu	0.76
27	Cherukanam Kavu I	0.73
28	Kavilottu Kavu	0.67
29	Unakoor Naga Kavu	0.62
30	Chenthanda Naga Kavu	0.60
31	Thottum Mundi Kavu	0.58
32	Ayitty Kavu	0.55
33	Orikka Kavu	0.52
34	Perumudikkal Bagavathy Kavu	0.52
35	Meethil Kattumuthy Kavu	0.50
36	Echikulangara Snpuram Kavu	0.49
37	Peralam Kavu	0.45
38	Vypiriyam Kavu	0.45
39	Theyyottu Theyya Kavu	0.43
40	Nagalayam Kavu	0.42
41	Kodakkadu Kizhakkekara Kavu	0.40

SI No.	Name of the Sacred Grove	Area in Hectare
42	Poomala Kavu II	0.37
43	Sastham Kavu I	0.37
44	Kuruvapilly Kavu	0.37
45	Sree Durga Bhagavathy Kavu	0.36
46	Udinoor Naga Kavu	0.35
47	Madakkal Gulika Kavu	0.34
48	Aara Kavu	0.32
49	Edattumuttam Naga Kavu	0.30
50	Karayil Thayneri Kavu	0.30
51	Chakrapani Siva Kavu	0.30
52	Podikkalam Kavu	0.29
53	Karamel Kavu II	0.28
54	Thimiri Kavu	0.27
55	Nagathinmoola Nagam Kavu	0.26
56	Chembilottu Bagavathy Kavu	0.23
57	Kurumba Bagavthy Kavu	0.23
58	Puthilottu Kavu	0.22
59	Oyalathu Puthiya Kavu	0.21
60	Madakkal Kavu	0.21
61	Pekkudam Kavu	0.19
62	Mellath Valappil Kavu	0.19
63	Karivallur Kavu	0.18
64	Vaniyillam Kavu	0.18
65	Thalichalam Kavu	0.17
66	Karuvapilly Naga Kavu	0.17
67	Parambathu Naga Kavu	0.16
68	Puzhakkara Perumundi Kavu	0.16
69	Chandera Kunnamangalam Kavu	0.15
70	Karamael Kavu I	0.15
71	Koyankara Kavu	0.15
72	Thottichal Naga Kavu	0.11
73	Chanthera Nagam Kavu	0.11
74	Machikkadu Kavu	0.10
75	Moyora Kavu	0.10
76	Dhasyath Nagam Kavu	0.10
77	Kanya Bhagavthy Kavu	0.09
78	Balal Naga Kavu	0.09
79	Kottoor Mahavishnu Kavu	0.07
80	Valiyaparambu Kalichan Kavu	0.06

Appendix II

Checklist of Angiosperms in Kavvayi River Basin

Sl No.	Scientific Name	Habit
	Family: Acanthaceae	
1	*Acanthus ilicifolius* L.	Shrub
2	*Andrographis atropurpurea* (Dennst.) Alston	Herb*[W]
3	*Andrographis elongata* (Vahl) Anders.	Herb*[W]
4	*Andrographis paniculata* (Burm. f.) Wall. ex Nees	Herb
5	*Andrographis stenophylla* C.B.Clarke	Herb*[PI]
6	*Asystasia chelonoides* Nees in Wall.	Herb
7	*Asystasia dalzelliana* Sant.	Herb
8	*Asystasia gangetica* (L.) Anderson	Herb
9	*Avicennia marina* (Forssk.) Vierh.	Tree
10	*Avicennia officinalis* L.	Tree
11	*Barleria cristata* L	Shrub
12	*Barleria prattensis* Sant.	Herb*[W]
13	*Barleria prionitis* L.	Shrub*[W]
14	*Crossandra infundibuliformis* (L.) Nees in Wall.	Shrub
15	*Dicliptera foetida* (Forssk.) Blatt.	Shrub
16	*Dicliptera paniculata* (Forssk.) I. Darbysh.	Herb
17	*Dipteracanthus prostrates* (Poir.) Nees in Wall.	Herb*[I]
18	*Ecbolium viride* (Forssk.) Alston in Trimen	Shrub
19	*Eranthemum capens* L.var. *capense* Hook. f.	Herb
20	*Haplanthodes neilgherryensis* (Wight) Majumdar	Herb*[W]
21	*Hygrophila ringens* (L.) Steud.	Herb
22	*Hygrophila schulli* (Buch.-Ham.)	Herb
23	*Justicia adhatoda* L.	Shrub
24	*Justicia ekakusuma* Pradeep & Sivar.	Herb*[SI]
25	*Justicia gendarussa* Burm. f.	Shrub
26	*Justicia japonica* Thunb.	Herb
27	*Justicia procumbens* L.	Herb
28	*Lepidagathis incurva* Buch.-Ham. ex D.Don	Herb
29	*Lepidagathis keralensis* Madhu. & Singh	Herb*[SI]
30	*Phaulopsis imbricata* (Forssk.) Sweet.	Herb
31	*Pseuderanthemum malabaricum* (Clarke) Gamble	Shrub
32	*Rhinacanthus nasutus* (L.) Kurz	Shrub
33	*Ruellia tuberosa* L.	Herb
34	*Rungia pectinata* (L.) Nees in DC.	Herb
35	*Staurugyne glutinosa* (Wall. ex Clarke) O. Ktze.	Herb

36	*Strobilanthes decurrens* Nees in DC.	Shrub*[SW]
37	*Strobilanthes heyneanus* Nees in Wall.	Shrub
38	*Strobilanthes integrifolius* (Dalz.) O. Ktze.	Shrub*[W]
39	*Thunbergia erecta* (Benth.) Anders.	Shrub
	Family: Agavaceae	
40	*Agave americana* L.	Shrub
41	*Furcraea foetida* (L.) Haworth	Shrub
	Family: Aizoaceae	
42	*Trianthema portulacastrum* L.	Herb
	Family: Alangiaceae	
43	*Alangium salviifolium* (L.f.) Wang.*ssp. hexapetalum* (Lam.) Wang.	Climber
	Family: Amaranthaceae	
44	*Achyranthes aspera* L.*var. aspera* Hook. f.	Herb
45	*Achyranthes bidentata* Bl.	Herb
46	*Aerva lanata* (L.) Juss. ex Schult	Herb
47	*Allmania nodiflora* (L.) R. Br. ex Wight in Hook.	Herb
48	*Alternanthera bettzickiana* (Regel) Voss	Herb
49	*Alternanthera brasiliana* (L.) Kuntze	Herb
50	*Alternanthera sessilis* (L.) R.Br. ex DC.	Herb
51	*Alternanthera tenella* Colla	Herb
52	*Amaranthus spinosus* L.	Herb
53	*Amaranthus tricolor* L.	Herb
54	*Amaranthus viridis* L.	Herb
55	*Celosia argentea* L. var. *argentea* Hook. f.	Herb
56	*Cyathula prostrate* (L.) Blume	Herb
57	*Gomprena celosioides* Mart.	Herb
	Family: Anacardiaceae	
58	*Anacardium occidentale* L.	Tree
59	*Holigarna arnottiana* Hook. f.	Tree*[W]
60	*Holigarna beddomei* Hook. f.	Tree*[SW,EN]
61	*Holigarna nigra* Bourd.	Tree*[SWI]
62	*Lannea coromandelica* (Houtt.) Merr.	Tree
63	*Mangifera indica* L.	Tree
64	*Spondias pinnata* (L. f.) Kurz	Tree
	Family: Ancistrocladaceae	
65	*Ancistrocladus heyneanus* Wall. ex J.Graham	Climber
	Family: Annonaceae	
66	*Annona reticulata* L.	Tree
67	*Annona squamosa* L.	Tree
68	*Cananga odorata* (Lam.) Hook. f. & Thoms.	Tree
69	*Polyalthia korintii* (Dunal) Benth.	Shrub

70	*Polyalthia longifolia* (Sonner.)	Tree
71	*Uvaria narum* (Dunal) Wall.	Climber
	Family: Apiaceae	
72	*Centella asiatica* (L.) Urban in Mart.	Herb
	Family: Apocynaceae	
73	*Aganosma cymosa* (Roxb.) G.Don	Climber
74	*Allamanda cathartica* L.	Climber
75	*Alstonia scholaris* (L.) R. Br.	Tree
76	*Catharanthus pusillus* (Murr.) G. Don	Herb
77	*Catharanthus roseus* (L.) G. Don	Herb
78	*Cerbera odollam* Gaertn. Fruct.	Tree
79	*Holarrhena pubescens* (Buch.-Ham.) Wall. ex G. Don	Tree
80	*Ichnocarpus frutescens* (L.) R. Br.	Climber
81	*Kammetia caryophyllata* (Roxb.) Nicolson & Suresh	Climber*^{W}
82	*Nerium oleander* L.	Shrub
83	*Plumeria obtusa* L.	Tree
84	*Plumeria rubra* L.	Tree
85	*Rauvolfia serpentina* (L.) Benth. ex Kurz	Shrub
86	*Tabernaemontana alternifolia* L.	Tree*^{W}
87	*Tabernaemontana divaricata* (L.) R. Br.	Shrub
88	*Wrightia tinctoria* (Roxb.) R. Br.	Tree
	Family: Araceae	
89	*Amorphophallus bonaccordensis* Sivad. & N. Mohanan	Herb*^{SW}
90	*Amorphophallus nicolsonianus* Sivad.	Herb*^{SW}
91	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Herb
92	*Ariopsis peltata* Nimmo in Graham	Herb
93	*Arisaema leschenaultii* Blume	Herb*^{SW}
94	*Caladium bicolor* (Ait. ex Dryand.) Vent.	Herb
95	*Caladium lindenii* (André) Madison	Herb
96	*Calamus thwaitesii* Becc. in Hook. f.	Climber
97	*Colocasia esculenta* (L.) Schott in Schott & Endl.	Herb
98	*Cryptocoryne retrospiralis* (Roxb.) Kunth, Enum.	Herb
99	*Cryptocoryne spiralis* (Retz.) Fisch. ex Wydler	Herb
100	*Dieffenbachia seguine* (Jacq.) Schott	Herb
101	*Pothos scandens* L.	Climber
102	*Typhonium flagelliforme* (Lodd.) Blume	Herb
103	*Typhonium roxburghii* Schott	Herb
104	*Amorphophallus commutatus* (Schott) Engl. in A. & C. DC.	Herb*^{W}
105	*Arisaema tortuosum* (Wall.) Schott in Schott & Endl.	Herb

106	*Pothos armatus* C.E.C. Fisch.	Climber*[SW]
	Family: Arecaceae	
107	*Areca catechu* L.	Tree
108	*Borassus flabellifer* L.	Tree
109	*Caryota urens* L.	Tree
110	*Cocos nucifera* L.	Tree
111	*Phoenix sylvestris* (L.) Roxb.	Tree
	Family: Aristolchiaceae	
112	*Aristolochia indica* L.	Climber
113	*Thottea siliquosa* (Lam.) Ding Hou	Shrub
	Family: Asclepiadaceae	
114	*Calotropis gigantean* (L.) R. Br. in Ait.f.	Shrub
115	*Ceropegia candelabrum* L.ssp.*candelabrum* Hook. f.	Climber
116	*Cosmostigma racemosum* (Roxb.) Wight	Climber
117	*Gymnema hirsutum* Wight & Arn. in Wight	Climber*[I]
118	*Gymnema sylvestre* (Retz.) R. Br. ex Schult. in Roem. & Schult.	Climber
119	*Holostemma ada-kodien* Schult. Schult. in Roem.	Climber
120	*Tylophora indica* (Burm. f.) Merr.	Climber
121	*Wattakaka volubilis* (L. f.) Stapf,	Climber
	Family: Asphodelaceae	
122	*Aloe vera* (L.) Burm.	Herb
	Family: Asteraceae	
123	*Acanthospermum hispidum* DC.	Herb
124	*Acmella calva* (DC.) R.K. Jansen	Herb
125	*Acmella paniculata* (Wall. ex DC.) R.K. Jansen	Herb
126	*Acmella uliginosa* (Sw.) Cass.	Herb
127	*Ageratina adenophora* (Spreng.) King & Robins.	Shrub
128	*Ageratum conyzoides* L.	Herb
129	*Ageratum houstonianum* Mill.	Herb
130	*Bidens pilosa*L. var. *minor* (Blume) Sherff	Herb
131	*Blumea axillaris* (Lam.) DC.	Herb
132	*Blumea clarkei* Hook. f.	Herb
133	*Blumea laevis* (Lour.) Merr.	Herb
134	*Blumea membranacea*Wall. ex DC.var. *membranacea* Hook. f.	Herb
135	*Blumea oxyodonta* DC in Wight	Herb
136	*Centratherum intermedium* Less.	Herb
137	*Chromolaena odorata* (L.) King & Robins.	Shrub
138	*Cissampelopsis corymbosa* (Wall. ex DC.) Jeffrey & Chen.	Climber
139	*Cosmos caudatus* Kunth in HBK	Herb

140	*Eclipta prostrata* L.	Herb
141	*Elephantopus scaber* L.	Herb
142	*Emilia scabra* DC.	Herb*[I]
143	*Emilia sonchifolia* (L.) DC. in Wight	Herb
144	*Epaltes divaricata* (L.) Cass., Bull.	Shrub
145	*Grangea maderaspatana* (L.) Poir	Herb
146	*Laggera crispata* (Vahl) Hepper & Wood	Herb
147	*Melampodium paludosum* HBK	Herb
148	*Mikania micrantha* Kunth in HBK	Climber
149	*Phyllocephalum indicum* (Less.) Kirkman	Herb
150	*Phyllocephalum phyllolaenum* (DC.) Narayana	Herb*[I]
151	*Sphaeranthus africanus* L.	Shrub
152	*Sphaeranthus indicus* L.	Herb
153	*Sphagneticola trilobata* (L.) Pruski	Shrub
154	*Synedrella nodiflora* (L.) Gaertn.	Herb
155	*Tridax procumbens*L.	Herb
156	*Vernonia cinerea* (L.) Less.	Herb
157	*Vernonia elliptica* DC. in Wight	Climber
158	*Wedelia trilobata* (L.) A. S. Hitchc.	Herb
	Family: Balsaminaceae	
159	*Impatiens balsamina* L.	Herb
160	*Impatiens chinensis* L.	Herb
161	*Impatiens dasysperma* Wight	Herb*[W,EN]
162	*Impatiens diversifolia* Wall. ex Wight & Arn.	Herb*[W]
163	*Impatiens flaccida* Arn.	Herb
164	*Impatiens herbicola* Hook. f.	Herb*[SW,VU]
165	*Impatiens minor* (DC.) Bennet	Herb*[PI]
	Family: Begoniaceae	
166	*Begonia malabarica* Lam.	Herb
	Family: Bignoniaceae	
167	*Millingtonia hortensis* L.f.	Tree
168	*Pajanelia longifolia* (Willd.) K. Schum.	Tree
169	*Spathodea campanulata* P. Beauv.	Tree
170	*Stereospermum colais* (Buch.-Ham. ex Dillw.) Mabb.	Tree
171	*Stereospermum suaveolens* (G. Don) DC.	Tree
172	*Tecoma stans* (L.) HBK	Shrub
	Family: Bixaceae	
173	*Bixa orellana* L.	Shrub
	Family: Bombacaceae	
174	*Bombax ceiba* L.	Tree
175	*Ceiba pentandra* (L.) Gaertn.	Tree

	Family: Boraginaceae	
176	*Cordia oblique* Willd.	Tree
177	*Heliotropium indicum* L.	Herb
178	*Heliotropium keralense* Sivar. & Manilal	Herb*[W]
179	*Heliotropium marifolium* Retz.	Herb
	Family: Brassicaceae	
180	*Brassica juncea* (L.) Czern. & Coss. in Czern.	Herb
	Family: Bromeliaceae	
181	*Ananas comosus* (L.) Merr.	Herb
	Family: Burmanniaceae	
182	*Burmannia coelestis* D.Don	Herb
	Family: Burseraceae	
183	*Garuga pinnata* Roxb.	Tree
	Family: Cactaceae	
184	*Cereus pterogonus* Lem.	Shrub
	Family: Campanulaceae	
185	*Lobelia alsinoides* Lam.	Shrub
	Family: Capparaceae	
186	*Capparis rheedei* DC.	Shrub*[W,VU]
187	*Capparis sepiaria* L.	Shrub
188	*Capparis zeylanica* L.	Shrub
189	*Cleome burmannii* Wight & Arn.	Herb
190	*Cleome rutidosperma* DC.	Herb
191	*Cleome viscosa* L.	Herb
192	*Crataeva magna* (Lour.) DC.	Tree
193	*Gynandropsis gynandra* (L.) Briq.	Herb
	Family: Caricaceae	
194	*Carica papaya* L.	Shrub
	Family: Caryophyllaceae	
195	*Polycarpaea corymbosa* (L.) Lam.	Herb
	Family: Casuarinaceae	
196	*Casuarina equisetifolia* L.	Tree
	Family: Celastraceae	
197	*Lophopetalum wightianum* Arn.	Tree
	Family: Chenopodiaceae	
198	*Chenopodium album* L.	Herb
	Family: Clusiaceae	
199	*Calophyllum inophyllum* L.	Tree
200	*Garcinia gummi-gutta* (L.) Robs.	Tree
201	*Garcinia mangostana* L.	Tree
202	*Mesua ferrea* L.	Tree
	Family: Combretaceae	

203	*Calycopteris floribunda* Lam.	Climber
204	*Combretum latifolium* Blume	Climber
205	*Quisqualis indica* L.	Climber
206	*Terminalia bellirica* (Gaertn.) Roxb.	Tree
207	*Terminalia catappa* L.	Tree
208	*Terminalia cuneata* Roth	Tree
209	*Terminalia elliptica* Willd.	Tree
210	*Terminalia paniculata* Roth.	Tree*[PI]
	Family: Commelinaceae	
211	*Commelina benghalensis* L.	Herb
212	*Commelina clavata* Clarke	Herb
213	*Commelina diffusa* Burm. f.	Herb
214	*Commelina erecta* L.	Herb
215	*Commelina longifolia* Lam.	Herb
216	*Commelina wightii* Raiz.	Herb*[W]
217	*Cyanotis axillaris* (L.) D. Don	Herb
218	*Cyanotis burmanniana* Wight	Herb*[W,VU]
219	*Cyanotis cristata* (L.) D. Don	Herb
220	*Cyanotis fasciculate* (Heyne ex Roth) Schult. f.	Herb
221	*Cyanotis papilionacea* (Burm. f.) Schult. f.	Herb*[PI]
222	*Cyanotis racemosa* Heyne ex Hassk.	Herb
223	*Floscopa scandens* Lour.	Herb
224	*Murdannia crocea* (Griff.) Faden	Herb*[PI]
225	*Murdannia gigantea* (Vahl) Brueck. in Engl. & Prantl	Herb
226	*Murdannia lanuginosa* (Wall. ex Clarke) Brueck.	Herb*[PI]
227	*Murdannia nudiflora* (L.) Brenan	Herb
228	*Murdannia pauciflora* (Wight) Brueck. in Engl. & Prantl	Herb
229	*Murdannia semiteres* (Dalz.) Sant.	Herb*[PI]
230	*Murdannia spirata* (L.) Brueck. in Engl. & Prantl	Herb
231	*Tradescantia pallida* (Rose) D.R.Hunt	Herb
	Family: Connaraceae	
232	*Connarus monocarpus* L.	Climber
233	*Connarus paniculatus* Roxb.	Climber
234	*Connarus wightii* Hook. f.	Shrub*[W]
235	*Rourea minor* (Gaertn.) Merr.	Climber
	Family: Convolvulaceae	
236	*Argyreia nervosa* (Burm. f.) Bojer	Climber
237	*Cuscuta reflexa* Roxb.	Climber
238	*Erycibe paniculata* Roxb.	Climber
239	*Evolvulus alsinoides* L. var. *alsinoides* Hook. f.	Herb

240	*Evolvulus nummularius* L.	Herb
241	*Hewittia malabarica* (L.) Suresh in Nicolson et al.	Climber
242	*Ipomoea barlerioides* (Choisy) Benth. ex Clarke in Hook. f.	Climber*[I]
243	*Ipomoea cairica* (L.) Sweet	Climber
244	*Ipomoea campanulata* L.	Climber
245	*Ipomoea eriocarpa* R. Br.	Climber
246	*Ipomoea hederifolia* L.	Climber
247	*Ipomoea marginata* (Desr.) Manitz	Climber
248	*Ipomoea mauritiana* Jacq.	Climber
249	*Ipomoea nil* (L.) Roth	Climber
250	*Ipomoea obscura* (L.) Ker-Gawl.	Climber
251	*Ipomoea pes-caprae* (L.) R. Br. in Tuckey	Herb
252	*Ipomoea pes-tigridis* L.	Climber
253	*Ipomoea pileata* Roxb.	Climber
254	*Ipomoea quamoclit* L.	Climber
255	*Ipomoea triloba* L.	Climber
256	*Jacquemontia pentantha* (Jacq.) G. Don	Climber
257	*Merremia umbellate* (L.) Hall. f. in Engl.	Climber
258	*Merremia vitifolia* (Burm. f.) Hall. f. in Engl.	Climber
259	*Neuropeltis malabarica* Ooststr.	Climber*[W]
260	*Xenostegia tridentate* (L.) Austin & Staples	Herb
261	*Xenostegia tridentata* (L.) Austin & Staplesssp. *hastata* (Desr.) Panigrahi & Murti	Herb
	Family: Costaceae	
262	*Costus speciosus* (Koenig) J.E. Smith	Herb
	Family: Crassulaceae	
263	*Bryophyllum pinnatum* (Lam.) Kurz	Herb
	Family: Cucurbitaceae	
264	*Benincasa hispida* (Thunb.) Cogn.	Climber
265	*Coccinia grandis* (L.) Voight	Climber
266	*Cucumis callosus* (Rottl.) Cogn. ex Cogn. & Harms.	Climber
267	*Cucumis melo* L.	Climber
268	*Cucumis sativus* L. f. *hardwickii* (Royl) W.J.de Wilde & Duyfjes	Climber
269	*Cucumis sativus* L. f. *sativus* Hook.	Climber
270	*Diplocyclos palmatus* (L.) Jeffrey	Climber
271	*Gymnopetalum tubiflorum* (Wight & Arn.) Cogn. in DC.	Climber
272	*Lagenaria siceraria* (Molina) Standley.	Climber
273	*Luffa cylindrica* (L.) Roem.	Climber
274	*Momordica charantia* var. *muricata* (Willd.) Chakrav.	Climber

275	*Momordica dioica* Roxb. ex Willd.	Climber
276	*Mukia maderaspatana* (L.) Roem.	Climber
277	*Solena amplexicaulis*(Lam.) Gandhi	Climber
278	*Trichosanthes anguina* L.	Climber
279	*Trichosanthes cucumerina* L.	Climber
280	*Trichosanthes lepiniana* (Naud.) Cogn. in A. & C. DC.	Climber
281	*Trichosanthes lobata* Roxb.	Climber*[PI]
282	*Trichosanthes nervifolia* L.	Climber
283	*Trichosanthes tricuspidata*Lour.var. *tricuspidata* Mohanan	Climber
284	*Zanonia indica* L.	Climber
285	*Zehneria maysorensis* (Wight & Arn.) Arn. in Hook.'s	Climber*[SW,EN]
	Family: Cycadaceae	
286	*Cycas circinalis* L.	Shrub
	Family: Cyperaceae	
287	*Carex indica* L.	Herb
288	*Cyperus arenarius* Retz.	Herb
289	*Cyperus castaneus* Willd.	Herb
290	*Cyperus compressus* L.	Herb
291	*Cyperus diffusus* Vahl	Herb
292	*Cyperus distans* L. f.	Herb
293	*Cyperus dubius* Rottb.	Herb
294	*Cyperus haspan* L.	Herb
295	*Cyperus iria* L.	Herb
296	*Cyperus javanicus* Houtt.	Herb
297	*Cyperus malaccensis* Lam.	Herb
298	*Cyperus rotundus* L.	Herb
299	*Cyperus zollingeri* Steud.	Herb
300	*Eleocharis dulcis* (Burm. f.) Trimen ex Hensch.	Herb
301	*Eleocharis retroflexa* (Poir.) Urban	Herb
302	*Fimbristylis aestivalis* Vahl, Enum.	Herb
303	*Fimbristylis ferruginea* (L.) Vahl, Enum.	Herb
304	*Fuirena umbellata* Rottb.	Herb
305	*Kyllinga brevifolia* Rottb.	Herb
306	*Kyllinga nemoralis* (J. R & G. Forst.) Dandy ex Hutch. & Dalz.	Herb
307	*Pycreus flavidus* (Retz.) Koyama	Herb
308	*Schoenoplectus litoralis* (Schrad.) Palla	Herb
	Family: Dichapetalaceae	
309	*Dichapetalum gelonioides* (Roxb.) Engl. in Engl. & Prantl	Shrub

	Family: Dioscoreaceae	
310	*Dioscorea alata* L.	Climber*[I]
311	*Dioscorea belophylla* Voigt	Climber
312	*Dioscorea bulbifera* L.	Climber
313	*Dioscorea hispida* Dennst.	Climber
314	*Dioscorea oppositifolia* L.	Climber
315	*Dioscorea pentaphylla* L.	Climber
316	*Dioscorea pubera* Blume	Climber
317	*Dioscorea wallichii* Hook. f.	Climber
	Family: Dipterocarpaceae	
318	*Hopea parviflora* Bedd.	Tree*[SW,VU]
319	*Hopea ponga* (Dennst.) Mabb.	Tree*[W]
320	*Hoppea fastigiata* (Griseb.) Clarke in Hook.f.	Tree
321	*Vateria indica* L.	Tree*[W]
	Family: Dracaenaceae	
322	*Dracaena terniflora* Roxb.	Shrub
	Family: Droseraceae	
323	*Drosera indica* L.	Herb
324	*Drosera peltata* Smith in Willd.	Herb
	Family: Ebenaceae	
325	*Diospyros bouxifolia* (Blume) Hiern	Tree
326	*Diospyros candolleana* Wight	Tree*[PI]
327	*Diospyros ebenum* Koenig	Tree*[DD]
328	*Diospyros peregrina* (Gaertn.) Gurke in in Engl. & Prantl	Tree
329	*Diospyros sylvatica* Roxb.	Tree
	Family: Elaeocarpaceae	
330	*Elaeocarpus variabilis* Zmarzty	Tree*[W]
	Family: Eriocaulaceae	
331	*Eriocaulon cuspidatum* Dalz.	Herb*[W]
332	*Eriocaulon heterolepis* Steud.	Herb*[W]
333	*Eriocaulon lancelotum* Miq. ex Koernicke	Herb*[SI]
334	*Eriocaulon parviflorum* (Fyson) R. Ansari & N.P. Balakr.	Herb*[PI]
335	*Eriocaulon quinquangulare* L.	Herb
336	*Eriocaulon sexangulare* L.	Herb
337	*Eriocaulon xeranthemum* Mart. in Wall.	Herb
	Family: Euphorbiaceae	
338	*Acalypha indica* L.	Herb
339	*Acalypha malabarica* Muell.-Arg.	Herb*[PI]

340	*Acalypha paniculata* Miq.	Herb
341	*Agrostistachys borneensis* Becc.	Tree
342	*Agrostistachys indica* Dalz.	Shrub*[PI]
343	*Agrostistachys borneensis* Becc.	Tree
344	*Antidesma acidum* Retz.	Shrub
345	*Antidesma bunius* (L.) Spreng.	Tree
346	*Antidesma montanum* Blume	Tree
347	*Aporosa cardiosperma* (Gaertn.) Merr.	Tree
348	*Breynia retusa* (Dennst.) Alston	Shrub
349	*Breynia vitis-idaea* (Burm.f.) C.E.C.Fisch.	Shrub
350	*Briedelia retusa* (L.) A.Juss.	Tree
351	*Briedelia stipularis* (L.) Blume	Shrub*[PI]
352	*Cleistanthus collinus* (Roxb.) Benth. ex Hook.f.	Tree
353	*Croton caudatus* Geisel.	Climber
354	*Croton malabaricus* Bedd.	Tree*[SW]
355	*Croton persimilis* Muell.-Arg.	Tree
356	*Euphorbia deccanensis* V.S.Raju	Herb*[SI]
357	*Euphorbia heterophylla* L.	Herb
358	*Euphorbia hirta* L.	Herb
359	*Euphorbia indica* Lam.	Herb
360	*Euphorbia milii* Desmoul	Shrub
361	*Euphorbia nivulia* Buch.-Ham.	Herb
362	*Euphorbia thymifolia* L.	Herb
363	*Excoecaria agallocha* L.	Tree
364	*Falconeria insignis* Royle	Tree
365	*Flueggea virosa* (Roxb. ex Willd.) Voigt	Shrub
366	*Glochidion zeylanicum* (Gaertn.) A. Juss.var.*zeylanicum* Hook. f.	Tree
367	*Hevea braziliensis* (Willd. ex A. Juss.) Muell.-Arg.	Tree
368	*Jatropha curcas* L.	Shrub
369	*Jatropha gossypifolia* L.	Shrub
370	*Macaranga indica* Wight	Tree
371	*Macaranga peltata* (Roxb.) Muell.-Arg. in DC.	Tree
372	*Mallotus philippensis*(Lam.) Muell.-Arg.	Tree
373	*Mallotus repandus* (Willd.) Muell.-Arg.	Shrub
374	*Manihot esculenta* Crantz.	Shrub
375	*Meineckia parvifolia* (Wight) Webster	Herb*[PI]
376	*Micrococca mercurialis* (L.) Benth	Herb
377	*Microstachys chamaelea* (L.) Muell.-Arg.	Herb
378	*Phyllanthus acidus* (L.) Skeels	Tree
379	*Phyllanthus amarus*Schum. & Thonn.	Herb

380	*Phyllanthus emblica* L.	Tree
381	*Phyllanthus leschenaultii* Müll.-Arg.	Shrub
382	*Phyllanthus reticulatus* Poir.	Shrub
383	*Phyllanthus rheedei* Wight	Herb
384	*Phyllanthus tenellus* Roxb.	Herb
385	*Phyllanthus urinaria* L.	Herb
386	*Phyllanthus virgatus* G. Forst.	Herb
387	*Ricinus communis* L.	Shrub
388	*Sauropus androgynus* (L.) Merr.	Shrub
389	*Tragia bicolor* Miq.	Climber*[Sl]
390	*Tragia involucrate* L.	Herb
391	*Antidesma alexiteria* L.	Tree
	Family: Fabaceae	
392	*Abrus precatorius* L.	Climber
393	*Acacia caesia* (L.) Willd.	Climber
394	*Acacia catechu* (L.f.) Willd.	Tree
395	*Acacia pennata* (L.) Willd.	Climber
396	*Acacia torta* (Roxb.) Craib	Climber
397	*Adenanthera pavonina* L.	Tree
398	*Aeschynomene americana* L.	Herb
399	*Aeschynomene aspera* L.	Shrub
400	*Albizia amara* (Roxb.) Boivin	Tree
401	*Albizia chinensis* (Osbeck) Merr.	Tree
402	*Albizia lebbeck* (L.) Benth.	Tree
403	*Albizia odoratissima* (L.f.) Benth.	Tree
404	*Albizia saman* (Jacq.) F.Muell.	Tree
405	*Alysicarpus bupleurifolius* (L.) DC.	Herb
406	*Alysicarpus racemosus* Benth.	Herb*[I]
407	*Bauhinia acuminata* L.	Shrub
408	*Bauhinia phoenicea* Wight & Arn.	Climber*[W]
409	*Bauhinia racemosa* Lam.	Tree
410	*Bauhinia tomentosa* L.	Shrub
411	*Butea monosperma* (Lam.) Taub.	Tree
412	*Caesalpinia coriaria* (Jacq.) Willd.	Tree
413	*Caesalpinia mimosoides* Lam.	Climber
414	*Caesalpinia pulcherrima* (L.) Swartz	Shrub
415	*Caesalpinia sappan* L.	Tree
416	*Cajanus scarabaeoides* (L.) Thouars	Herb
417	*Calopogonium mucunoides* Desv.	Climber
418	*Canavalia africana* Dunn	Climber
419	*Canavalia gladiata* (Jacq.) DC.	Climber
420	*Canavalia maritima* (Aubl.) Thouars in Desv.	Climber

421	*Cassia fistula* L.	Tree
422	*Centrosema molle* Benth.	Climber
423	*Chamaecrista mimosoides* (L.) Greene	Herb
424	*Chamaecrista nictitans* (L.) Moench ssp. *patellaria* (Collad.) Irwin & Barneby var. *glabrata* (Vogel) Irwin & Barneby	Herb
425	*Clitoria ternatea* L. var. *pleniflora* Fantz	Climber
426	*Clitoria ternatia* L. var. *ternatea* Hook. f.	Climber
427	*Crotalaria juncea* L.	Herb
428	*Crotalaria laburnifolia* L.	Shrub
429	*Crotalaria pallida* Dryand.var *pallida* Manilal & Sivar.	Shrub
430	*Crotalaria quinquefolia* L.	Herb
431	*Dalbergia horrida* (Dennst.) Mabb.*.	Climber*[W]
432	*Dalbergia latifolia* Roxb.	Tree*[VU]
433	*Delonix regia* (Boj. ex Hook.) Rafin.	Tree
434	*Derris scandens* (Roxb.) Benth.	Climber
435	*Derris trifoliata* Lour.	Climber
436	*Desmodium biarticulatum* (L.) F.v. Muell.	Herb
437	*Desmodium gangeticum* (L.) DC.	Herb
438	*Desmodium heterocarpon* (L.) DC. *heterocarpon* Mohanan	Shrub
439	*Desmodium heterophyllum* (Willd.) DC.	Herb
440	*Desmodium scorpiurus* (Sw.) Desv.	Herb
441	*Desmodium triflorum* (L.) DC.	Herb
442	*Desmodium triquetrum* (L.) DC.	Shrub
443	*Dichrostachys cinerea* (L.) Wight & Arn.	Tree
444	*Erythrina suberosa* Roxb.	Tree
445	*Erythrina variegate* L.	Tree
446	*Flemingia strobilifera* (L.) R. Br. ex Ait.f.	Shrub
447	*Geissaspis cristata* Wight & Arn.	Herb
448	*Gliricidia sepium* (Jacq.) Kunth ex Walp.	Tree
449	*Indigofera trifoliata* L. in Torner	Herb
450	*Indigofera zollingeriana* Miq.	Tree
451	*Lablab purpureus* (L.) Sweet	Climber
452	*Macrotyloma uniflorum* (Lam.) Verdc.	Climber
453	*Mimosa diplotricha* C. Wight *ex* Sanvalle	Climber
454	*Mimosa pudica* L.	Herb
455	*Mucuna pruriens* (L.) DC.	Climber
456	*Peltophorum pterocarpum* (DC.) Backer ex Heyne	Tree
457	*Pongamia pinnata* (L.) Pierre	Tree*[W]
458	*Pseudarthria viscida* (L.) Wight & Arn.	Shrub
459	*Pterocarpus marsupium* Roxb.	Tree

460	*Racosperma auriculiforme* (Benth.) Pedley	Tree
461	*Racosperma mangium* (Willd.) Pedley	Tree
462	*Saraca asoca* (Roxb.) de Wilde	Tree*[VU]
463	*Senna alata* (L.) Roxb.	Herb
464	*Senna hirsuta* (L.) Irwin & Barneby	Shrub
465	*Senna occidentalis* (L.) Link	Shrub
466	*Senna siamea* (Lam.) Irwin & Barneby	Tree
467	*Senna tora* (L.) Roxb.	Herb
468	*Smithia conferta* Smith in Rees	Herb
469	*Spatholobus parviflorus* (Roxb. ex DC.) O. Ktze.	Climber
470	*Stylosanthes fruticosa* (Retz.) Alston in Trimen	Shrub
471	*Tamarindus indica* L.	Tree
472	*Tephrosia purpurea* (L.) Pers.	Herb
473	*Vigna adenantha* (Meyer) Marechal	Climber
474	*Vigna trilobata* (L.) Verdc.	Climber
475	*Vigna unguiculata* (L.) Walp. ssp. cylindrica (L.) Eselt. in Hedrick	Climber
476	*Vigna vexillata* (L.) A. Rich. in Sagra	Climber
477	*Xylia xylocarpa* (Roxb.) Taub.	Tree
478	*Zornia diphylla* (L.) Pers.	Herb
479	*Zornia gibbosa* Span.	Herb
	Family: Flacourtiaceae	
480	*Flacourtia indica* (Burm. f.) Merr.	Shrub
481	*Hydnocarpus macrocarpa* (Bedd.) Warb. in Engl. & Prantl	Tree*[SW,VU]
482	*Hydnocarpus pentandra* (Buch.-Ham.) Oken	Tree*[W]
	Family: Gentianaceae	
483	*Canscora diffusa* (Vahl) R.Br. ex Roem. & Schult.	Herb
484	*Canscora pauciflora* Dalz.	Herb*[W]
	Family: Gesneriaceae	
485	*Rhynchoglossum notonianum* (Wall.) Burtt	Herb
	Family: Gnetaceae	
486	*Gnetum edule* (Willd.) Blume	Climber
	Family: Goodeniaceae	
487	*Scaevola sericea* G. Forst. ex Vahl	Shrub
	Family: Hippocrateaceae	
488	*Hippocratea arnottiana* Wight	Climber*[SI]
489	*Salacia chinensis* L.	Climber
490	*Salacia fruticosa* Heyne ex Lawson in Hook. f.	Climber*[W]
	Family: Hydrocharitaceae	
491	*Blyxa aubertii* L.C. Rich.	Herb

492	*Blyxa octandra* (Roxb.)Planch. *ex* Thwaites	Herb
493	*Ottelia alismoides* (L.) Pers.	Herb
	Family: Hypoxidaceae	
494	*Curculigo orchioides* Gaertn.	Herb
	Family: Lamiaceae	
495	*Anisochilus carnosus* (L. f.) Wall. ex Benth.	Herb
496	*Anisomeles indica* (L.) O. Ktze.	Herb
497	*Clerodendrum inerme* (L.) Gaertn.	Shrub
498	*Hyptis capitata Jacq.*	Shrub
499	*Hyptis suaveolens* (L.) Poit.	Shrub
500	*Isodon wightii* (Benth.) Hara	Herb*[PI]
501	*Leucas aspara* (Willd.) Link	Herb
502	*Leucas biflora* (Vahl) R. Br.	Herb
503	*Leucas ciliata* Benth. *ex* Wall.	Herb
504	*Ocimum americanum* L.	Herb
505	*Ocimum tenuiiflorum* L.	Shrub
506	*Orthosiphon thymiflorus* (Roth) Sleesen	Herb
507	*Platostoma hispidum* (L.) Paton	Herb
508	*Plectranthus amboinicus* (Lour.) Spreng.	Herb
509	*Plectranthus rotundifolius* (Poir.) Spreng.	Herb
510	*Pogostemon deccanensis* (Panigrahi) Press	Herb*[SI]
511	*Pogostemon paniculatus* (Willd.) Benth. in Wall.	Herb
512	*Pogostemon purpurascens* Benth. in DC.	Herb*[SWI]
513	*Pogostemon quadrifolius* (Benth.) F.Muell.	Herb*[I]
	Family: Lauraceae	
514	*Alseodaphne semecarpifolia* Nees	Tree
515	*Cinnamomum heyneanum* Nees in Wall.	Shrub*[W]
516	*Cinnamomum malabatrum* (Burm. f.) Blume	Tree*[W]
517	*Cinnamomum verum* Presl	Tree
518	*Litsea floribunda* (Blume) Gamble	Tree*[W]
519	*Litsea glutinosa* (Lour.) Robins.	Tree
520	*Persea macrantha* (Nees) Kosterm.	Tree
521	*Litsea deccanensis* Gamble	Tree
	Family: Lecythidaceae	
522	*Careya arborea* Roxb.	Tree
	Family: Leeaceae	
523	*Leea indica* (Burm. f.) Merr.	Shrub
524	*Leea macrophylla* Roxb. ex Hornem.	Shrub
	Family: Lentibulariaceae	
525	*Utricularia cecilii* Taylor	Herb*[W]
526	*Utricularia graminifolia* Vahl	Herb

527	*Utricularia lazulina* Taylor	Herb*[W]
528	*Utricularia malabarica* M.K. Janarth. & Henry	Herb*[SI]
529	*Utricularia reticulata* Smith	Herb
530	*Utricularia striatula* Smith	Herb
531	*Utricularia uliginosa* Vahl	Herb
	Family: Liliaceae	
532	*Asparagus fysonii* Macbr.*	Shrub*[W,EN]
533	*Asparagus racemosus* Willd.	Climber
534	*Gloriosa superba* L.	Climber
535	*Iphigenia indica* (L.) A. Gray ex Kunth	Herb
	Family: Linaceae	
536	*Hugonia mystax* L.	Climber
	Family: Loganiaceae	
537	*Mitrasacme indica* Wight	Herb
538	*Strychnos nux-vomica* L.	Tree
539	*Strychnos vanprukii* Craib	Climber*[W]
	Family: Loranthaceae	
540	*Dendrophthoe falcata* (L. f.) Etting.	Herb
541	*Helicanthes elastic* (Desr.) Danser	Shrub*[W]
542	*Macrosolen capitellatus* (Wight & Arn.) Danser	Shrub
543	*Macrosolen parasiticus* (L.) Danser	Shrub
544	*Scurrula parasitica* L.	Shrub
	Family: Lythraceae	
545	*Ammannia baccifera* L.	Herb
546	*Cuphea hyssopifolia* Kunth in HBK	Shrub
547	*Lagerstroemia indica* L.	Shrub
548	*Lagerstroemia microcarpa* Wight	Tree*[W]
549	*Lagerstroemia speciosa* (L.) Pers.	Tree
550	*Lawsonia inermis* L.	Shrub
551	*Rotala indica* (Willd.) Koehne in Engl.	Herb
552	*Rotala malabarica* Pradeep, Joseph & Sivar.	Herb*[SI]
553	*Rotala malampuzhensis* R.V. Nair ex Cook	Herb*[W]
554	*Rotala rosea* (Poir.) Cook, Boissiera	Herb
555	*Sonneratia alba* J. E. Smith in Rees	Tree
556	*Sonneratia caseolaris* (L.) Engl.	Tree
557	*Woodfordia fruticosa* (L.) Kurz	Shrub
	Family: Magnoliaceae	
558	*Magnolia champaca* (L.) Baill.	Tree
	Family: Malvaceae	
559	*Abelmoschus angulosus* Wall. ex Wight & Arn.	Shrub
560	*Abelmoschus esculentus* (L.) Moench.	Herb

561	*Abutilon indicum* (L.) Sweet ssp. Indicum	Shrub
562	*Herissantia crispa* (L.) Briz.	Herb
563	*Hibiscus hispidissimus* Griff.	Shrub
564	*Hibiscus lunariifolius* Willd.	Shrub
565	*Hibiscus micranthus* L.f.	Shrub
566	*Hibiscus mutabilis* L.	Shrub
567	*Hibiscus platanifolius* (Willd.) Sweet	Tree
568	*Hibiscus rosa-sinensis* L.	Shrub
569	*Hibiscus sabdariffa* L.	Shrub
570	*Hibiscus surattensis* L.	Shrub
571	*Pavonia burchellii* (DC.) Dyer	Shrub
572	*Sida acuta* Burm. f.	Shrub
573	*Sida cordata* (Burm. f.) Borss.	Herb
574	*Sida cordifolia* L.	Shrub
575	*Sida mysorensis* Wight & Arn.	Shrub
576	*Sida rhombifolia* L.	Shrub
577	*Sida rhomboidea* Roxb. ex Fleming.	Shrub*[PI]
578	*Talipariti tiliaceum* (L.) Fryxell, Contr.	Tree
579	*Theobroma cacao* L.	Tree
580	*Thespesia lampas* (Cav.) Dalz. & Gibs.	Shrub
581	*Thespesia populnea* (L.) Soland.	Tree
582	*Urena lobata* L. ssp. *lobata* Hook. f.	Shrub
583	*Urena lobata* L. ssp. *sinuata* (L.) Borss.	Shrub
	Family: Marantaceae	
584	*Maranta arundinacea* L.	Herb
585	*Stachyphrynium spicatum* (Roxb.) Schum.	Herb*[W]
	Family: Melastomataceae	
586	*Melastoma malabathricum* L.	Shrub
587	*Memecylon randerianum* SM & MR Almeida	Shrub*[SW]
588	*Memecylon talbotianum* Brandis in Talbot	Tree*[W]
589	*Memecylon umbellatum* Burm.f.	Shrub
590	*Memecylon wightii* Thw.	Shrub
591	*Osbeckia aspera* (L.) Blume	Herb
592	*Osbeckia muralis* Naud.	Herb*[W]
593	*Osbeckia wynaadensis* Clarke in Hook. f.	Shrub*[SW]
594	*Sonerila elegans* Wight var. *beddomei* Giri & M.P. Nayar	Herb*[SW,VU]
	Family: Meliaceae	
595	*Aglaia elaeagnoidea* (A.Juss.) Benth.	Tree
596	*Aglaia lawii* (Wight) Saldanha in Saldanha & Nicolson	Tree*[VU]

597	*Azadirachta indica* A. Juss.	Tree
598	*Chukrasia tabularis* A. Juss.	Tree
599	*Dysoxylum malabaricum* Bedd. ex Hiern in Hook. f.	Tree*[SW]
600	*Naregamia alata* Wight & Arn.	Herb*[PI]
601	*Swietenia macrophylla* King in Hook.	Tree
602	*Swietenia mahagoni* (L.) Jacq.	Tree
	Family: Menispermaceae	
603	*Anamirta cocculus* (L.) Wight & Arn.	Climber
604	*Cocculus laurifolius* DC.	Tree
605	*Cyclea peltata* (Lam.) Hook. f. & Thoms.	Climber
606	*Diploclisia glaucascens* (Blume) Diels in Engl.	Climber
607	*Stephania japonica* (Thunb.) Miers	Climber
608	*Tiliacora acuminata* (Poir.) Miers ex Hook.f. & Thoms.	Climber
609	*Tinospora cordifolia* (Willd.) Miers.	Climber
610	*Tinospora sinensis* (Lour.) Merr.	Climber
	Family: Menyanthaceae	
611	*Nymphoides indica* (L.) O.Ktze.	Herb
612	*Nymphoides krishnakesara* Joseph & Sivar.	Herb*[W]
	Family: Molluginaceae	
613	*Glinus oppositifolius* (L.) A. DC.	Herb
614	*Mollugo nudicaulis* Lam.	Herb
615	*Mollugo pentaphylla* L.	Herb
616	*Mollugo stricta* L.	Herb
	Family: Moraceae	
617	*Antiaris toxicaria* Lesch.	Tree
618	*Artocarpus gomezianus* Wall.	Tree
619	*Artocarpus heterophyllus* Lam.	Tree
620	*Artocarpus hirsutus* Lam.	Tree*[SW]
621	*Artocarpus incisus* (Thunb.) L.f.	Tree
622	*Ficus arnottiana* (Miq.) Miq.	Tree
623	*Ficus benghalensis* L. var.*benghalensis* Hook. f.	Tree
624	*Ficus callosa* Willd.	Tree
625	*Ficus exasperata* Vahl	Tree
626	*Ficus heterophylla* L.f.	Tree
627	*Ficus hispida* L. f.	Tree
628	*Ficus microcarpa* L. f.	Tree
629	*Ficus racemosa* L.	Tree
630	*Ficus religiosa* L.	Tree
631	*Ficus tinctoria* G. Forst. ssp. *parasitica* (Koen. ex Willd.) Corner	Tree
632	*Morus alba* L.	Shrub

	Family: Moringaceae	
633	*Moringa pterygosperma* Gaertn.	Tree
	Family: Musaceae	
634	*Musa x paradisiaca* L.	Herb
	Family: Myristicaceae	
635	*Knema attenuata* (Hook. f. & Thoms.) Warb.	Tree*[W]
636	*Myristica fragrans* Houtt.	Tree
	Family: Myrsinaceae	
637	*Ardisia solanacea* Roxb.	Shrub
638	*Myrsine wightiana* Wall. ex DC.	Tree
	Family: Myrtaceae	
639	*Pimenta dioica* (L.) Merr.	Tree
640	*Psidium guajava* L.	Tree
641	*Syzygium aromaticum* (L.) Merr. & Perry	Tree
642	*Syzygium caryophyllatum* (L.) Alston in Trimen	Tree
643	*Syzygium cumini* (L.) Skeels var *axillare* (Gamble) Tenjarla & Kashyapa	Tree*[W]
644	*Syzygium cumini* (L.) Skeelsvar *cumini* Manilal & Sivar	Tree
645	*Syzygium grande* (Wight) Walp.	Tree
646	*Syzygium jambos* (L.) Alston in Trimen	Tree
647	*Syzygium malaccense* (L) Merr. & Perry	Tree
648	*Syzygium travancoricum* Gamble	Tree*[SW,CE]
649	*Syzygium zeylanicum* (L.) DC.	Tree
	Family: Nyctaginaceae	
650	*Boerhavia diffusa* L.	Herb
651	*Bougainvillea glabra* Choisy in DC.	Shrub
652	*Bougainvillea spectabilis* Willd.	Shrub
	Family: Nyctanthaceae	
653	*Nyctanthes arbor-tristis* L.	Shrub
	Family: Nymphaeaceae	
654	*Nymphaea caerulea* Savi.	Herb
	Family: Ochnaceae	
655	*Gomphia serrata* (Gaertn.) Kanis	Shrub
	Family: Oleaceae	
656	*Chionanthus mala-elengi* (Dennst.) P.S.Green ssp. *mala-elengi*	Tree*[PI]
657	*Jasminum angustifolium* (L.) Willd.	Climber
658	*Jasminum azoricum* Burm. f.	Climber
659	*Jasminum malabaricum* Wight	Climber*[W]
660	*Myxopyrum smilacifolium* (Wall.) Blume	Climber
661	*Olea dioica* Roxb.	Tree*[I]
	Family: Onagraceae	

662	*Ludwigia adscendens* (L.) Hara	Herb
663	*Ludwigia hyssopifolia* (G. Don) Exell	Herb
664	*Ludwigia octovalvis* (Jacq.) Raven	Herb
	Family: Opiliaceae	
665	*Cansjera rheedei* Gmel.	Climber
	Family: Orchidaceae	
666	*Acampe praemorsa* (Roxb.) Blatt. & McCann	Herb
667	*Bulbophyllum sterile* (Lam.) Suresh in Nicolson, Suresh & Manilal	Herb*[Pl]
668	*Seidenfia rheedei* (Sw.) Szlach.	Herb
669	*Spathoglottis plicata* Blume	Herb
670	*Zeuxine longilabris* (Lindl.) Benth. ex Hook. f.	Herb
	Family: Oxalidaceae	
671	*Averrhoa bilimbi* L.	Tree
672	*Biophytum intermedium* Wight	Herb
673	*Biophytum reinwardtii* (Zucc.) Klotzsch *var. reinwardtii* Hook. f.	Herb
674	*Oxalis corniculata* L.	Herb
	Family: Pandanaceae	
675	*Pandanus amaryllifolius* Roxb.	Shrub
676	*Pandanus foetidus* Roxb.	Shrub
677	*Pandanus furcatus* Roxb.	Shrub
	Family: Passifloraceae	
678	*Passiflora edulis* Sims in Curtis	Climber
679	*Passiflora foetida* L.	Climber
	Family: Pedaliaceae	
680	*Martynia annua* L.	Shrub
681	*Pedalium murex* L.	Herb
682	*Sesamum indicum* L.	Herb
683	*Sesamum radiatum* Schum.	Herb
	Family: Periplocaceae	
684	*Cryptolepis buchananii* Roem. & Schult.	Climber
685	*Hemidesmus indicus* (L.) R. Br.var. *indicus* Hook. f.	Climber
	Family: Phyllanthaceae	
686	*Phyllanthus acidus* (L.) Skeels.	Tree
	Family: Piperaceae	
687	*Peperomia pellucida* (L.) Kunth	Herb
688	*Piper betle* L.	Climber
689	*Piper longum* L.	Shrub
690	*Piper nigrum* L. var. *nigrum* Hook.f.	Climber
	Family: Plantaginaceae	
691	*Bacopa monnieri* (L.) Pennell.	Herb

	Family: Plumbaginaceae	
692	*Plumbago zeylanica* L.	Shrub
	Family: Poaceae	
693	*Alloteropsis cimicina* (L.) Stapf	Herb
694	*Alloteropsis semialata* (R.Br.) Hitch.	Herb
695	*Apluda mutica* L.	Herb
696	*Apocopis mangalorensis* (Hochst.) Henrard	Herb*PI
697	*Arundinella cannanorica* V.J.Nair, Sreek. & N.C.Nair	Herb*W
698	*Arundinella ciliata* (Roxb.) Nees ex Miq. in Verh.	Herb*PI
699	*Arundinella leptochloa* (Nees ex Steud.) Hook. f.	Herb
700	*Arundinella mesophylla Nees ex Steud.*	Herb*SI
701	*Arundinella metzii* Hochst. ex Miq.*	Herb*W
702	*Arundinella tuberculata* Munro *ex* Lisboa	Herb*PI
703	*Axonopus compressus* (Sw.) P.Beauv.	Herb
704	*Bambusa bambos* (L.) Voss in Vilmorin	Shrub
705	*Bhidea fischeri* Sreek. & B.V.Shetty	Herb*SI
706	*Brachiaria miliiformis* (J. Presl ex C. Presl) A.	Herb
707	*Brachiaria ramosa* (L.) Stapf in Prain	Herb
708	*Brachiaria remota* (Retz.) Haines	Herb
709	*Brachiaria reptans* (L.) C.A.Gardner & C.E.Hubb.	Herb
710	*Centotheca lappacea* (L.) Desv.	Herb
711	*Chloris barbata* Sw.	Herb
712	*Chrysopogon aciculatus* (Retz.) Trin.	Herb
713	*Chrysopogon hackelii* (Hook.f.) C.E.C. Fisch. in Gamble	Herb*PI
714	*Coix lacryma-jobi* L.	Herb
715	*Cymbopogon citrates* (DC.) Stapf	Herb
716	*Cymbopogon flexuosus* (Nees ex Steud.) Wats. in Atkins.	Herb
717	*Cynodon dactylon* (L.) Pers.	Herb
718	*Cyrtococcum trigonum* (Retz.) A. Camus	Herb
719	*Dacteyloctenium aegypticum* (L.) P. Beauv	Herb
720	*Digitaria bicornis* (Lam.) Roem. & Schult. ex Loud.	Herb
721	*Digitaria ciliaris* (Retz.) Koeler	Herb
722	*Dimeria bialata* C.E.C. Fisch.	Herb*SI
723	*Dimeria hohenackeri* Hochst. ex Miq.	Herb*PI
724	*Echinochloa colona* (L.) Link	Herb
725	*Eleusine indica* (L.) Gaertn.	Herb

726	*Eragrostis tenella* (L.) P. Beauv. ex Roem. & Schult.var. *tenella* Manilal & Sivar.	Herb
727	*Eragrostis tenuifolia* (A. Rich.) Hochst. ex Steud.	Herb
728	*Eragrostis unioloides* (Retz.) Nees ex Steud.	Herb
729	*Eragrostis viscose* (Retz.) Trin.	Herb
730	*Eulalia trispicata* (Schult.) Henrard	Herb
731	*Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult.	Herb
732	*Isachne globosa* (Thunb.) O. Ktze.	Herb
733	*Isachne miliacea* Roth	Herb
734	*Ischaemum burmanicum* Bor. *var. burmanicum*; R. Kr. Singh & P.S.N. Rao	Herb
735	*Ischaemum commutatum* Hack. in A. & C. DC	Herb
736	*Ischaemum indicum* (Houtt.) Merr.	Herb
737	*Ischaemum molle*Hook.f.	Herb
738	*Ischaemum muticum* L.	Herb
739	*Ischaemum pappinisseriensis* Ravi	Herb*[SI]
740	*Ischaemum timorense* Kunth	Herb
741	*Ischaemum tumidum*Stapf ex Bor var. *calicutensis* (Sreek., V.J. Nair & N.C. Nair) R. Kr. Singh & P.S.N. Rao	Herb*[SI]
742	*Microchloa indica* (L.f.) P. Beauv.	Herb
743	*Oplismenus burmannii* (Retz.) P. Beauv.	Herb
744	*Oplismenus compositus* (L.) P. Beauv.	Herb
745	*Oryza rufipogon* Griff.	Herb
746	*Oryza sativa* L.	Herb
747	*Panicum brevifolium* L.	Herb
748	*Panicum maximum* Jacq.	Herb
749	*Panicum notatum* Retz.	Herb
750	*Panicum repens* L.	Herb
751	*Panicum trypheron* Schult.	Herb
752	*Paspalum canarae* (Steud.) Veldk.	Herb*[PI]
753	*Paspalum conjugatum* Berg.	Herb
754	*Paspalum scrobiculatum* L.	Herb
755	*Pennisetum orientale* L.C. Rich. in Pers.	Herb
756	*Pennisetum pedicellatum* Trin.	Herb
757	*Pennisetum polystachyon* (L.) Schult.	Herb
758	*Perotis indica* (L.) O. Ktze.	Herb
759	*Pseudanthistiria umbellata* (Hack.) Hook. f.	Herb
760	*Rottboellia cochinchinensis* (Lour.) W. D. Clayton	Herb
761	*Saccharum arundinaceum* Retz., Obs.	Shrub
762	*Saccharum spontaneum* L., Mant.	Shrub

763	*Sacciolepis interrupta* (Willd.) Stapf in Prain	Herb
764	*Setaria pumila* (Poir.) Roem. & Schult.	Herb
765	*Spodiopogon rhizophorus* Steud.	Herb*[SWI]
766	*Sporobolus indicus* (L.) R. Br. var.*diander* (Retz.) Jovet & Guedes	Herb
767	*Themeda triandra* Forssk.	Herb
768	*Tripsacum laxum* Nash	Herb
769	*Vetiveria zizanioides* (L.)	Shrub
	Family: Polygalaceae	
770	*Polygala elongata* Klein ex Willd.	Herb
771	*Salomonia ciliata* (L.) DC.	Herb
772	*Xanthophyllum arnottianum* Wight	Tree*[W]
	Family: Polygonaceae	
773	*Persicaria barbata* (L.) Hara	Herb
	Family: Pontederiaceae	
774	*Eichhornia crassipes* (Mart.) Solms.	Herb
775	*Monochoria vaginalis* (Burm. f.) Presl	Herb
	Family: Portulacaceae	
776	*Portulaca oleracea* L.	Herb
777	*Talinum portulacifolium* (Forssk.) Asch.	Herb
	Family: Primulaceae	
778	*Aegiceras corniculatum* (L.) Balco.	Shrub
	Family: Proteaceae	
779	*Helicia nilagirica* Bedd.	Tree*[SW]
	Family: Ranunculaceae	
780	*Naravelia zeylanica* (L.) DC.	Climber
	Family: Rhamnaceae	
781	*Ventilago maderaspatana* Gaertn.	Climber
782	*Ziziphus mauritiana* Lam.	Tree
783	*Ziziphus nummularia* (Burm.f.) Wight & Arn.	Climber
784	*Ziziphus oenoplia* (L.) Mill.	Climber
785	*Ziziphus rugosa* Lam.	Shrub
786	*Ziziphus xylopyrus* (Retz.) Willd.	Tree
	Family: Rhizophoraceae	
787	*Bruguiera cylindrica* (L.) Blume, Enum.	Tree
788	*Carallia brachiata* (Lour.) Merr.	Tree
789	*Kandelia candel* (L.) Druce	Tree
790	*Rhizophora apiculata* Blume, Enum.	Tree
791	*Rhizophora mucronata* Poir.	Tree
	Family: Rubiaceae	
792	*Benkara malabarica* (Lam.) Tirveng.	Shrub
793	*Canthium angustifolium* Roxb.	Shrub

794	*Canthium coromandelicum* (Burm.f.) Alston	Shrub
795	*Canthium rheedei* DC.	Shrub*[PI]
796	*Canthium travancoricum* (Bedd.) Hook. f.	Shrub*[SW]
797	*Catunaregam spinosa* (Thunb.) Tirveng.	Shrub
798	*Chassalia curviflora* (Wall. ex Kurz) Thw. var. *ophioxyloides* (Wall.) Deb & Krishna	Shrub
799	*Coffea arabica* L.	Shrub
800	*Gardenia jasminoides* Ellis	Shrub
801	*Gardenia resinifera* Roth	Tree
802	*Geophila repens* (L.) Johnst.	Herb
803	*Hamelia patens* Jacq.	Shrub
804	*Hedyotis cyanantha* Kurz	Shrub
805	*Hedyotis neesiana* Arn.	Herb
806	*Ixora brachiata* Roxb. ex DC.	Shrub*[W]
807	*Ixora coccinea* L.	Shrub
808	*Ixora elongata* Heyne ex G. Don	Shrub*[I]
809	*Ixora javanica* (Blume) DC.	Shrub
810	*Ixora malabarica* (Dennst.) Mabb.	Shrub*[SW,VU]
811	*Ixora nigricans* R. Br. ex Wight & Arn.	Shrub
812	*Ixora pavetta* Andr.	Tree
813	*Ixora polyantha* Wight	Shrub*[W]
814	*Knoxia wightiana* Wall. ex Wight & Arn.	Herb*[PI]
815	*Mitracarpus hirtus* (L.) DC.	Herb
816	*Morinda citrifolia* L.	Tree
817	*Morinda pubescens* J. E. Smith in Rees	Tree
818	*Morinda umbellata* L.	Climber
819	*Mussaenda frondosa* L.	Shrub*[PI]
820	*Neanotis rheedei* (Wall. *ex* Wight & Arn.) Lewis	Herb*[W]
821	*Neanotis tubulosa* (G. Don) Mabb.	Herb
822	*Oldenlandia auricularia* (L.) K. Schum. in Engl. & Prantl	Herb
823	*Oldenlandia corymbosa* L. var. *corymbosa* Hook. f.	Herb
824	*Oldenlandia herbacea* (L.) Roxb.	Herb
825	*Oldenlandia umbellata* L.	Herb
826	*Ophiorhiza mongus* L.	Herb
827	*Ophiorrhiza hirsutula* Wight *ex* Hook. f.	Shrub
828	*Ophiorrhiza mungos* L.	Herb
829	*Pavetta breviflora* DC.	Shrub*[SW]
830	*Pavetta hispidula* Wight & Arn.	Shrub
831	*Pavetta indica* L. var. *indica* Hook.f.	Shrub

832	*Pseudomussaenda lanceolata* (Forssk.) Wernham	Shrub
833	*Psychotria flavida* Talbot	Shrub*[SW]
834	*Psydrax umbellata* (Wight) Bridson	Tree
835	*Richardia scabra* L.	Herb
836	*Spermacoce articularis* L. f.	Herb
837	*Spermacoce latifolia* Aubl.	Herb
838	*Spermacoce ocymoides* Burm.f.	Herb
839	*Spermacoce pusilla* Wall. in Roxb.	Herb
840	*Tarenna asiatica* (L.) O.Ktze. *ex* K. Schum.	Shrub
	Family: Rutaceae	
841	*Aegle marmelos* (L.) Corrêa	Tree
842	*Atalantia wightii* Tanaka	Shrub
843	*Citrus aurantifolia* (Christm. & Panz.) Swingle	Shrub
844	*Citrus limon* (L.) Burm. f.	Tree
845	*Citrus medica* L.	Shrub
846	*Glycosmis mauritiana* (Lam.) Tanaka	Shrub
847	*Glycosmis pentaphylla* (Retz.) DC.	Shrub
848	*Melicope lunu-ankenda* (Gaertn.) Hartley	Tree
849	*Murraya koenigii* (L.) Spreng.	Shrub
850	*Murraya paniculata* (L.) Jack.	Shrub
851	*Naringi crenulata* (Roxb.) Nicolson in Saldanha & Nicolson	Tree
852	*Toddalia asiatica* (L.) Lam.	Climber
853	*Zanthoxylum rhetsa* (Roxb.) DC.	Tree
	Family: Salicaceae	
854	*Flacourtia jangomas* (Lour.) Raeusch.	Tree
	Family: Santalaceae	
855	*Santalam album* L.	Tree
	Family: Sapindaceae	
856	*Allophylus cobbe* (L.) Raeusch.	Shrub
857	*Cardiospermum halicacabum* L.	Climber
858	*Sapindus emarginatus* Vahl	Tree
859	*Sapindus trifoliatus* L.	Tree
860	*Schleichera oleosa* (Lour.) Oken	Tree
	Family: Sapotaceae	
861	*Chrysophyllum cainito* L.	Tree
862	*Madhuca longifolia* (Koenig) Macbr. var. *latifolia* (Roxb.) A. Chev.	Tree
863	*Madhuca neriifolia* (Moon) H. J. Lam	Tree
864	*Manilkara zapota* (L.) P.Royen	Tree
865	*Mimusops elengi* L.	Tree
	Family: Scrophulariaceae	

866	*Centranthera indica* (L.) Gamble	Herb
867	*Dopatrium junceum* (Roxb.) Buch.-Ham. ex Benth.	Herb
868	*Limnophila repens* (Benth.) Benth.	Herb
869	*Lindernia antipoda* (L.) Alston in Trimen	Herb
870	*Lindernia ciliata* (Colsm.) Pennell	Herb
871	*Lindernia crustacea* (L.) F.v. Muell.	Herb
872	*Lindernia hyssopioides* (L.) Haines	Herb
873	*Lindernia viscosa* (Hornem.) Merr.	Herb
874	*Mecardonia procumbens* (Mill.) Small	Herb
875	*Microcarpaea minima* (Koenig ex Retz.) Merr.	Herb
876	*Rhamphicarpa longiflora* (Arn.) Benth.	Herb*[I]
877	*Russelia equisetiformis* Schltr. & Cham.	Herb
878	*Scoparia dulcis* L.	Herb
879	*Sopubia trifida* Buch.-Ham. *ex* D. Don	Herb
880	*Striga angustifolia* (D. Don) Saldanha	Herb
881	*Striga asiatica* (L.) O. Ktze.	Herb
882	*Striga gesnerioides* (Willd.) Vatke	Herb
883	*Parasopubia delphiniifolia* (L.) H.-P. Hofm. & Eb. Fisch.	Herb
	Family: Simaroubaceae	
884	*Ailanthus excelsa* Roxb.	Tree
885	*Ailanthus triphysa* (Dennst.)	Tree
886	*Simarouba glauca* DC.	Tree
887	*Quassia indica* (Gaertn.) Nooteb. in Steenis	Tree
	Family: Smilacaceae	
888	*Smilax wightii* A. DC. in A. & C. DC.	Climber*[SW]
889	*Smilax zeylanica* L.	Climber
	Family: Solanaceae	
890	*Capsicum annuum* L.var. *annuum* Gamble	Shrub
891	*Capsicum frutescens* L.	Herb
892	*Datura stramonium* L.	Shrub
893	*Physalis angulata* L.	Herb
894	*Solanum americanum* Mill.	Herb
895	*Solanum melongena* L. var. *insanum* (L.) Prain	Shrub
896	*Solanum torvum* Sw.	Shrub
897	*Solanum violaceum* Ortega	Shrub
	Family: Sphenocleaceae	
898	*Sphenoclea zeylanica* Gaertn., Fruct.	Shrub
	Family: Sterculiaceae	
899	*Abroma augusta* (L.) L. f.	Shrub
900	*Helicteres isora* L.	Shrub
901	*Melochia corchorifolia* L.	Herb

902	*Pterospermum diversifolium* Blume	Tree
903	*Pterospermum reticulatum* Wight & Arn.	Tree*[SW.VU]
904	*Pterospermum rubiginosum*Heyne ex Wight & Arn.	Tree*[W]
905	*Pterygota alata* (Roxb.) R. Br.	Tree
906	*Sterculia balanghas* L.	Tree
907	*Sterculia guttata* Roxb. ex DC.	Tree
908	*Waltheria indica* L.	Shrub
	Family: Symphoremataceae	
909	*Symphorema involucratum* Roxb.	Climber
	Family: Symplocaceae	
910	*Symplocos cochinchinensis* (Lour.) Moore ssp. *laurina* (Retz.) Nooteb.	Tree
	Family: Theaceae	
911	*Camellia sinensis* (L.) O.Ktze.	Tree
	Family: Tiliaceae	
912	*Corchorus aestuans* L.	Herb
913	*Corchorus capsularis* L.	Herb
914	*Corchorus trilocularis* L.	Herb
915	*Grewia abutilifolia* Vent. *ex* Juss.	Shrub
916	*Grewia flavescens* Juss.	Shrub
917	*Grewia nervosa* (Lour.) Panigrahi	Shrub
918	*Grewia serrulata* DC.	Tree
919	*Grewia tiliifolia* Vahl	Tree
920	*Triumfetta rhomboidea* Jacq.	Shrub
	Family: Trichopodaceae	
921	*Trichopus zeylanicus* Gaertn. ssp. *travancoricus* (Bedd.) Burkill *ex* Narayanan	Herb*[SWI]
	Family: Turneraceae	
922	*Turnera subulata* Smith in Rees	Shrub
	Family: Typhaceae	
923	*Typha angustifolia* L.	Shrub
	Family: Ulmaceae	
924	*Celtis philippensis* Blanco var. *wightii* (Planch.) Soep. in Steenis	Tree
925	*Celtis timorensis* Span.	Tree
926	*Holoptelea integrifolia* (Roxb.) Planch.	Tree
927	*Trema orientalis* (L.) Blume	Tree
	Family: Urticaceae	
928	*Elatostema cuneatum* Wight	Herb
929	*Laportea interrupta* (L.) Chew	Herb
930	*Pilea microphylla* (L.) Liebm.	Herb
931	*Pouzolzia zeylanica* (L.) Bennett	Herb

	Family: Verbenaceae	
932	*Callicarpa tomentosa* (L.) L. in Murr.	Shrub
933	*Citharexylum spinosum* L.	Tree
934	*Clerodendrum incisum* Klotzsch. in Peters	Shrub
935	*Clerodendrum indicum* (L.) O. Ktze.	Shrub
936	*Clerodendrum infortunatum* L.	Shrub
937	*Clerodendrum paniculatum* L	Shrub
938	*Duranta erecta* L.	Shrub
939	*Holmskioldia sanguinea* Retz.	Shrub
940	*Lantana camara* L.	Shrub
941	*Phyla nodiflora* (L.) Greene	Herb
942	*Premna coriacea* Clarke in Hook. f.	Shrub
943	*Premna serratifolia* L.	Shrub
944	*Priva cordifolia* (L.f.) Druce	Herb
945	*Rotheca serratum* (L.) Steane & Mabb.	Shrub
946	*Stachytarpheta cayennensis* (Rich.) Schauer in DC.	Shrub
947	*Stachytarphetajamaicensis* (L.) Vahl	Shrub
948	*Tectona grandis* L. f.	Tree
949	*Vitex altissima* L. f.	Tree
950	*Vitex negundo* L.	Shrub
951	*Vitex trifolia* L.	Shrub
	Family: Violaceae	
952	*Hybanthus ennaespermus* (L.) F.v. Muell.	Herb
	Family: Vitaceae	
953	*Ampelocissus indica* (L.) Planch.	Climber
954	*Ampelocissus latifolia* (Roxb.) Planch.	Climber
955	*Cayratia mollissima* (Wall.) Gagnep. in Lecomte	Climber
956	*Cayratia trifolia* (L.) Domin	Climber
957	*Cissus discolor* Blume	Climber
958	*Cissus glyptocarpa* (Thw.) Planch. in A. & C. DC.	Climber
959	*Cissus latifolia* Lam.	Climber
960	*Cissus repens* Lam.	Climber
961	*Cayratia pedata* (Lam.) A. Juss. *ex* Gagnep. var. *glabra* Gamble	Climber*[SW,VU]
	Family: Zingiberaceae	
962	*Amomum muricatum* Bedd.	Herb*[SW]
963	*Curcuma aeruginosa* Roxb.	Herb
964	*Curcuma longa* L.	Herb
965	*Curcuma neilgherrensis* Wight	Herb*[W]
966	*Curcuma oligantha* Trimen var. *oligantha* Hook. f.	Herb

967	*Curcuma zanthorrhiza* Roxb.	Herb
968	*Zingiber neesanum* (Graham) Ramam. in Saldanha & Nicolson	Herb*[W]
969	*Zingiber officinale* Rosc.	Herb
970	*Zingiber zerumbet* (L.) J.E. Smith	Herb

Appendix III

Checklist of Spiders in Kavvayi River Basin

No	Family	Species	Guild
	Araneidae		
1		*Arachnura angura* Tikader, 1970	Orb weavers
2		*Araneus mitificus*, Simon, 1886	Orb weavers
3		*Argiope aemula*, Walckenaer, 1842	Orb weavers
4		*Argiope anasuja,* Thorell, 1887	Orb weavers
5		*Argiope pulchella,* Thorell, 1881	Orb weavers
6		*Cyclosa hexatuberculata,* Tikader, 1982	Orb weavers
7		*Cyclosa bifida,* Doleschall 1859	Orb weavers
8		*cyclosa* sp.1	Orb weavers
9		*Cyrtarachne keralensis,* Jose, 2011	Orb weavers
10		*Cyrtophora citricola*, Forskal, 1775	Orb weavers
11		*Eriovixia excelsa*, Simon, 1889	Orb weavers
12		*Eriovixia laglaizei*, Simon, 1877	Orb weavers
13		*Gasteracantha geminata*, Fabricius, 1798	Orb weavers
14		*Gea subarmata*, Thorell, 1890	Orb weavers
15		*Neoscona bengalensis*, Tikader & Bal, 1981	Orb weavers
16		*Neoscona mukerjei* ,Tikader, 1980	Orb weavers
17		*Neoscona nautica* , L. Koch, 1875	Orb weavers
18		*Neoscona vigilans*, Blackwall, 1865	Orb weavers
19		*Neoscona* sp.	Orb weavers
20		*Parawixia dehaani*, Doleschall, 1859	Orb weavers
21		*Poltys* sp 1	Orb weavers
22		*Poltys* sp 2	Orb weavers
	CORINNIDAE		
23		*Castianeira zetes*, Simon, 1897	Foliage runners
	CTENIDAE		
24		*Ctenus cochinensis*, Gravely, 1931	Ground runners
25		*Ctenus* sp.	Ground runners
	ERESIDAE		

26		*Stegodyphus sarasinorum*, Karsch, 1892	Sheet web weavers
	GNAPHOSIDAE		
27		*Scotophaeus* sp.1	Ground runners
28		*Scotophaeus* sp.2	Ground runners
	HERSILIIDAE		
29		*Hersilia savignyi*, Lucas, 1836	Foliage runners
	LINYPHIIDAE		
30		*Atypena* sp.1	Wandering sheet weavers
31		*Neriene sundaica*, Simon, 1905	Wandering sheet weavers
	LYCOSIDAE		
32		*Hippasa agelenoides*, Simon, 1884	Ground runners
33		*Lycosa mackenziei*, Gravely, 1925	Ground runners
34		*Pardosa pseudoannulata*,Bosenberg&Strand,1906	Ground runners
35		*Pardosa sumatrana*, Thorell 1890	Ground runners
	EUTICHURIDAE		
36		*Cheiracanthium danieli*, Tikader, 1975	Foliage runners
37		*Cheiracanthium melanostomum*, Thorell, 1895	Foliage runners
	NEPHILIDAE		
38		*Nephila pilipes*, Fabricius, 1793	Orb weavers
39		*Nephilengys malabarensis*, Walckenaer, 1841	Orb weavers
	OXYOPIDAE		
40		*Oxyopes birmanicus*, Thorell, 1887	Stalkers
41		*Oxyopes javanus*, Thorell, 1887	Stalkers
42		*Oxyopes lineatipes*, C. L. Koch, 1847	Stalkers
43		*Oxyopes shweta*, Tikader, 1970	Stalkers
44		*Oxyopes sunandae*, Tikader, 1970	Stalkers
45		*Oxyopes* sp.	Stalkers
46		*Hamadruas insulana*, Thorell 1891	Stalkers
	PHILODROMIDAE		
47		*Tibellus elongates*, Tikader, 1960	Ambushers
	PHOLCIDAE		
48		*Artema atlanta*, Walckenaer, 1837	Space web builders
49		*Crossopriza lyoni*, Blackwall 1867	Space web builders
50		*Pholcus phalangioides*, Fuesslin 1775	Space web builders
	PISAURIDAE		
51		Dendrolycosa gitae, Tikader, 1970	Ambushers
52		*Perenethis venusta*, L. Koch, 1878	Ambushers
53		*Nilus albocinctus*, Doleschall, 1859	Ambushers
	SALTICIDAE		
54		*Asemonea tenuipes*, O.P.Cambridge, 1869	Stalkers

55		*Bavia kairali*, Samson.D and P.A Sebastian, 2002	Stalkers
56		*Brettus albolimbatus*, Simon, 1900	Stalkers
57		*Carrhotus viduus*, C.L. Koch, 1846	Stalkers
58		*Epeus indicus*, Proszynski, 1992	Stalkers
59		*Epeus tener* , Simon 1877	
60		*Epocilla aurantiaca*, Simon, 1885	Stalkers
61		*Chalcotropis pennatus,* Simon 1902	Stalkers
62		*Hasarius adansoni*, Audouin, 1826	Stalkers
63		*Hyllus semicupreus*, Simon, 1885	Stalkers
		Rhene flavigera. C. L. Koch 1846	Stalkers
65		*Menemerus bivittatus*, Dufour, 1831	Stalkers
66		*Myrmarachne kochi,* Reimoser, 1925	Stalkers
67		*Myrmarachne orientales,* Tikader, 1973	Stalkers
68		*Myrmarachne plataleoides,* O. Pickard-Cambridge, 1869	Stalkers
69		*Phintella vittata*, C.L. Koch, 1846	Stalkers
70		*Plexippus paykulli*, Audouin, 1826	Stalkers
71		*Plexippus petersi,* Karsch, 1878	Stalkers
72		*Portia fimbriata*, Doleschall, 1859	Stalkers
73		*Siler semiglaucus,* Simon, 1901	Stalkers
74		*Telamonia dimidiata* , Simon, 1899	Stalkers
75		*Thiania bhamoensis*, Thorell,1887	Stalkers
	SCYTODIDAE		
76		*Scytodes pallida,* Doleschall, 1859	Stalkers
77		*Scytodes thoracica,* Latreille, 1802	Stalkers
	SPARASSIDAE		
78		*Heteropoda venatoria*, Linnaeus, 1767	Foliage runners
79		*Olios milleti,* Pocock, 1901	Foliage runners
80		*Thelcticopis* sp.	Foliage runners
	TETRAGNATHIDAE		
81		*Leucauge decorata*, Blackwall, 1864	Orb weavers
82		*Leucauge pondae*, Tikader, 1970	Orb weavers
83		*Opadometa fastigata,* Simon 1877	Orb weavers
84		*Tetragnatha maxillosa,* Thorell, 1895	Orb weavers
85		*Tetragnatha mandibulata,* Walckenaer, 1841	Orb weavers
86		*Tetragnatha viridorufa* ,Gravely, 1921	Orb weavers
87		*Tetragnatha javana,* Thorell 1890	Orb weavers
88		*Tylorida striata,* Thorell, 1877	Orb weavers
	THERAPHOSIDAE		
89		*Chilobrachys hardwicki*, Pocock, 1895	Stalkers
	THERIDIIDAE		

90		*Achaearanea durgae,* Tikadar 1970	Space web builders
91		*Argyrodes flavescens*, Cambridge. 1880	Space web builders
92		*Argyrodes flavescens,* OP Cambridge 1869	Space web builders
93		*Chrysso nigra,* O. Pickard-Cambridge. 1880	Space web builders
94		*Meotipa pictuarata*, Simon, 1895	Space web builders
95		*Parasteatoda mundula*, L. Koch1872	Space web builders
96		*Ariamnes flagellum,* Doleschall 1857	Space web builders
97		*Chrysso angula,* Tikader, 1970	Space web builders
98		*Theridion manjithar,* Tikader, 1970	Space web builders
99		*Phycosoma* sp.	Space web builders
	THOMISIDAE		
100		*Amyciaea forticeps*, O.P.Cambridge, 1873	Ambushers
101		*Camaricus fomosus,* Thorell, 1887	Ambushers
102		*Indoxysticus minutus,* Tikader, 1960	
103		*Thomisus lobosus*. Tikader 1965	Ambushers
104		*Runcinia affinis,* Simon, 1897	Ambushers
105		*Runcinia roonwali,* Tikader, 1965	Ambushers
106		*Strigoplus netravati,* Tikader, 1963	Ambushers
107		*Thomisus projectus,* Tikader, 1960	Ambushers
108		*Oxytate virens,* Thorell, 1891	Ambushers
	ULOBORIDAE		
109		*Miagrammopes extensus,* Simon, 1889	Orb weavers
110		*Uloborus danolius,* Tikader, 1969	Orb weavers
111		*Uloborus krishnae,* Tikader, 1970	Orb weavers
112		*Zosis geniculata,* Olivier, 1789	Orb weavers

Appendix IV

Checklist of Orthoptera (Grasshoppers) in Kavvayi River Basin

SI No.	Scientific Name	Status
	Family ACRIDIDAE MacLeay, 1821	
1	Acrida exaltata (Walker, 1859)	
2	Acrida gigantea (Herbst, 1786)	
3	Phlaeoba infumata Brunner Von Wattenwyl, 1893	
4	Dittopternis venusta (Walker, 1870)	
5	Oedaleus abruptus (Thunberg, 1815)	
6	Tylotropidius varicornis (Walker, 1870)	
7	Diabolocatantops pinguis (Stal, 1861)	
8	Choroedocus illustris (Walker, 1870)	Endemic
9	Diabolocatantops innotabilis (Walker, 1870)	

10	Catantops indicus Bolívar, 1902	
11	Oxya fuscovittata (Marschall, 1836)	
12	Spathosternum prasiniferum prasiniferum (Walker, 1871)	
13	Locusta migratoria migratoria (Linnaeus, 1758)	
14	Trilophidia annulata (Thunberg, 1815)	
15	Hieroglyphus banian (Fabricius, 1798)	
16	Oxya hyla hyla Serville, 1831	
17	Paraconophyma polita Uvarov, 1921	Endemic
	Family PYRGOMORPHIDAE Brunner von Wattenwyl, 1874	
18	Atractomorpha crenulata (Fabricius, 1793)	
19	Neorthacris acuticeps nilgirensis (Uvarov, 1929)	Endemic
20	Aularches miliaris (Linnaeus, 1758)	Endemic
21	Chrotogonus (Chrotogonus) oxypterus (Blanchard, 1836)	
22	Poekilocerus pictus (Fabricius, 1775)	
	Family CHOROTYPIDAE Stal, 1873	
23	Phyllochoreia ramakrishnai Bolívar, 1914	Endemic
24	Phyllochoreia unicolor Westwood, 1839	Endemic
	Family TETRIGIDAE Rambur, 1838	
25	Paratettix variabilis Bolívar, 1887	

Appendix V

Checklist of Odonates in Kavvayi River Basin

Sl No	Scientific name	English Name
	Class: Insecta	
	Order: Odonata	
	Suborder: Anisoptera	**Dragonflies**
	Family: Aeshnidae	**Darners**
1	*Anax immaculifrons* Rambur, 1842	Blue Darner
2	*Gynacantha dravida* Lieftinck, 1960	Brown Darner
	Family: Gomphidae	**Clubtails**
3	*Ictinogomphus rapax* Rambur, 1842	Common Clubtail
	Family:Libellulidae	**Skimmers**
4	*Acisoma panorpoides* Rambur, 1842	Trumpet-Tail
5	*Aethriamanta brevipennis* Rambur, 1842	Scarlet Marsh Hawk
6	*Brachydiplax sobrina* Rambur, 1842	Little Blue Marsh Hawk
7	*Brachythemis contaminata* Fabricius,1793	Ditch Jewel
8	*Bradinopyga geminata* Rambur, 1842	Granite Ghost
9	*Crocothemis servilia* Drury, 1770	Ruddy Marsh Skimmer
10	*Diplacodes nebulosa* Fabricius, 1793	Black Tipped Ground Skimmer

11	*Diplacodes trivialis* Rambur, 1842	Ground Skimmer
12	*Neurothemis fulvia* Drury, 1773	Fulvous Forest Skimmer
13	*Neurothemis intermedia* Rambur, 1842	Ruddy Meadow Skimmer
14	*Neurothemis tullia* Drury, 1773	Pied Paddy Skimmer
15	*Orthetrum chrysis* Selys, 1891	Brown-Backed Red Marsh Hawk
16	*Orthetrum sabina* Drury, 1770	Green Marsh Hawk
17	*Palpopleura sexmaculata* Fabricius, 1787	Blue-Tailed Yellow Skimmer
18	*Pantala flavescens* Fabricius, 1798	Wandering Glider
19	*Potamarcha congener* Rambur, 1842	Yellow-Tailed Ashy Skimmer
20	*Rhodothemis rufa* Rambur, 1842	Rufous Marsh Glider
21	*Rhyothemis variegata* Linnaeus, 1763	Common Picturewing
22	*Tetrathemis platyptera*Selys, 1878	Pigmy Skimmer
23	*Tholymis tillarga* Fabricius, 1798	Coral-Tailed Cloud-Wing
24	*Tramea limbata* Desjardins,1832	Black Marsh Trotter
25	*Trithemis aurora* Burmeister, 1839	Crimson Marsh Glider
26	*Trithemis kirbyi* Selys, 1891	Scarlet Rock Glider
27	*Trithemis pallidinervis* Kirby, 1889	Long-Legged Marsh Glider
28	*Urothemis signata* Rambur, 1842	Circater Crimson Glider
29	*Zyxomma petiolatum* Rambur, 1842	Brown Dusk Hawk
	Suborder: Zygoptera	**Damselflies**
	Family: Calopterygidae	**Glories**
30	*Neurobasis chinensis* Linnaeus, 1758	Stream Glory
31	*Vestalis gracilis* Rambur, 1842	Clear-Winged Forest Glory
	Family :Coenagrionidae	**Marsh Darts**
32	*Aciagrion occidentale* Laidlaw, 1919	Green-Striped Slender Dartlet
33	*Agriocnemis pygmaea* Rambur, 1842	White Dartlet
34	*Agriocnemis splendidissima* Laidlaw,1919	Splendid Dartlet
35	*Ceriagrion cerinorubellum* Brauer, 1865	Orange-Tailed Marsh Dart
36	*Ceriagrion coromandelianum* Fabricius, 1798	Coromandel Marsh Dart
37	*Ischnura aurora* Brauer, 1865	Golden Dartlet
38	*Pseudagrion microcephalum*Rambur, 1842	Blue Grass Dart
39	*Pseudagrion rubriceps* Selys, 1876	Saffron-Faced Grass Dart
	Family: Lestidae	**Spreadwings**
40	*Lestes elatus* Hagen in Selys, 1862	Emerald Spreadwing
41	*Lestes malabarica* Fraser, 1929	Malabar Spreadwing
	Family : Platycnemididae	**Bush Darts**
42	*Copera marginipes* Rambur, 1842	Yellow Bush Dart

Appendix VI

Checklist of Butterflies in Kavvayi River Basin

SI No	Scientific name	Common name	Status
	PAPILIONIDAE		
1	*Troides minos*	Sahyadri Birdwing	VC
2	*Pachliopta aristolochiae*	Common Rose	VC
3	*Pachliopta pandiyana Moore*	Malabar Rose	C, E
4	*Pachliopta hector*	Crimson Rose	C, Sch I
5	*Papilio clytia clytia*	Oriental Common Mime	VC, Sch I
6	*Papilio demoleus*	Lime Butterfly	VC
7	*Papilio liomedon*	Malabar Banded Swallowtail	R, Sch I
8	*Papilio dravidarum*	Malabar Raven	VC
9	*Papilio helenus*	Red Helen	VC
10	*Papilio polytes*	Common Mormon	VC
11	*Papilio polymnestor*	Blue Mormone	VC
12	*papilio paris*	Paris Peacock	VC
13	*Papilio buddha*	Malabar Banded Peacock	C
14	*Graphium sarpedon*	Common Bluebottle	VC
15	*Graphium doson*	Common Jay	R
16	*Graphium agamemnon*	Tailed Jay	VC
	PIERIDAE		
17	*Delias eucharis*	Common Jezebel	VC
18	*Prioneris sita*	Painted Sawtooth	VC, Sch IV
19	*Leptosia nina*	Psyche	VC
20	*Cepora nerissa*	Common Gull	C, Sch II
21	*Cepora nadina*	Lesser Gull	R, Sch II
22	*Belenois aurota aurota*	Pioneer	R
23	*Appias lyncida*	Chocolate Albatross	VC, Sch II
24	*Appias albina*	Common Albatross	VC
25	*Ixias pyrene*	Yellow Orange Tip	C
26	*Hebomoia glaucippe*	Sahyadri Great Orange Tip	VC
27	*Pareronia hippia*	Dark Wanderer	VC
28	*Catopsilia pomona*	Lemon Emigrant	VC
29	*Catopsilia pyranthe pyranthe*	Mottled Emigrant	VC
30	*Eurema brigitta*	Small Grass Yellow	VC
31	*Eurema hecabe*	Common Grass Yellow	VC
32	*Eurema blanda*	Three-spot Grass Yellow	VC
	LYCAENIDAE		
33	*Spalgis epeus*	Apefly	C
34	*Castalius rosimon*	Common Pierrot	VC, Sch I
35	*Caleta decidia decidia*	Angled Pierrot	VC
36	*Discolampa ethion ethion*	Oriental Banded Blue Pierrot	R
37	*Acytolepis puspa felderi*	Malabar Common Hedge Blue	R

38	*Neopithecops zalmora*	Quaker	VC
39	*Megisba malaya*	Malyan	VC
40	*Euchrysops cnejus*	Gram Blue	R, Sch II
41	*Lampides boeticus*	Pea Blue	R, Sch II
42	*Jamides bochus*	Dark Cerulean	R
43	*Jamides celeno*	Common Cerulean	VC
44	*Prosotas nora*	Common Lineblue	R
45	*Talicada nyseus*	Red pierrot	VC
46	*Thaduka multicaudata*	Many-Tailed Oak Blue	C
47	*Arhopala centaurus pirama*	Tamil Centaur Oakblue	R
48	*Surendra quercetorum*	Common Acacia Blue	R
49	*Spindasis vulcanus*	Common Sliver Line	C
50	*Loxura atymnus atymnus*	Sahyadri Yamfly	VC
51	*Cheritra freja*	Common Imperial	R
52	*Rathinda amor*	Monkey Puzzle	VC
53	*Zesius chrysomallus*	Red spot	R
54	*Zeltus amasa*	Indian Fluffy Tit	C
55	*Virachola isocrates*	Common Guava Blue	R
56	*Rapala manea*	Slate Flash	R
57	*Rapala lankana*	Malabar Flash	R
58	*Curetis thetis*	Indian Sun Beam	R
59	*Curetis siva*	Shiva Sun Beam	R, E
	RIODINIDAE		
60	*Abisara echerius*	Plum Judy	VC
	NYMPHALIDAE		
61	*Danaus chrysippus*	Oriental Plain Tiger	VC
62	*Danaus genutia*	Stripped Tiger	VC
63	*Tirumala limniace*	Blue Tiger	VC
64	*Tirumala septentrionis*	Dark Blue Tiger	VC
65	*Parantica aglea*	Glassy Blue Tiger	VC
66	*Euploea core*	Common Crow	VC
67	*Ariadne ariadne*	Angled Castor	VC
68	*Ariadne merione*	Common Castor	VC
69	*Cupha erymanthis*	Sahyadri Rustic	VC
70	*Phalanta phalantha*	Common Leopard	VC
71	*Cirrochroa thais*	Tamil Yeoman	VC, E
72	*Vindula erota*	Sahyadri Cruiser	VC
73	*Junonia hierta*	Oriental Yellow Pansy	VC
74	*Junonia orithya*	Blue Pansy	VC
75	*Junonia lemonias*	Lemon Pansy	VC
76	*Junonia almana*	Oriental Peacock Pansy	VC
77	*Junonia atlites*	Oriental Grey Pansy	VC
78	*Junonia iphita*	Oriental Chocolate Pansy	VC
79	*Kaniska canace*	Sahyadri Blue Admiral	R

80	*Hypolimnas misippus*	Danaid Eggfly	VC, Sch I
81	*Hypolimnas bolina*	Great Eggfly	VC
82	*Kallima horsfieldi*	Sahyadri Blue oakleaf	C, E
83	*Doleschallia bisaltide malabarica*	Malabar Autumn Leaf	R
84	*Cyrestis thyodamas*	Map Butterfly	VC
85	*Neptis jumbah*	Chestnut-Streaked Sailer	R
86	*Neptis hylas*	Indian Common Sailor	VC
87	*Pantoporia hordonia*	Oriental Common Lascar	VC
88	*Athyma inara*	Colour Sergeant	C
89	*Athyma ranga*	Blackvein Sergeant	C
90	*Athyma perius*	Common Sergeant	R
91	*Moduza procris*	Sahyadri Commander	VC
92	*Parthenos sylvia*	Sahyadri Clipper	VC, Sch II
93	*Tanaecia lepidea*	Grey Count	VC Sch II
94	*Euthalia lubentina*	Gaudy Baron	R
95	*Charaxes athamas*	Common Nawab	C
96	*Charaxes solon*	Pale Black Rajah	R
97	*Acraea terpsicore*	Tawny Coster	VC
98	*Melanitis leda*	Common Evening Brown	VC
99	*Melanitis zitenius*	Sahyadri Great Evening Brown	R
100	*Elymnias hypermnestra*	Common Palmfly	C
101	*Lethe europa*	Dakhan Bamboo Treebrown	C
102	*Lethe rohria*	Dakhan Common Tree Brown	C
103	*Mycalesis perseus*	Common Bushbrown	C
104	*Mycalesis mineus*	Dark-Brand Bushbrown	R
105	*Mycalesis junonia*	Malabar Glad-eye-Bushbrown	VC, E
106	*Orsotriaena medus*	Sahyadri Medus Brown	VC
107	*Ypthima baldus*	Sahyadri Common Fivering	VC
108	*Ypthima huebneri*	Common Fourring	VC
	HESPERIIDAE		
109	*Bibasis sena*	Orange-tail Awl	R
110	*Choaspes benjaminii*	Indian Awlking	R
111	*Hasora chromus*	Common Banded Awl	C
112	*Hasora taminatus*	White-Banded Awl	R
113	*Hasora badra*	Common Awl	R
114	*Badamia exclamationis*	Brown Awl	R
115	*Celaenorrhinus ambareesa*	Dakhan Spotted Flat	R
116	*Tagiades gana silvia*	Snuffused Snow Flat	VC
117	*Gerosis bhagava*	Common Yellow-breasted Flat	R
118	*Tagiades japetus*	Common Snow Flat	VC
119	*Tagiades litigiosa*	Water Snow Flat	VC
120	*Sarangesa dasahara*	Common Small Flat	VC
121	*Sarangesa purendra pandra*	Spotted small Flat	R
122	*Pseudocoladenia dan*	Fulvious Pied Flat	VC

123	*Coladenia indrani indra*	Tricolor Pied Flat	VC
124	*Iambrix salsala*	Chestnut Bob	VC
125	*Notocrypta curvifascia*	Restricted Demon	VC
126	*Matapa aria*	Common Redeye	R
127	*Borbo cinnara*	Rice Swift	VC
128	*Aeromachus pygmaeus*	Pygmy scrub Hopper	VC
129	*Ampittia dioscorides*	Bush Hopper	R
130	*Psolos fuligo*	Coon	VC
131	*Notocrypta paralysos*	Common Banded Demon	R
132	*Udaspes folus*	Grass Demon	VC
133	*Suastus gremius*	Indian Palm Bob	C
134	*Gangara thyrsis*	Giant Redeye	R
135	*Telicota bambusae*	Dark Palm Dart	R
136	*Oriens concinna*	Tamil Dartlet	C
137	*Oriens goloides*	Smaller Dartlet	R
138	*Taractrocera maevius*	Oriental Grass Dart	R
139	*Pelopidas mathias*	Dakhan Small Branded Swift	R
140	*Erionota thrax*	Palm Redeye	R

(VC- Very Common, C- Common, R- Rare, E- Endemic to WG, Sch- Schedule)

Appendix VII

Checklist of Moths in Kavvayi River Basin

Sl No	Family	Genus	Species
1	Arctiidae	*Asura*	*Asura rubricosa*
2	Arctiidae	*Ceryx*	*Ceryx* sp.
3	Arctiidae	*Curoba*	*Curoba sangarida*
4	Arctiidae	*Cyana*	*Cyana peregrina* (Walker, 1854)
5	Arctiidae	*Eressa*	*Eressa confinis* (Walker, 1854)
6	Arctiidae	*Euchromius*	*Euchromius* sp.
7	Arctiidae	*Euchromius*	*Euchromius* sp.
8	Arctiidae	*Hemonia*	*Hemonia orbiferana* Walker, 1863
9	Arctiidae	*Hemonia*	*Hemonia* sp.
10	Arctiidae	*Lyclene*	*Lyclene* sp.
11	Arctiidae	*Nepita*	*Nepita conferta* (Walker, 1854)
12	Arctiidae	*Pareuchaetes*	*Pareuchaetes pseudoinsulata* Rego Barros, 1956
13	Arctiidae	*pericallia*	*pericallia* sp.
14	Arctiidae	*Pseudoblabes*	*Pseudoblabes oophora* Zeller, 1853
15	Arctiidae	*Schistophleps*	*Schistophleps* sp.
16	Arctiidae	*Scirpophaga*	*Scirpophaga excerptalis* (Walker, 1863)
17	Arctiidae	*Spilosoma*	*Spilosoma* sp.
18	Arctiidae	*Spilosoma*	*Spilosoma urticae* (Esper, 1789)

Sl No	Family	Genus	Species
19	Arctiidae	*Stictane*	*Stictane* sp.
20	Arctiidae	*Syntomoides*	*Syntomoides* sp.
21	Arctiidae	*Trischalis*	*Trischalis* sp.
22	Erebidae	*Achaea*	*Achaea janata* (Linnaeus, 1758)
23	Erebidae	*Achaea*	*Aemene* sp
24	Erebidae	*Aloa*	*Aloa lactinea* (Cramer, [1777])
25	Erebidae	*Amata*	*Amata bicincta* (Kollar, [1844])
26	Erebidae	*Amata*	*Amata* sp
27	Erebidae	*Amerila*	*Amerila astreus* (Drury, 1773)
28	Erebidae	*Arctornis*	*Arctornis kumatai* Inoue, 1956
29	Erebidae	*Arctornis*	*Arctornis*sp .
30	Erebidae	*Argina*	*Argina astrea*
31	Erebidae	*Argyresthia*	*Argyresthia* sp.
32	Erebidae	*Artaxa*	*Artaxa* sp.
33	Erebidae	*Artena*	*Artena dotata* (Fabricius, 1794)
34	Erebidae	*Asta*	*Asta quadrilinea*
35	Erebidae	*Asura*	*Asura conferta*
36	Erebidae	*Bastilla*	*Bastilla fulvotaenia* (Guenée, 1852)
37	Erebidae	*Bertula*	*Bertula* sp.
38	Erebidae	*Bocana*	*Bocana manifestalis* Walker, [1859]
39	Erebidae	*Colobochyla*	*Colobochyla* sp.
40	Erebidae	*Creatonotos*	*Creatonotos gangis* (Linnaeus, 1763)
41	Erebidae	*Creatonotos*	*Creatonotos transiens* (Walker, 1855)
42	Erebidae	*Daddala*	*Daddala* sp
43	Erebidae	*Diacrisia*	*Diacrisia* sp.
44	Erebidae	*Diacrisia*	*Diomea* sp.
45	Erebidae	*Eilema antica*	*Eilema antica* Walker 1854(2)
46	Erebidae	*Erebus*	*Erebus ephesperis*
47	Erebidae	*Erebus*	*Erebus ephesperis* (Hübner, 1827)
48	Erebidae	*Erebus*	*Erebus hieroglyphica* (Drury, 1773)
49	Erebidae	*Erebus*	*Erebus macrops* (Linnaeus, 1758)
50	Erebidae	*Ericeia*	*Ericeia* sp.
51	Erebidae	*Eublemma*	*Eublemma accedens* Felder and Rogenhofer, 1874
52	Erebidae	*Eublemma*	*Eublemma albostriata* Wileman & West, 1929
53	Erebidae	*Eublemma*	*Eublemma cochylioides* (Guenee, 1852)
54	Erebidae	*Eudocima*	*Eudocima homaena* (Hübner, [1823])
55	Erebidae	*Eudocima*	*Eudocima phalonia* (Linnaeus, 1763)
56	Erebidae	*Eudocima*	*Eudocima cajeta*
57	Erebidae	*Euproctis*	*Euproctis icilia*
58	Erebidae	*Euproctis*	*Euproctis* sp.1
59	Erebidae	*Euproctis*	*Euproctis* sp.2
60	Erebidae	*Fodina*	*Fodina* sp.
61	Erebidae	*Hadennia*	*Hadennia* sp.
62	Erebidae	*Hipoepa*	*Hipoepa* sp.
63	Erebidae	*Hulodes*	*Hulodes drylla*
64	Erebidae	*Hydrillodes*	*Hydrillodes lentalis* Guenée, 1854

Sl No	Family	Genus	Species
65	Erebidae	*Macrobrochis*	*Macrobrochis gigas* (Walker, 1854)
66	Erebidae	*Macrobrochis*	*Macrobrochis* sp.
67	Erebidae	*Mangina*	*Mangina argus* (Kollar, [1847])
68	Erebidae	*Miltochrista*	*Miltochrista* sp.
69	Erebidae	*Mocis*	*Mocis undata*
70	Erebidae	*Nodaria*	*Nodaria tristis* (Butler, 1879)
71	Erebidae	*Olene*	*Olene* sp.
72	Erebidae	*Olepa*	*Olepa ricini* (Fabricius, 1775)
73	Erebidae	*Ophiusa*	*Ophiusa triphaenoides* (Walker, 1858)
74	Erebidae	*Oraesia*	*Oraesia emarginata* (Fabricius, 1794)
75	Erebidae	*Orvasca*	*Orvasca* sp.
76	Erebidae	*Orvasca*	*Orvasca subnotata* Walker, 1865
77	Erebidae	*Pangora*	*Pangora* sp.
78	Erebidae	*Pericyma*	*Pericyma cruegeri* (Butler, 1886)
79	Erebidae	*Prolophota*	*Prolophota* sp.
80	Erebidae	*Simplicia*	*Simplicia* sp.
81	Erebidae	*Spilarctia*	*Spilarctia luteum*
82	Erebidae	*Spilarctia*	*Spilarctia mona* (Swinhoe, 1885)
83	Erebidae	*Spilosoma*	*Spilosoma lutea* (Hufnagel, 1766)
84	Erebidae	*Syntomis*	*Syntomis* sp.
85	Erebidae	*Thyas*	*Thyas coronata* Hubner, 1824
86	Erebidae	*Thyas*	*Thyas honesta* Hübner 1806
87	Erebidae	*Utetheisa*	*Utetheisa pulchella* (Linnaeus, 1758)
88	Eupterotidae	*Eupterote*	*Eupterote hibisci Fabricius* 1775
89	Eupterotidae	*Eupterote*	*Eupterote* sp.
90	Eupterotidae	*Eupterote*	*Eupterote* sp. 1
91	Eupterotidae	*Eupterote*	*Eupterote* sp. 2
92	Eupterotidae	*Eupterote*	*Eupterote* sp. 3
93	Eupterotidae	*Ganisa*	*Ganisa postica* Walker, 1855
94	Eupterotidae	*Ganisa*	*Ganisa* sp.
95	Hyblaeidae	*Hyblaea*	*Hyblaea puera* (Cramer, 1777)
96	Nolidae	*Blenina*	*Blenina* sp.
97	Sphingidae	*Angonyx*	*Angonyx krishna*
98	Sphingidae	*Hippotion*	*Hippotion boerhaviae* (Fabricius, 1775)
99	Sphingidae	*Psilogramma*	*Psilogramma increta* (Walker, [1865])
100	Tortricidae	*Adoxophyes*	*Adoxophyes moderatana* Walker 1863
101	Tortricidae	*Homona*	*Homona coffearia* Nietner 1861
102	Uraniidae	*Micronia*	*Micronia aculeata* Guenée, 1857
103	Uraniidae	*Orudiza*	*Orudiza protheclaria* Walker, 1861
104	Zygaenidae	*Cyclosia*	*Cyclosia* Sp.
105	Euteliidae	*Penicillaria*	*Penicillaria jocosatrix* Guenée, 1852
106	Saturniidae	*Actias*	*Actias selene* (Hübner, 1807)
107	Saturniidae	*Antheraea*	*Antheraea paphia* Linnaeus 1758
108	Saturniidae	*Antheua*	*Antheua servula* Drury 1773
109	Alucitidae	*Alucita*	*Alucita* sp.
110	Autostichidae	*Autosticha*	*Autosticha* sp.
111	Autostichidae	*Autosticha*	*Autosticha* sp.

Sl No	Family	Genus	Species
112	Autostichidae	*Symmoca*	*Symmoca signatella* (Herrich-Schaffer, 1854)
113	Blastobasidae	*Blastobasis*	*Blastobasis* sp.
114	Bombycidae	*Trilocha*	*Trilocha* sp
115	Choreutidae	*Choreutis*	*Choreutis* sp.
116	Cosmopterigidae	*Anatrachyntis*	*Anatrachyntis* sp.
117	Cosmopterigidae	*Ascalenia*	*Ascalenia* sp.
118	Cosmopterigidae	*Cosmopterix*	*Cosmopterix* sp.1
119	Cosmopterigidae	*Cosmopterix*	*Cosmopterix victor* Stringer 1930
120	Cosmopterigidae	*Labdia*	*Labdia antennella*
121	Cosmopterigidae	*Labdia*	*Labdia semicoccinea* Stainton 1859
122	Cosmopterigidae	*Macrobathra*	*Macrobathra* sp.
123	Cossidae	*Phragmataecia*	*Phragmataecia* sp.
124	Crambidae	*Agathodes*	*Agathodes ostentalis* (Geyer, 1833)
125	Crambidae	*Ancylolomia*	*Ancylolomia japonica* Zeller, 1877
126	Crambidae	*Ancylolomia*	*Ancylolomia* sp.
127	Crambidae	*Ancylolomia*	*Ancylolomia* sp.
128	Crambidae	*Antigastra*	*Antigastra catalaunalis* (Duponchel, 1833)
129	Crambidae	*Botyodes*	*Botyodes diniasalis* (Walker, 1859)
130	Crambidae	*Bradina*	*Bradina geminalis* Caradja 1927
131	Crambidae	*Calamotropha*	*Calamotropha* sp.
132	Crambidae	*Chilo*	*Chilo infuscatellus* Snellen, 1890
133	Crambidae	*Chilo*	*Chilo partellus*
134	Crambidae	*Cnaphalocrocis*	*Cnaphalocrocis medinalis* (Guenee, 1854)
135	Crambidae	*Cnaphalocrocis*	*Cnaphalocrocis poeyalis* (Boisduval, 1833)
136	Crambidae	*Cnaphalocrocis*	*Cnaphalocrocis* sp.
137	Crambidae	*Diaphania*	*Diaphania indica* (Saunders, 1851)
138	Crambidae	*Diasemia*	*Diasemia accalis* (Walker, 1859)
139	Crambidae	*Diasemia*	*Diasemia reticularis* (Linnaeus, 1761)
140	Crambidae	*Elophila*	*Elophila* sp.
141	Crambidae	*Elophila*	*Elophila* sp.
142	Crambidae	*Eoophyla*	*Eoophyla* sp
143	Crambidae	*Eoophyla*	*Eoophyla* sp.
144	Crambidae	*Euclasta*	*Euclasta* sp.
145	Crambidae	*Eurrhyparodes*	*Eurrhyparodes bracteolalis* (Zeller, 1852)
146	Crambidae	*Glyphodes*	*Glyphodes bicolor* (Swainson, 1821)
147	Crambidae	*Glyphodes*	*Glyphodes bivitralis*
148	Crambidae	*Glyphodes*	*Glyphodes itysalis*
149	Crambidae	*Glyphodes*	*Glyphodes shafferorum* Viette 1987
150	Crambidae	*Goniorhynchus*	*Goniorhynchus plumbeizonalis* Hampson, 1896
151	Crambidae	*Goniorhynchus*	*Goniorhynchus* sp.
152	Crambidae	*Haritalodes*	*Haritalodes derogata* (Fabricius, 1775)
153	Crambidae	*Hendecasis*	*Hendecasis* sp.
154	Crambidae	*Herpetogramma*	*Herpetogramma* sp.
155	Crambidae	*Isocentris*	*Isocentris* sp.
156	Crambidae	*Lamprosema*	*Lamprosema tampiusalis* Walker 1859
157	Crambidae	*Maruca*	*Maruca vitrata* (Fabricius, 1787)

Sl No	Family	Genus	Species
158	Crambidae	*Metoeca*	*Metoeca foedalis* (Guenée, 1854)
159	Crambidae	*Musotima*	*Musotima* sp.
160	Crambidae	*Nacoleia*	*Nacoleia* sp.
161	Crambidae	*Nacoleia*	*Nacoleia* sp.
162	Crambidae	*Nausinoe*	*Nausinoe geometralis* (Guenée, 1854)
163	Crambidae	*Noorda*	*Noorda* sp.
164	Crambidae	*Notarcha*	*Notarcha aurolinealis* (Walker, 1859)
165	Crambidae	*Omiodes*	*Omiodes indicata* (Fabricius, 1775)
166	Crambidae	*Omiodes*	*Omiodes* sp.
167	Crambidae	*Pachynoa*	*Pachynoa sabelialis*
168	Crambidae	*Paliga*	*Paliga* sp.
169	Crambidae	*Palpita*	*Palpita annulifer* Inoue 1996
170	Crambidae	*Palpita*	*Palpita* sp.
171	Crambidae	*Parapoynx*	*Parapoynx fluctuosalis* (Zeller, 1852)
172	Crambidae	*Parapoynx*	*Parapoynx* sp
173	Crambidae	*Parapoynx*	*Parapoynx* sp. 1
174	Crambidae	*Parapoynx*	*Parapoynx* sp. 2
175	Crambidae	*Parapoynx*	*Parapoynx stagnalis* (Zeller, 1852)
176	Crambidae	*Parotis*	*Parotis marginata* (Hampson, 1893)
177	Crambidae	*Patissa*	*Patissa fulvosparsa* Butler 1881
178	Crambidae	*Patissa*	*Pattissa* sp.
179	Crambidae	*Piletocera*	*Piletocera sodalis* (Leech, 1889)
180	Crambidae	*Piletocera*	*Piletocera* sp.
181	Crambidae	*Pseudocatharylla*	*Pseudocatharylla* sp.
182	Crambidae	*Pygospila*	*Pygospila tyres* (Cramer, 1789)
183	Crambidae	*Pyrausta*	*Pyrausta* sp.
184	Crambidae	*Sameodes*	*Sameodes cancellalis* (Zeller, 1852)
185	Crambidae	*Sameodes*	*Sameodes* sp.
186	Crambidae	*Scirpophaga*	*Scirpophaga incertulas* (Walker, 1863)
187	Crambidae	*Scirpophaga*	*scirpophaga* sp
188	Crambidae	*Scirpophaga*	*Scirpophaga* sp.
189	Crambidae	*Spoladea*	*Spoladea recurvalis* (Fabricius, 1775)
190	Crambidae	*Stenia*	*Stenia minoralis* Snellen 1880
191	Crambidae	*Strepsinoma*	*Strepsinoma* sp.
192	Crambidae	*Sufetula*	*Sufetula rectifascialis* Hampson, 1896
193	Crambidae	*Thysanoidma*	*Thysanoidma octalis* Hampson, 1891
194	Crambidae	*Trichophysetis*	*Trichophysetis* sp.
195	Drepanidae	*Callidrepana*	*Callidrepana* sp.
196	Elachistidae	*Agonopterix*	*Agonopterix* sp.
197	Eriocottidae	*Spirama*	*Spirama* sp.
198	Gelechiidae	*Anarsia*	*Anarsia* sp.
199	Gelechiidae	*Compsoctena*	*Compsoctena* sp.
200	Gelechiidae	*Dichomeris*	*Dichomeris harmonias* Meyrick, 1922
201	Gelechiidae	*Dichomeris*	*Dichomeris* sp. 1
202	Gelechiidae	*Dichomeris*	*Dichomeris* sp. 2
203	Gelechiidae	*Dichomeris*	*Dichomeris* sp. 3
204	Gelechiidae	*Dichomeris*	*Dichomeris* sp. 4

Sl No	Family	Genus	Species
205	Gelechiidae	*Dichomeris*	*Dichomeris* sp. 5
206	Gelechiidae	*Dichomeris*	*Dichomeris* sp. 6
207	Gelechiidae	*Gelechia*	*Gelechia* sp.
208	Gelechiidae	*Helcystogramma*	*Helcystogramma* sp.
209	Gelechiidae	*Hypatima*	*Hypatima* sp.
210	Gelechiidae	*Stegasta*	*Stegasta* sp.
211	Gelechiidae	*Teleiodes*	*Teleiodes* sp.
212	Gelechiidae	*Thiotricha*	*Thiotricha* sp.
213	Geometridae	*Achrosis*	*Achrosis intexta* (Swinhoe, 1891)
214	Geometridae	*Amraica*	*Amraica* sp.
215	Geometridae	*Aporandria*	*Aporandria specularia* (Guenée, 1857)
216	Geometridae	*Argyrocosma*	*Argyrocosma* sp.
217	Geometridae	*Biston*	*Biston suppressaria* (Guenée, 1857)
218	Geometridae	*Borbacha*	*Borbacha pardaria* (Guenée, 1857)
219	Geometridae	*Buzura*	*Buzura suppressaria* Guenée 1858
220	Geometridae	*Chiasmia*	*Chiasmia nora*
221	Geometridae	*Chiasmia*	*Chiasmia* sp.
222	Geometridae	*Comibaena*	*Comibaena* sp.
223	Geometridae	*Comostola*	*Comostola laesaria* (Walker, 1861)
224	Geometridae	*Comostola*	*Comostola rubripunctata*
225	Geometridae	*Comostola*	*Comostola* sp.
226	Geometridae	*Dasyboarmia*	*Dasyboarmia* sp. 1
227	Geometridae	*Dasyboarmia*	*Dasyboarmia* sp. 2
228	Geometridae	*Derambila*	*Derambila* sp.
229	Geometridae	*Dysphania*	*Dysphania percota*
230	Geometridae	*Eupithecia*	*Eupithecia* sp.
231	Geometridae	*Gonodontis*	*Gonodontis* sp.
232	Geometridae	*Hemistola*	*Hemistola* sp.
233	Geometridae	*Hemistola*	*Hemistola tenuilinea*
234	Geometridae	*Hemithea*	*Hemithea* sp.
235	Geometridae	*Heterostegane*	*Heterostegane urbica*
236	Geometridae	*Hyperythra*	*Hyperythra lutea* (Stoll, [1781])
237	Geometridae	*Hyperythra*	*Hyperythra* sp.
238	Geometridae	*Hyposidra*	*Hyposidra talaca* (Walker, 1860)
239	Geometridae	*Jodis*	*Jodis* sp.
240	Geometridae	*Menophr*	*Menophra* sp.
241	Geometridae	*Naxa*	*Naxa seriaria* (Motschulsky, 1866)
242	Geometridae	*Naxa*	*Naxa textilis* Walker, 1856
243	Geometridae	*Noreia*	*Noreia* sp.
244	Geometridae	*Ornithospila*	*Ornithospila* sp.
245	Geometridae	*Ozola*	*Ozola* sp.
246	Geometridae	*Pelagodes*	*Pelagodes* sp.
247	Geometridae	*Petelia*	*Petelia* sp.
248	Geometridae	*Problepsis*	*Problepsis vulgaris*
249	Geometridae	*Pseudotelphusa*	*Pseudotelphusa* sp.
250	Geometridae	*Ruttellerona*	*Ruttellerona* sp.
251	Geometridae	*Ruttellerona*	*Ruttellerona pallicostaria* (Moore, [1868])

Sl No	Family	Genus	Species
252	Geometridae	*Scopula*	*Scopula emissaria* (Walker, 1861)
253	Geometridae	*Scopula*	*Scopula minorata* Boisduval, 1833
254	Geometridae	*Semiothisa*	*Semiothisa eleonora*
255	Geometridae	*Semiothisa*	*Semiothisa honoria* Hampson 1912
256	Geometridae	*Traminda*	*Traminda aventiaria* (Guenée, 1857)
257	Gracillariidae	*Eteoryctis*	*Eteoryctis syngramma* Meyrick, 1914
258	Immidae	*Imma*	*Imma* sp.
259	Lasiocampidae	*Gastropacha*	*Gastropacha* sp.
260	Lasiocampidae	*Gastropacha*	*Gastropacha pardale* Walker 1855
261	Lecithoceridae	*Deltoplastis*	*Deltoplastis* sp.
262	Lecithoceridae	*Homaloxestis*	*Homaloxestis* sp.
263	Lecithoceridae	*Lecithocera*	*Lecithocera concinna* Turner 1919
264	Lecithoceridae	*Lecithocera*	*Lecithocera* sp.
265	Lecithoceridae	*Lecithocera*	*Lecithocera tenella*
266	Lecithoceridae	*Odonestis*	*Odonestis* sp.
267	Limacodidae	*Altha*	*Altha nivea* Walker, 1862
268	Limacodidae	*Altha*	*Altha subnotata* Walker 1865
269	Limacodidae	*Lithacodes*	*Lithacodes* sp.
270	Limacodidae	*Miresa*	*Miresa argentifera* Walker, 1855
271	Limacodidae	*Narosa*	*Narosa* sp.
272	Limacodidae	*Phocoderma*	*Phocoderma* sp.
273	Limacodidae	*Praesetora*	*Praesetora* sp.
274	Limacodidae	*Praesetora*	*Scopelodes* sp.
275	Limacodidae	*Thosea*	*Thosea* sp.
276	Lyonettidae	*Leucoptera*	*Leucoptera* sp.
277	Noctuidae	*Acontia*	*Acontia nitidula* (Fabricius, 1787)
278	Noctuidae	*Amyna*	*Amyna natalis* (Walker, [1859])
279	Noctuidae	*Amyna*	*Amyna octo* (Guenée, 1852)
280	Noctuidae	*Amyna*	*Amyna punctum* (Fabricius, 1794)
281	Noctuidae	*Amyna*	*Amyna* sp.
282	Noctuidae	*Anua*	*Anua coronata*
283	Noctuidae	*Arsacia*	*Arsacia rectalis* (Walker, 1863)
284	Noctuidae	*Artena*	*Artena dotata*
285	Noctuidae	*Asota*	*Asota caricae* (Fabricius, 1775)
286	Noctuidae	*Asota*	*Asota plana* Walker, 1854
287	Noctuidae	*Asota*	*Asota producta* (Butler, 1875)
288	Noctuidae	*Bocana*	*Bocana manifestalis* Walker, [1859]
289	Noctuidae	*Callopistria*	*Callopistria* sp.
290	Noctuidae	*Cerynea*	*Cerynea* sp.
291	Noctuidae	*Chalciope*	*Chalciope mygdon* (Cramer, [1777])
292	Noctuidae	*Chasmina*	*Chasmina candida* (Walker, 1865)
293	Noctuidae	*Condica*	*Condica* sp.
294	Noctuidae	*Diarsia*	*Diarsia* sp.
295	Noctuidae	*Egnasia*	*Egnasia ephyrodalis* Walker, 1858
296	Noctuidae	*Entomogramma*	*Entomogramma fautrix* Guenée, 1852
297	Noctuidae	*Ercheia*	*Ercheia* sp.
298	Noctuidae	*Eustrotia*	*Eustrotia marginata* Moore 1881

Sl No	Family	Genus	Species
299	Noctuidae	*Helicoverpa*	*Helicoverpa* sp.
300	Noctuidae	*Hoplodrina*	*Hoplodrina* sp.
301	Noctuidae	*Loxioda*	*Loxioda* sp.
302	Noctuidae	*Maliattha*	*Maliattha separata* Walker, 1863
303	Noctuidae	*Maliattha*	*Maliattha* sp.
304	Noctuidae	*Mythimna*	*Mythimna* sp.
305	Noctuidae	*Neochera*	*Neochera dominia* (Cramer, [1780])
306	Noctuidae	*Neochera*	*Neochera inopis*
307	Noctuidae	*Nolasena*	*Nolasena ferrifervens* Walker 1857
308	Noctuidae	*Polytela*	*Polytela gloriosae* (Fabricius, 1775)
309	Noctuidae	*Protodeltote*	*Protodeltote* sp.
310	Noctuidae	*Pseudozarba*	*Pseudozarba* sp.
311	Noctuidae	*Sesamia*	*Sesamia* sp.
312	Noctuidae	*Spodoptera*	*Spodoptera litura* (Fabricius, 1775)
313	Noctuidae	*Spodoptera*	*Spodoptera mauritia* (Boisduval, 1833)
314	Noctuidae	*Trigonodes*	*Trigonodes hyppasia* (Cramer, [1779])
315	Noctuidae	*Xanthodes*	*Xanthodes acontia gradsi*
316	Noctuidae	*Xanthodes*	*Xanthodes graelsi*
317	Noctuidae	*Xanthodes*	*Xanthodes transversa*
318	Noctuidae	*Zurobata*	*Zurobata vacillans* Walker 1864
319	Pyralidae	*Endotricha*	*Endotricha consocia* (Butler, 1879)
320	Pyralidae	*Herculia*	*Herculia pelasgalis* Walker 1859
321	Pyralidae	*Noctuides*	*Noctuides melanophia Staudinge*, 1892

Appendix VIII

Checklist of Birds in Kavvayi River Basin

No	English name	Species name	IUCN
	I. ORDER ANSERIFORMES		
	1. Family Anatidae (ducks, geese, swans)		
1	Lesser Whistling Duck	*Dendrocygna javanica*	LC
2	Garganey	*Spatula querquedula*	LC
	II. ORDER GALLIFORMES		
	2. Family Phasianidae (partridges, pheasants, grouse)		
3	Indian Peafowl	*Pavo cristatus*	LC
4	Jungle Bush Quail	*Perdicula asiatica*	LC
5	Grey Junglefowl	*Gallus sonneratii*	LC
6	Red Spurfowl	*Galloperdix spadicea*	LC
	III. ORDER PHOENICOPTERI-FORMES		

	3. Family Podicipedidae (grebes)		
7	Little Grebe	*Tachybaptus ruficollis*	LC
	IV. ORDER COLUMBIFORMES		
	4. Family Columbidae (pigeons)		
8	Rock Pigeon (Rock Dove)	*Columba livia*	LC
9	Spotted Dove	*Streptopelia chinensis*	LC
10	Pompadour Green Pigeon (Grey-fronted Green Pigeon)	*Treron pompadora*	LC
11	Yellow-legged Green Pigeon (Yellow-footed Green Pigeon)	*Treron phoenicopterus*	LC
12	Emerald Dove	*Chalcophaps indica*	LC
	V. ORDER CAPRIMULGIFORMES		
	5. Family Caprimulgidae (nightjars)		
13	Grey Nightjar (Jungle Nightjar)	*Caprimulgus indicus*	LC
14	Indian Nightjar	*Caprimulgus asiaticus*	LC
	6. Family Apodidae (swifts)		
15	Brown-backed Needletail	*Hirundapus giganteus*	LC
16	Indian Swiftlet	*Aerodramus unicolor*	LC
17	Asian Palm Swift	*Cypsiurus balasiensis*	LC
18	Alpine Swift	*Tachymarptis melba*	LC
19	Indian House Swift (Little Swift)	*Apus affinis*	LC
	VI. ORDER CUCULIFORMES		
	7. Family Cuculidae (cuckoos)		
20	Greater Coucal	*Centropus sinensis*	LC
21	Blue-faced Malkoha	*Phaenicophaeus viridirostris*	LC
22	Pied Cuckoo (Pied Crested Cuckoo, Jacobian Cuckoo)	*Clamator jacobinus*	LC
23	Asian Koel	*Eudynamys scolopaceus*	LC
24	Banded Bay Cuckoo	*Cacomantis sonneratii*	LC
25	Common Hawk Cuckoo	*Hierococcyx varius*	LC
26	Indian Cuckoo	*Cuculus micropterus*	LC
	VII. ORDER GRUIFORMES		
	8. Family Rallidae (rails and coots)		
27	Ruddy-breasted Crake	*Zapornia fusca*	LC
28	White-breasted Waterhen	*Amaurornis phoenicurus*	LC
29	Purple Swamphen	*Porphyrio porphyrio*	LC
30	Common Moorhen (Eurasian Moorhen)	*Gallinula chloropus*	LC
	VIII. ORDER PELECANIFORMES		

	9. Family Ciconiidae (storks)		
31	Asian Openbill	*Anastomus oscitans*	LC
32	Black Stork	*Ciconia nigra*	LC
33	Woolly-necked Stork (Asian Woollyneck)	*Ciconia episcopus*	VU
34	European White Stork	*Ciconia ciconia*	LC
	10. Family Ardeidae (herons)		
35	Yellow Bittern	*Ixobrychus sinensis*	LC
36	Chinnamon Bittern	*Ixobrychus Chinnamomeus*	LC
37	Black-crowned Night Heron	*Nycticorax nycticorax*	LC
38	Striated Heron (Green-backed Heron, Little Heron)	*Butorides striata*	LC
39	Indian Pond Heron	*Ardeola grayii*	LC
40	Cattle Egret	*Bubulcus ibis*	LC
41	Grey Heron	*Ardea cinerea*	LC
42	Purple Heron	*Ardea purpurea*	LC
43	Great Egret	*Ardea alba*	LC
44	Intermediate Egret	*Ardea intermedia*	LC
45	Little Egret	*Egretta garzetta*	LC
46	Western Reef Egret (Western Reef Heron)	*Egretta gularis*	LC
	11. Family Threskiornithidae (ibises)		
47	Black-headed Ibis	*Threskiornis melanocephalus*	NT
48	Glossy Ibis	*Plegadis falcinellus*	LC
	12. Family Phalacrocoracidae (cormorants)		
49	Little Cormorant	*Microcarbo niger*	LC
50	Indian Cormorant	*Phalacrocorax fuscicollis*	LC
	13. Family Anhingidae (darters)		
51	Oriental Darter	*Anhinga melanogaster*	NT
	IX. ORDER CHARADRIIFORMES		
	14. Family Recurvirostridae (stilts and avocets)		
52	Black-winged Stilt	*Himantopus himantopus*	LC
	15. Family Charadriidae (plovers & lapwings)		
53	Grey Plover (Black-bellied Plover)	*Pluvialis squatarola*	LC
54	Pacific Golden Plover	*Pluvialis fulva*	LC
55	Little Ringed Plover	*Charadrius dubius*	LC
56	Kentish Plover	*Charadrius alexandrinus*	LC

57	Lesser Sand Plover	*Charadrius mongolus*	LC
58	Greater Sand Plover	*Charadrius leschenaultii*	LC
59	Yellow-wattled Lapwing	*Vanellus malarbaricus*	LC
60	Grey-headed Lapwing	*Vanellus cinereus*	LC
61	Red-wattled Lapwing	*Vanellus indicus*	LC
	16. Family Jacanidae (jacanas)		
62	Bronze-winged Jacana	*Metopidius indicus*	LC
	17. Family Scolopacidae (sandpipers)		
63	Whimbrel	*Numenius phaeopus*	LC
64	Eurasian Curlew	*Numenius arquata*	NT
65	Ruddy Turnstone	*Arenaria interpres*	LC
66	Ruff	*Calidris pugnax*	LC
67	Curlew Sandpiper	*Calidris ferruginea*	LC
68	Temminck's Stint	*Calidris temminckii*	LC
69	Long-toed Stint	*Calidris subminuta*	LC
70	Sanderling	*Calidris alba*	LC
71	Dunlin	*Calidris alpina*	LC
72	Little Stint	*Calidris minuta*	LC
73	Eurasian Woodcock	*Scolopax rusticola*	LC
74	Pintail Snipe	*Gallinago stenura*	LC
75	Common Snipe	*Gallinago gallinago*	LC
76	Terek Sandpiper	*Xenus cinereus*	LC
77	Common Sandpiper	*Actitis hypoleucos*	LC
78	Green Sandpiper	*Tringa ochropus*	LC
79	Common Greenshank	*Tringa nebularia*	LC
80	Common Redshank	*Tringa totanus*	LC
81	Wood Sandpiper	*Tringa glareola*	LC
82	Marsh Sandpiper	*Tringa stcgnatilis*	LC
	18. Family Glareolidae (coursers and pratincoles)		
83	Oriental Pratincole	*Glareola maldivarum*	LC
84	Little Pratincole (Small Pratincole)	*Glareola lactea*	LC
	19. Family Laridae (gulls and terns)		
85	River Tern	*Sterna aurantia*	NT
86	Common Tern	*Sterna hirundo*	LC
	X. ORDER ACCIPITRIFORMES		
	20. Family Accipitridae (kites, hawks and eagles)		
87	Black-winged Kite (Black-shouldered	*Elanus caeruleus*	LC

	Kite)		
88	Oriental Honey Buzzard (Crested Honey Buzzard)	*Pernis ptilorhynchus*	LC
89	Crested Serpent Eagle	*Spilornis cheela*	LC
90	Changeable Hawk Eagle (Crested Hawk Eagle)	*Nisaetus cirrhatus*	LC
91	Black Eagle	*Ictinaetus malaiensis*	LC
92	Indian Spotted Eagle	*Clanga hastata*	VU
93	Greater Spotted Eagle	*Clanga clanga*	VU
94	Booted Eagle	*Hieraaetus pennatus*	LC
95	Western Marsh Harrier (Eurasian Marsh-Harrier)	*Circus aeruginosus*	LC
96	Pallid Harrier	*Circus macrourus*	NT
97	Montagu's Harrier	*Circus pygargus*	LC
98	Crested Goshawk	*Accipiter trivirgatus*	LC
99	Shikra	*Accipiter badius*	LC
100	White-bellied Sea Eagle	*Haliaeetus leucogaster*	LC
101	Brahminy Kite	*Haliastur indus*	LC
102	Black Kite	*Milvus migrans*	LC
	XI. ORDER STRIGIFORMES		
	21. Family Tytonidae (barn owls)		
103	Common Barn Owl	*Tyto alba*	LC
	22. Family Strigidae (owls)		
104	Brown Hawk Owl (Brown Boobook)	*Ninox scutulata*	LC
105	Jungle Owlet	*Glaucidium radiatum*	LC
106	Spotted Owlet	*Athene brama*	LC
107	Collared Scops Owl (Indian Scops Owl)	*Otus bakkamoena*	LC
108	Brown Fish Owl	*Ketupa zeylonensis*	LC
	XII. ORDER TROGONIFORMES		
	23. Family Trogonidae (trogons)		
109	Malabar Trogon	*Harpactes fasciatus*	LC
	XIII. ORDER BUCEROTIFORMES		
	24. Family Bucerotidae (hornbills)		
110	Malabar Grey Hornbill	*Ocyceros griseus*	LC
	25. Family Upupidae (hoopoes)		
111	Common Hoopoe (Eurasian Hoopoe)	*Upupa epops*	LC
	XIV. ORDER PICIFORMES		
	26. Family Picidae (woodpeckers)		

112	Heart-spotted Woodpecker	*Hemicircus canente*	LC
113	Common Golden-backed Woodpecker (Common Flameback)	*Dinopium javanense*	LC
114	Lesser Golden-backed Woodpecker (Black-rumped Flameback)	*Dinopium benghalense*	LC
115	Rufous Woodpecker	*Micropternus brachyurus*	LC
116	Brown-capped Pygmy Woodpecker	*Dendrocopos moluccensis*	LC
	27. Family Ramphastidae (toucans and barbets)		
117	White-cheeked Barbet	*Psilopogon viridis*	LC
118	Malabar Barbet	*Psilopogon malabaricus*	LC
119	Coppersmith Barbet	*Psilopogon haemacephalus*	LC
	XV. ORDER CORACIIFORMES		
	28. Family Meropidae (bee-eaters)		
120	Green Bee-eater	*Merops orientalis*	LC
121	Chestnut-headed Bee-eater	*Merops leschenaulti*	LC
122	Blue-tailed Bee-eater	*Merops philippinus*	LC
	29. Family Coraciidae (rollers)		
123	Indian Roller	*Coracias benghalensis*	LC
	30. Family Alcedinidae (kingfishers)		
124	Oriental Dwarf Kingfisher (Black-backed Dwarf Kingfisher)	*Ceyx erithaca*	LC
125	Common Kingfisher	*Alcedo atthis*	LC
126	Pied Kingfisher	*Ceryle rudis*	LC
127	Stork-billed Kingfisher	*Pelargopsis capensis*	LC
128	White-throated Kingfisher (White-breasted Kingfisher)	*Halcyon smyrnensis*	LC
	XVI. ORDER FALCONIFORMES		
	31. Family Falconidae (falcons and caracaras)		
129	Common Kestrel (Eurasian Kestrel)	*Falco tinnunculus*	LC
130	Peregrine Falcon	*Falco peregrinus*	LC
	XVII. ORDER PSITTACIFORMES		
	32. Family Psittaculidae (old world parrots)		
131	Plum-headed Parakeet	*Psittacula cyanocephala*	LC
132	Rose-ringed Parakeet	*Psittacula krameri*	LC
133	Vernal Hanging Parrot	*Loriculus vernalis*	LC
	XIII. ORDER PASSERIFORMES		

	33. Family Pittidae (pittas)		
134	Indian Pitta	*Pitta brachyura*	LC
	34. Family Campephagidae (minivets and cuckooshrikes)		
135	Small Minivet	*Pericrocotus cinnamomeus*	LC
136	Scarlet Minivet (Orange Minivet)	*Pericrocotus flammeus*	LC
137	Ashy Minivet	*Pericrocotus divaricatus*	LC
138	Large Cuckooshrike	*Coracina javensis*	LC
139	Black-headed Cuckooshrike	*Lalage melanoptera*	LC
	35. Family Oriolidae (orioles, figbirds and allies)		
140	Black-hooded Oriole	*Oriolus xanthornus*	LC
141	Indian Golden Oriole	*Oriolus kundoo*	LC
142	Black-naped Oriole	*Oriolus chinensis*	LC
	36. Family Artamidae (woodswallows, australian magpies and allies)		
143	Ashy Woodswallow	*Artamus fuscus*	LC
	37. Family Vangidae (vangas and helmet-shrikes)		
144	Bar-winged Flycatcher-shrike	*Hemipus picatus*	LC
145	Common Woodshrike	*Tephrodornis pondicerianus*	LC
	38. Family Aegithinidae (ioras)		
146	Common Iora	*Aegithina tiphia*	LC
	39. Family Dicruridae (drongos)		
147	Black Drongo	*Dicrurus macrocercus*	LC
148	Ashy Drongo	*Dicrurus leucophaeus*	LC
149	Bronzed Drongo	*Dicrurus aeneus*	LC
150	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	LC
	40. Family Laniidae (shrikes)		
151	Brown Shrike	*Lanius cristatus*	LC
152	Long-tailed Shrike	*Lanius schach*	LC
	41. Family Corvidae (crows and jays)		
153	Rufous Treepie	*Dendrocitta vagabunda*	LC
154	House Crow	*Corvus splendens*	LC
155	Large-billed Crow	*Corvus macrorhynchos*	LC
	42. Family Monarchidae (monarchs)		
156	Black-naped Monarch	*Hypothymis azurea*	LC
157	Indian Paradise-flycatcher (Asian Paradise-flycatcher)	*Terpsiphone paradisi*	LC
	43. Family Dicaeidae (flowerpeckers)		

158	Thick-billed Flowerpecker	*Dicaeum agile*	LC
159	Pale-billed Flowerpecker	*Dicaeum erythrorhynchos*	LC
	44. Family Nectariniidae (sunbirds)		
160	Little Spiderhunter	*Arachnothera longirostra*	LC
161	Purple-rumped Sunbird	*Leptocoma zeylonica*	LC
162	Crimson-backed Sunbird	*Leptocoma minima*	LC
163	Purple Sunbird	*Cinnyris asiaticus*	LC
164	Loten's Sunbird (Long-billed Sunbird)	*Cinnyris lotenius*	LC
	45. Family Irenidae (fairy bluebirds and leafbirds)		
165	Golden-fronted Leafbird	*Chloropsis aurifrons*	LC
166	Jerdon's Leafbird	*Chloropsis jerdoni*	LC
	46. Family Ploceidae (weavers)		
167	Baya Weaver	*Ploceus philippinus*	LC
	47. Family Estrildidae (waxbills)		
168	Indian Silverbill (White-throated Munia)	*Euodice malabarica*	LC
169	White-rumped Munia	*Lonchura striata*	LC
170	Scaly-breasted Munia	*Lonchura punctulata*	LC
171	Black-headed Munia (Tricoloured Munia)	*Lonchura malacha*	LC
	48. Family Passeridae (sparrows, snowfinches and allies)		
172	House Sparrow	*Passer domesticus*	LC
	49. Family Motacillidae (wagtails and pipits)		
173	Richard's Pipit	*Anthus richardi*	LC
174	Paddyfield Pipit (Oriental Pipit)	*Anthus rufulus*	LC
175	Grey Wagtail	*Motacilla cinerea*	LC
176	White-browed Wagtail	*Motacilla maderaspatensis*	LC
177	White Wagtail	*Motacilla alba*	LC
	50. Family Alaudidae (larks)		
178	Ashy-crowned Sparrow Lark	*Eremopterix griseus*	LC
179	Jerdon's Bushlark	*Mirafra affinis*	LC
180	Greater Short-toed Lark	*Calandrella brachydactyla*	LC
181	Oriental Skylark	*Alauda gulgula*	LC
182	Malabar Lark	*Galerida malabarica*	LC
	51. Family Cisticolidae (cisticolas)		

183	Zitting Cisticola	*Cisticola juncidis*	LC
184	Golden-headed Cisticola	*Cisticola exilis*	LC
185	Grey-breasted Prinia	*Prinia hodgsonii*	LC
186	Jungle Prinia	*Prinia sylvatica*	LC
187	Plain Prinia	*Prinia inornata*	LC
188	Common Tailorbird	*Orthotomus sutorius*	LC
	52. Family Acrocephalidae (brush, reed and swamp warblers)		
189	Blyth's Reed Warbler	*Acrocephalus dumetorum*	LC
190	Clamorous Reed Warbler	*Acrocephalus stentoreus*	LC
	53. Family Hirundinidae (swallows)		
191	Streak-throated Swallow	*Petrochelidon fluvicola*	LC
192	Red-rumped Swallow	*Cecropis daurica*	LC
193	Wire-tailed Swallow	*Hirundo smithii*	LC
194	Barn Swallow	*Hirundo rustica*	LC
	54. Family Pycnonotidae (bulbuls)		
195	Red-whiskered Bulbul	*Pycnonotus jocosus*	LC
196	Red-vented Bulbul	*Pycnonotus cafer*	LC
197	White-browed Bulbul	*Pycnonotus luteolus*	LC
198	Yellow-browed Bulbul	*Acritillas indica*	LC
	55. Family Phylloscopidae (old world leaf warblers)		
199	Greenish Leaf Warbler (Greenish Warbler)	*Seicercus trochiloides*	LC
	56. Family Pellorneidae (smaller babblers)		
200	Puff-throated Babbler	*Pellorneum ruficeps*	LC
	57. Family Leiothrichidae (babblers, laughing-thrushes and allies)		
201	Rufous Babbler	*Argya subrufa*	LC
202	Jungle Babbler	*Turdoides striata*	LC
203	Yellow-billed Babbler	*Turdoides affinis*	LC
	58. Family Sturnidae (starlings)		
204	Rosy Starling	*Pastor roseus*	LC
205	Brahminy Starling	*Sturnia pagodarum*	LC
206	Common Myna	*Acridotheres tristis*	LC
207	Jungle Myna	*Acridotheres fuscus*	LC
	59. Family Muscicapidae (chats and flycatchers)		
208	Indian Robin	*Saxicoloides fulicatus*	LC
209	Oriental Magpie Robin	*Copsychus saularis*	LC

210	Asian Brown Flycatcher	*Muscicapa dauurica*	LC
211	Tickell's Blue Flycatcher	*Cyornis tickelliae*	LC
212	Malabar Whistling Thrush[1]	*Myophonus horsfieldii*	LC
213	Pied Bushchat	*Saxicola caprata*	LC
214	Desert Wheatear	*Oenanthe deserti*	LC
	60. Family Turdidae (thrushes)		
215	Orange-headed Thrush	*Geokichla citrina*	LC

Appendix IX

Checklist of Reptiles in Kavvayi River Basin

SI No.	Scientific Name	Common Name	IUCN	WPA
	Order TESDUDINES			
	Family EMYDIDAE			
1	*Melanochelys trijuga* (Schweigger)	Indian Pond Terrapin	NT	
	Family TESTUDINIDAE			
2	*Lissemys punctata* (Lacépède, 1788)	Indian Flap-shelled Turtle	LC	Sch. I
	Order SQUAMATA			
	Suborder SAURIA			
	Family GEKKONIDAE			
3	*Hemidactylus brookii* (Gray,1845)	Spotted House Gecko	NE	
4	*Hemidactylus frenatus* (Schlegel,1836)	Tic-Ticky House Gecko	LC	
	Family AGAMIDAE			
5	*Calotes versicolor* (Daudin,1802)	Indian Garden Lizard	NE	
6	*Calotes rouxii* (Duméril & Bibron, 1837)	Roux's Forest Lizard	LC	
	Family SCINCIDAE			
7	*Eutropis carinata*(Schneider, 1801)	Common Indian Skink	LC	
8	*Eutropis macularia* (Blyth, 1853)	Bronze Skink	NE	
9	*Lygosoma punctata* (Gmelin, 1799)	Common snake skink	NE	
10	*Ristella* species			
	Family LACERTIDAE			
11	*Ophisops* species			
	Family VARANIDAE			
12	*Varanus bengalensis* (Daudin,1802)	Indian Monitor Lizard	LC	Sch. I
	Suborder SERPENTES			
	Family TYPHLOPIDAE			
13	*Indotyphlops braminus* (Daudin,1803)	Common Blind Snake	NE	Sch. IV
14	*Grypotyphlops acutus* (Dumeril & Bibron,1844)	Beaked Blind Snake	LC	Sch. IV

	Family PYTHONIDAE			
28	*Python molurus* (Linnaeus, 1758)	Indian Rock Python	LC	Sch. I
	Family ERYCIDAE			
29	*Eryx conicus* (Schneider, 1801)	Common Sand Boa	NE	Sch. IV
	Family COLUBRIDAE			
15	*Ptyas mucosa*(Linnaeus,1758)	Indian Rat Snake	NE	Sch.II
16	*Oligodon arnensis* (Shaw,1802)	Common Kukri Snake	NE	Sch.IV
	Oligodon taeniolatus (Jerdon, 1853)	Russell's Kukuri Snake	LC	Sch.IV
17	*Dendrelaphis tristis* (Daudin,1803)	Common Indian Bronze-back	NE	Sch.IV
18	*Lycodon aulicus* (Linnaeus,1754)	Common Wolf Snake	NE	Sch.IV
20	*Ahaetulla nasuta* (Bonnaterre,1790)	Green Vine Snake	NE	Sch.IV
21	*Boiga trigonata* (Schneider, 1802)	Common Cat Snake	LC	Sch.IV
	Family NATRICIDAE			
19	*Xenochrophis piscator* (Schneider,1799)	Checkered Keelback	NE	Sch.II
	Family ELAPIDAE			
23	*Cerberus rynchops* (Schneider, 1799)	Dog-faced water snake	LC	Sch.II
24	*Bungarus caereleus* (Schneider)	Common Krait	NE	Sch.IV
25	*Naja naja* (Linnaeus,)	Indian Kobra	NE	Sch.II
	Family VIPERIDAE			
26	*Daboia russelii* (Shaw & Nodder, 1797)	Russel's Viper	NE	Sch.II
27	*Echis carinatus* (Schneider, 1801)	Saw-scaled Viper	NE	Sch.IV

Appendix X

Checklist of Amphibians in Kavvayi River Basin

Sl No	Scientific Name	Common Name	IUCN Status
	Class: AMPHIBIA Gray		
	Order : ANURA Fischer von Waldheim		
	Family: BUFONIDAE Gray		
	Genus ***Duttaphrynus***, Frost, Grant, Faivovich, Bain, Haas, Hddad, Desa, Channing, Wilkinson, Donnellan, Raxworthy, Campbell, Blotto, Moler, Drewes, Nussbaum, Lynch, Green and Wheeler		
1	*Duttaphrynus melanostictus* (Schneider, 1799)	Common Indian Toad	Least Concern
	Family: DICROGLOSSIDAE Anderson		
	Genus ***Euphlyctis*** Fitzinger		
2	*Euphlyctis cyanophlyctis* (Schneider, 1799)	Skittering Frog	Least Concern
3	*Euphlyctis hexadactylus* (Lesson, 1834)	Indian Pond Frog	Least Concern

4	*Euphlyctis aloysii*Joshy, Alam, Kurabayashi, Sumida & Kuramoto, 2009	Aloysius Pond Frog	Least Concern
	Genus ***Hoplobatrachus*** Peters		
5	*Hoplobatrachus tigerinus* (Daudin, 1803)	Indian Bullfrog	Least Concern
	Genus ***Fejervarya***Dubois, Ohler and Biju		
6	*Fejervarya sahyadris* Dubois, Ohler & Biju, 2001	Fejervarya Frog	Endangered
	Genus ***Sphaerotheca*** Gunther		
7	*Sphaerotheca breviceps* (Schneider, 1799)	Indian Burrowing Frog	Least Concern
	Genus ***Fejervarya***Howladar		
8	*Fejervarya rufescens* (Jerdon, 1853)	Rufescent Burrowing Frog	Least Concern
9	*Fejervarya brevipalmata* (Peters, 1871)	Short-webbed Frog	Data Deficient
	Family: MICROHYLIDAE Gunther		
	Genus ***Kaloula***Gray		
10	*Kaloula taprobanica* Parker, 1934	Painted Frog	Least Concern
	Genus ***Microhyla*** Tschudi		
11	*Microhyla ornata* (Dumeril & Bibron,1841)	Ornate Narrow-mouthed Frog	Least Concern
12	*Microhyla rubra* (Jerdon, 1854)	Reddish Narrow-mouthed Frog	Least Concern
13	*Microhyla spp.*	Narrow-mouthed Frog	
	Genus ***Ramanella*** Rao and Ramanna		
14	*Ramanella variegata* (Stoliczka, 1872)	Variegated Ramanella	Least Concern
	Family: RANIDAE Rafinesque		
	Genus ***Hylarana***Tschudi		
15	*Hylarana malabarica* (Tschudi, 1838)	Fungoid Frog	Least Concern
	Family: RHACOPHORIDAE Hoffman		
	Genus ***Polypedates***Tschudi		
16	*Polypedates maculatus*(Gray, 1834)	Common Indian Tree Frog	Least Concern
17	*Polypedates occidentalis* Das & Dutta, 2006	Charpa Tree frog	Data Deficient
	Genus ***Pseudophilautus***Laurent		
18	*Pseudophilautus wynaadensis* (Jerdon,1854)	Jerdon's Bush Frog	Least Concern
	Genus ***Rhacophorus*** Kuhl and Van Hasselt		
19	*Rhacophorus malabaricus* Jerdon, 1870	Malabar Gliding Frog	Least Concern
	Order : GYMNOPHIONA Muller		
	Family: ICHTHYOPHIDAE Taylor		
	Genus ***Uraeotyphlus*** Peters		
20	*Uraeotyphlus spp.*	Caecilian	

Appendix XI

Checklist of Fishes in Kavvayi River Basin

SI NO	*Scientific Name*	Common Name	IUCN
	Class: Actinopterygii		
	Order: Anguilliformes		
	Family: Ophichthidae		
1	*Pisodonophis boro* (Hamilton, 1822)	Rice-Paddy Eel	Least Concern
	Order: Clupeiformes		
	Family: Clupeidae		
2	*Dayella malabarica* (Day, 1873)	Day's round Herring	Least Concern
3	*Ehirava fluviatilis* (Deraniyagala, 1929)	Malabar Sprat	Not Evaluated
	Family: Engraulidae		
4	*Thryssa gautamiensis* (Babu Rao, 1971)	Gautama Thryssa	Data Defiecient
	Order: Cypriniformes		
	Family: Cyprinidae		
5	*Devario malabaricus* (Jerdon, 1849)	Giant Danio	Least Concern
6	*Rasbora daniconius* (Hamilton, 1822)	Common Rasbora	Least Concern
7	*Puntius amphibious* (Valenciennes, 1842)	Scarlet-banded Barb	Data Defiecient
8	*Puntius vittatus* (Day, 1865)	Kooli Barb	Least Concern
9	*Pethia ticto* (Hamilton, 1822)	Two Spot Barb	Least Concern
10	*Dawkinsia filamentosa* (Valenciennes, 1844)	Filament Barb	Least Concern
11	*Haludaria fasciata* (Jerdon, 1849)	Melon Barb	Least Concern
12	*Systomus sarana ssp. Subnasutus* (Valenciennes, 1842)	Peninsular Olive Barb	Least Concern
13	*Garra mullya* (Sykes, 1839)	Mullya Garra	Least Concern
	Order: Batrachoidiformes		
	Family: Batrachoididae		
14	*Allenbatrachus grunniens* (Linnaeus, 1758)	Toadfish	Not Evaluated
	Order: Beloniformes		
	Family: Hemiramphidae		
15	*Zenarcopterus gilli* (Smith, 1945)	Viviparous Half beak	Least Concern
	Family: Zenarchopteridae		
16	*Zenarcopterus straiga* (Blyth, 1858)	Hooghly Half beak	Not Evaluated
	Family: Belonidae		
17	*Xenentodon cancila* (Hamilton, 1822)	Freshwater Needle fish	Least Concern
	Order: Cyprinodontiformes		
	Family: Aplocheilidae		
18	*Aplocheilus lineatus* (Valenciennes, 1846)	Striped panchax	Least Concern
19	*Aplocheilus blocki* (Arnold, 1911)	Dwarf or Green Punchax	Least Concern

	Order: Scorpaeniformes		
	Family: Platycephalidae		
20	*Platycephalus indicus* (Linnaeus, 1758)	Flathead	Data Deficient
	Order: Perciformes		
	Family: Latidae		
21	*Lates calcarcifer* (Bloch, 1790)	Barramundi	Not Evaluated
	Family: Ambassidae		
22	*Ambassis commersoni* (Lacepède, 1802)	Commerson's Glassy Perchlet	Least Concern
	Family: Terapontidae		
23	*Terapon jarbua* (Forsskål, 1775)	Jarbua Terapon	Least Concern
	Family: Sillaginidae		
24	*Sillago sihama* (Forsskål, 1775)	Silver sillago	Not Evaluated
	Family: Monodactylidae		
25	*Psettus argenteus* (Linnaeus, 1758)	Butterfly fish	Not Evaluated
	Family: Carangidae		
26	*Alectis ciliaris*(Bloch, 1787)	Ciliated threadfish	Least Concern
	Family: Leiognathidae		
27	*Leognathus equulus* (Forsskål, 1775)	Common Ponyfish	Least Concern
28	*Secutor ruconius* (Hamilton, 1822)	Deep Pugnose Ponyfish	Not Evaluated
	Family: Lutjanidae		
29	*Lutjanus malabaricus* (Bloch & Schneider, 1801)	Malabar blood snapper	Not Evaluated
30	*Lutjanus deodecacanthoides* (Bleeker, 1854)	Sunbeam snapper	Not Evaluated
	Family: Lobotidae		
31	*Lobotes surinamensis* (Bloch, 1790)	Triple Tail	Least Concern
	Family: Gerreidae		
32	*Gerres oblongus* (Cuvier, 1830)	Slender Silver-biData Deficienty	Least Concern
33	*Gerres limbatus* (Cuvier, 1830)	Saddleback silver-biddy	Least Concern
34	*Gerres filimentosus* (Cuvier, 1829)	Whipfin Silver-biddy	Least Concern
	Family: Sparidae		
35	*Acanthopagrus latus* (Houttuyn, 1782)	Yellow sea Bream	Data Deficient
36	*Crenidens crenidens* (Forsskål, 1775)	Karenteen Seabream	Least Concern
	Family: Scatophagidae		
37	*Scatophagus argus* (Linnaeus, 1766)	Spotted Scat	Least Concern
	Family: Nandidae		
38	*Pristolepis marginata* (Jerdon, 1849)	Malabar Catopra	Least Concern
	Family: Cichlidae		
39	*Etroplus maculates* (Bloch, 1795)	Orange Chromide	Least Concern
40	*Etroplus suratensis* (Bloch, 1790)	Pearlspot Cichlid	Least Concern
41	*Oreochromis mossambica* (Peters, 1852)	Tilapia/Mossambique Cichlet	Near Threatened

	Family: Gobiidae		
42	*Glossobius giuris* (Hamilton, 1822)	Fresh Water Goby	Least Concern
43	*Taenioides cirratus* (Blyth, 1860)	Whiskered Eel Goby	Data Defiecient
	Family: Osphronemidae		
44	*Pseudosphromenus cupanus* (Cuvier, 1831)	Spiketail Paradise Fish	Least Concern
	Family: Channidae		
45	*Channa orientalis* (Bloch & Schneider, 1801)	Walking snakehead	Not Evaluated
46	*Channa punctate* (Bloch, 1793)	Spotted snakehead	Least Concern
	Family: Siganidae		
47	*Siganus canaliculatus* (Park, 1797)	White-spotted spinefoot	Not Evaluated
	Order: Mugiliformes		
	Family: Mugilidae		
48	*Mugil cephalus* (Linnaeus, 1758)	Flathead Mullet	Least Concern
49	*Moolgarda cunnesius* (Valenciennes, 1836)	Longarm mullet	Not Evaluated
50	*Valamugil buchanani* (Bleeker, 1853)	Blue tail Mullet	Not Evaluated
	Order: Synbranchiformes		
	Family: Mastacembelidae		
51	*Macrognathus guntheri* (Day, 1865)	Malabar spinyeel	Least Concern
52	*Mastacembelus armatus* (Lacepède, 1800)	Spiny eel	Least Concern
	Family: Fistulariidae		
53	*Fistularia petimba* (Lacepède, 1803)	Red Cornet Fish	Least Concern
	Order: Atheriniformes		
	Family: Atherinidae		
54	*Atherinomorus lacunosus* (Forster, 1801)	Wide-banded hardy head silverside	Not Evaluated
	Order: Pleuronectiformes		
	Family: Paralichthyidae		
55	*Pseudorhombus arsius* (Hamilton, 1822)	Large tooth flounder	Not Evaluated
	Family: Cynoglossidae		
56	*Cynoglossus punticeps* (Richardson, 1846)	Speckled tonguesole	Not Evaluated
	Family: Soleidae		
57	*Solea ovata* (Richardson, 1846)	Ovate sole	Not Evaluated
	Order: Lophiiformes		
	Family: Antennariidae		
58	*Antennatus nummifer* (Cuvier, 1817)	Spotfin frogfish	Least Concern
	Order: Tetraodontiformes		
	Family: Triacanthidae		
59	*Triacanthus biaculeatus* (Bloch, 1786)	Short-nosed Tripodfish	Not Evaluated
	Family: Tetraodontidae		
60	*Arothron hispidus* (Linnaeus, 1758)	White-spotted Puffer	Least Concern

61	*Arothron immaculatus* (Bloch & Schneider, 1801)	Immaculate Puffer	Least Concern
62	*Arothron leopardus* (Day, 1878)	Banded leopard blowfish	Data Defiecient
63	*Chelonodon fluviatilis* (Hamilton, 1822)	Green puffer fish	Least Concern
64	*Chelonodon patoca* (Hamilton, 1822)	Milk spotted Puffer	Least Concern
	Order: Siluriformes		
	Family: Clariidae		
65	*Clarias batrachus* (Linnaeus, 1758)	Walking Catfish	Least Concern
	Family: Bagridae		
66	*Mystus gulio* (Hamilton, 1822)	Long-whiskered Catfish	Least Concern
	Family: Ariidae		
67	*Arius arius* (Hamilton, 1822)	Threadfin Sea Cat fish	Least Concern
	Family: Heteropneustidae		
68	*Heteropneustes fossilis* (Bloch, 1794)	Stinging catfish	Least Concern

Appendix XII

Checklist of Mammals in Kavvayi River Basin

SI NO	Scientific Name	Common Name	IUCN
	Order: Lagomorpha		
	Family: Leporidae		
1	*Lepus nigricollis* (F. Cuvier, 1823)	Indian Hare	LC
	Order: Rodentia		
	Family: Muridae		
2	*Bandicota bengalensi* (Gray, 1835)	Lesser Bandicoot Rat	LC
3	*Bandicota indica*(Bechstein, 1800)	Greater Bandicoot Rat	LC
4	*Mus booduga* (Gray, 1837)	Little Indian Field Mouse	LC
5	*Mus musculus* (Linnaeus, 1758)	House Mouse	LC
6	*Rattus rattus*(Linnaeus, 1758)	House Rat	LC
7	*Tatera indica*(Hardwicke, 1807)	Indian Gerbil	LC
	Family: Sciuridae		
8	*Funnambulus palmarum*(Linnaeus, 1766)	Three striped Palm Squirrel	LC
	Family: Hystricidae		
9	*Hystrix indica* (Kerr, 1792)	Indian Crested Porcupine	LC
	Order: Eulipotyphla		
	Family: Soricidae		
10	*Suncus murinus* (Linnaeus, 1766)	House Shrew	LC

	Order: Chiroptera		
	Family: Pteropodidae		
11	*Cynopterus brachyotis*(Müller, 1838)	Common Short-nosed Fruit Bat	LC
12	*Cynopterus sphinx*(Vahl, 1797)	Short -nosed Fruit Bat	LC
13	*Pteropus giganteus*(Brünnich, 1782)	Indian Flying Fox	LC
	Family: Vespertilionidae		
14	*Kerivoula picta*(Pallas, 1767)	Painted Bat	LC
	Family: Megadermatidae		
15	*Megaderma iyra* (É. Geoffroy, 1810)	Indian False Vampire	LC
	Family: Vespertilionidae		
16	*Myotis montivagus*(Dobson, 1874)	Burmese Whiskered Bat	LC
17	*Pipistrellus sp.*	Pipistrelle	
	Family: Hipposideridae		
18	*Hipposiderous spp.*		
	Family: Rhinolophidae		
19	*Rhinolophus rouxii* (Temminck, 1835)	Rufous Horseshoe Bat	LC
	Order: Carnivora		
	Family: Leporidae		
20	*Canis aureus* (Linnaeus, 1758)	Common Jackal	LC
21	*Vulpes bengalensis*(Shaw, 1800)	Indian Fox	LC
	Family: Felidae		
22	*Felis chaus*(Schreber, 1777)	Jungle Cat	LC
	Family: Herpestidae		
23	*Herpestes edwardsii*(É. Geoffroy Saint-Hilaire, 1818)	Common Mongoos	LC
	Family: Viverridae		
24	*Paradoxurus hermaphrodites* (Pallas, 1777)	Common Palm Civet	LC
25	*Viverricula indica* (É. Geoffroy Saint-Hilaire, 1803)	Small Indian Civet	LC

Appendix XIII
Checklist of Angiosperms in Different Ecosystems of Kavvayi River Basin

Sl No.	Species Name	SG	KM	KU	IT	LB
	Family: Acanthaceae					
1	*Andrographis atropurpurea* (Dennst.) Alston		*			
2	*Andrographis elongata* (Vahl) Anders.		*	*		
3	*Andrographis paniculata* (Burm. f.) Wall. ex Nees	*	*		*	*
4	*Andrographis stenophylla* C.B.Clarke		*			
5	*Asystasia chelonoides* Nees in Wall.		*			
6	*Asystasia dalzelliana*Sant.	*	*		*	*
7	*Asystasia gangetica* (L.) Anderson	*	*		*	*
8	*Barleria cristata* L		*	*	*	*
9	*Barleria prattensis* Sant.		*			
10	*Barleria prionitis* L.				*	*
11	*Crossandra infundibuliformis* (L.) Nees in Wall.		*	*		
12	*Dicliptera foetida* (Forssk.) Blatt.	*				
13	*Dicliptera paniculata*(Forssk.) I. Darbysh.					*
14	*Dipteracanthus prostrates* (Poir.) Nees in Wall.	*				*
15	*Ecbolium viride* (Forssk.) Alston in Trimen	*				
16	*Eranthemum capens* L.var. *capense* Hook. f.					*
17	*Haplanthodes neilgherryensis* (Wight) Majumdar				*	*
18	*Justicia adhatoda*L.	*				*
19	*Justicia ekakusuma* Pradeep & Sivar.				*	*
20	*Justicia gendarussa* Burm. f.	*			*	
21	*Justicia japonica* Thunb.		*		*	*
22	*Justicia procumbens* L.		*			
23	*Lepidagathis incurva* Buch.-Ham. *ex* D.Don					*
24	*Lepidagathis keralensis* Madhu. & Singh	*	*		*	*
25	*Phaulopsis imbricata* (Forssk.) Sweet.	*				*
26	*Pseuderanthemum malabaricum* (Clarke) Gamble		*		*	*
27	*Rhinacanthus nasutus*(L.) Kurz				*	*
28	*Ruellia tuberosa* L.	*	*			
29	*Rungia pectinata* (L.) Nees in DC.					*
30	*Staurugyne glutinosa* (Wall. ex Clarke) O. Ktze.					*
31	*Strobilanthes decurrens* Nees in DC.			*		
32	*Strobilanthes heyneanus* Nees in Wall.					*
33	*Strobilanthes integrifolius*(Dalz.) O. Ktze.		*			*
34	*Thunbergia erecta* (Benth.) Anders.	*				

	Family: Agavaceae					
35	*Agave americana* L.	*				
36	*Furcraea foetida*(L.) Haworth				*	*
	Family: Aizoaceae					
37	*Trianthema portulacastrum* L.				*	*
	Family: Alangiaceae					
38	*Alangium salviifolium* (L.f.) Wang. ssp. *hexapetalum* (Lam.) Wang.	*			*	*
	Family: Amaranthaceae					
39	*Achyranthes aspera* L.*var. aspera* Hook. f.	*	*	*	*	*
40	*Achyranthes bidentata* Bl.					*
41	*Aerva lanata* (L.) Juss. ex Schult	*	*	*	*	*
42	*Allmania nodiflora* (L.) R. Br. ex Wight in Hook.		*	*		
43	*Alternanthera bettzickiana* (Regel) Voss	*	*	*	*	*
44	*Alternanthera brasiliana* (L.) Kuntze	*	*		*	*
45	*Alternanthera sessilis* (L.) R.Br. ex DC.		*		*	*
46	*Alternanthera tenella* Colla	*	*			
47	*Amaranthus spinosus* L.		*		*	*
48	*Amaranthus tricolor* L.		*		*	
49	*Amaranthus viridis* L.	*	*		*	*
50	*Celosia argentea* L. var. *argentea* Hook. f.		*	*	*	*
51	*Cyathula prostrate* (L.) Blume					*
52	*Gomprena celosioides* Mart.		*		*	*
	Family: Anacardiaceae					
53	*Anacardium occidentale* L.	*	*	*	*	*
54	*Holigarna arnottiana* Hook. f.	*	*	*		*
55	*Holigarna beddomei* Hook. f.	*				
56	*Holigarna nigra* Bourd.	*				
57	*Lannea coromandelica* (Houtt.) Merr.	*				*
58	*Mangifera indica* L.	*	*	*	*	*
59	*Spondias pinnata* (L. f.) Kurz		*			
	Family: Ancistrocladaceae					
60	*Ancistrocladus heyneanus* Wall. ex J.Graham				*	*
	Family: Annonaceae					
61	*Annona reticulata* L.	*	*	*		
62	*Polyalthia korintii* (Dunal) Benth.	*	*			*
63	*Polyalthia longifolia* (Sonner.)	*				
64	*Uvaria narum* (Dunal) Wall.	*	*		*	*
	Family: Apiaceae					
65	*Centella asiatica* (L.) Urban in Mart.	*	*	*	*	*
	Family: Apocynaceae					
66	*Aganosma cymosa* (Roxb.) G.Don				*	*
67	*Allamanda cathartica* L.	*	*		*	*

68	*Alstonia scholaris* (L.) *R. Br.*	*	*		*	*
69	*Catharanthus pusillus* (Murr.) G. Don				*	*
70	*Catharanthus roseus* (L.) G. Don		*	*		
71	*Holarrhena pubescens* (Buch.-Ham.) Wall. ex G. Don	*	*		*	*
72	*Ichnocarpus frutescens*(L.) R. Br.	*	*		*	*
73	*Kammetia caryophyllata*(Roxb.) Nicolson & Suresh					*
74	*Nerium oleander* L.		*			
75	*Plumeria obtusa* L.	*				
76	*Plumeria rubra* L.	*	*			*
77	*Rauvolfia serpentina* (L.) Benth. ex Kurz	*	*		*	*
78	*Tabernaemontana alternifolia* L.	*	*	*	*	*
79	*Tabernaemontana divaricata* (L.) R. Br.		*			*
80	*Wrightia tinctoria* (Roxb.) R. Br.		*		*	*
	Family: Araceae					
81	*Amorphophallus bonaccordensis* Sivad. & N. Mohanan	*				
82	*Amorphophallus commutatus* (Schott) Engl. in A. & C. DC.				*	
83	*Amorphophallus nicolsonianus* Sivad.		*	*		
84	*Amorphophallus paeoniifolius* (Dennst.) Nicolson				*	*
85	*Ariopsis peltata*Nimmo in Graham				*	*
86	*Arisaema leschenaultii* Blume	*				
87	*Arisaema tortuosum* (Wall.) Schott in Schott & Endl.				*	
88	*Caladium bicolor* (Ait. ex Dryand.) Vent.		*	*		
89	*Caladium lindenii* (André) Madison		*	*		
90	*Calamus thwaitesii* Becc. in Hook. f.	*				
91	*Colocasia esculenta* (L.) Schott in Schott & Endl.	*				
92	*Cryptocoryne spiralis* (Retz.) Fisch. ex Wydler				*	*
93	*Dieffenbachia seguine* (Jacq.) Schott	*				
94	*Pothos armatus* C.E.C. Fisch.				*	
95	*Pothos scandens* L.	*	*	*	*	*
96	*Typhonium flagelliforme*(Lodd.) Blume				*	*
97	*Typhonium roxburghii*Schott				*	*
	Family: Arecaceae					
98	*Areca catechu* L.	*	*		*	*
99	*Borassus flabellifer* L.	*	*			
100	*Caryota urens* L.	*	*	*	*	*
101	*Cocos nucifera* L.	*	*	*	*	*
102	*Phoenix sylvestris* (L.) Roxb.		*			
	Family: Aristolchiaceae					
103	*Aristolochia indica* L.	*	*		*	*
104	*Thottea siliquosa* (Lam.) Ding Hou	*	*			*

	Family: Asclepiadaceae					
105	*Calotropis gigantea*(L.) R. Br. in Ait.f.		*	*	*	*
106	*Ceropegia candelabrum* L.ssp.*candelabrum* Hook. f.				*	*
107	*Cosmostigma racemosum* (Roxb.) Wight	*	*		*	*
108	Gymnema hirsutum Wight & Arn. in Wight		*			
109	*Gymnema sylvestre* (Retz.) R. Br. ex Schult. in Roem. & Schult.				*	*
110	*Holostemma ada-kodien* Schult. Schult. in Roem.					*
111	*Tylophora indica*(Burm. f.) Merr.	*			*	*
112	*Wattakaka volubilis*(L. f.) Stapf	*			*	*
	Family: Asteraceae					
113	*Acanthospermum hispidum* DC.		*	*	*	*
114	*Acmella calva* (DC.) R.K. Jansen		*			
115	*Acmella paniculata* (Wall. ex DC.) R.K. Jansen		*			
116	*Acmella uliginosa* (Sw.) Cass.		*	*		
117	*Ageratina adenophora* (Spreng.) King & Robins.		*			
118	*Ageratum conyzoides* L.	*	*	*	*	*
119	*Ageratum houstonianum* Mill.		*			
120	*Bidens pilosa*L. var. *minor* (Blume) Sherff				*	*
121	*Blumea axillaris* (Lam.) DC.		*	*		
122	*Blumea clarkei* Hook. f.		*	*		
123	*Blumea laevis* (Lour.) Merr.		*	*		
124	*Blumea membranacea*Wall. ex DC.var. *membranacea* Hook. f.		*	*	*	*
125	*Blumea oxyodonta* DC in Wight		*	*	*	*
126	*Centratherum intermedium* Less.		*			
127	*Chromolaena odorata* (L.) King & Robins.	*	*	*	*	*
128	*Cissampelopsis corymbosa* (Wall. ex DC.) Jeffrey & Chen.		*			
129	*Cosmos caudatus* Kunth in HBK				*	*
130	*Eclipta prostrata* L.	*	*			*
131	*Elephantopus scaber* L.	*	*		*	*
132	*Emilia scabra* DC.		*			
133	*Emilia sonchifolia* (L.) DC. in Wight	*	*		*	*
134	*Grangea maderaspatana*(L.) Poir	*			*	*
135	*Laggera crispata* (Vahl) Hepper & Wood		*			
136	*Melampodium paludosum* HBK		*			
137	*Mikania micrantha* Kunth in HBK	*			*	*
138	*Phyllocephalum indicum* (Less.) Kirkman		*			
139	*Phyllocephalum phyllolaenum*(DC.) Narayana					*
140	*Synedrella nodiflora* (L.) Gaertn.		*		*	*
141	*Tridax procumbens*L.	*	*	*	*	*
142	*Vernonia cinerea*(L.) Less.	*	*	*	*	*

143	*Vernonia elliptica* DC. in Wight	*				
144	*Wedelia trilobata* (L.) A. S. Hitchc.				*	*
	Family: Balsaminaceae					
145	*Impatiens balsamina* L.				*	*
146	*Impatiens chinensis* L.				*	*
147	*Impatiens dasysperma* Wight		*			
148	*Impatiens diversifolia* Wall. ex Wight & Arn.		*			
149	*Impatiens flaccida* Arn.					*
150	*Impatiens herbicola* Hook. f.		*			
151	*Impatiens minor* (DC.) Bennet	*	*		*	*
	Family: Begoniaceae					
152	*Begonia malabarica* Lam.		*			
153	*Millingtonia hortensis* L.f.				*	*
154	*Pajanelia longifolia*(Willd.) K. Schum.				*	*
155	*Spathodea campanulata* P. Beauv.	*			*	
156	*Stereospermum colais* (Buch.-Ham. ex Dillw.) Mabb.	*				*
157	*Stereospermum suaveolens* (G. Don) DC.		*	*		
158	*Tecoma stans* (L.) HBK		*	*		
	Family: Bixaceae					
159	*Bixa orellana* L.	*				
	Family: Bombacaceae					
160	*Bombax ceiba* L.	*	*		*	*
161	*Ceiba pentandra* (L.) Gaertn.		*			
162	*Cordia oblique* Willd.				*	*
163	*Heliotropium indicum* L.	*	*		*	*
164	*Heliotropium keralense* Sivar. & Manilal	*	*		*	*
165	*Heliotropium marifolium* Retz.				*	*
	Family: Brassicaceae					
166	*Brassica juncea* (L.) Czern. & Coss. in Czern.				*	
	Family: Bromeliaceae					
167	*Ananas comosus* (L.) Merr.	*				
	Family: Burmanniaceae					
168	*Burmannia coelestis* D.Don				*	*
	Family: Burseraceae					
169	*Garuga pinnata* Roxb.				*	*
	Family: Cactaceae					
170	*Cereus pterogonus* Lem.				*	*
	Family: Capparaceae					
171	*Capparis rheedei* DC.				*	*
172	*Capparis sepiaria* L.				*	*
173	*Capparis zeylanica* L.				*	*
174	*Cleome burmannii* Wight & Arn.	*	*			

175	*Cleome rutidosperma* DC.				*	*
176	*Cleome viscosa* L.	*	*	*	*	*
177	*Crataeva magna* (Lour.) DC.		*			
178	*Gynandropsis gynandra* (L.) Briq.		*	*		
	Family: Caricaceae					
179	*Carica papaya* L.	*	*			
	Family: Caryophyllaceae					
180	*Polycarpaea corymbosa*(L.) Lam.				*	*
	Family: Casuarinaceae					
181	*Casuarina equisetifolia* L.	*	*		*	
	Family: Celastraceae					
182	*Lophopetalum wightianum*Arn.	*				*
	Family: Chenopodiaceae					
183	*Chenopodium album* L.		*			
	Family: Clusiaceae					
84	*Calophyllum inophyllum* L.	*	*		*	
85	*Garcinia gummi-gutta* (L.) Robs.	*	*			
86	*Garcinia mangostana* L.	*				
87	*Mesua ferrea* L.	*				
	Family: Combretaceae					
88	*Calycopteris floribunda* Lam.	*	*	*	*	
89	*Combretum latifolium* Blume	*			*	*
90	*Commelina benghalensis* L.	*			*	*
91	*Commelina clavata* Clarke	*				
92	*Commelina diffusa* Burm. f.	*	*	*	*	*
93	*Commelina erecta* L.		*	*	*	*
94	*Commelina longifolia* Lam.		*			
95	*Commelina wightii* Raiz.				*	*
96	*Quisqualis indica* L.		*			
97	*Terminalia bellirica* (Gaertn.) Roxb.	*			*	*
98	*Terminalia catappa* L.	*	*	*	*	*
99	*Terminalia cuneata* Roth	*				
200	*Terminalia elliptica* Willd.	*	*		*	
201	*Terminalia paniculata* Roth.	*	*	*	*	*
	Family: Commelinaceae					
202	*Cyanotis axillaris* (L.) D. Don				*	*
203	*Cyanotis burmanniana* Wight				*	*
204	*Cyanotis cristata* (L.) D. Don		*			*
205	*Cyanotis fasciculate* (Heyne ex Roth) Schult. f.					*
206	*Cyanotis papilionacea* (Burm. f.) Schult. f.					*
207	*Cyanotis racemosa* Heyne ex Hassk.		*			
208	*Murdannia crocea*(Griff.) Faden				*	*

209	*Murdannia gigantea* (Vahl) Brueck. in Engl. & Prantl		*			
210	*Murdannia lanuginosa* (Wall. ex Clarke) Brueck.				*	*
211	*Murdannia nudiflora* (L.) Brenan				*	*
212	*Murdannia pauciflora* (Wight) Brueck. in Engl. & Prantl		*			
213	*Murdannia semiteres* (Dalz.) Sant.		*	*	*	*
214	*Murdannia spirata* (L.) Brueck. in Engl. & Prantl		*			
215	*Tradescantia pallida* (Rose) D.R.Hunt		*			
	Family: Connaraceae					
216	*Connarus monocarpus*L.	*				*
217	*Connarus paniculatus* Roxb.	*				
218	*Connarus wightii* Hook. f.	*	*			*
219	*Rourea minor*(Gaertn.) Merr.	*				*
	Family: Convolvulaceae					
220	*Argyreia nervosa* (Burm. f.) Bojer				*	*
221	*Cuscuta reflexa* Roxb.					*
222	*Erycibe paniculata* Roxb.				*	*
223	*Evolvulus alsinoides* L.var. *alsinoides* Hook. f.		*	*	*	*
224	*Evolvulus nummularius* L.				*	*
225	*Hewittia malabarica* (L.) Suresh in Nicolson et al.		*		*	*
226	*Ipomoea barlerioides* (Choisy) Benth. ex Clarke in Hook. f.	*	*	*		
227	*Ipomoea cairica*(L.) Sweet		*			*
228	*Ipomoea campanulata* L.		*			
229	*Ipomoea eriocarpa* R. Br.	*	*			
230	*Ipomoea hederifolia*L.		*			*
231	*Ipomoea marginata* (Desr.) Manitz		*		*	
232	*Ipomoea mauritiana* Jacq.	*	*			*
233	*Ipomoea nil*(L.) Roth					*
234	*Ipomoea obscura* (L.) Ker-Gawl.	*				
235	*Ipomoea pes-caprae* (L.) R. Br. in Tuckey		*			
236	*Ipomoea pes-tigridis* L.					*
237	*Ipomoea pileata* Roxb.				*	*
238	*Ipomoea quamoclit* L.		*			
239	*Ipomoea triloba* L.		*			
240	*Jacquemontia pentantha* (Jacq.) G. Don	*	*			
241	*Merremia umbellata*(L.) Hall. f. in Engl.				*	*
242	*Merremia vitifolia* (Burm. f.) Hall. f. in Engl.				*	*
243	*Neuropeltis malabarica* Ooststr.				*	*
244	*Xenostegia tridentata*(L.) Austin & Staples	*			*	*
245	*Xenostegia tridentata* (L.) Austin & Staplesssp. *hastata* (Desr.) Panigrahi & Murti				*	*

	Family: Costaceae					
246	*Costus speciosus* (Koenig) J.E. Smith	*	*	*	*	*
	Family: Crassulaceae					
247	*Bryophyllum pinnatum* (Lam.) Kurz	*	*	*		*
	Family: Cucurbitaceae					
248	*Coccinia grandis* (L.) Voight	*				
249	*Cucumis callosus* (Rottl.) Cogn. *ex* Cogn. & Harms.		*			
250	*Cucumis sativus* L. f. hardwickii (Royl) W.J.de Wilde & Duyfjes		*			
251	*Diplocyclos palmatus* (L.) Jeffrey	*				*
252	*Gymnopetalum tubiflorum* (Wight & Arn.) Cogn. in DC.		*			
253	*Luffa cylindrica* (L.) Roem.		*			
254	*Momordica charantia* var. *muricata* (Willd.) Chakrav.		*	*		
255	*Momordica dioica* Roxb. ex Willd.	*			*	*
256	*Mukia maderaspatana* (L.) Roem.	*	*		*	*
257	*Solena amplexicaulis*(Lam.) Gandhi				*	*
258	*Trichosanthes lepiniana* (Naud.) Cogn. in A. & C. DC.		*	*		
259	*Trichosanthes lobata* Roxb.		*			
260	*Trichosanthes nervifolia*L.		*		*	*
261	*Trichosanthes tricuspidata*Lour.var. *tricuspidata* Mohanan		*		*	*
262	*Zanonia indica* L.		*			
263	*Zehneria maysorensis* (Wight & Arn.) Arn. in Hook.'s		*			
	Family: Cycadaceae					
264	*Cycas circinalis* L.		*			
	Family: Cyperaceae					
265	*Carex indica* L.		*			
266	*Cyperus arenarius* Retz.		*		*	
267	*Cyperus castaneus* Willd.				*	*
268	*Cyperus compressus* L.		*			*
269	*Cyperus diffusus* Vahl		*	*		
270	*Cyperus distans* L. f.					*
271	*Cyperus dubius* Rottb.		*		*	
272	*Cyperus haspan* L.		*			
273	*Cyperus javanicus* Houtt.		*			
274	*Cyperus malaccensis* Lam.		*			
275	*Cyperus rotundus* L.	*	*	*		
276	*Cyperus zollingeri* Steud.	*	*			
277	*Kyllinga brevifolia* Rottb.		*			*
278	*Kyllinga nemoralis* (J. R & G. Forst.) Dandy ex		*			*

	Hutch. & Dalz.					
279	*Pycreus flavidus* (Retz.) Koyama		*			
	Family: Dichapetalaceae					
280	*Dichapetalum gelonioides* (Roxb.) Engl. in Engl. & Prantl	*				
	Family: Dioscoreaceae					
281	*Dioscorea alata* L.	*			*	*
282	*Dioscorea belophylla* Voigt	*	*			
283	*Dioscorea bulbifera* L.	*	*			*
284	*Dioscorea hispida* Dennst.					*
285	*Dioscorea oppositifolia* L.	*	*	*	*	*
286	*Dioscorea pentaphylla* L.	*			*	*
287	*Dioscorea pubera* Blume		*			
288	*Dioscorea wallichii* Hook. f.	*				*
	Family: Dipterocarpaceae					
289	*Hopea parviflora* Bedd.	*				
290	*Hopea ponga* (Dennst.) Mabb.	*	*	*	*	*
291	*Hoppea fastigiata*(Griseb.) Clarke in Hook.f.					*
292	*Vateria indica*L.	*				*
	Family: Dracaenaceae					
293	*Dracaena terniflora* Roxb.	*				*
	Family: Droseraceae					
294	*Drosera indica*L.				*	*
295	*Drosera peltata* Smith in Willd.		*	*		
	Family: Ebenaceae					
296	*Diospyros bouxifolia* (Blume) Hiern	*	*	*		*
297	*Diospyros candolleana* Wight*					*
298	*Diospyros ebenum* Koenig		*			
299	*Diospyros peregrina* (Gaertn.) Gurke in in Engl. & Prantl	*				
300	*Diospyros sylvatica* Roxb.	*				
	Family: Elaeocarpaceae					
301	*Elaeocarpus variabilis* Zmarzty	*	*			
	Family: Eriocaulaceae					
302	*Eriocaulon cuspidatum* Dalz.					*
303	*Eriocaulon heterolepis* Steud.				*	*
304	*Eriocaulon lancelotum* Miq. ex Koernicke				*	*
305	*Eriocaulon parviflorum* (Fyson) R. Ansari & N.P. Balakr.				*	*
306	*Eriocaulon quinquangulare* L.		*		*	
307	*Eriocaulon sexangulare* L.	*	*		*	
308	*Eriocaulon xeranthemum* Mart. in Wall.	*			*	*
	Family: Euphorbiaceae					

309	*Acalypha indica* L.		*			*
310	*Acalypha malabarica* Muell.-Arg.		*	*		
311	*Acalypha paniculata* Miq.					*
312	*Agrostistachys borneensis* Becc.	*	*	*		*
313	*Agrostistachys indica* Dalz.	*				
314	*Antidesma acidum* Retz.	*			*	*
315	*Antidesma alexiteria* L.				*	
316	*Antidesma bunius* (L.) Spreng.				*	*
317	*Antidesma montanum* Blume	*			*	
318	*Aporosa cardiosperma*(Gaertn.) Merr.	*	*		*	*
319	*Breynia retusa* (Dennst.) Alston	*	*	*	*	
320	*Breynia vitis-idaea* (Burm.f.) C.E.C.Fisch.	*	*		*	*
321	*Briedelia retusa* (L.) A.Juss.	*	*		*	*
322	*Briedelia stipularis* (L.) Blume	*			*	*
323	*Cleistanthus collinus* (Roxb.) Benth. ex Hook.f.	*				
324	*Croton caudatus* Geisel.		*		*	*
325	*Croton malabaricus* Bedd.	*				
326	*Croton persimilis* Muell.-Arg.	*			*	*
327	*Euphorbia deccanensis* V.S.Raju	*			*	*
328	*Euphorbia heterophylla*L.	*	*		*	*
329	*Euphorbia hirta* L.	*	*	*	*	*
330	*Euphorbia indica* Lam.	*	*			
331	*Euphorbia nivulia* Buch.-Ham.				*	*
332	*Euphorbia thymifolia* L.					*
333	*Falconeria insignis* Royle		*		*	*
334	*Flueggea virosa* (Roxb. ex Willd.) Voigt				*	*
335	*Glochidion zeylanicum*(Gaertn.) A. Juss.var.*zeylanicum* Hook. f.	*				*
336	*Hevea braziliensis* (Willd. ex A. Juss.) Muell.-Arg.	*	*			
337	*Jatropha curcas*L.		*			*
338	*Jatropha gossypifolia*L.				*	*
339	*Macaranga indica* Wight		*			
340	*Macaranga peltata* (Roxb.) Muell.-Arg. in DC.	*	*	*	*	*
341	*Mallotus philippensis*(Lam.) Muell.-Arg.				*	*
342	*Mallotus repandus* (Willd.) Muell.-Arg.				*	*
343	*Manihot esculenta* Crantz.		*	*		
344	*Meineckia parvifolia* (Wight) Webster		*	*		
345	*Micrococca mercurialis* (L.) Benth				*	*
346	*Microstachys chamaelea* (L.) Muell.-Arg.	*	*	*	*	*
347	*Phyllanthus amarus*Schum. & Thonn.	*	*	*	*	*
348	*Phyllanthus emblica* L.	*	*		*	*
349	*Phyllanthus leschenaultii* Müll.-Arg.		*	*		
350	*Phyllanthus reticulatus* Poir.	*			*	*

351	*Phyllanthus rheedei* Wight		*			
352	*Phyllanthus tenellus* Roxb.		*			
353	*Phyllanthus urinaria* L.					*
354	*Phyllanthus virgatus* G. Forst.		*			
355	*Ricinus communis* L.		*			*
356	*Tragia bicolor* Miq.		*			
357	*Tragia involucrata*L.	*			*	*
	Family: Fabaceae					
358	*Abrus precatorius* L.	*			*	*
359	*Acacia caesia* (L.) Willd.	*			*	*
360	*Acacia catechu* (L.f.) Willd.				*	
361	*Acacia pennata* (L.) Willd.					*
362	*Acacia torta* (Roxb.) Craib	*				
363	*Adenanthera pavonina* L.	*	*	*		*
364	*Aeschynomene americana* L.					*
365	*Aeschynomene aspera* L.					*
366	*Albizia amara* (Roxb.) Boivin	*				
367	*Albizia chinensis* (Osbeck) Merr.				*	
368	*Albizia lebbeck* (L.) Benth.	*	*			
369	*Albizia odoratissima (L.f.) Benth.*		*		*	*
370	*Albizia saman*(Jacq.) F.Muell.	*				*
371	*Alysicarpus bupleurifolius (L.) DC.*		*		*	*
372	*Alysicarpus racemosus Benth.*		*	*		
373	*Bauhinia acuminata* L.	*				
374	*Bauhinia phoenicea* Wight & Arn.	*				
375	*Bauhinia racemosa* Lam.		*			
376	*Bauhinia tomentosa* L.		*			
377	*Butea monosperma* (Lam.) Taub.	*	*			*
378	*Caesalpinia coriaria* (Jacq.) Willd.		*			
379	*Caesalpinia mimosoides* Lam.	*			*	
380	*Caesalpinia pulcherrima* (L.) Swartz		*			
381	*Cajanus scarabaeoides* (L.) Thouars		*			*
382	*Calopogonium mucunoides* Desv.	*	*	*		*
383	*Canavalia africana* Dunn		*			
384	*Canavalia gladiata* (Jacq.) DC.				*	*
385	*Cassia fistula* L.	*	*		*	*
386	*Centrosema molle* Benth.	*	*	*	*	*
387	*Chamaecrista mimosoides* (L.) Greene				*	*
388	*Chamaecrista nictitans* (L.) Moench ssp. *patellaria* (Collad.) Irwin & Barneby var. *glabrata* (Vogel) Irwin & Barneby				*	*
389	*Clitoria ternatea* L. var. *pleniflora* Fantz	*	*	*	*	*
390	*Clitoria ternatia* L. var. *ternatea* Hook. f.				*	*

391	*Crotalaria juncea* L.	*				
392	*Crotalaria laburnifolia* L.		*			
393	*Crotalaria pallida* Dryand.var *pallida* Manilal & Sivar.	*	*	*	*	*
394	*Crotalaria quinquefolia* L.					*
395	*Dalbergia latifolia* Roxb.	*	*			
396	*Delonix regia* (Boj. ex Hook.) Rafin.		*		*	*
397	*Derris scandens* (Roxb.) Benth.				*	*
398	*Desmodium biarticulatum* (L.) F.v. Muell.		*			
399	*Desmodium gangeticum* (L.) DC.	*			*	*
400	*Desmodium heterocarpon* (L.) DC. *heterocarpon* Mohanan				*	*
401	*Desmodium heterophyllum* (Willd.) DC.				*	*
402	*Desmodium scorpiurus* (Sw.) Desv.				*	*
403	*Desmodium triflorum* (L.) DC.		*			*
404	*Desmodium triquetrum* (L.) DC.					*
405	*Dichrostachys cinerea* (L.) Wight & Arn.					*
406	*Erythrina suberosa* Roxb.		*			
407	*Erythrina variegata*L	*			*	*
408	*Flemingia strobilifera* (L.) R. Br. ex Ait.f.				*	
409	*Geissaspis cristata* Wight & Arn.				*	*
410	*Gliricidia sepium*(Jacq.) Kunth ex Walp.	*	*	*	*	*
411	*Indigofera trifoliata* L. in Torner					*
412	*Indigofera zollingeriana* Miq.		*			
413	*Lablab purpureus* (L.) Sweet		*			
414	*Macrotyloma uniflorum* (Lam.) Verdc.		*			
415	*Mimosa diplotricha* C. Wight ex Sanvalle	*	*			
416	*Mimosa pudica* L.	*	*	*	*	*
417	*Mucuna pruriens* (L.) DC.	*			*	*
418	*Peltophorum pterocarpum* (DC.) Backer ex Heyne	*	*			*
419	*Pongamia pinnata* (L.) Pierre	*	*		*	*
420	*Pseudarthria viscida* (L.) Wight & Arn.	*			*	*
421	*Pterocarpus marsupium* Roxb.		*			
422	*Racosperma auriculiforme*(Benth.) Pedley	*	*		*	*
423	*Racosperma mangium* (Willd.) Pedley	*				
424	*Saraca asoca* (Roxb.) de Wilde	*	*			
425	*Senna alata* (L.) Roxb.	*				*
426	*Senna hirsuta* (L.) Irwin & Barneby					*
427	*Senna occidentalis*(L.) Link					*
428	*Senna siamea*(Lam.) Irwin & Barneby					*
429	*Senna tora*(L.) Roxb.	*				*
430	*Smithia conferta* Smith in Rees					*
431	*Spatholobus parviflorus*(Roxb. ex DC.) O. Ktze.		*			*

432	*Stylosanthes fruticosa* (Retz.) Alston in Trimen				*	*
433	*Tamarindus indica* L.	*	*	*	*	*
434	*Tephrosia purpurea* (L.) Pers.	*			*	*
435	*Vigna adenantha* (Meyer) Marechal		*			
436	*Vigna trilobata* (L.) Verdc.				*	*
437	*Vigna unguiculata* (L.) Walp. ssp. cylindrica (L.) Eselt. in Hedrick		*			
438	*Vigna vexillata* (L.) A. Rich. in Sagra		*			
439	*Xylia xylocarpa* (Roxb.) Taub.	*	*			*
440	*Zornia diphylla* (L.) Pers.	*				
441	*Zornia gibbosa* Span.				*	*
	Family: Flacourtiaceae					
442	*Flacourtia indica* (Burm. f.) Merr.	*	*		*	*
443	*Hydnocarpus macrocarpa* (Bedd.) Warb. in Engl. & Prantl	*				
444	*Hydnocarpus pentandra* (Buch.-Ham.) Oken	*	*		*	*
	Family: Gentianaceae					
445	*Canscora diffusa* (Vahl) R.Br. ex Roem. & Schult.				*	*
446	*Canscora pauciflora* Dalz.				*	*
	Family: Gesneriaceae					
447	*Rhynchoglossum notonianum* (Wall.) Burtt				*	*
	Family: Gnetaceae					
448	*Gnetum edule* (Willd.) Blume	*	*			
	Family: Hippocrateaceae					
449	*Hippocratea arnottiana* Wight					*
450	*Salacia chinensis* L.	*				*
451	*Salacia fruticosa* Heyne ex Lawson in Hook. f.	*				*
	Family: Hydrocharitaceae					
452	*Blyxa octandra* (Roxb.)Planch. ex Thwaites				*	*
453	*Ottelia alismoides* (L.) Pers.				*	*
	Family: Hypoxidaceae					
454	*Curculigo orchioides* Gaertn.	*	*		*	*
	Family: Lamiaceae					
455	*Anisochilus carnosus (L. f.) Wall. ex Benth.*		*		*	*
456	*Anisomeles indica (L.) O. Ktze.*		*		*	*
457	*Hyptis capitata* Jacq.				*	
458	*Hyptis suaveolens* (L.) Poit.	*	*	*	*	*
459	*Isodon wightii* (Benth.) Hara		*	*		
460	*Leucas aspara* (Willd.) Link	*	*	*	*	*
461	*Leucas biflora* (Vahl) R. Br.		*			*
462	*Leucas ciliata* Benth. ex Wall.		*			
463	*Ocimum americanum* L.				*	*
464	*Ocimum tenuiiflorum* L.	*	*			

165	*Orthosiphon thymiflorus* (Roth) Sleesen		*			
166	*Platostoma hispidum* (L.) Paton					*
167	*Plectranthus amboinicus* (Lour.) Spreng.		*			
168	*Plectranthus rotundifolius* (Poir.) Spreng.		*	*		
169	*Pogostemon deccanensis*(Panigrahi) Press					*
170	*Pogostemon paniculatus* (Willd.) Benth. in Wall.		*			
171	*Pogostemon purpurascens* Benth. in DC.	*				*
172	*Pogostemon quadrifolius* (Benth.) F.Muell.					*
	Family: Lauraceae					
173	*Alseodaphne semecarpifolia* Nees				*	*
174	*Cinnamomum heyneanum* Nees in Wall.		*	*		
175	*Cinnamomum malabatrum*(Burm. f.) Blume	*			*	*
176	*Cinnamomum verum*Presl	*	*			*
177	*Litsea deccanensis* Gamble				*	
178	*Litsea floribunda* (Blume) Gamble	*				
179	*Litsea glutinosa* (Lour.) Robins.					*
180	*Persea macrantha* (Nees) Kosterm.	*				
	Family: Lecythidaceae					
181	*Careya arborea* Roxb.	*	*		*	*
	Family: Leeaceae					
182	*Leea indica*(Burm. f.) Merr.	*	*		*	*
183	*Leea macrophylla* Roxb. ex Hornem.	*				*
	Family: Lentibulariaceae					
184	*Utricularia cecilii* Taylor				*	*
185	*Utricularia graminifolia* Vahl				*	*
186	*Utricularia lazulina* Taylor				*	*
187	*Utricularia malabarica*M.K. Janarth. & Henry				*	*
188	*Utricularia reticulata* Smith				*	*
189	*Utricularia striatula* Smith				*	*
190	*Utricularia uliginosa* Vahl				*	*
	Family: Liliaceae					
191	*Asparagus fysonii* Macbr.*					*
192	*Asparagus racemosus Willd.*	*	*	*	*	*
193	*Gloriosa superba*L.	*	*		*	*
194	*Iphigenia indica* (L.) A. Gray ex Kunth					*
195	*Hugonia mystax*L.	*		*	*	*
	Family: Loganiaceae					
196	*Mitrasacme indica* Wight		*		*	*
197	*Strychnos nux-vomica* L.	*	*	*	*	*
198	*Strychnos vanprukii* Craib	*	*		*	*
	Family: Loranthaceae					
199	*Dendrophthoe falcata* (L. f.) Etting.	*			*	*

500	*Helicanthes elastica*(Desr.) Danser				*	*
501	*Macrosolen capitellatus* (Wight & Arn.) Danser	*				
502	*Macrosolen parasiticus* (L.) Danser	*			*	*
503	*Scurrula parasitica* L.					*
	Family: Lythraceae					
504	*Cuphea hyssopifolia* Kunth in HBK		*			
505	*Lagerstroemia indica* L.	*				
506	*Lagerstroemia microcarpa* Wight	*				
507	*Lagerstroemia speciosa* (L.) Pers.	*	*			
508	*Rotala malabarica* Pradeep, Joseph & Sivar.	*			*	*
509	*Rotala malampuzhensis* R.V. Nair ex Cook		*		*	*
510	*Woodfordia fruticosa* (L.) Kurz	*				
	Family: Malvaceae					
511	*Abelmoschus angulosus* Wall. ex Wight & Arn.				*	
512	*Abelmoschus esculentus (L.) Moench.*		*			
513	*Abutilon indicum* (L.) Sweet ssp. *Indicum*					*
514	*Herissantia crispa* (L.) Briz.		*			
515	*Hibiscus hispidissimus* Griff.	*	*		*	*
516	*Hibiscus lunariifolius* Willd.		*	*		
517	*Hibiscus micranthus* L.f.		*			
518	*Hibiscus mutabilis* L.		*			
519	*Hibiscus platanifolius* (Willd.) Sweet	*				
520	*Hibiscus rosa-sinensis* L.	*				
521	*Hibiscus sabdariffa* L.		*			
522	*Hibiscus surattensis* L.	*	*			*
523	*Pavonia burchellii* (DC.) Dyer		*			
524	*Sida acuta* Burm. f.	*	*	*		*
525	*Sida cordata* (Burm. f.) Borss.	*	*		*	*
526	*Sida cordifolia*L.	*	*			*
527	*Sida mysorensis* Wight & Arn.		*			
528	*Sida rhombifolia*L.	*	*		*	*
529	*Sida rhomboidea* Roxb. ex Fleming.	*	*			
530	*Thespesia lampas* (Cav.) Dalz. & Gibs.		*			
531	*Urena lobata* L. ssp. *lobata* Hook. f.	*	*		*	*
532	*Urena lobata* L. ssp. *sinuata* (L.) Borss.	*	*		*	*
	Family: Marantaceae					
533	*Stachyphrynium spicatum* (Roxb.) Schum.	*				*
	Family: Melastomataceae					
534	*Melastoma malabathricum* L.	*	*	*	*	*
535	*Memecylon randerianum*SM & MR Almeida	*	*	*	*	*
536	*Memecylon talbotianum* Brandis in Talbot	*				
537	*Memecylon umbellatum* Burm.f.	*	*		*	*

538	*Memecylon wightii* Thw.	*				
539	*Osbeckia aspera* (L.) Blume		*			
540	*Osbeckia muralis* Naud.		*	*	*	*
541	*Osbeckia wynaadensis* Clarke in Hook. f.		*			
542	*Sonerila elegans* Wight var. *beddomei* Giri & M.P. Nayar		*	*		
	Family: Meliaceae					
543	*Aglaia elaeagnoidea* (A.Juss.) Benth.	*	*		*	*
544	*Aglaia lawii* (Wight) Saldanha in Saldanha & Nicolson	*				
545	*Azadirachta indica* A.Juss.	*	*		*	*
546	*Chukrasia tabularis* A. Juss.	*				
547	*Dysoxylum malabaricum Bedd.* ex Hiern in Hook. f.	*				
548	*Naregamia alata* Wight & Arn.	*	*	*	*	*
549	*Swietenia macrophylla* King in Hook.	*				
550	*Swietenia mahagoni* (L.) Jacq.		*			
	Family: Menispermaceae					
551	*Anamirta cocculus* (L.) Wight & Arn.	*	*	*	*	*
552	*Cocculus laurifolius* DC.	*				
553	*Cyclea peltata* (Lam.) Hook. f. & Thoms.	*	*	*	*	*
554	*Diploclisia glaucascens* (Blume) Diels in Engl.					*
555	*Stephania japonica* (Thunb.) Miers		*			
556	*Tiliacora acuminata* (Poir.) Miers ex Hook.f. & Thoms.	*				
557	*Tinospora cordifolia* (Willd.) Miers.	*	*		*	*
558	*Tinospora sinensis* (Lour.) Merr.	*			*	*
	Family: Menyanthaceae					
559	*Nymphoides indica* (L.) O.Ktze.	*				
560	*Nymphoides krishnakesara* Joseph & Sivar.					*
	Family: Molluginaceae					
561	*Glinus oppositifolius* (L.) A. DC.				*	*
562	*Mollugo nudicaulis* Lam.	*				
563	*Mollugo pentaphylla*L.	*	*		*	*
564	*Mollugo stricta*L.				*	*
	Family: Moraceae					
565	*Antiaris toxicaria* Lesch.	*	*			*
566	*Artocarpus gomezianus Wall.*		*	*		
567	*Artocarpus heterophyllus* Lam.	*	*	*	*	
568	*Artocarpus hirsutus* Lam.	*	*		*	
569	*Artocarpus incisus (Thunb.) L.f.*		*	*		
570	*Ficus arnottiana* (Miq.) Miq.	*	*		*	*
571	*Ficus benghalensis* L. var.*benghalensis* Hook. f.	*			*	*
572	*Ficus callosa* Willd.				*	*

573	*Ficus exasperata* Vahl				*	*
574	*Ficus heterophylla* L.f.				*	*
575	*Ficus hispida*L. f.	*	*	*	*	*
576	*Ficus microcarpa* L. f.	*				
577	*Ficus racemosa* L.	*			*	*
578	*Ficus religiosa* L.	*	*		*	*
579	*Ficus tinctoria* G. Forst. ssp. *parasitica* (Koen. ex Willd.) Corner	*			*	*
	Family: Moringaceae					
580	*Moringa pterygosperma* Gaertn.		*	*		
	Family: Musaceae					
581	*Musa x paradisiaca* L.		*	*		
	Family: Myristicaceae					
582	*Knema attenuata* (Hook. f. & Thoms.) Warb.	*				*
583	*Myristica fragrans* Houtt.		*			
	Family: Myrsinaceae					
584	*Ardisia solanacea Roxb.*	*				
585	*Myrsine wightiana* Wall. ex DC.	*				
	Family: Myrtaceae					
586	*Psidium guajava* L.	*	*	*		
587	*Syzygium aromaticum* (L.) Merr. & Perry		*			
588	*Syzygium caryophyllatum* (L.) Alston in Trimen	*			*	*
589	*Syzygium cumini* (L.) Skeelsvar *cumini* Manilal & Sivar	*			*	*
590	*Syzygium grande*(Wight) Walp.	*				*
591	*Syzygium jambos* (L.) Alston in Trimen		*	*		
592	*Syzygium malaccense* (L) Merr. & Perry		*			
593	*Syzygium travancoricum* Gamble	*				*
594	*Syzygium zeylanicum*(L.) DC.		*		*	*
	Family: Nyctaginaceae					
595	*Boerhavia diffusa* L.	*	*	*	*	*
596	*Bougainvillea glabra* Choisy in DC.		*			
597	*Bougainvillea spectabilis* Willd.		*			
598	*Nyctanthes arbor-tristis* L.	*				
	Family: Ochnaceae					
599	*Gomphia serrata* (Gaertn.) Kanis	*			*	*
	Family: Oleaceae					
600	*Chionanthus mala-elengi* (Dennst.) P.S.Green ssp. *mala-elengi*					*
601	*Jasminum angustifolium* (L.) Willd.	*				
602	*Jasminum azoricum* Burm. f.					*
603	*Jasminum malabaricum* Wight	*	*	*	*	*
604	*Myxopyrum smilacifolium* (Wall.) Blume	*				

605	*Olea dioica* Roxb.	*			*	*
	Family: Onagraceae					
606	*Ludwigia hyssopifolia* (G. Don) Exell					*
607	*Ludwigia octovalvis*(Jacq.) Raven					*
	Family: Opiliaceae					
608	*Cansjera rheedei* Gmel.				*	*
	Family: Orchidaceae					
609	*Acampe praemorsa* (Roxb.) Blatt. & McCann	*	*		*	*
610	*Bulbophyllum sterile*(Lam.) Suresh in Nicolson, Suresh & Manilal	*				*
611	*Seidenfia rheedei* (Sw.) Szlach.		*			
612	*Spathoglottis plicata* Blume		*			
613	*Zeuxine longilabris* (Lindl.) Benth. ex Hook. f.		*			*
	Family: Oxalidaceae					
614	*Biophytum intermedium* Wight		*	*		
615	*Biophytum reinwardtii* (Zucc.) Klotzsch *var. reinwardtii* Hook. f.		*	*	*	*
616	*Oxalis corniculata* L.				*	*
	Family: Pandanaceae					
617	*Pandanus amaryllifolius* Roxb.	*	*			*
618	*Pandanus foetidus* Roxb.		*			
619	*Pandanus furcatus* Roxb.	*				
	Family: Passifloraceae					
620	*Passiflora edulis* Sims in Curtis	*	*			
621	*Passiflora foetida* L.	*	*		*	*
	Family: Pedaliaceae					
622	*Martynia annua*L.				*	*
623	*Pedalium murex* L.				*	*
624	*Sesamum indicum* L.					*
625	*Sesamum radiatum* Schum.					*
	Family: Periplocaceae					
626	*Cryptolepis buchananii* Roem. & Schult.	*			*	*
627	*Hemidesmus indicus* (L.) R. Br.var. *indicus* Hook. f.	*	*	*	*	*
	Family: Piperaceae					
628	*Peperomia pellucida*(L.) Kunth		*			*
629	*Piper betle* L.		*	*		
630	*Piper longum* L.	*				*
631	*Piper nigrum* L. var. *nigrum* Hook.f.	*	*			*
	Family: Plumbaginaceae					
632	*Plumbago zeylanica* L.	*				*
	Family: Poaceae					
633	*Alloteropsis cimicina* (L.) Stapf				*	*
634	*Alloteropsis semialata* (R.Br.) Hitch.		*	*		

635	*Apluda mutica* L.		*	*	*	*
636	*Apocopis mangalorensis*(Hochst.) Henrard				*	*
637	*Arundinella cannanorica* V.J.Nair, Sreek. & N.C.Nair				*	*
638	*Arundinella ciliata* (Roxb.) Nees *ex* Miq. in Verh.		*	*		
639	*Arundinella leptochloa*(Nees ex Steud.) Hook. f.				*	*
640	*Arundinella mesophylla* Nees ex Steud.				*	
641	*Arundinella metzii* Hochst. ex Miq.*				*	*
642	*Arundinella tuberculata* Munro *ex* Lisboa		*	*		
643	*Axonopus compressus* (Sw.) P.Beauv.				*	*
644	*Bambusa bambos* (L.) Voss in Vilmorin	*				
645	*Bhidea fischeri* Sreek. & B.V.Shetty				*	*
646	*Brachiaria miliiformis*(J. Presl ex C. Presl) A.					*
647	*Brachiaria ramosa* (L.) Stapf in Prain		*			*
648	*Brachiaria reptans* (L.) C.A.Gardner & C.E.Hubb.					*
649	*Centotheca lappacea* (L.) Desv.		*		*	*
650	*Chloris barbata* Sw.					*
651	*Chrysopogon aciculatus* (Retz.) Trin.					*
652	*Chrysopogon hackelii*(Hook.f.) C.E.C. Fisch. in Gamble					*
653	*Coix lacryma-jobi* L.		*			
654	*Cymbopogon citrates* (DC.) Stapf		*	*	*	*
655	*Cymbopogon flexuosus* (Nees ex Steud.) Wats. in Atkins.	*				*
656	*Cynodon dactylon* (L.) Pers.	*	*			*
657	*Cyrtococcum trigonum* (Retz.) A. Camus				*	*
658	*Dacteyloctenium aegypticum* (L.) P. Beauv				*	*
659	*Dalbergia horrida* (Dennst.) Mabb.*	*	*		*	*
660	*Digitaria bicornis* (Lam.) Roem. & Schult. ex Loud.					*
661	*Digitaria ciliaris* (Retz.) Koeler					*
662	*Dimeria bialata* C.E.C. Fisch.					*
663	*Dimeria hohenackeri* Hochst. ex Miq.					*
664	*Echinochloa colona*(L.) Link					*
665	*Eleusine indica* (L.) Gaertn.		*			*
666	*Eragrostis tenella* (L.) P. Beauv. ex Roem. & Schult.var. *tenella*; Manilal & Sivar.					*
667	*Eragrostis tenuifolia*(A. Rich.) Hochst. ex Steud.					*
668	*Eragrostis unioloides* (Retz.) Nees ex Steud.		*			*
669	*Eragrostis viscosa* (Retz.) Trin.		*			*
670	*Eulalia trispicata* (Schult.) Henrard		*			
671	*Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult.		*		*	*
672	*Isachne globosa* (Thunb.) O. Ktze.					*

573	*Isachne miliacea* Roth				*	*
574	*Ischaemum burmanicum* Bor. *var. burmanicum*; R. Kr. Singh & P.S.N. Rao					*
575	*Ischaemum commutatum* Hack. in A. & C. DC				*	*
576	*Ischaemum indicum*(Houtt.) Merr.				*	*
577	*Ischaemum molle*Hook.f.					*
578	*Ischaemum muticum*L.				*	*
579	*Ischaemum pappinisseriensis* Ravi					*
580	*Ischaemum timorense*Kunth					*
581	*Ischaemum tumidum*Stapf ex Bor var. *calicutensis* (Sreek., V.J. Nair & N.C. Nair) R. Kr. Singh & P.S.N. Rao				*	*
582	*Microchloa indica* (L.f.) P. Beauv.				*	*
583	*Oplismenus burmannii* (Retz.) P. Beauv.				*	*
584	*Oplismenus compositus*(L.) P. Beauv.				*	*
585	*Oryza rufipogon* Griff.				*	*
586	*Oryza sativa* L.					*
587	*Panicum brevifolium*L.				*	*
588	*Panicum maximum* Jacq.		*			
589	*Panicum notatum* Retz.				*	*
590	*Panicum repens* L.				*	*
591	*Panicum trypheron* Schult.		*			
592	*Paspalum canarae* (Steud.) Veldk.		*	*		
593	*Paspalum conjugatum* Berg.		*			
594	*Paspalum scrobiculatum* L.		*		*	*
595	*Pennisetum orientale* L.C. Rich. in Pers.		*			
596	*Pennisetum pedicellatum* Trin.	*	*			
597	*Pennisetum polystachyon* (L.) Schult.		*			*
598	*Perotis indica* (L.) O. Ktze.					*
599	*Pseudanthistiria umbellata* (Hack.) Hook. f.				*	*
600	*Rottboellia cochinchinensis* (Lour.) W. D. Clayton					*
601	*Sacciolepis interrupta* (Willd.) Stapf in Prain					*
602	*Setaria pumila* (Poir.) Roem. & Schult.					*
603	*Spodiopogon rhizophorus* Steud.					*
604	*Sporobolus indicus*(L.) R. Br. var.*diander* (Retz.) Jovet & Guedes					*
605	*Themeda triandra*Forssk.				*	*
606	*Tripsacum laxum* Nash		*			
	Family: Polygalaceae					
607	*Polygala elongata* Klein ex Willd.				*	*
608	*Salomonia ciliata* (L.) DC.					*
609	*Xanthophyllum arnottianum* Wight	*				*
	Family: Pontederiaceae					

710	*Monochoria vaginalis*(Burm. f.) Presl				*	*
	Family: Portulacaceae					
711	*Portulaca oleracea* L.		*		*	*
	Family: Proteaceae					
712	*Helicia nilagirica* Bedd.	*				
	Family: Ranunculaceae					
713	*Naravelia zeylanica* (L.) DC.	*			*	*
	Family: Rhamnaceae					
714	*Ventilago maderaspatana* Gaertn.	*				
715	*Ziziphus mauritiana*Lam.				*	*
716	*Ziziphus nummularia* (Burm.f.) Wight & Arn.	*				
717	*Ziziphus oenoplia* (L.) Mill.	*	*	*	*	*
718	*Ziziphus rugosa*Lam.	*	*		*	*
719	*Ziziphus xylopyrus* (Retz.) Willd.	*				
	Family: Rhizophoraceae					
720	*Carallia brachiata* (Lour.) Merr.	*	*	*	*	*
	Family: Rubiaceae					
721	*Benkara malabarica* (Lam.) Tirveng.		*	*	*	*
722	*Canthium angustifolium* Roxb.	*				
723	*Canthium coromandelicum* (Burm.f.) Alston	*	*		*	*
724	*Canthium rheedei* DC.	*				
725	*Canthium travancoricum* (Bedd.) Hook. f.	*				
726	*Catunaregam spinosa* (Thunb.) Tirveng.	*	*	*	*	*
727	*Chassalia curviflora*(Wall. ex Kurz) Thw. var. *ophioxyloides* (Wall.) Deb & Krishna	*	*		*	*
728	*Coffea arabica* L.	*	*			
729	*Gardenia jasminoides* Ellis	*				
730	*Gardenia resinifera* Roth	*				
731	*Geophila repens* (L.) Johnst.	*				
732	*Hamelia patens* Jacq.	*				
733	*Hedyotis cyanantha* Kurz		*		*	*
734	*Hedyotis neesiana* Arn.	*				
735	*Ixora brachiata* Roxb. ex DC.	*	*			*
736	*Ixora coccinea*L.	*	*	*	*	*
737	*Ixora elongata* Heyne ex G. Don	*				
738	*Ixora javanica* (Blume) DC.	*				
739	*Ixora malabarica* (Dennst.) Mabb.	*				
740	*Ixora nigricans* R. Br. ex Wight & Arn.	*				
741	*Ixora pavetta* Andr.	*				
742	*Ixora polyantha* Wight	*				
743	*Knoxia wightiana* Wall.*ex* Wight & Arn.		*	*		
744	*Mitracarpus hirtus* (L.) DC.	*	*	*	*	*

745	*Morinda citrifolia* L.				*	*
746	*Morinda pubescens* J. E. Smith in Rees	*	*			
747	*Morinda umbellata* L.	*				
748	*Mussaenda frondosa* L.	*			*	*
749	*Neanotis rheedei* (Wall. ex Wight & Arn.) Lewis		*		*	*
750	*Neanotis tubulosa* (G. Don) Mabb.				*	*
751	*Oldenlandia auricularia* (L.) K. Schum. in Engl. & Prantl		*			
752	*Oldenlandia corymbosa* L. var. *corymbosa* Hook. f.	*	*	*	*	*
753	*Oldenlandia herbacea* (L.) Roxb.					*
754	*Oldenlandia umbellata* L.		*			
755	*Ophiorhiza mongus* L.	*	*			*
756	*Ophiorrhiza hirsutula* Wight ex Hook. f.		*			
757	*Pavetta breviflora* DC.	*				
758	*Pavetta hispidula* Wight & Arn.		*			
759	*Pavetta indica* L. var. *indica* Hook.f.	*			*	*
760	*Pseudomussaenda lanceolata* (Forssk.) Wernham		*			
761	*Psychotria flavida* Talbot	*				
762	*Psydrax umbellata* (Wight) Bridson				*	*
763	*Richardia scabra* L.	*				
764	*Spermacoce articularis* L. f.				*	*
765	*Spermacoce latifolia* Aubl.				*	*
766	*Spermacoce ocymoides* Burm.f.		*		*	*
767	*Spermacoce pusilla* Wall. in Roxb.					*
768	*Tarenna asiatica* (L.) O.Ktze. ex K. Schum.	*				
	Family: Rutaceae					
769	*Aegle marmelos* (L.) Corrêa		*			*
770	*Atalantia wightii* Tanaka	*			*	
771	*Citrus aurantifolia* (Christm. & Panz.) Swingle		*	*		
772	*Citrus limon* (L.) Burm. f.		*			
773	*Citrus medica* L.	*				*
774	*Glycosmis mauritiana* (Lam.) Tanaka				*	*
775	*Glycosmis pentaphylla* (Retz.) DC.	*			*	*
776	*Melicope lunu-ankenda* (Gaertn.) Hartley				*	*
777	*Murraya koenigii* (L.) Spreng.	*	*	*		
778	*Murraya paniculata* (L.) Jack.		*			
779	*Naringi crenulata* (Roxb.) Nicolson in Saldanha & Nicolson	*				*
780	*Toddalia asiatica* (L.) Lam.	*				
781	*Zanthoxylum rhetsa* (Roxb.) DC.	*	*		*	*
	Family: Santalaceae					
782	*Santalam album* L.	*	*		*	*
	Family: Sapindaceae					

783	*Allophylus cobbe* (L.) Raeusch.	*			*	*
784	*Cardiospermum halicacabum* L.	*	*	*	*	*
785	*Sapindus emarginatus* Vahl	*				
786	*Sapindus trifoliatus* L.					*
787	*Schleichera oleosa*(Lour.) Oken	*	*			*
	Family: Sapotaceae					
788	*Chrysophyllum cainito* L.	*			*	
789	*Madhuca longifolia* (Koenig) Macbr. var. *latifolia* (Roxb.) A. Chev.	*				
790	*Madhuca neriifolia* (Moon) H. J. Lam	*	*			*
791	*Manilkara zapota* (L.) P.Royen		*			
792	*Mimusops elengi* L.	*	*		*	*
	Family: Scrophulariaceae					
793	*Centranthera indica* (L.) Gamble		*		*	*
794	*Dopatrium junceum* (Roxb.) Buch.-Ham. ex Benth.					*
795	*Limnophila repens*(Benth.) Benth.	*				*
796	*Lindernia antipoda* (L.) Alston in Trimen	*			*	
797	*Lindernia ciliata* (Colsm.) Pennell					*
798	*Lindernia crustacea* (L.) F.v. Muell.					*
799	*Lindernia hyssopioides*(L.) Haines					*
800	*Lindernia viscosa* (Hornem.) Merr.					*
801	*Mecardonia procumbens*(Mill.) Small				*	*
802	*Microcarpaea minima*(Koenig ex Retz.) Merr.				*	*
803	*Parasopubia delphiniifolia* (L.) H.-P. Hofm. & Eb. Fisch.				*	
804	*Rhamphicarpa longiflora* (Arn.) Benth.				*	*
805	*Russelia equisetiformis* Schltr. & Cham.		*			
806	*Scoparia dulcis* L.	*	*	*	*	*
807	*Sopubia trifida*Buch.-Ham. ex D. Don				*	*
808	*Striga angustifolia* (D. Don) Saldanha		*			*
809	*Striga asiatica* (L.) O. Ktze.		*		*	*
810	*Striga gesnerioides* (Willd.) Vatke				*	*
	Family: Simaroubaceae					
811	*Ailanthus excelsa* Roxb.	*	*	*		
812	*Ailanthus triphysa* (Dennst.)	*	*		*	
813	*Quassia indica* (Gaertn.) Nooteb. in Steenis	*	*			
814	*Simarouba glauca* DC.	*				
	Family: Smilacaceae					
815	*Smilax wightii* A. DC. in A. & C. DC.	*				
816	*Smilax zeylanica*L.	*	*	*	*	*
	Family: Solanaceae					
817	*Capsicum annuum* L.var. *annuum* Gamble		*	*	*	*
818	*Capsicum frutescens* L.		*		*	*

819	*Datura stramonium* L.		*		*	*
820	*Physalis angulata* L.					*
821	*Solanum americanum* Mill.	*	*			*
822	*Solanum melongena* L. var. *insanum* (L.) Prain		*			
823	*Solanum torvum* Sw.	*	*	*	*	*
824	*Solanum violaceum* Ortega		*			
	Family: Sterculiaceae					
825	*Abroma augusta (L.) L. f.*		*			
826	*Helicteres isora* L.	*	*	*	*	*
827	*Melochia corchorifolia* L.		*		*	*
828	*Pterospermum diversifolium* Blume		*		*	*
829	*Pterospermum reticulatum* Wight & Arn.	*	*			
830	*Pterospermum rubiginosum*Heyne ex Wight & Arn.	*	*	*	*	*
831	*Pterygota alata* (Roxb.) R. Br.	*	*	*		*
832	*Sterculia balanghas* L.		*			
833	*Sterculia guttata* Roxb. ex DC.	*	*	*	*	*
834	*Waltheria indica* L.				*	*
	Family: Symphoremataceae					
835	*Symphorema involucratum* Roxb.					*
	Family: Symplocaceae					
836	*Symplocos cochinchinensis* (Lour.) Moore ssp. *laurina* (Retz.) Nooteb.	*				
	Family: Theaceae					
837	*Camellia sinensis* (L.) O.Ktze.		*	*		
	Family: Tiliaceae					
838	*Corchorus aestuans* L.	*			*	*
839	*Corchorus capsularis*L.				*	*
840	*Corchorus trilocularis* L.		*			
841	*Grewia abutilifolia* Vent. ex Juss.		*	*		
842	*Grewia flavescens* Juss.		*	*		
843	*Grewia nervosa*(Lour.) Panigrahi	*	*	*	*	*
844	*Grewia serrulata* DC.	*				
845	*Grewia tiliifolia* Vahl	*				
846	*Triumfetta rhomboidea* Jacq.	*			*	*
	Family: Trichopodaceae					
847	*Trichopus zeylanicus* Gaertn. ssp. *travancoricus* (Bedd.) Burkill ex Narayanan	*				
	Family: Turneraceae					
848	*Turnera subulata*Smith in Rees				*	*
	Family: Ulmaceae					
849	*Celtis philippensis* Blanco var. *wightii* (Planch.) Soep. in Steenis				*	*
850	*Celtis timorensis* Span.	*				

851	*Holoptelea integrifolia*(Roxb.) Planch.					*
852	*Trema orientalis* (L.) Blume	*	*	*	*	*
	Family: Urticaceae					
853	*Elatostema cuneatum* Wight					*
854	*Laportea interrupta* (L.) Chew					*
855	*Pilea microphylla* (L.) Liebm.					*
856	*Pouzolzia zeylanica* (L.) Bennett		*		*	*
	Family: Verbenaceae					
857	*Callicarpa tomentosa* (L.) L. in Murr.	*				*
858	*Citharexylum spinosum* L.	*				
859	*Clerodendrum incisum* Klotzsch. in Peters		*			
860	*Clerodendrum indicum* (L.) O. Ktze.		*			
861	*Clerodendrum infortunatum* L.	*	*	*	*	*
862	*Clerodendrum paniculatum* L	*			*	*
863	*Duranta erecta* L.		*			
864	*Holmskioldia sanguinea* Retz.		*			
865	*Lantana camara*L.	*	*	*	*	*
866	*Phyla nodiflora* (L.) Greene		*			*
867	*Premna coriacea* Clarke in Hook. f.	*				
868	*Premna serratifolia* L.	*			*	*
869	*Priva cordifolia* (L.f.) Druce	*				
870	*Rotheca serratum*(L.) Steane & Mabb.					*
871	*Stachytarpheta cayennensis* (Rich.) Schauer in DC.		*			
872	*Stachytarphetajamaicensis* (L.) Vahl	*	*	*	*	*
873	*Tectona grandis* L. f.	*	*		*	*
874	*Vitex altissima* L. f.	*	*		*	*
875	*Vitex negundo* L.		*		*	*
876	*Vitex trifolia* L.				*	*
	Family: Violaceae					
877	*Hybanthus ennaespermus*(L.) F.v. Muell.				*	*
	Family: Vitaceae					
878	*Ampelocissus indica* (L.) Planch.		*			
879	*Ampelocissus latifolia* (Roxb.) Planch.	*			*	*
880	*Cayratia mollissima* (Wall.) Gagnep. in Lecomte		*			
881	*Cayratia pedata* (Lam.) A. Juss. ex Gagnep. var. glabra Gamble	*				
882	*Cayratia trifolia* (L.) Domin				*	*
883	*Cissus discolor*Blume	*	*	*		*
884	*Cissus glyptocarpa* (Thw.) Planch. in A. & C. DC.	*				
885	*Cissus latifolia* Lam.	*	*		*	*
886	*Cissus repens* Lam.	*				
	Family: Zingiberaceae					
887	*Amomum muricatum* Bedd.	*				

888	*Curcuma aeruginosa* Roxb.	*				
889	*Curcuma longa* L.		*	*		
890	*Curcuma neilgherrensis* Wight	*	*	*		
891	*Curcuma oligantha*Trimen var. *oligantha* Hook. f.				*	*
892	*Curcuma zanthorrhiza*Roxb.				*	*
893	*Zingiber neesanum* (Graham) Ramam. in Saldanha & Nicolson	*		*		
894	*Zingiber officinale* Rosc.	*	*	*		
895	*Zingiber zerumbet*(L.) J.E. Smith				*	*

Appendix XIV
Checklist of Butterflies in Different Ecosystems of Kavvayi River Basin

Sl No.	Species Name	Common Name	LB	RE	SG	KM	IT
	HESPERIIDAE						
1	*Aeromachus pygmaeus*	Pygmy scrub Hopper		*	*	*	*
2	*Ampittia dioscorides*	Bush Hopper	*	*			
3	*Badamia exclamationis*	Brown Awl	*			*	
4	*Bibasis sena*	Orange-tail Awl	*	*			
5	*Borbo cinnara*	Rice Swift	*	*	*	*	*
6	*Celaenorrhinus ambareesa*	Dakhan Spotted Flat	*	*			
7	*Choaspes benjaminii*	Indian Awlking		*			
8	*Coladenia indrani indra*	Tricolor Pied Flat	*	*	*	*	*
9	*Erionota thrax*	Palm Redeye	*			*	
10	*Gangara thyrsis*	Giant Redeye	*				
11	*Gerosis bhagava*	Common Yellow-breasted Flat	*				
12	*Hasora badra*	Common Awl		*			
13	*Hasora chromus*	Common Banded Awl	*		*		*
14	*Hasora taminatus*	White-Banded Awl		*		*	
15	*Iambrix salsala*	Chestnut Bob	*	*	*	*	*
16	*Matapa aria*	Common Redeye		*		*	
17	*Notocrypta curvifascia*	Restricted Demon	*	*	*	*	*
18	*Notocrypta paralysos*	Common Banded Demon		*	*	*	
19	*Oriens concinna*	Tamil Dartlet	*	*	*	*	*
20	*Oriens goloides*	Smaller Dartlet		*	*		*
21	*Pelopidas mathias*	Dakhan Small Branded Swift	*		*		*
22	*Pseudocoladenia dan*	Fulvious Pied Flat	*	*	*	*	*
23	*Psolos fuligo*	Coon	*	*	*	*	*

24	*Sarangesa dasahara*	Common Small Flat	*	*	*	*	*
25	*Sarangesa purendra pandra*	Spotted small Flat	*				
26	*Suastus gremius*	Indian Palm Bob	*	*		*	
27	*Tagiades gana silvia*	Snuffused Snow Flat	*	*	*	*	*
28	*Tagiades japetus*	Common Snow Flat	*	*	*	*	
29	*Tagiades litigiosa*	Water Snow Flat	*	*	*	*	
30	*Taractrocera maevius*	Oriental Grass Dart	*		*	*	*
31	*Telicota bambusae*	Dark Palm Dart			*	*	*
32	*Udaspes folus*	Grass Demon	*	*	*	*	*
	LYCAENIDAE						
33	*Acytolepis puspa felderi*	Malabar Common Hedge Blue					*
34	*Arhopala centaurus pirama*	Tamil Centaur Oakblue	*				
35	*Caleta decidia decidia*	Angled Pierrot	*		*	*	*
36	*Castalius rosimon*	Common Pierrot	*		*	*	*
37	*Cheritra freja*	Common Imperial	*			*	
38	*Curetis siva*	Shiva Sun Beam		*	*		
39	*Curetis thetis*	Indian Sun Beam	*		*		
40	*Discolampa ethion ethion*	Oriental Banded Blue Pierrot	*				
41	*Euchrysops cnejus*	Gram Blue	*				*
42	*Jamides bochus*	Dark Cerulean	*		*		
43	*Jamides celeno*	Common Cerulean	*	*	*	*	*
44	*Lampides boeticus*	Pea Blue	*				
45	*Loxura atymnus atymnus*	Sahyadri Yamfly	*	*	*	*	*
46	*Megisba malaya*	Malyan	*	*	*	*	*
47	*Neopithecops zalmora*	Quaker	*	*	*	*	*
48	*Prosotas nora*	Common Lineblue	*				
49	*Rapala lankana*	Malabar Flash	*				
50	*Rapala manea*	Slate Flash	*				
51	*Rathinda amor*	Monkey Puzzle	*	*	*	*	*
52	*Spalgis epeus*	Apefly	*			*	*
53	*Spindasis vulcanus*	Common Sliver Line	*		*	*	*
54	*Surendra quercetorum*	Common Acacia Blue	*		*		
55	*Talicada nyseus*	Red pierrot	*	*	*	*	*
56	*Thaduka multicaudata*	Many-Tailed Oak Blue	*		*	*	
57	*Virachola isocrates*	Common Guava Blue	*	*			*
58	*Zeltus amasa*	Indian Fluffy Tit			*	*	*
59	*Zesius chrysomallus*	Red spot	*				
	RIODINIDAE						
60	*Abisara echerius*	Plum Judy	*	*	*	*	*
	NYMPHALIDAE						

61	*Acraea terpsicore*	Tawny Coster	*	*	*	*	*
62	*Ariadne ariadne*	Angled Castor	*	*	*	*	*
63	*Ariadne merione*	Common Castor	*	*	*	*	*
64	*Athyma inara*	Colour Sergeant		*	*	*	
65	*Athyma perius*	Common Sergeant	*				
66	*Athyma ranga*	Blackvein Sergeant	*		*	*	
67	*Charaxes athamas*	Common Nawab		*	*	*	*
68	*Charaxes solon*	Pale Black Rajah		*			
69	*Cirrochroa thais*	Tamil Yeoman	*	*	*	*	*
70	*Cupha erymanthis*	Sahyadri Rustic	*	*	*	*	*
71	*Cyrestis thyodamas*	Map Butterfly	*	*	*	*	*
72	*Danaus chrysippus*	Oriental Plain Tiger	*	*	*	*	*
73	*Danaus genutia*	Stripped Tiger	*	*	*	*	*
74	*Doleschallia bisaltide malabarica*	Malabar Autumn Leaf	*				
75	*Elymnias hypermnestra*	Common Palmfly	*	*	*	*	
76	*Euploea core*	Common Crow	*	*	*	*	*
77	*Euthalia lubentina*	Gaudy Baron	*			*	
78	*Hypolimnas bolina*	Great Eggfly	*	*	*		*
79	*Hypolimnas misippus*	Danaid Eggfly	*	*	*	*	*
80	*Junonia almana*	Oriental Peacock Pansy	*	*	*	*	*
81	*Junonia atlites*	Oriental Grey Pansy	*	*	*	*	*
82	*Junonia hierta*	Oriental Yellow Pansy	*	*	*	*	*
83	*Junonia iphita*	Oriental Chocolate Pansy	*	*	*	*	*
84	*Junonia lemonias*	Lemon Pansy	*	*	*	*	*
85	*Junonia orithya*	Blue Pansy	*	*	*	*	*
86	*Kallima horsfieldi*	Sahyadri Blue oakleaf		*	*	*	
87	*Kaniska canace*	Sahyadri Blue Admiral		*	*		
88	*Lethe europa*	Dakhan Bamboo Treebrown	*	*	*	*	
89	*Lethe rohria*	Dakhan Common Tree Brown		*	*	*	*
90	*Melanitis leda*	Common Evening Brown	*	*	*	*	*
91	*Melanitis zitenius*	Sahyadri Great Evening Brown				*	
92	*Moduza procris*	Sahyadri Commander	*		*	*	*
93	*Mycalesis junonia*	Malabar Glad-eye-Bushbrown	*	*	*	*	*
94	*Mycalesis mineus*	Dark-Brand Bushbrown	*	*	*		
95	*Mycalesis perseus*	Common Bushbrown	*	*	*		*
96	*Neptis hylas*	Indian Common Sailor	*	*	*	*	*
97	*Neptis jumbah*	Chestnut-Streaked Sailer	*		*	*	
98	*Orsotriaena medus*	Sahyadri Medus Brown	*	*	*	*	*
99	*Pantoporia hordonia*	Oriental Common Lascar	*	*	*	*	*

100	*Parantica aglea*	Glassy Blue Tiger	*	*	*	*	*
101	*Parthenos sylvia*	Sahyadri Clipper	*	*	*	*	*
102	*Phalanta phalantha*	Common Leopard	*	*	*	*	*
103	*Tanaecia lepidea*	Grey Count	*	*	*	*	*
104	*Tirumala limniace*	Blue Tiger	*	*	*	*	*
105	*Tirumala septentrionis*	Dark Blue Tiger	*	*	*	*	
106	*Vindula erota*	Sahyadri Cruiser	*	*	*	*	*
107	*Ypthima baldus*	Sahyadri Common Fivering	*	*	*	*	*
108	*Ypthima huebneri*	Common Fourring	*	*	*	*	*
	PAPILIONIDAE						
109	*Graphium agamemnon*	Tailed Jay	*	*	*	*	*
110	*Graphium doson*	Common Jay		*	*		
111	*Graphium sarpedon*	Common Bluebottle	*	*	*	*	*
112	*Pachliopta aristolochiae*	Common Rose	*		*	*	*
113	*Pachliopta hector*	Crimson Rose	*	*	*	*	*
114	*Pachliopta pandiyana Moore*	Malabar Rose		*	*	*	*
115	*Papilio buddha*	Malabar Banded Peacock	*		*	*	
116	*Papilio clytia clytia*	Oriental Common Mime	*	*	*	*	*
117	*Papilio demoleus*	Lime Butterfly	*	*	*	*	*
118	*Papilio dravidarum*	Malabar Raven	*		*	*	*
119	*Papilio helenus*	Red Helen	*	*	*	*	*
120	*Papilio liomedon*	Malabar Banded Swallowtail	*				
121	*papilio paris*	Paris Peacock	*	*	*	*	*
122	*Papilio polymnestor*	Blue Mormone	*	*	*	*	*
123	*Papilio polytes*	Common Mormon	*	*	*	*	*
124	*Troides minos*	Sahyadri Birdwing	*	*	*	*	*
	PIERIDAE						
125	*Appias albina*	Common Albatross	*	*	*	*	*
126	*Appias lyncida*	Chocolate Albatross	*	*	*	*	*
127	*Belenois aurota aurota*	Pioneer	*	*			
128	*Catopsilia pomona*	Lemon Emigrant	*	*	*	*	*
129	*Catopsilia pyranthe pyranthe*	Mottled Emigrant	*	*	*	*	*
130	*Cepora nadina*	Lesser Gull		*			
131	*Cepora nerissa*	Common Gull	*	*	*		
132	*Delias eucharis*	Common Jezebel	*	*	*	*	*
133	*Eurema blanda*	Three-spot Grass Yellow	*	*	*	*	*
134	*Eurema brigitta*	Small Grass Yellow	*	*	*		*
135	*Eurema hecabe*	Common Grass Yellow	*	*	*	*	*
136	*Hebomoia glaucippe*	Sahyadri Great Orange Tip	*	*	*	*	
137	*Ixias pyrene*	Yellow Orange Tip		*	*		

138	*Leptosia nina*	Psyche	*	*	*	*	*
139	*Pareronia hippia*	Dark Wanderer	*	*	*	*	*
140	*Prioneris sita*	Painted Sawtooth	*	*	*	*	*

Appendix XV

Checklist of Birds in Different Ecosystems of Kavvayi River Basin

Sl No.	Species Name		SG	KM	KU	IT
	I. ORDER ANSERIFORMES					
	1. Family Anatidae (ducks, geese, swans)					
1	Garganey	*Spatula querquedula*			*	
2	Lesser Whistling Duck	*Dendrocygna javanica*			*	
	II. ORDER GALLIFORMES					
	2. Family Phasianidae (partridges, pheasants, grouse)					
3	Grey Junglefowl	*Gallus sonneratii*	*	*		*
4	Indian Peafowl	*Pavo cristatus*	*	*		*
5	Jungle Bush Quail	*Perdicula asiatica*	*			*
6	Red Spurfowl	*Galloperdix spadicea*	*	*	*	*
	III. ORDER PHOENICOPTERIFORMES					
	3. Family Podicipedidae (grebes)					
7	Little Grebe	*Tachybaptus ruficollis*			*	
	IV. ORDER COLUMBIFORMES					
	4. Family Columbidae (pigeons)					
8	Emerald Dove	*Chalcophaps indica*	*	*	*	*
9	Pompadour Green Pigeon (Grey-fronted Green Pigeon)	*Treron pompadora*	*	*		*
10	Rock Pigeon (Rock Dove)	*Columba livia*	*	*	*	*
11	Spotted Dove	*Streptopelia chinensis*	*	*	*	*
12	Yellow-legged Green Pigeon (Yellow-footed Green Pigeon)	*Treron phoenicopterus*				*
	V. ORDER CAPRIMULGIFORMES					
	5. Family Caprimulgidae (nightjars)					
13	Grey Nightjar (Jungle Nightjar)	*Caprimulgus indicus*	*	*		*
14	Indian Nightjar	*Caprimulgus asiaticus*	*	*		*
	6. Family Apodidae (swifts)					
15	Alpine Swift	*Tachymarptis melba*	*	*	*	*
16	Asian Palm Swift	*Cypsiurus balasiensis*	*	*	*	*
17	Brown-backed Needletail	*Hirundapus giganteus*	*	*		*
18	Indian House Swift (Little Swift)	*Apus affinis*	*	*	*	*

19	Indian Swiftlet	*Aerodramus unicolor*	*	*		*
	VI. ORDER CUCULIFORMES					
	7. Family Cuculidae (cuckoos)					
20	Asian Koel	*Eudynamys scolopaceus*	*	*	*	*
21	Banded Bay Cuckoo	*Cacomantis sonneratii*	*	*	*	*
22	Blue-faced Malkoha	*Phaenicophaeus viridirostris*	*	*		*
23	Common Hawk Cuckoo	*Hierococcyx varius*	*	*	*	*
24	Greater Coucal	*Centropus sinensis*	*	*	*	*
25	Indian Cuckoo	*Cuculus micropterus*	*	*	*	*
26	Pied Cuckoo (Pied Crested Cuckoo, Jacobian Cuckoo)	*Clamator jacobinus*	*	*	*	*
	VII. ORDER GRUIFORMES					
	8. Family Rallidae (rails and coots)					
27	Common Moorhen (Eurasian Moorhen)	*Gallinula chloropus*			*	
28	Purple Swamphen	*Porphyrio porphyrio*	*		*	
29	Ruddy-breasted Crake	*Zapornia fusca*			*	
30	White-breasted Waterhen	*Amaurornis phoenicurus*	*	*	*	
	VIII. ORDER PELECANIFORMES					
	9. Family Ciconiidae (storks)					
31	Asian Openbill	*Anastomus oscitans*	*	*	*	
32	Black Stork	*Ciconia nigra*			*	
33	European White Stork	*Ciconia ciconia*			*	
34	Woolly-necked Stork (Asian Woollyneck)	*Ciconia episcopus*	*		*	
	10. Family Ardeidae (herons)					
35	Black-crowned Night Heron	*Nycticorax nycticorax*	*		*	
36	Cattle Egret	*Bubulcus ibis*	*	*	*	*
37	Chinnamon Bittern	*Ixobrychus Chinnamomeus*	*		*	
38	Great Egret	*Ardea alba*	*	*	*	
39	Grey Heron	*Ardea cinerea*	*		*	
40	Indian Pond Heron	*Ardeola grayii*	*	*	*	*
41	Intermediate Egret	*Ardea intermedia*	*	*	*	
42	Little Egret	*Egretta garzetta*	*	*	*	
43	Purple Heron	*Ardea purpurea*			*	
44	Striated Heron (Green-backed Heron, Little Heron)	*Butorides striata*	*		*	
45	Western Reef Egret (Western Reef Heron)	*Egretta gularis*			*	
46	Yellow Bittern	*Ixobrychus sinensis*	*		*	

	11. Family Threskiornithidae (ibises)					
47	Black-headed Ibis	*Threskiornis melanocephalus*	*	*	*	
48	Glossy Ibis	*Plegadis falcinellus*			*	
	12. Family Phalacrocoracidae (cormorants)					
49	Indian Cormorant	*Phalacrocorax fuscicollis*			*	
50	Little Cormorant	*Microcarbo niger*	*		*	
	13. Family Anhingidae (darters)					
51	Oriental Darter	*Anhinga melanogaster*			*	
	IX. ORDER CHARADRIIFORMES					
	14. Family Recurvirostridae (stilts and avocets)					
52	Black-winged Stilt	*Himantopus himantopus*			*	
	15. Family Charadriidae (plovers & lapwings)					
53	Greater Sand Plover	*Charadrius leschenaultii*			*	
54	Grey Plover (Black-bellied Plover)	*Pluvialis squatarola*			*	
55	Kentish Plover	*Charadrius alexandrinus*			*	
56	Lesser Sand Plover	*Charadrius mongolus*			*	
57	Little Ringed Plover	*Charadrius dubius*			*	
58	Pacific Golden Plover	*Pluvialis fulva*			*	
59	Yellow-wattled Lapwing	*Vanellus malarbaricus*	*		*	*
60	Red-wattled Lapwing	*Vanellus indicus*	*	*	*	*
	IX. ORDER CHARADRIIFORMES					
	16. Family Jacanidae (jacanas)					
61	Bronze-winged Jacana	*Metopidius indicus*			*	
	IX. ORDER CHARADRIIFORMES					
	17. Family Scolopacidae (sandpipers)					
62	Common Greenshank	*Tringa nebularia*	*			
63	Common Redshank	*Tringa totanus*			*	
64	Common Sandpiper	*Actitis hypoleucos*			*	
65	Common Snipe	*Gallinago gallinago*			*	
66	Curlew Sandpiper	*Calidris ferruginea*			*	
67	Dunlin	*Calidris alpina*			*	
68	Eurasian Curlew	*Numenius arquata*			*	
69	Green Sandpiper	*Tringa ochropus*			*	

70	Little Stint	*Calidris minuta*	*		*	
71	Marsh Sandpiper	*Tringa stagnatilis*			*	
72	Pintail Snipe	*Gallinago stenura*			*	
73	Sanderling	*Calidris alba*			*	
74	Temminck's Stint	*Calidris temminckii*			*	
75	Terek Sandpiper	*Xenus cinereus*			*	
76	Whimbrel	*Numenius phaeopus*			*	
77	Wood Sandpiper	*Tringa glareola*			*	
	IX. ORDER CHARADRIIFORMES					
	18. Family Laridae (gulls and terns)					
78	Common Tern	*Sterna hirundo*	*			
79	River Tern	*Sterna aurantia*			*	
	X. ORDER ACCIPITRIFORMES					
	19. Family Accipitridae (kites, hawks and eagles)					
80	Black Eagle	*Ictinaetus malaiensis*				*
81	Black Kite	*Milvus migrans*	*	*	*	*
82	Black-winged Kite (Black-shouldered Kite)	*Elanus caeruleus*	*	*	*	*
83	Booted Eagle	*Hieraaetus pennatus*				*
84	Brahminy Kite	*Haliastur indus*	*	*	*	*
85	Crested Goshawk	*Accipiter trivirgatus*	*	*		*
86	Crested Serpent Eagle	*Spilornis cheela*	*	*	*	*
87	Greater Spotted Eagle	*Clanga clanga*				*
88	Indian Spotted Eagle	*Clanga hastata*	*	*		*
89	Montagu's Harrier	*Circus pygargus*			*	
90	Oriental Honey Buzzard (Crested Honey Buzzard)	*Pernis ptilorhynchus*	*	*		*
91	Pallid Harrier	*Circus macrourus*			*	
92	Shikra	*Accipiter badius*	*	*	*	*
93	Western Marsh Harrier (Eurasian Marsh-Harrier)	*Circus aeruginosus*			*	
94	White-bellied Sea Eagle	*Haliaeetus leucogaster*	*			
	XI. ORDER STRIGIFORMES					
	20. Family Tytonidae (barn owls)					
95	Common Barn Owl	*Tyto alba*	*	*	*	*
	21. Family Strigidae (owls)					
96	Brown Fish Owl	*Ketupa zeylonensis*	*			
97	Brown Hawk Owl (Brown Boobook)	*Ninox scutulata*	*	*		
98	Collared Scops Owl (Indian Scops Owl)	*Otus bakkamoena*	*	*	*	*

99	Jungle Owlet	*Glaucidium radiatum*	*	*		*
100	Spotted Owlet	*Athene brama*	*	*	*	*
	XII. ORDER TROGONIFORMES					
	22. Family Trogonidae (trogons)					
101	Malabar Trogon	*Harpactes fasciatus*	*			*
	XIII. ORDER BUCEROTIFORMES					
	23. Family Bucerotidae (hornbills)					
102	Malabar Grey Hornbill	*Ocyceros griseus*	*			
	XIII. ORDER BUCEROTIFORMES					
	24. Family Upupidae (hoopoes)					
103	Common Hoopoe (Eurasian Hoopoe)	*Upupa epops*	*			
	XIV. ORDER PICIFORMES					
	25. Family Picidae (woodpeckers)					
104	Brown-capped Pygmy Woodpecker	*Dendrocopos moluccensis*	*	*		*
105	Common Golden-backed Woodpecker (Common Flameback)	*Dinopium javanense*	*	*	*	*
106	Heart-spotted Woodpecker	*Hemicircus canente*	*	*		*
107	Lesser Golden-backed Woodpecker (Black-rumped Flameback)	*Dinopium benghalense*	*	*	*	*
108	Rufous Woodpecker	*Micropternus brachyurus*	*	*	*	*
	26. Family Ramphastidae (toucans and barbets)					
109	Coppersmith Barbet	*Psilopogon haemacephalus*	*	*	*	*
110	Malabar Barbet	*Psilopogon malabaricus*	*	*		*
111	White-cheeked Barbet	*Psilopogon viridis*	*	*	*	*
	XV. ORDER CORACIIFORMES					
	27. Family Meropidae (bee-eaters)					
112	Blue-tailed Bee-eater	*Merops philippinus*	*	*	*	*
113	Green Bee-eater	*Merops orientalis*	*	*	*	*
	28. Family Coraciidae (rollers)					
114	Indian Roller	*Coracias benghalensis*	*	*	*	*
	29. Family Alcedinidae (kingfishers)					
115	Common Kingfisher	*Alcedo atthis*	*	*	*	*
116	Oriental Dwarf Kingfisher (Black-backed Dwarf Kingfisher)	*Ceyx erithaca*	*	*	*	
117	Pied Kingfisher	*Ceryle rudis*	*	*	*	
118	Stork-billed Kingfisher	*Pelargopsis capensis*	*	*	*	
119	White-throated Kingfisher (White-	*Halcyon smyrnensis*	*	*	*	*

	breasted Kingfisher)					
	XVI. ORDER FALCONIFORMES					
	30. Family Falconidae (falcons and caracaras)					
120	Common Kestrel (Eurasian Kestrel)	*Falco tinnunculus*	*	*		*
	XVII. ORDER PSITTACIFORMES					
	31. Family Psittaculidae (old world parrots)					
121	Plum-headed Parakeet	*Psittacula cyanocephala*	*	*	*	*
122	Rose-ringed Parakeet	*Psittacula krameri*	*	*	*	*
123	Vernal Hanging Parrot	*Loriculus vernalis*	*	*		*
	XIII. ORDER PASSERIFORMES					
	32. Family Pittidae (pittas)					
124	Indian Pitta	*Pitta brachyura*	*	*	*	*
	33. Family Campephagidae (minivets and cuckooshrikes)					
125	Ashy Minivet	*Pericrocotus divaricatus*	*	*	*	
126	Black-headed Cuckooshrike	*Lalage melanoptera*	*	*		*
127	Scarlet Minivet (Orange Minivet)	*Pericrocotus flammeus*	*	*		
128	Small Minivet	*Pericrocotus cinnamomeus*				*
129	Large Cuckooshrike	*Coracina javensis*	*	*		*
	34. Family Oriolidae (orioles, figbirds and allies)					
130	Black-hooded Oriole	*Oriolus xanthornus*	*	*	*	*
131	Black-naped Oriole	*Oriolus chinensis*	*	*		*
132	Indian Golden Oriole	*Oriolus kundoo*	*	*	*	*
	35. Family Artamidae (woodswallows, australian magpies and allies)					
133	Ashy Woodswallow	*Artamus fuscus*	*	*	*	*
	36. Family Vangidae (vangas and helmet-shrikes)					
134	Bar-winged Flycatcher-shrike	*Hemipus picatus*	*	*	*	*
135	Common Woodshrike	*Tephrodornis pondicerianus*	*	*	*	*
	37. Family Aegithinidae (ioras)					
136	Common Iora	*Aegithina tiphia*	*	*	*	*
	38. Family Dicruridae (drongos)					
137	Black Drongo	*Dicrurus macrocercus*	*	*	*	*
138	Bronzed Drongo	*Dicrurus aeneus*	*	*	*	*

139	Ashy Drongo	*Dicrurus leucophaeus*	*	*		*
140	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	*	*	*	*
	39. Family Laniidae (shrikes)					
141	Long-tailed Shrike	*Lanius schach*	*	*	*	
142	Brown Shrike	*Lanius cristatus*	*	*	*	*
	40. Family Corvidae (crows and jays)					
143	House Crow	*Corvus splendens*	*	*	*	*
144	Large-billed Crow	*Corvus macrorhynchos*	*	*	*	*
145	Rufous Treepie	*Dendrocitta vagabunda*	*	*	*	*
	41. Family Monarchidae (monarchs)					
146	Black-naped Monarch	*Hypothymis azurea*	*			
147	Indian Paradise-flycatcher (Asian Paradise-flycatcher)	*Terpsiphone paradisi*	*	*	*	*
	42. Family Dicaeidae (flowerpeckers)					
148	Pale-billed Flowerpecker	*Dicaeum erythrorhynchos*	*	*	*	*
149	Thick-billed Flowerpecker	*Dicaeum agile*	*	*	*	*
	43. Family Nectariniidae (sunbirds)					
150	Crimson-backed Sunbird	*Leptocoma minima*	*	*	*	
151	Little Spiderhunter	*Arachnothera longirostra*	*	*		
152	Loten's Sunbird (Long-billed Sunbird)	*Cinnyris lotenius*	*	*	*	*
153	Purple Sunbird	*Cinnyris asiaticus*	*	*	*	*
154	Purple-rumped Sunbird	*Leptocoma zeylonica*	*	*	*	*
	44. Family Irenidae (fairy bluebirds and leafbirds)					
155	Golden-fronted Leafbird	*Chloropsis aurifrons*	*	*	*	*
156	Jerdon's Leafbird	*Chloropsis jerdoni*	*	*	*	*
	45. Family Ploceidae (weavers)					
157	Baya Weaver	*Ploceus philippinus*	*	*	*	
	46. Family Estrildidae (waxbills)					
158	Black-headed Munia (Tricoloured Munia)	*Lonchura malacha*	*	*	*	*
159	Scaly-breasted Munia	*Lonchura punctulata*	*	*	*	
160	White-rumped Munia	*Lonchura striata*	*	*	*	*
	47. Family Passeridae (sparrows, snowfinches and allies)					
161	House Sparrow	*Passer domesticus*	*	*		*
	48. Family Motacillidae (wagtails and pipits)					

162	Grey Wagtail	*Motacilla cinerea*	*	*	*	
163	Paddyfield Pipit (Oriental Pipit)	*Anthus rufulus*	*	*	*	
164	Richard's Pipit	*Anthus richardi*	*	*		
165	White Wagtail	*Motacilla alba*	*	*		*
166	White-browed Wagtail	*Motacilla maderaspatensis*	*	*	*	*
	49. Family Alaudidae (larks)					
167	Ashy-crowned Sparrow Lark	*Eremopterix griseus*	*	*		*
168	Jerdon's Bushlark	*Mirafra affinis*	*	*	*	*
169	Malabar Lark	*Galerida malabarica*	*	*	*	*
170	Oriental Skylark	*Alauda gulgula*				*
	50. Family Cisticolidae (cisticolas)					
171	Common Tailorbird	*Orthotomus sutorius*	*	*	*	
172	Grey-breasted Prinia	*Prinia hodgsonii*	*	*	*	*
173	Jungle Prinia	*Prinia sylvatica*	*	*		*
174	Plain Prinia	*Prinia inornata*	*	*	*	*
175	Zitting Cisticola	*Cisticola juncidis*	*	*	*	
	51. Family Acrocephalidae (brush, reed and swamp warblers)					
176	Blyth's Reed Warbler	*Acrocephalus dumetorum*	*	*	*	*
177	Clamorous Reed Warbler	*Acrocephalus stentoreus*			*	
	52. Family Hirundinidae (swallows)					
178	Barn Swallow	*Hirundo rustica*	*	*	*	
179	Red-rumped Swallow	*Cecropis daurica*	*	*	*	*
180	Streak-throated Swallow	*Petrochelidon fluvicola*	*	*		
181	Wire-tailed Swallow	*Hirundo smithii*	*	*	*	
	53. Family Pycnonotidae (bulbuls)					
182	Red-vented Bulbul	*Pycnonotus cafer*	*	*	*	*
183	Red-whiskered Bulbul	*Pycnonotus jocosus*	*	*	*	*
184	White-browed Bulbul	*Pycnonotus luteolus*	*	*	*	*
185	Yellow-browed Bulbul	*Acritillas indica*	*	*	*	*
	54. Family Phylloscopidae (old world leaf warblers)					
186	Greenish Leaf Warbler (Greenish Warbler)	*Seicercus trochiloides*	*	*	*	
	55. Family Pellorneidae (smaller babblers)					
187	Puff-throated Babbler	*Pellorneum ruficeps*	*	*		
	56. Family Leiothrichidae (babblers, laughing-thrushes and allies)					
188	Jungle Babbler	*Turdoides striata*	*	*	*	*

189	Rufous Babbler	*Argya subrufa*	*	*	*	*
190	Yellow-billed Babbler	*Turdoides affinis*	*	*	*	*
	57. Family Sturnidae (starlings)					
191	Brahminy Starling	*Sturnia pagodarum*	*	*	*	
192	Common Myna	*Acridotheres tristis*	*	*	*	*
193	Jungle Myna	*Acridotheres fuscus*	*	*		*
194	Rosy Starling	*Pastor roseus*	*	*	*	
	58. Family Muscicapidae (chats and flycatchers)					
195	Asian Brown Flycatcher	*Muscicapa dauurica*	*	*		*
196	Indian Robin	*Saxicoloides fulicatus*	*			
197	Malabar Whistling Thrush	*Myophonus horsfieldii*	*	*		
198	Oriental Magpie Robin	*Copsychus saularis*	*	*	*	*
199	Pied Bushchat	*Saxicola caprata*	*	*	*	*
200	Tickell's Blue Flycatcher	*Cyornis tickelliae*	*	*	*	*
	59. Family Turdidae (thrushes)					
201	Orange-headed Thrush	*Geokichla citrina*	*	*	*	*

Appendix XVI
Checklist of Reptiles in Different Ecosystems of Kavvayi River Basin

SI No.	Scientific Name	Common Name	SG	KM	KU	IT
	Order TESDUDINES					
	Family EMYDIDAE					
1	*Melanochelys trijuga* (Schweigger)	Indian Pond Terrapin	*	*	*	
	Family TESTUDINIDAE					
2	*Lissemys punctata* (Lacépède, 1788)	Indian Flap-shelled Turtle	*	*	*	
	Order SQUAMATA					
	Suborder SAURIA					
	Family GEKKONIDAE					
3	*Hemidactylus brookii* (Gray,1845)	Spotted House Gecko	*	*		*
4	*Hemidactylus frenatus* (Schlegel,1836)	Tic-Ticky House Gecko	*	*		
	Family AGAMIDAE					
5	*Calotes versicolor* (Daudin,1802)	Indian Garden Lizard	*	*	*	*
6	*Calotes rouxii* (Duméril & Bibron, 1837)	Roux's Forest Lizard	*	*		*
	Family SCINCIDAE					
7	*Eutropis*	Common	*	*	*	*

	carinata(Schneider, 1801)	Indian Skink				
8	*Eutropis macularia* (Blyth, 1853)	Bronze Skink	*	*	*	*
9	*Lygosoma punctata* (Gmelin, 1799)	Common snake skink	*	*		*
10	*Ristella* species		*	*		
	Family LACERTIDAE					
11	*Ophisops* species		*	*		
	Family VARANIDAE					
12	*Varanus bengalensis* (Daudin,1802)	Indian Monitor Lizard	*	*	*	*
	Suborder SERPENTES					
	Family TYPHLOPIDAE					
13	*Indotyphlops braminus* (Daudin,1803)	Common Blind Snake	*	*		
14	*Grypotyphlops acutus* (Dumeril & Bibron,1844)	Beaked Blind Snake	*	*		
	Family PYTHONIDAE					
15	*Python molurus* (Linnaeus, 1758)	Indian Rock Python	*	*	*	*
	Family ERYCIDAE					
16	*Eryx conicus* (Schneider, 1801)	Common Sand Boa	*	*		*
	Family COLUBRIDAE					
17	*Ptyas mucosa*(Linnaeus,1758)	Indian Rat Snake	*	*	*	*
18	*Oligodon arnensis* (Shaw,1802)	Common Kukri Snake	*	*		*
19	*Oligodon taeniolatus* (Jerdon, 1853)	Russell's Kukuri Snake	*	*		*
20	*Dendrelaphis tristis* (Daudin,1803)	Common Indian Bronze-back	*	*	*	*
21	*Lycodon aulicus* (Linnaeus,1754)	Common Wolf Snake	*	*	*	
22	*Ahaetulla nasuta* (Bonnaterre,1790)	Green Vine Snake	*	*	*	*
23	*Boiga trigonata* (Schneider, 1802)	Common Cat Snake	*	*		*
	Family NATRICIDAE					
24	*Xenochrophis piscator* (Schneider,1799)	Checkered Keelback	*	*	*	*
	Family ELAPIDAE					
25	*Cerberus rynchops* (Schneider, 1799)	Dog-faced water snake	*			
26	*Bungarus caereleus*	Common Krait	*	*	*	*

	(Schneider)					
27	*Naja naja* (Linnaeus.)	Indian Kobra	*	*	*	*
	Family VIPERIDAE					
28	*Daboia russelii* (Shaw & Nodder, 1797)	Russel's Viper	*	*	*	*
29	*Echis carinatus* (Schneider, 1801)	Saw-scaled Viper	*			*

Appendix XVII

Checklist of Amphibians in Different Ecosystems of Kavvayi River Basin

Sl No.	Species Name	Common Name	SG	KM	KU	IT
	Class: AMPHIBIA Gray					
	Order : ANURA Fischer von Waldheim					
	Family: BUFONIDAE Gray					
	Genus ***Duttaphrynus***, Frost, Grant, Faivovich, Bain, Haas, Hddad, Desa, Channing, Wilkinson, Donnellan, Raxworthy, Campbell, Blotto, Moler, Drewes, Nussbaum, Lynch, Green and Wheeler					
1	*Duttaphrynus melanostictus* (Schneider, 1799)	Common Indian Toad	*	*	*	*
	Family: DICROGLOSSIDAE Anderson					
	Genus ***Euphlyctis*** Fitzinger					
2	*Euphlyctis cyanophlyctis* (Schneider, 1799)	Skittering Frog	*	*	*	*
3	*Euphlyctis hexadactylus* (Lesson, 1834)	Indian Pond Frog	*	*	*	*
4	*Euphlyctis aloysii* Joshy, Alam, Kurabayashi, Sumida & Kuramoto, 2009	Aloysius Pond Frog	*			
	Genus ***Hoplobatrachus*** Peters					
5	*Hoplobatrachus tigerinus* (Daudin, 1803)	Indian Bullfrog	*	*	*	*
	Genus ***Fejervarya*** Dubois, Ohler and Biju					
6	*Fejervarya sahyadris* Dubois, Ohler & Biju, 2001	Fejervarya Frog	*	*	*	*
	Genus ***Sphaerotheca*** Gunther					
7	*Sphaerotheca breviceps* (Schneider, 1799)	Indian Burrowing Frog	*	*	*	*

	Genus ***Fejervarya*** Howladar					
8	*Fejervarya rufescens* (Jerdon, 1853)	Rufescent Burrowing Frog	*	*	*	*
9	*Fejervarya brevipalmata* (Peters, 1871)	Short-webbed Frog	*	*		
	Family: MICROHYLIDAE Gunther					
	Genus ***Kaloula***Gray					
10	*Kaloula taprobanica* Parker, 1934	Painted Frog	*			
	Genus ***Microhyla*** Tschudi					
11	*Microhyla ornata* (Dumeril & Bibron,1841)	Ornate Narrow-mouthed Frog	*	*	*	*
12	*Microhyla rubra* (Jerdon, 1854)	Reddish Narrow-mouthed Frog	*	*	*	*
13	*Microhyla spp.*	Narrow-mouthed Frog	*		*	*
	Genus ***Ramanella*** Rao and Ramanna					
14	*Ramanella variegata* (Stoliczka, 1872)	Variegated Ramanella	*			
	Family: RANIDAE Rafinesque					
	Genus ***Hylarana***Tschudi					
15	*Hylarana malabarica* (Tschudi, 1838)	Fungoid Frog	*			
	Family: RHACOPHORIDAE Hoffman					
	Genus ***Polypedates***Tschudi					
16	*Polypedates maculatus*(Gray, 1834)	Common Indian Tree Frog	*	*		*
17	*Polypedates occidentalis* Das & Dutta, 2006	Charpa Tree frog	*	*		
	Genus ***Pseudophilautus***Laurent					
18	*Pseudophilautus wynaadensis* (Jerdon,1854)	Jerdon's Bush Frog	*	*		*
	Genus ***Rhacophorus*** Kuhl and Van Hasselt					
19	*Rhacophorus malabaricus* Jerdon, 1870	Malabar Gliding Frog	*	*		
	Order : GYMNOPHIONA Muller					
	Family: ICHTHYOPHIDAE Taylor					
	Genus ***Uraeotyphlus*** Peters					
20	*Uraeotyphlus spp.*	Caecilian	*			

Appendix XVIII

Species distribution pattern in wetlands of Lateritic hills of Kavvayi River Basin

Sl. No.	Name	Wetland Type			Status and Occurrence	
		SEP	SP	PP		
1	*Alternanthera sessilis* (L.) R. Br. ex.	*	*			all month
2	*Ammannia baccifera* L.	*				Aug-Sep
3	*Burmannia coelestis* D. Don, Prodr.	*	*			Sep-Oct
4	*Commelina diffusa* Burm. f.	*				Jun-Jul
5	*Commelina erecta*L.	*				Jun-Jul
6	*Commelina wightii*Raiz.	*			E	Jun-Jul
7	*Cyanotis axillaris* (L.) D. Don,	*				Jul-Aug
8	*Cyanotis burmanniana* Wight, Ic	*			V	Jul-Aug
9	*Cyanotis cristata*(L.) D. Don.	*				Jun-Jul
10	*Cyperus distans* L.	*				Sep-Oct
11	*Cyperus malaccensis* Lam.	*				Aug-Sep
12	*Cyperus rotundus* L	*				Sep-Oct
13	*Dactyloctenium aegyptium* (L.) P.	*				all months
14	*Dopatrium junceum* (Roxb.) Buch.-	*	*	*		Jul-Aug
15	*Drosera indica* L.	*				Jul-Aug
16	*Eclipta prostrata* (L.) L.	*	*			all months
17	*Eleocharis retroflexa* (Poir.)	*				Sep-Oct
18	*Eriocaulon cuspidatum* Dalz.	*	*	*	En	Aug-Sep
19	*Eriocaulon heterolepis* Steud.	*	*	*	E	Jun-Jul
20	*Eriocaulon madayiparense* Swapna,	*			E	Jun-Jul
21	*Eriocaulon robustobrownianum*	*			E	Jul-Aug
22	*Eriocaulon sexangulare* L.	*				Sep-Oct
23	*Eriocaulon stellulatum* Koernicke,	*	*	*	E	Jul-Aug
24	*Eriocaulon truncatum* Bunch.	*				Jun-Jul
25	*Eriocaulon xeranthemum* Mart.	*				Jun-Jul
26	*Hydrilla verticillata*(L.f.) Royle	*	*	*		all months
27	*Impatiens diversifolia* Wall. ex Wight	*	*		E	Jun-Jul
28	*Kyllinga brevifolia* Rottb.	*	*			Jun-Jul
29	*Kyllinga bulbosa* P. Beauv.	*	*			Jul-Aug
30	*Limnophila repens*(Benth.) Benth.	*	*			Jul-Aug
31	*Lindernia ciliata* (Colsm.) Pennell	*				Jun-Jul
32	*Lindernia crustacea* (L.) F.v. Muell.	*	*	*		Jul-Aug
33	*Lindernia hyssopioides* Lindernia	*	*	*		Jul-Aug
34	*Lindernia oppositifolia* (Retz.)	*				Jun-Jul

35	*Lindernia parviflora* (Roxb.) Haines.	*				Jul-Aug
36	*Lindernia rotundifolia* (L.) Mukerjee.	*	*			Jul-Aug
37	*Lindernia viscosa* (Hornem.) Merr.	*	*			Jun-Jul
38	*Ludwigia hyssopifolia* (G. Don)	*	*			Jul-Aug
39	*Ludwigia octovalvis* (Jacq.) Raven.	*	*			Jul-Aug
40	*Ludwigia perennis* L.	*	*			all months
41	*Murdannia crocea* (Griff.) Faden	*	*		E	Jul-Aug
42	*Murdannia lanuginosa* (Wall. ex	*	*		V	Sep-Oct
43	*Murdannia nudiflora* (L.) Brenan.	*	*			Aug-Sep
44	*Murdannia semiteres* (Dalz.) Sant.	*			E	Sep-Oct
45	*Myriophyllum aquaticum* (Vell.)		*	*		Jul-Aug
46	*Nymphoides indica* (L.) O.Ktze.	*		*		all months
47	*Nymphoides krishnakesara* Joseph &	*	*	*	E	Jul-Aug
48	*Oldenlandia diffusa* (Willd.) Roxb.	*	*			Jul-Aug
49	*Ottelia alismoides* (L.) Pers.		*	*		Jun-Jul
50	*Paspalum canarae* (Steud.) Veldk.	*			E	Sep-Oct
51	*Paspalum conjugatum*Berg.	*				all months
52	*Pogostemon deccanensis* (Panigrahi)	*	*	*	E	Aug-Sep
53	*Rotala malabarica*Pradeep, Joseph &	*	*	*	E	Jun-Jul
54	*Rotala malampuzhensis* R.V. Nair ex	*	*	*	E	Jun-Jul
55	*Rotala rosea* (Poir.) Cook.	*		*		Jun-Jul
56	*Sacciolepis interrupta* (Willd.) Stapf.	*	*			all months
57	*Sagittaria guayanensis* HBKssp.	*		*		Jul-Aug
58	*Utricularia cecilii* Taylor, Proc.	*	*	*	E	Jul-Aug
59	*Utricularia graminifolia* Vahl, Enum.	*	*			Jul-Aug
60	*Utricularia reticulata*Smith, Exot.	*	*			Jul-Aug
61	*Utricularia striatula* Smith, Res.	*	*			Jul-Aug
62	*Xyris indica* L.	*	*			Jul-Aug
63	*Xyris pauciflora* Willd.	*	*			Jul-Aug

SEP = Small ephemeral pools, SP=Seasonal ponds, PP=Permanent pools; E=Endemic, V=Vulnerable, En=Endangered

Appendix XIX

Species distribution pattern in different microhabitats of Lateritic hills of Kavvayi River Basin

No.	Species Name	Microhabitats									Presence of Species*
		B	CEC	EFV	ERS	RCF	SEP	SFD	SRA	TCTA	
1	*Abrus precatorius* L.									*	1
2	*Abutilon indicum* (L.) Sweet.									*	1
3	*Acacia caesia* (L.) Willd.									*	1
4	*Acacia pennata* (L.) Willd.									*	1
5	*Acalypha indica* L.									*	1
6	*Acalypha* paniculata Miq.									*	1
7	*Acampae praemorsa* (Roxb.) Blatt. & McCann.									*	1
8	*Acanthospermum hispidum* DC.									*	1
9	*Achyranthes aspera* L.									*	1
10	*Achyranthes bidentata* Blume.									*	1
11	*Aegle marmelos* (L.) Correa.									*	1
12	*Aeschynomene americana* L.									*	1
13	*Aeschynomene aspera* L.									*	1
14	*Aganosma cymosa* (Roxb.) G. Don									*	1
15	*Ageratum conyzoides* (L.) L.									*	1
16	*Aglaia elaeagnoidea* (A.Juss.) Benth.									*	1
17	*Alangium alpinum* (C.B.Clarke) W.W.Sm. & Cave.									*	1
18	*Allamanda cathartica* L.									*	1
19	*Alloteropsis cimicina* (L.) Stapf .			*							1

20	*Alloteropsis semialata* (R.Br.) Hitchc.			*							1
21	*Alseodaphne semecarpifolia* Nees .									*	1
22	*Alstonia scholaris* (L.) R. Br.									*	1
23	*Alternanthera bettzickiana* (Regel) G.Nicholson.									*	1
24	*Alternanthera brasiliana* (L.) Kuntze.									*	1
25	*Alysicarpus bupleurifolius* (L.) DC.									*	1
26	*Amaranthus spinosus* L.									*	1
27	*Amaranthus viridis* L.									*	1
28	*Amorphophallus paeoniifolius* (D ennst.) Nicolson.									*	1
29	*Ampelocissus latifolia* (Roxb.) Planch.									*	1
30	*Anamirta cocculus* (L.) Wight & Arn.									*	1
31	*Ancistrocladus heyneanus* Wall. ex J.Graham.									*	1
32	*Anisomeles indica* (L.) Kuntze.									*	1
33	*Antidesma acidum* Retz.									*	1
34	*Antidesma bunius* (L.) Spreng.									*	1
35	*Apluda mutica* L.									*	1
36	*Apocopis mangalorensis* (Hochst. ex Steud.) Henrard.									*	1
37	*Ariopsis peltata* Nimmo.	*				*					2
38	*Aristolochia indica* L.									*	1
39	*Asystasia dalzelliana* Santapau									*	1

40	*Asystasia gangetica* (L.) T.Anderson									*	1
41	*Atlantia wightii* Tanaka.									*	1
42	*Axonopus compressus* (Sw.) P.Beauv.									*	1
43	*Azadirachta indica* A.Juss.									*	1
44	*Barleria cristata* L.									*	1
45	*Barleria prionitis* L.									*	1
46	*Begonia crenata* Dryand	*	*			*					3
47	*Begonia integrifolia* Dalzell	*									1
48	*Begonia malabarica* Lam.	*									1
49	*Begonia trichocarpa* Dalzell.	*									1
50	*Benkara malabarica* (Lam.) Tirveng.									*	1
51	*Bhidea fischeri* Sreek. & B.V. Shetty.									*	1
52	*Bidnes pilosa* (Blume) Sherff.									*	1
53	*Biophytum reinwardtii* (Zucc.) Klotzsch.			*							1
54	*Blumea membranacea* DC.									*	1
55	*Blumea oxyodonta* DC.									*	1
56	*Blyxa octandra* (Roxb.) Planch. ex Thwaites.									*	1
57	*Boerhavia diffusa* L.								*		1
58	*Bombax ceiba* L.									*	1
59	*Brachiaria reptans* (L.) C.A.Gardner & C.E.Hubb.									*	1
60	*Breynia retusa* (Dennst.) Alston.								*		1
61	*Breynia vitis-idaea* (Burm.f.) C.E.C.Fisch.									*	1
62	*Bridelia retusa* (L.) A.Juss.									*	1

63	*Bridelia stipularis* (L.) Blume.									*	1
64	*Bulbophyllum neilgherrense* Wight.									*	1
65	*Burmannia coelestis* D.Don.									*	1
66	*Butea monosperma* (Lam.) Taub.									*	1
67	*Cajanus scarabaeoides* (L.) Thouars.									*	1
68	*Callicarpa tomentosa* (L.) L.									*	1
69	*Calopogonium mucunoides* Desv.									*	1
70	*Calotropis gigantea* (L.) Dryand.									*	1
71	*Calycopteris floribunda* (Roxb.) Lam. ex Poir.									*	1
72	*Canavalia gladiata* (Jacq.) DC.									*	1
73	*Canscora diffusa* (Vahl) R.Br. ex Roem. & Schult.									*	1
74	*Canscora pauciflora* Dalzell.									*	1
75	*Cansjera rheedei* J.F.Gmel.									*	1
76	*Canthium coromandelicum* (Bur m.f.) Alston.									*	1
77	*Capparis rheedei* DC.									*	1
78	*Capparis sepiaria* L.									*	1
79	*Capparis zeylanica* L.									*	1
80	*Capsicum annuum* L.									*	1
81	*Capsicum frutescens* L.									*	1
82	*Caralia brachiatia* (Lour.) Merr.									*	1
83	*Cardiospermum halicacabum* L.								*		1
84	*Careya arborea* Roxb.									*	1
85	*Cassia fistula* L.									*	1
86	*Catunaregam spinosa (Thunb.)* Tirveng.									*	1

87	Celosia argentea L.									*	1
88	*Cinnamomum malabatrum* (Burm .f.) J.Presl.									*	1
89	*Cissus latifolia* Lam.									*	1
90	*Cleome rutidosperma* DC.									*	1
91	*Cleome viscosa* L.									*	1
92	*Clerodendrum infortunatum* L.								*	*	2
93	*Clitoria ternatea* L.								*	*	2
94	*Commelina benghalensis* L.								*		1
95	*Commelina diffusa* Burm.f.			*	*			*	*		4
96	*Commelina erecta* L.			*	*			*	*	*	5
97	*Connarus wightii* Hook.f.								*	*	2
98	*Cosmos caudatus* Kunth								*	*	2
99	*Croton roxburghii* Wall.								*	*	2
100	*Curculigo orchioides* Gaert.								*		1
101	*Cyclea peltata* (Lam.) Hook.f. & Thomson.								*	*	2
102	*Cymbopogon citratus* (DC.) Stapf.								*	*	2
103	*Cynodon dactylon* (L.) Pers.								*	*	2
104	*Dalbergia horrida* (Dennst.) Mabb.								*	*	2
105	*Delonix regia* (Hook.) Raf.									*	1
106	*Derris scandens* (Roxb.) Benth.									*	1
107	*Desmodium gangeticum* (L.) DC.									*	1
108	*Desmodium heterophyllum* (Willd .) DC.			*							1
109	*Desmodium triflorum* (L.) DC.			*							1
110	*Dopatrium junceum* (Roxb.) Buch.-Ham. ex Benth.						*				1

111	*Drosera indica* L.			*							1
112	*Eragrostis nigra* Nees ex Steud.			*					*		2
113	*Eragrostis unioloides* (Retz.) Nees ex Steud.			*					*		2
114	*Eriocaulon cuspidatum* Dalzell.			*	*	*	*	*	*		6
115	*Eriocaulon heterolepis* Steud.		*	*	*	*	*	*	*		7
116	*Eriocaulon lanceolatum* Miq. ex Körn							*			1
117	*Eriocaulon lanceolatum* Miq. ex Körn.				*						1
118	*Eriocaulon madayiparense.*		*	*			*				3
119	*Eriocaulon parviflorum* (Fyson) R.Ansari & N.P.Ba!akr.				*			*			2
120	*Eriocaulon quinquangulare* L.		*	*							2
121	*Eriocaulon robustobrownianum* Ruhland.		*	*			*	*			4
122	*Eriocaulon sexangulare* L.			*			*	*	*		4
123	*Eriocaulon stellulatum* Körn.			*			*	*	*		4
124	*Eriocaulon truncatum* Buch.-Ham. ex Mart.			*			*	*			3
125	*Eriocaulon xeranthemum* Mart.			*			*	*	*		4
126	*Erycibe paniculata* Roxb.									*	1
127	*Erythrina variegata* L.									*	1
128	*Evolvulus alsinoides* (L.) L.								*		1
129	*Ficus arnottiana* (Miq.) Miq.									*	1
130	*Ficus benghalensis* L.									*	1
131	*Ficus callosa* Willd.									*	1
132	*Ficus exasperata* Vahl .									*	1
133	*Ficus religiosa* L.									*	1
134	*Flacourtia indica* (Burm. f.) Merr.								*		1

135	*Flueggea virosa* (Roxb. ex Willd.) Royle .									*	1
136	*Gloriosa superba* L.									*	1
137	*Glycosmis mauritiana* (Lam.) Tanaka									*	1
138	*Glycosmis pentaphylla* (Retz.) DC.									*	1
139	*Grewia nervosa* (Lour.) Panigrahi .									*	1
140	*Gymnema sylvestre* (Retz.) Schult.								*	*	2
141	*Habenaria longicorniculata* J.Graham .							*	*		2
142	*Habenaria periyarensis* Sasidh., K.P.Rajesh & Augustine.							*	*		2
143	*Haplanthodes nilgherrensis* (Wight) R.B.Majumdar.									*	1
144	*Heliotropium indicum* L.									*	1
145	*Heliotropium keralense* Sivarajan & Manilal.									*	1
146	*Heliotropium marifolium* J.König ex Retz.			*		*		*	*		4
147	*Hemidesmus indicus* (L.) R. Br. ex Schult.								*	*	2
148	*Hippocratea arnottiana* Wight.									*	1
149	*Holarrhena pubescens* Wall.								*		1
150	*Holigarna arnottiana* Hook.f.									*	1
151	*Hopea fastigiata* (Griseb.) C.B.Clarke									*	1
152	*Hopea ponga* (Dennst.) Mabb.									*	1

153	*Hugonia mystax* Cav.									*	1
154	*Hydnocarpus pentandrus* (Buch.-Ham.) Oken.									*	1
155	*Hyptis suaveolens* (L.) Poit.								*	*	2
156	*Ichnocarpus fruiescens* (L.) W.T.Aiton								*		1
157	*Impatiens dasysperma* Wight.			*				*	*		3
158	*Impatiens diversifolia* B.Heyne.	*	*						*		3
159	*Impatiens minor* (DC.) S.M. Almeida.	*	*	*		*		*	*		6
160	*Impatiens scapiflora* B.Heyne.	*									1
161	*Ipomoea cairica* (L.) Sweet.									*	1
162	*Ipomoea hederifolia* L.									*	1
163	*Ixora brachiata* Roxb.									*	1
164	*Ixora coccinea* L.									*	1
165	*Jasminum azoricum* L.									*	1
166	*Jasminum malabaricum* Wight									*	1
167	*Jatropha curcas* L.									*	1
168	*Justicia adhatoda* L.									*	1
169	*Justicia ekakusuma* Pradeep & Sivar.									*	1
170	*Justicia japonica* Thunb.			*							1
171	*Kyllinga nemoralis* (J.R.Forst. & G.Forst.) Dandy ex Hutch. & Dalziel.					*					1
172	*Lannea coromandelica* (Houtt.) Merr.									*	1
173	*Lantana camara* L.								*	*	2
174	*Leea indica* (Burm. f.) Merr.									*	1

175	*Leea macrophylla* Roxb. ex Hornem.									*	1
176	*Lepidagathis keralensis* Madhus. &N.P.Singh .			*	*	*		*		*	5
177	*Leucas aspera* (Willd.) Link .								*	*	2
178	*Leucas biflora* (Vahl) R.Br. ex Sm.									*	1
179	*Lindernia hyssopoides* (L.) Haines.									*	1
180	*Mallotus philippensis* (Lam.) Müll.Arg.									*	1
181	*Mallotus repandus* (Willd.) Müll.Arg.									*	1
182	*Mangifera indica* L.									*	1
183	*Melastoma malabathricum* L.									*	1
184	*Memecylon randerianum* SM & MR Almeida									*	1
185	*Memecylon umbellatum* Burm. f.								*	*	2
186	*Merremia tridentata* (L.) Hallier f.									*	1
187	*Mimusops elengi* L.									*	1
188	*Mitracarpus hirtus* (L.) DC.									*	1
189	*Mollugo pentaphylla* L.									*	1
190	*Mukia maderaspatana* (L.) M.Roem.									*	1
191	*Murdannia crocea* (Griff.) Faden .				*			*			2
192	*Murdannia nudiflora* (L.) Brenan.			*							1
193	*Murdannia semiteres* (Dalzell) Santapau.			*							1
194	*Naregamia alata* Wight & Arn.							*	*		2

195	*Neanotis hohenackeri* P.Daniel & Vajr.			*	*			*	*		4
196	*Neanotis rheedei* (Wight & Arn.) W.H.Lewis.				*	*		*			3
197	*Neanotis tubulosa* (G.Don) Mabb.					*					1
198	*Neuropeltis malabarica* Ooststr.									*	1
199	*Nymphoides indica* (L.) Kuntze.						*				1
200	*Nymphoides krishnakesara* K.T.Joseph & Sivar.						*				1
201	*Oldenlandia corymbosa* L.									*	1
202	*Oldenlandia corymbosa* L.					*					1
203	*Olea dioica* Roxb.									*	1
204	*Parasopubia delphiniifolia* (L.) H.-P.Hofm. & Eb.Fisch.			*				*	*		3
205	*Paspalum conjugatum* P.J.Bergius.			*				*	*		3
206	*Paspalum scrobiculatum* L.			*				*	*		3
207	*Phyla nodiflora* (L.) Greene.									*	1
208	*Piper nigrum* L.									*	1
209	*Plumbago zeylanica* L.									*	1
210	*Pogostemon deccanensis* (Panigrahi) Press.							*	*	*	3
211	*Pogostemon quadrifolius* (Benth.) F.Muell.									*	1
212	*Polyalthia korintii* (Dunal) Benth. & Hook.f. ex Hook.f. & Thoms.								*	*	2
213	*Polycarpaea corymbosa* (L.) Lam.			*	*	*		*			4
214	*Polygala chinensis* L.			*							1

215	*Polygala elongata* Klein ex Willd.			*						*	2
216	*Pongamia pinnata* (L.) Pierre.								*	*	2
217	*Pseuderanthemum malabaricum* Gamble.								*	*	2
218	*Pterospermum diversifolium* Blume, Bijdr.								*	*	2
219	*Rotala malabarica* Pradeep, K.T.Joseph & Sivar.						*				1
220	*Rotala malampuzhensis* R.V. Nair ex Cook.						*	*	*		3
221	*Rotala rosea* (Poir.) C.D.K. Cook ex H. Hara .						*				1
222	*Samanea saman* (Jacq.) Merr.								*	*	2
223	*Santalum album* L.								*	*	2
224	*Sapindus trifoliatus* L.								*	*	2
225	*Schleichera oleosa* (Lour.) Merr.								*	*	2
226	*Scoparia dulcis* L.								*	*	2
227	*Sesamum indicum* L.								*	*	2
228	*Sesamum radiatum* Schumach. & Thonn.								*	*	2
229	*Sida acuta* Burm.f.								*	*	2
230	*Sida cordifolia* L.								*	*	2
231	*Sida rhombifolia* L.								*	*	2
232	*Smilax zeylanica* L.								*	*	2
233	*Solanum torvum* Sw.								*	*	2
234	*Stachytarpheta jamaicensis* (L.) Vahl.								*	*	2
235	*Striga angustifolia* (D. Don) C.J. Saldanha.			*				*			2
236	*Striga asiatica* (L.) Kuntze			*				*			2

237	*Striga gesnerioides* (Willd.) Vatke			*				*	*		3
238	*Strychnos nux-vomica* L.									*	1
239	*Symphorema involucratum* Roxb.									*	1
240	*Synedrella nodiflora* (L.) Gaertn.									*	1
241	*Syzygium caryophyllatum* (L.) Alston.									*	1
242	*Syzygium cumini* (L.) Skeels.									*	1
243	*Tabernaemontana alternifolia* L.									*	1
244	*Tamarindus indica* L.									*	1
245	*Tectona grandis* L.f.									*	1
246	*Terminalia bellirica* (Gaertn.) Roxb.									*	1
247	*Tinospora cordifolia* (Willd.) Miers .									*	1
248	*Trema orientalis* (L.) Blume.									*	1
249	*Trianthema portulacastrum* L.									*	1
250	*Tridax procumbens* (L.) L.									*	1
251	*Tylophora indica* (Burm. f.) Merr.									*	1
252	*Utricularia aurea* Lour.			*				*	*		3
253	*Utricularia caerulea* L.		*	*				*	*		4
254	*Utricularia cecilii* P.Taylor.	*	*	*	*		*	*	*		7
255	*Utricularia graminifolia* Vahl		*	*			*	*	*		5
256	*Utricularia reticulata* Sm.			*				*			2
257	*Utricularia striatula* Sm.			*							1
258	*Utricularia uliginosa* Vahl.			*							1
259	*Uvaria narum* (Dunal) Wall. ex Hook.f. & Thoms.									*	1
260	*Vernonia cinerea* (L.) Less.									*	1

261	*Vitex negundo* L.									*	1
262	*Wrightia tinctoria* R.Br.									*	1
263	*Ziziphus oenopolia* (L.) Mill.								*	*	2

*indicates the total number of microhabitats where particular species recorded

EFV=Ephemeral flush Vegetation, ERS=Exposed rock Surfaces, RCF=Rock crevices/fissures, SEP=Small ephemeral pools, SFD=Soil-filled depressions, TCTA=Tree cover and tree associated, B=Boulders, CEC=Crust edges or cliffs, SRA=Soil-rich Areas.

Appendix XX

Checklist of Butterflies and Identified Host plants in Kavvayi River Basin

Sl No.	Scientific Name of Butterfly	Common Name of Butterfly	Scientific name of Host plant
	HESPERIIDAE		
1	*Badamia exclamationis*	Brown Awl	*Terminalia bellirica*
2	*Ampittia dioscorides*	Bush Hopper	*Oryza sativa*
3	*Iambrix salsala*	Chestnut Bob	*Grasses*
4	*Hasora chromus*	Common Banded Awl	*Pongamia pinnata*
			Ricinus communis
5	*Taractrocera maevius*	Common Grass Dart	*Grasses*
6	*Sarangesa dasahara*	Common Small Flat	*Asystasia spp.*
7	*Psolos fuligo*	Coon	*Zingiber sp.*
8	*Pseudocoladenia dan*	Fulvious Pied Flat	*Achyranthus sp.*
9	*Gangara thyrsis*	Giant Redeye	*Caryota urens*
			Cocos nucifera
0	*Udaspes folus*	Grass Demon	*Zingiber sp.*
			Curcuma sp.
1	*Suastus gremius*	Indian Palm Bob	*Caryota urens*
			Cocos nucifera
2	*Notocrypta curvifascia*	Restricted Demon	*Zingiber sp.*
			Costus speciosus
			Curcuma sp.
3	*Borbo cinnara*	Rice Swift	*Cymbopogon sp.*
			Eragrotis sp.
			Ischaemum sp
			Oryza sativa
			Pennisetum sp
4	*Sarangesa purendra*	Spotted Small Flat	*Asystasia spp.*
5	*Tagiades gana*	Suffused Snow Flat	*Dioscorea sp.*
6	*Tagiades litigiosa*	Water Snow Flat	*Dioscorea sp.*
			Smilax sp.
	LYCAENIDAE		
7	*Caleta caleta*	Angled Pierrot	*Ziziphus rugosa*
8	*Surendra quercetorum*	Common Acacia Blue	*Acacia spp.*
9	*Jamides celeno*	Common Cerulean	*Abrus precatorius*
			Pongamia pinnata
			Saraca asoca
			Xylia xylocarpa
0	*Cheritra freja*	Common Imperial	*Cinnamomum sp.*
			Ixora sp.
			Saraca asoca

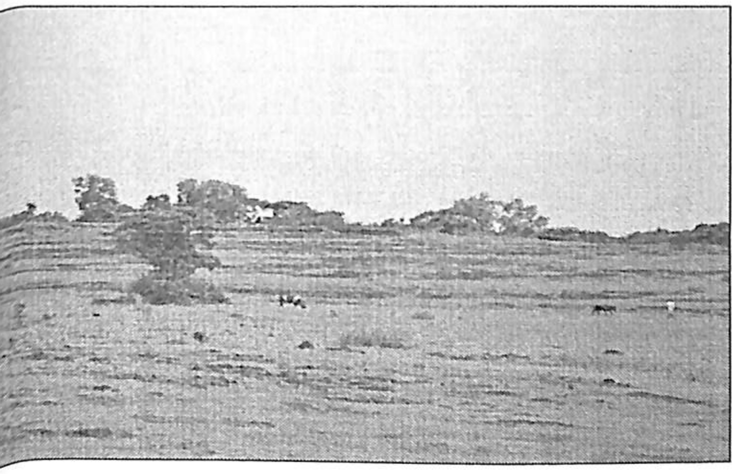
			Xylia xylocarpa
21	*Prosotas nora*	Common Line Blue	*Acacia cathechu*
22	*Castalius rosimon*	Common pierrot	*Ziziphus mauritiana*
			Ziziphus rugosa
23	*Spindasis vulcanus*	Common Sliver Line	*Canthium sp.*
			Ziziphus mauritiana
			Ziziphus rugosa
24	*Jamides bochus*	Dark Cerulean	*Crotalaria spp*
			Pongamia pinnata
			Xylia xylocarpa
25	*Curetis thetis*	Indian Sun Beam	*Abrus precatorius*
			Derris scandens
			Pongamia pinnata
26	*Rathinda amor*	Monkey Puzzle	*Ixora coccinea*
27	*Tajuria cippus*	Peacock Royal	*Dendrophthoe falcate*
28	*Zesius chrysomallus*	Red spot	*Anacardium occidentale*
			Psidium guajava
			Terminalia paniculata
29	*Rapala manea*	Slate Flash	*Acacia spp.*
			Antidesma acidum
			Quisqualis indica
			Ziziphus sp.
30	*Loxura atymnus*	Yamfly	*Discorea pentaphylla*
			Smilax sp.
	NYMPHALIDAE		
31	*Ariadne ariadne*	Angled Castor	*Ricinus communis*
32	*Lethe europa*	Bamboo Treebrown	*Bamboos*
33	*Athyma ranga*	Blackvein Sergeant	*Olea dioica*
34	*Junonia orithya*	Blue Pansy	*Barleria spp.*
35	*Tirumala limniace*	Blue Tiger	*Calotropis gigantean*
			Tylophora indica
			Wattakaka volubilis
36	*Neptis jumbah*	Chestnut-Streaked Sailer	*Bombax ceiba*
			Hibiscus sp.
			Pongamia pinnata
			Xylia xylocarpa
			Ziziphus sp.
37	*Parthenos sylvia*	Clipper	*Tinospora cordifolia*
38	*Moduza procris*	Commander	*Mussaenda frondosa*
39	*Mycalesis perseus*	Common Bushbrown	*Oplismenus compositus*
			Oryza spp.
40	*Ariadne merione*	Common Castor	*Ricinus communis*

41	*Euploea core*	Common Crow	*Ficus arnottiana*
			Ficus benghalensis
			Ficus racemosa
			Ficus religiosa
			Hemidesmus indicus
			Holarrhena pubescens
			Ichnocarpus frutescens
			Nerium oleander
42	*Melanitis leda*	Common Evening Brown	*Cyrtococcum spp.*
			Oryza sativa
			Panicum spp
43	*Ypthima huebneri*	Common Fourring	*Grasses*
44	*Pantoporia hordonia*	Common Lascar	*Acacia intsia*
45	*Phalanta phalantha*	Common Leopard	*Flacourtia sp.*
			Smilax sp.
46	*Elymnias hypermnestra*	Common Palmfly	*Areca catechu*
			Cocos nucifera
47	*Neptis hylas*	Common Sailor	*Bombax ceiba*
			Canavalia gladiate
			Xylia xylocarpa
48	*Hyplolimnas misippus*	Danaid Eggfly	*Abutilon sp.*
			Barleria cristata
			Hibiscus sp.
			Portulaca oleracea
49	*Mycalesis mineus*	Dark-Brand Bushbrown	*Grasses*
50	*Euthalia lubentina*	Gaudy Baron	*Anacardium occidentale*
			Mangifera indica
51	*Parantica aglea*	Glassy Blue Tiger	*Calotropis gigantean*
			Cryptolepis buchanani
			Tylophora indica
52	*Hyplolimnas bolina*	Great Eggfly	*Portulaca oleracea*
			Sida rhombifolia
53	*Tanaecia lepidea*	Grey Count	*Careya arborea*
			Melastoma malathricum
54	*Junonia atlites*	Grey Pansy	*Barleria spp.*
55	*Junonia lemonias*	Lemon Pansy	*Barleria spp.*
56	*Orostriaena medus*	Nigger	*Oryza sativa*
57	*Junonia almana*	Peacock Pansy	*Barleria spp.*
58	*Danaus chrysippus*	Plain Tiger	*Calotropis gigantean*
			Cryptolepis buchanani
59	*Cupha erymanthis*	Rustic	*Flacourtia sp.*
60	*Junonia hierta*	Yellow Pansy	*Barleria spp.*

	PAPILIONIDAE		
61	*Papilio polymnestor*	Blue Mormone	*Citrus sp.*
62	*Graphium sarpedon*	Bluebottle	*Abrus precatoriu*
			Abutilon sp.
			Acacia cathechu
63	*Papilio buddha*	Buddha Peacock	*Zanthoxylum rhetsa*
64	*Papilio clytia*	Common Mime	*Cinnamomum sp.*
65	*Papilio polytes*	Common Mormon	*Aegle marmelos*
			Citrus sp.
			Murraya koenigii
			Murraya koenigii
66	*Pachliopta aristolochiae*	Common Rose	*Aristolochia indica*
67	*Pachliopta hector*	Crimson Rose	*Aristolochia indica*
68	*Papilio demoleus*	Lime butterfly	*Aegle marmelo*
			Citrus sp.
			Murraya koenigii
69	*papilio paris*	Paris Peacock	*Citrus sp.*
			Toddalia asiatica
70	*Papilio helenus*	Red Helen	*Citrus sp.*
			Toddalia asiatica
			Zanthoxylum rhetsa
71	*Triodes minos*	Southern Birdwing	*Aristolochia indica*
72	*Graphium agamemnon*	Tailed Jay	*Annona reticulate*
			Cinnamomum sp.
			Polyalthia longifolia
	PIERIDAE		
73	*Appias lyncida*	Chocolate Albatross	*Capparis spp.*
74	*Catospilia pomona*	Common Emigrant	*Cassia fistula*
75	*Eurema hecabe*	Common Grass Yellow	*Acacia spp.*
			Albizzia spp.
			Caesalpinia spp.
			Cassia fistula
76	*Cepora nerissa*	Common Gull	*Capparis spp.*
77	*Delias eucharis*	Common Jezebel	*Dendrophthoe falcate*
78	*Hebomoia glaucippe*	Giant Orange Tip	*Capparis spp.*
79	*Catospilia pyranthe*	Mottled Emigrant	*Cassia fistula*
80	*Leptosia nina*	Psyche	*Capparis spp.*
			Cleome viscosa
81	*Eurema blanda*	Three spot Grass Yellow	*Albizzia spp.*
			Cassia fistula
			Delonix regia

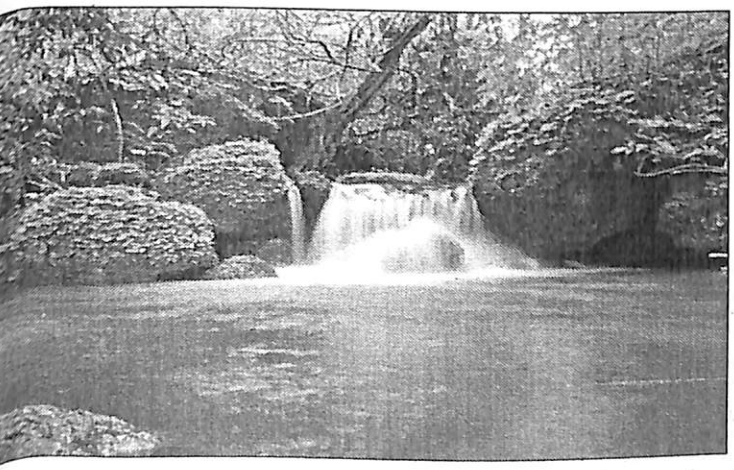
PLATE I
ECOSYSTEMS IN KAVVAYI RIVER BASIN

MADAYIPARA LATERITIC HILLOCK DURING FLOWERING SEASON (August)



LATERITIC HILLOCKS

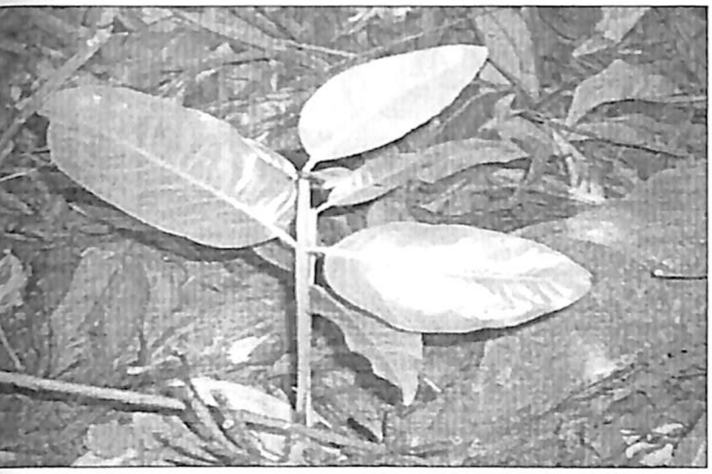
SACRED GROVE



KAANAM

KUTHIRU

PLATE II
SELECTED ANGIOSPERM SPECIES IN KAVVAYI RIVER BASIN

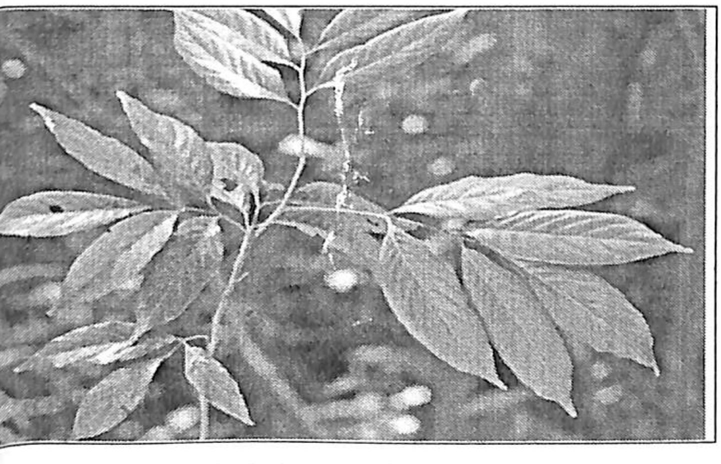


Syzygium travancoricum
Critically Endangered

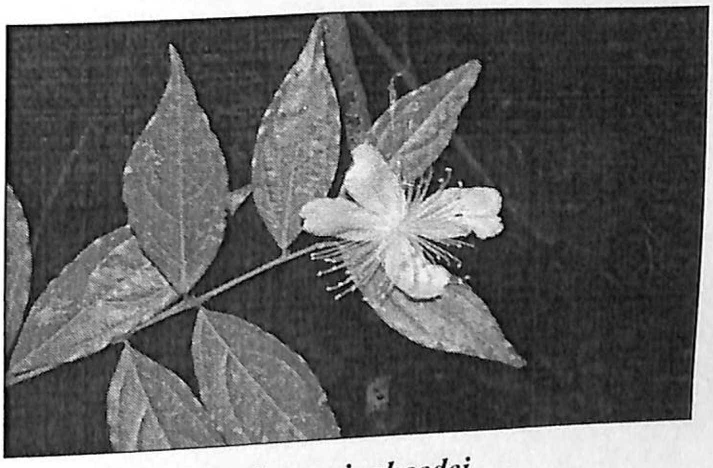
Hopea ponga
Endangered

Saraca asoca
Vulnerable

Hopea parviflora
Vulnerable

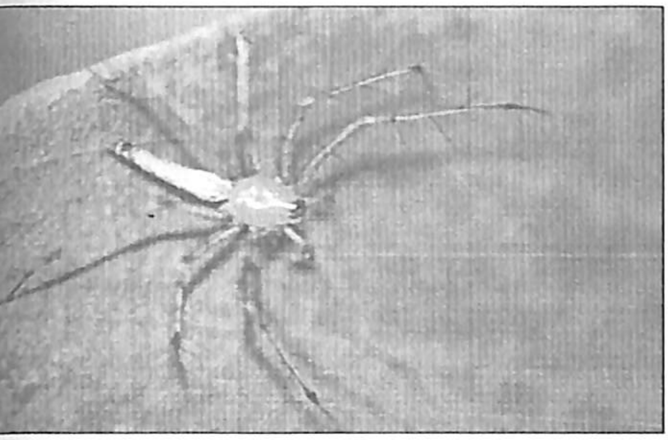


Aglaia lawii
Vulnerable

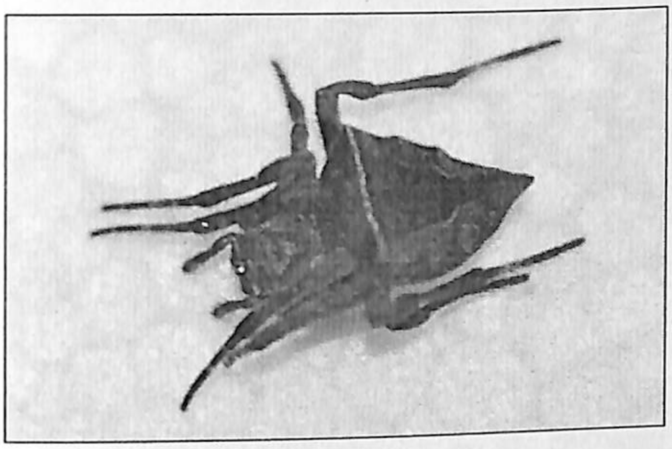


Capparis rheedei
Vulnerable

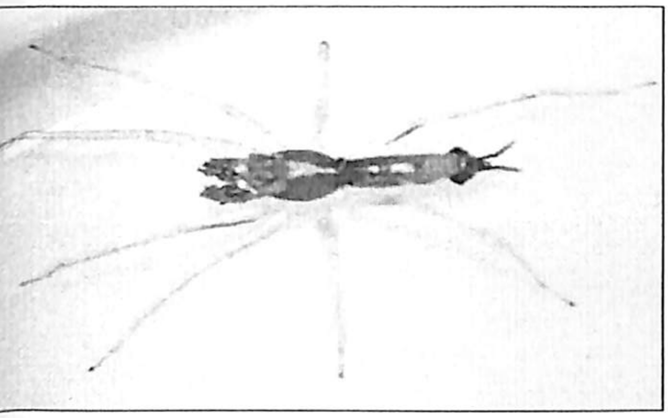
PLATE III
SELECTED SPIDER SPECIES IN KAVVAYI RIVER BASIN



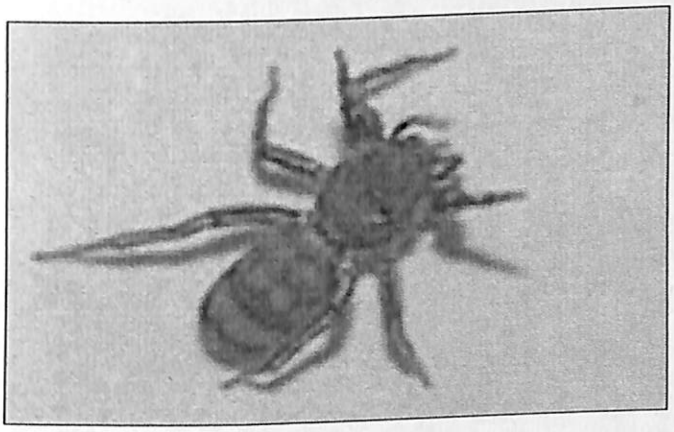
Oxyopes sunandae



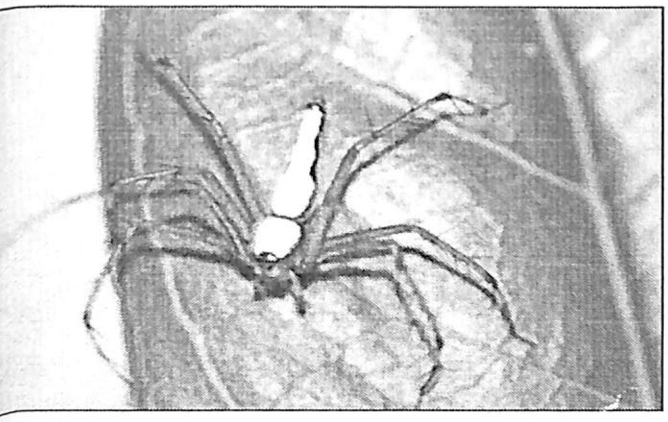
Parawixia dehanni



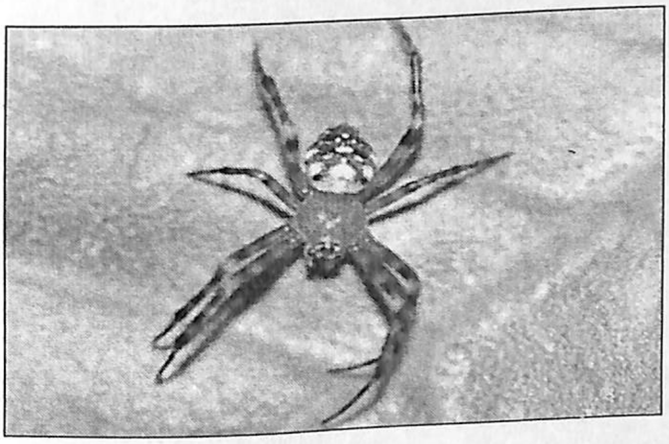
Asemonea tenuipes



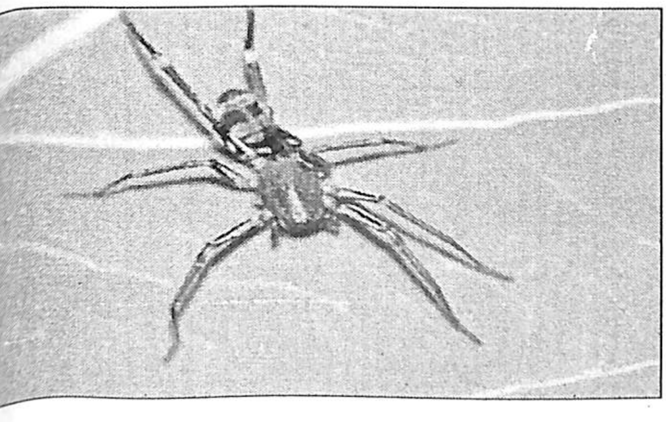
Siler semiglaucus



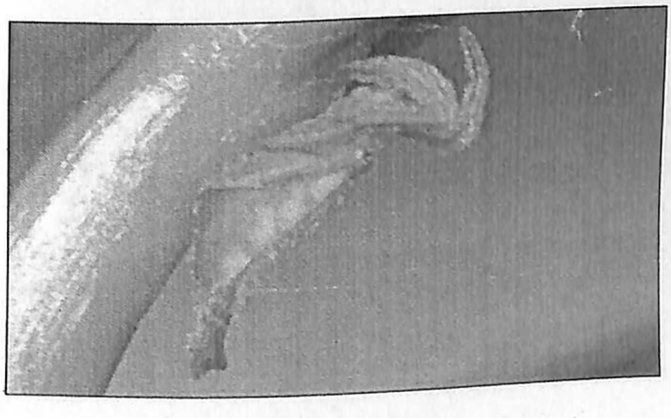
Oxyopes sweta



Gea subarmata

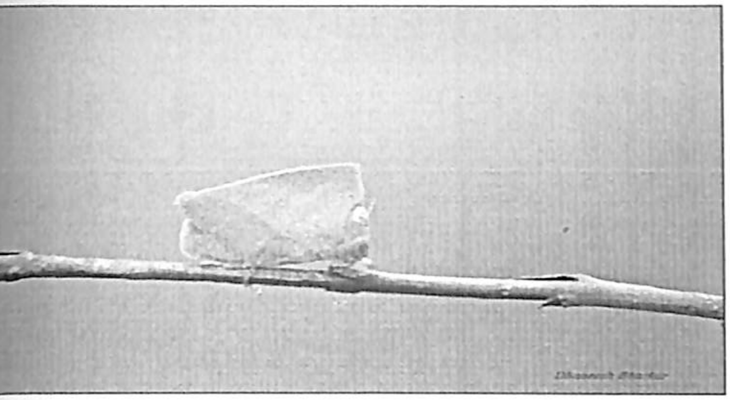


Castianeira zetes



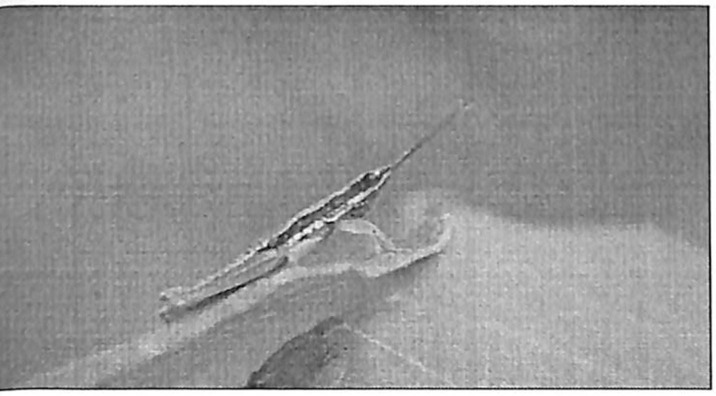
Arachnura angura

PLATE IV
SELECTED GRASSHOPPER SPECIES IN KAVVAYI RIVER BASIN

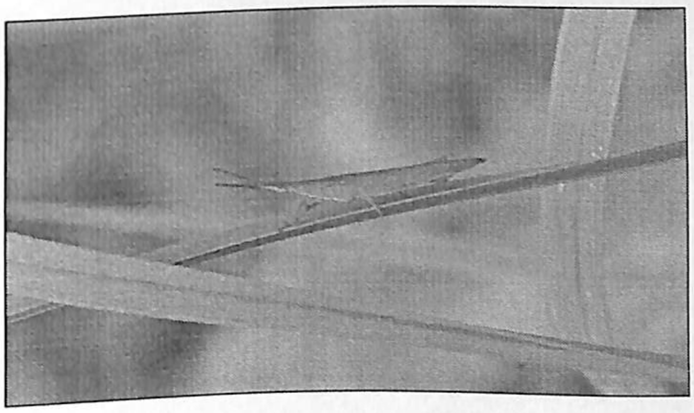


Phyllochoreia ramakrishnai

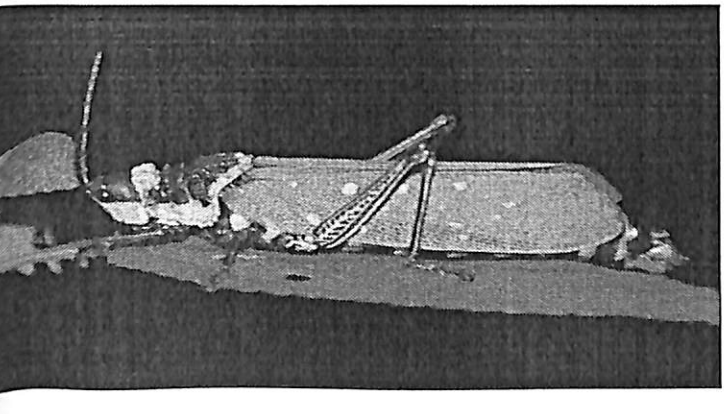
Chrotogonus oxypterus



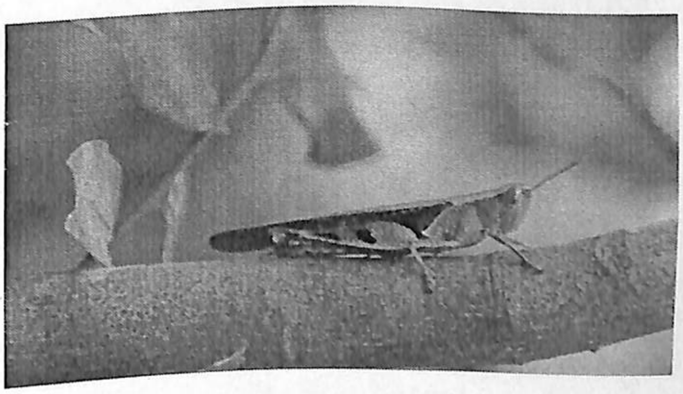
Neorthacris acuticeps nilgirensis



Atractomorpha crenulata

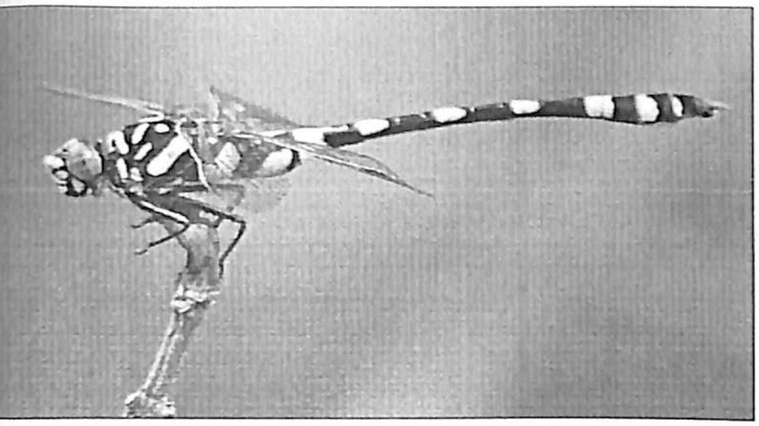


Aularches miliaris



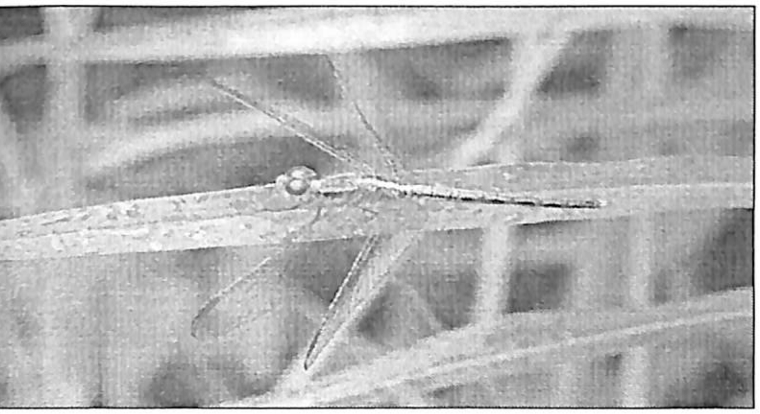
Diabolocatantops innotabilis

PLATE V
SELECTED ODONATE SPECIES IN KAVVAYI RIVER BASIN

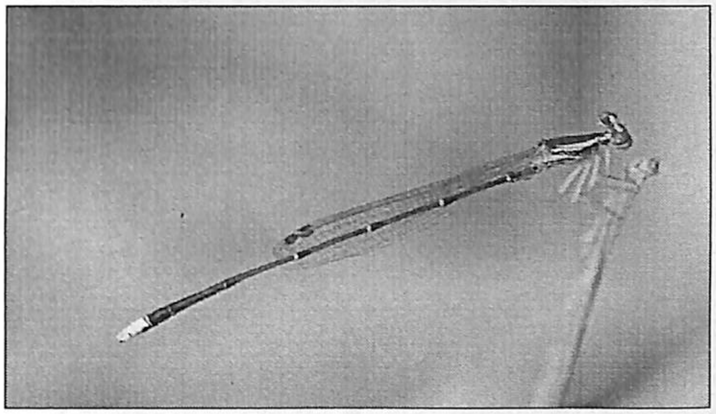


Ictinogomphus rapax

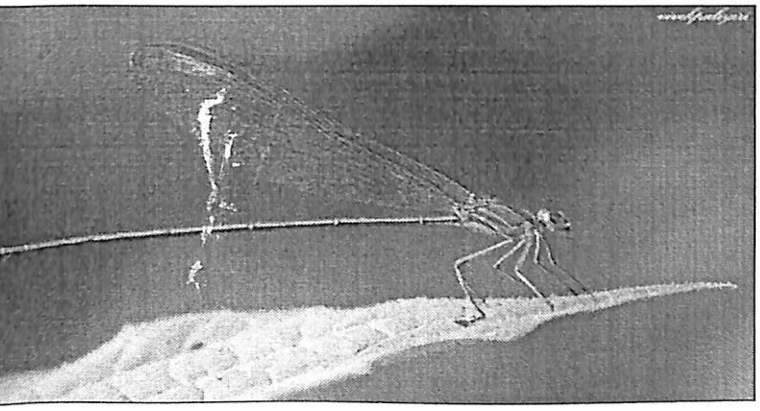
Aethriamanta brevipennis



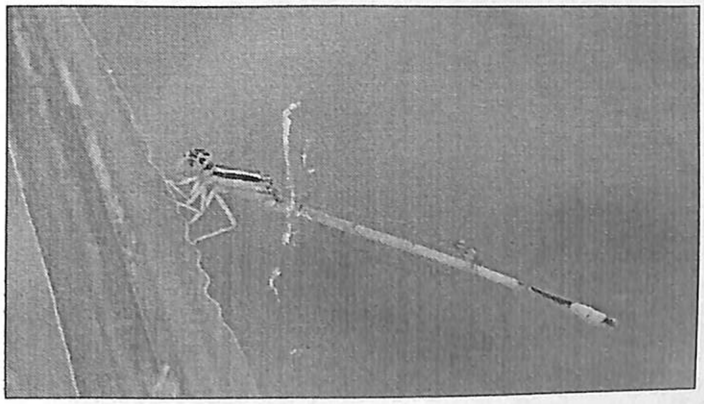
Neurothemis intermedia



Copera marginipes

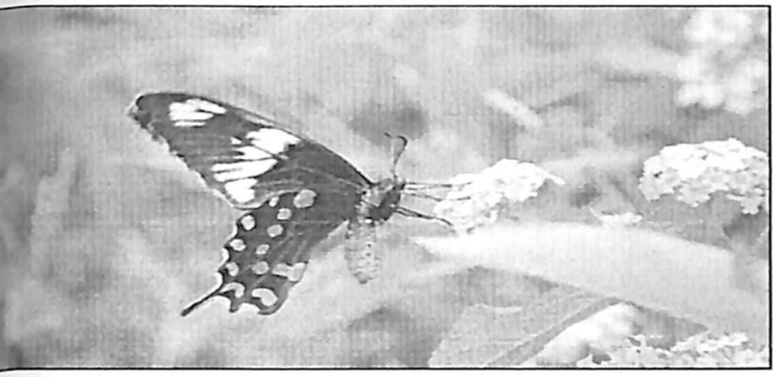


Vestalis gracilis

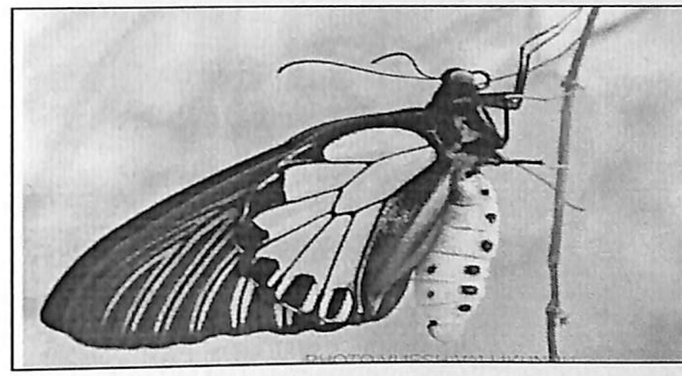


Ischnura aurora

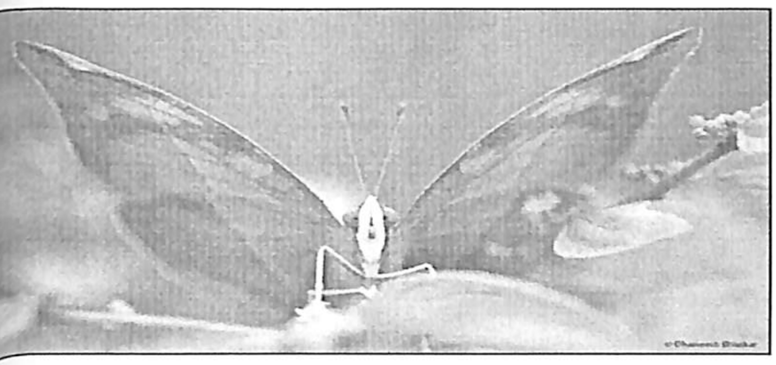
PLATE VI
SELECTED BUTTERFLY SPECIES IN KAVVAYI RIVER BASIN



Pachliopta hector
Crimson Rose

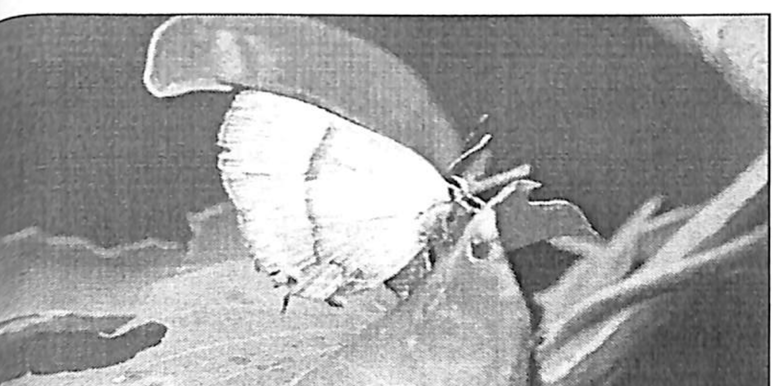


Troides minos
Sahyadri Birdwing (EN)

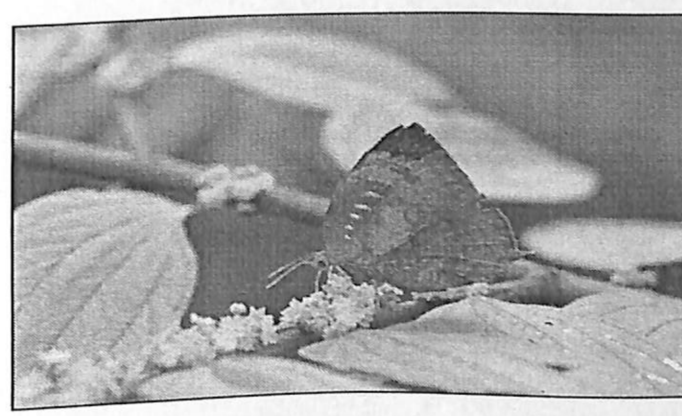


Doleschallia bisaltide
Malabar Autumn Leaf (EN)

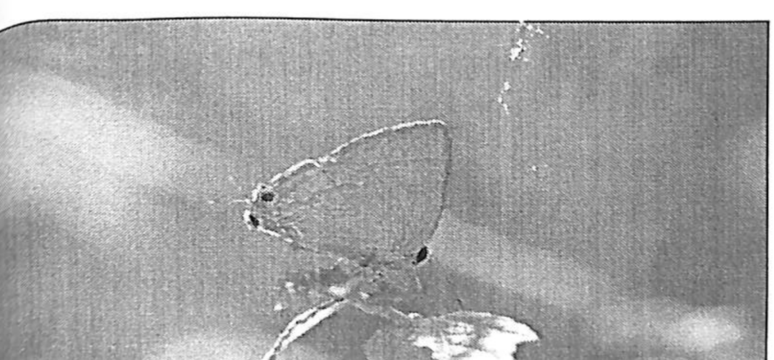
Papilio liomedon
Malabar Banded Swallowtail (EN)



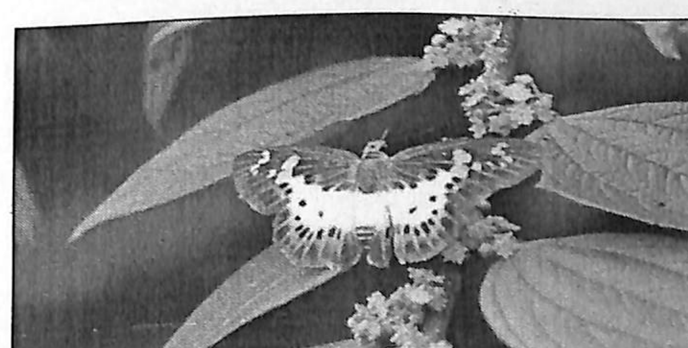
Rapala lankana
Malabar Flash (EN)



Arhopala centaurus
Centaur Oak Blue



Rapala manea
Slate Flash

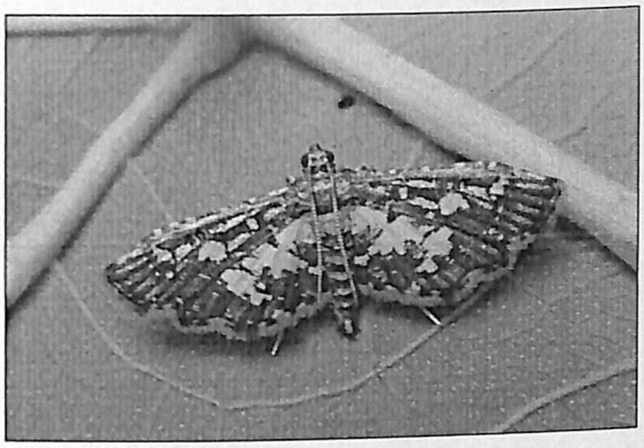


Gerosis bhagava
Yellow Breasted Snow Flat

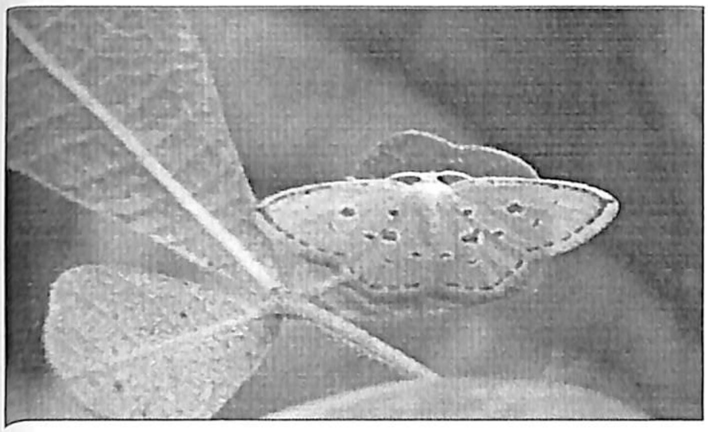
PLATE VII

SELECTED MOTH SPECIES IN KAVVAYI RIVER BASIN

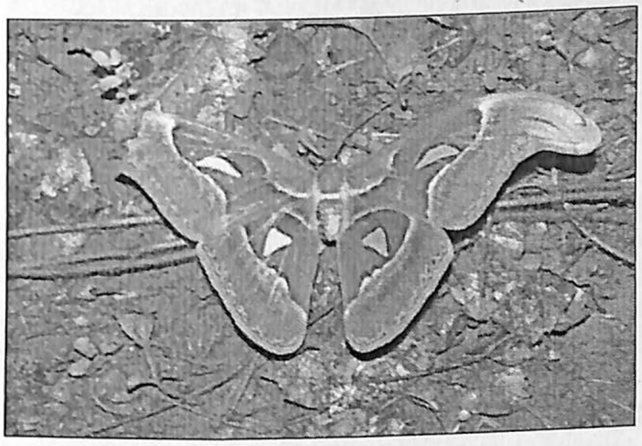
Semiothisa eleonora



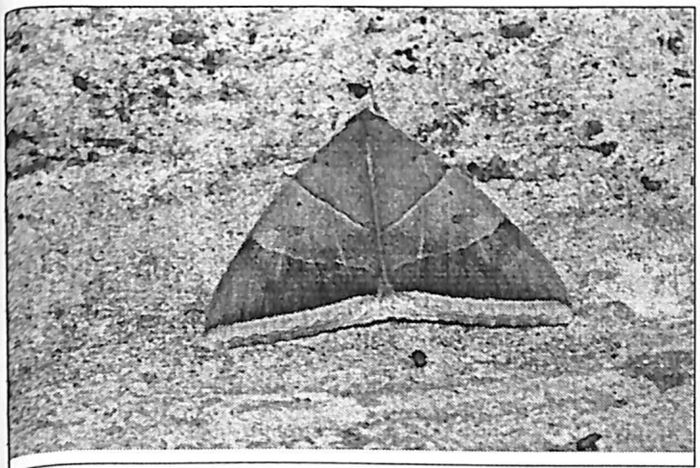
Eurrhyparodes bracteolalis



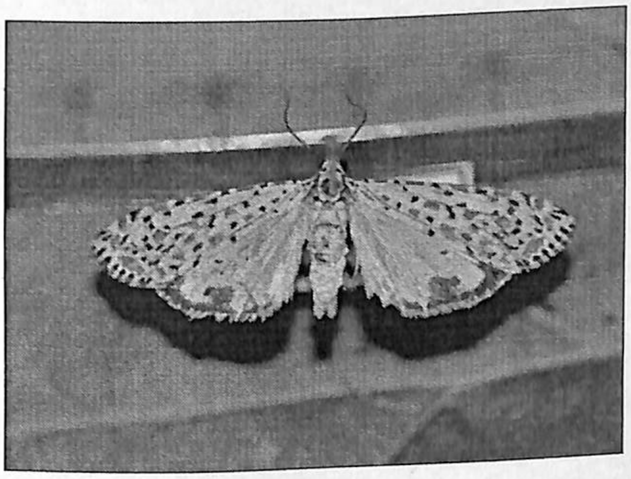
Comostola laesaria



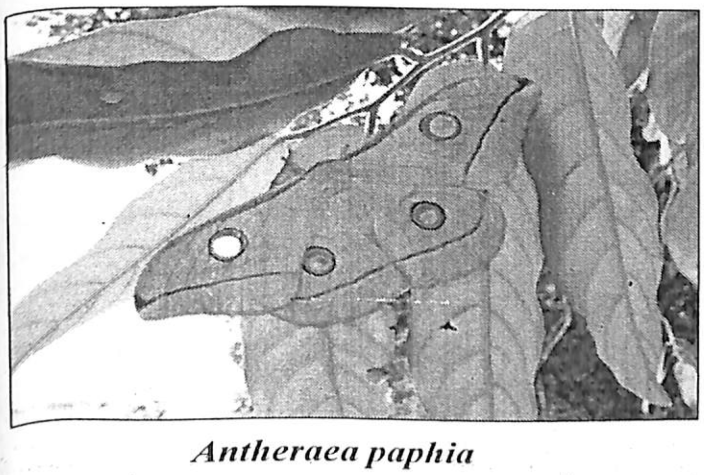
Attacus atlas



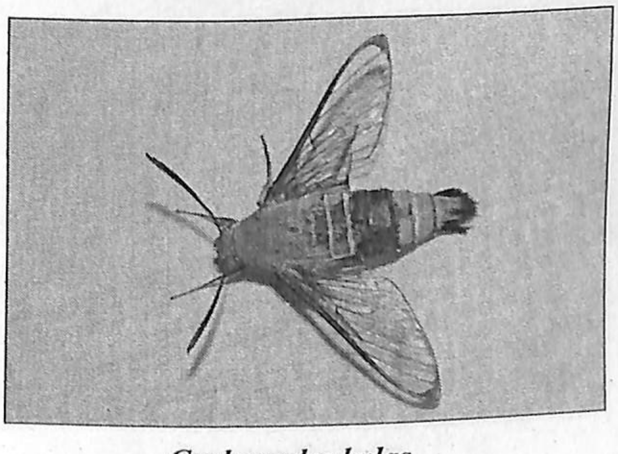
Artena dotata



Utetheisa pulchella

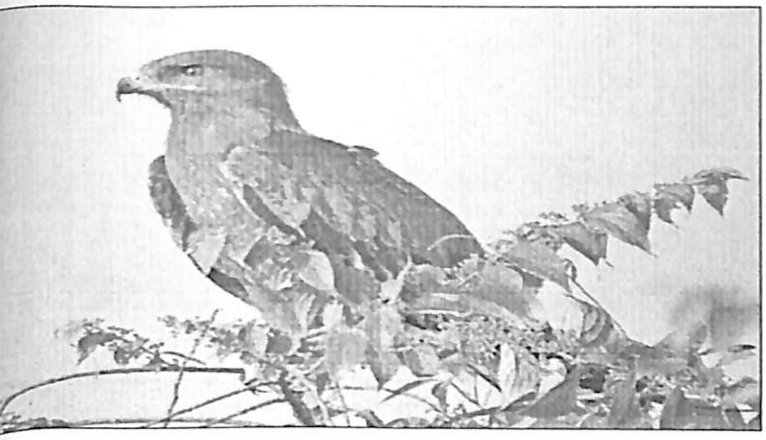


Antheraea paphia



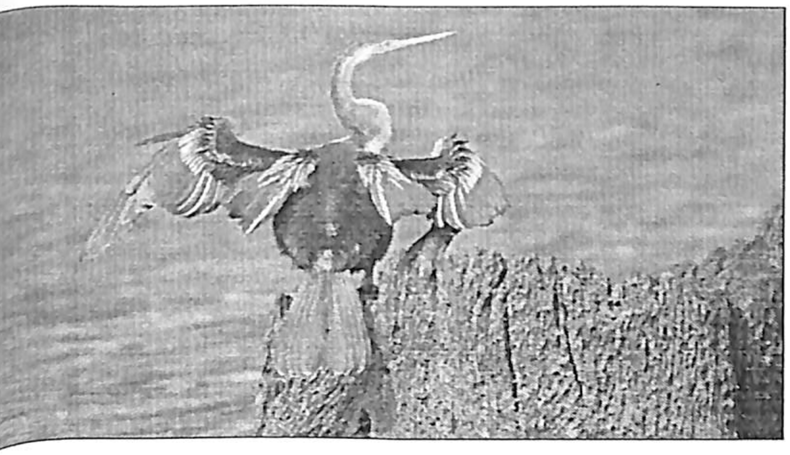
Cephonodes hylas

PLATE VIII
SELECTED BIRD SPECIES IN KAVVAYI RIVER BASIN



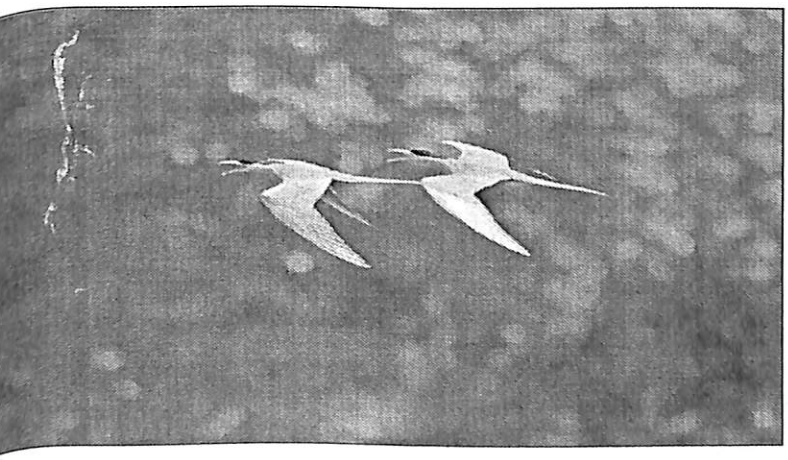
Clanga clanga (VU)

Ciconia episcopus (VU)

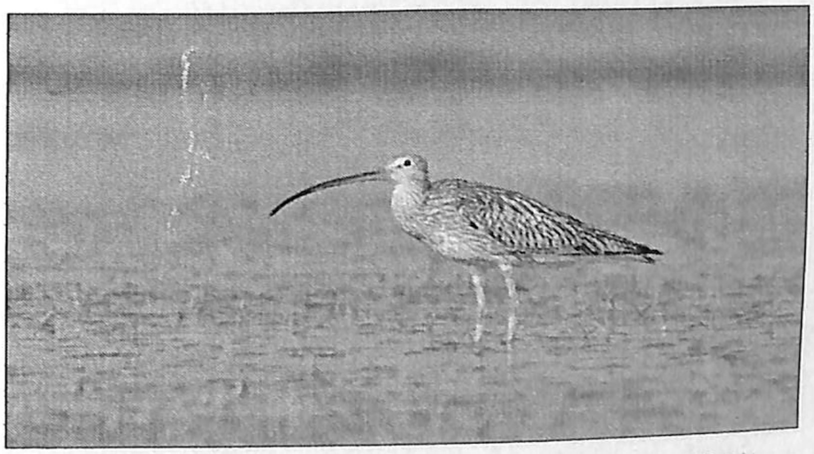


Anhinga melanogaster (NT)

Threskiornis melanocephalus (NT)



Sterna aurantia (NT)

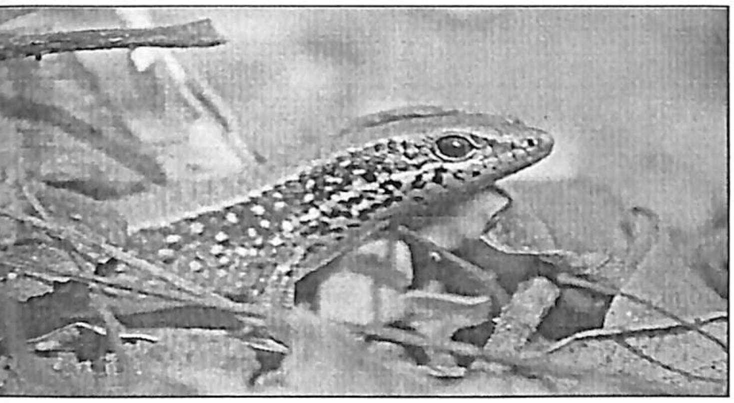


Numenius arquata (NT)

PLATE IX
SELECTED REPTILE SPECIES IN KAVVAYI RIVER BASIN

Echis carinatus

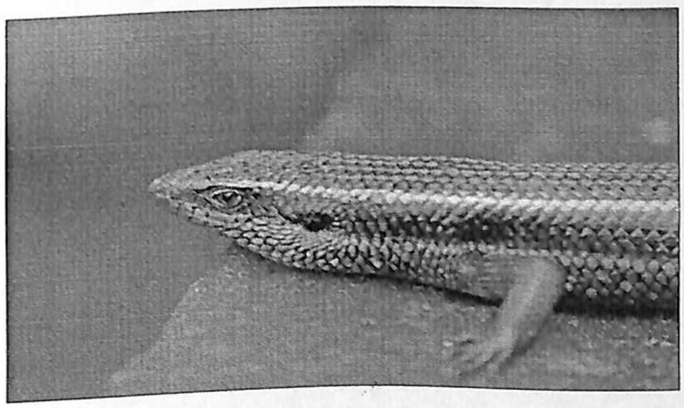
Ophisops beddomei



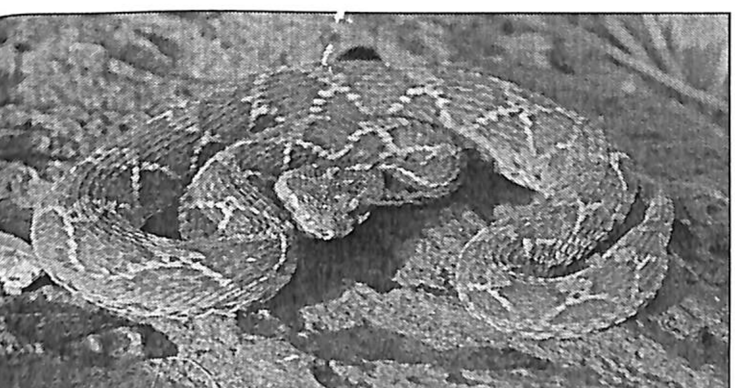
Eutropis macularia

Ristella spp.

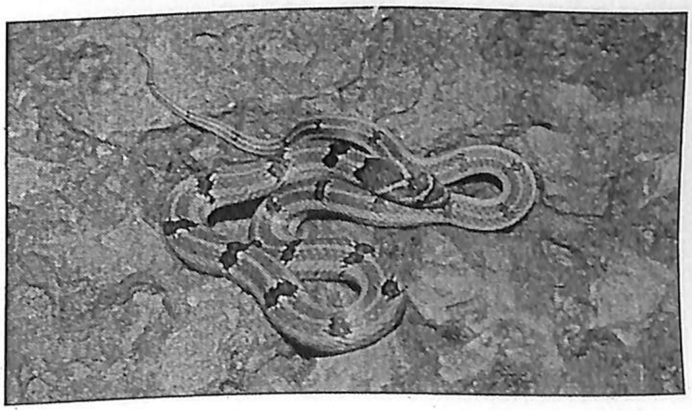
Lygosoma punctata



Eutropis carinata



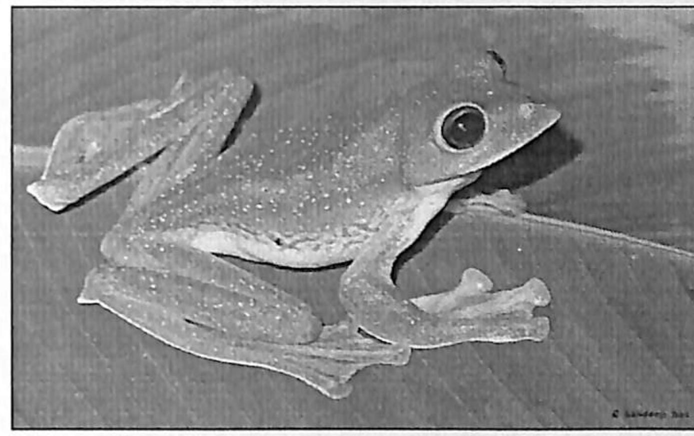
Echis carinatus



Oligodon taeniolatus

PLATE X
SELECTED AMPHIBIAN SPECIES IN KAVVAYI RIVER BASIN

Fejervarya rufescens

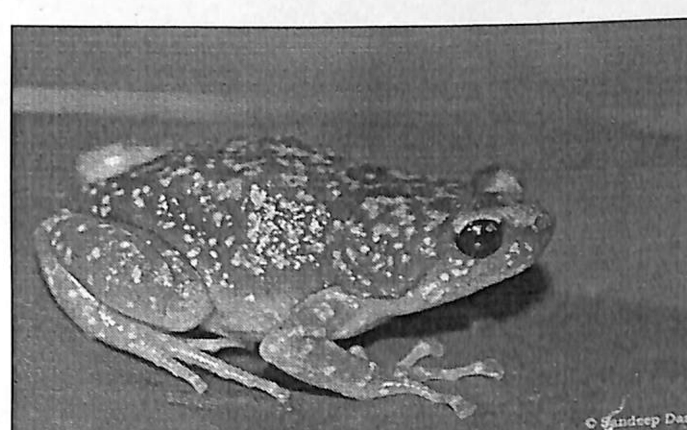


Rhacophorous malabaricus

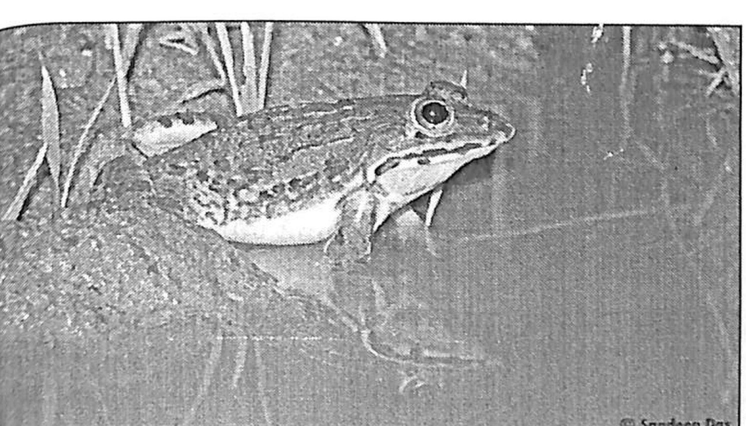
Uperodon taprobanicus

Fejervarya sahyadris **(Endangered)**

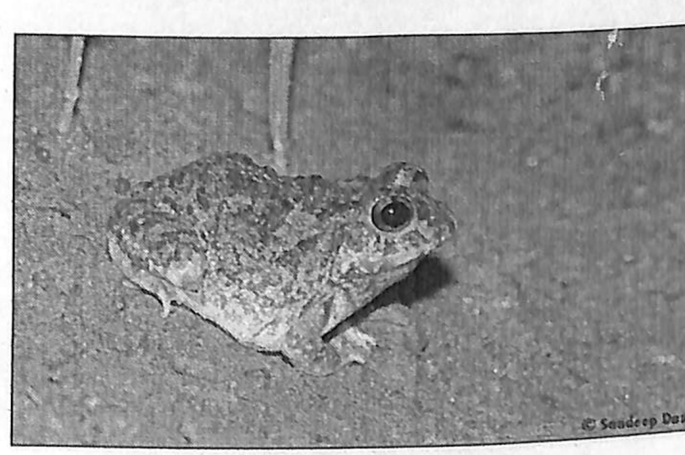
Pseudophilautus wynaadensis



Variegated ramanella



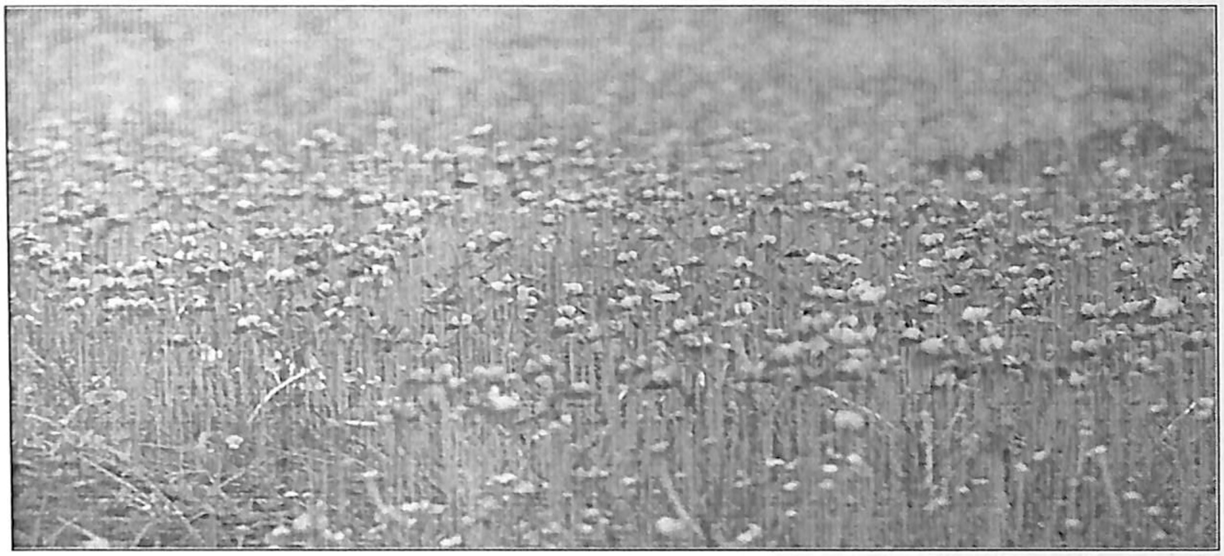
Hoplobatrachus tigerinus



Sphaerotheca breviceps

PLATE XI

MICROHABITATS OF LATAERITIC BIOTOPES IN KAVVAYI RIVER BASIN



EPHEMERAL FLUSH VEGETATION

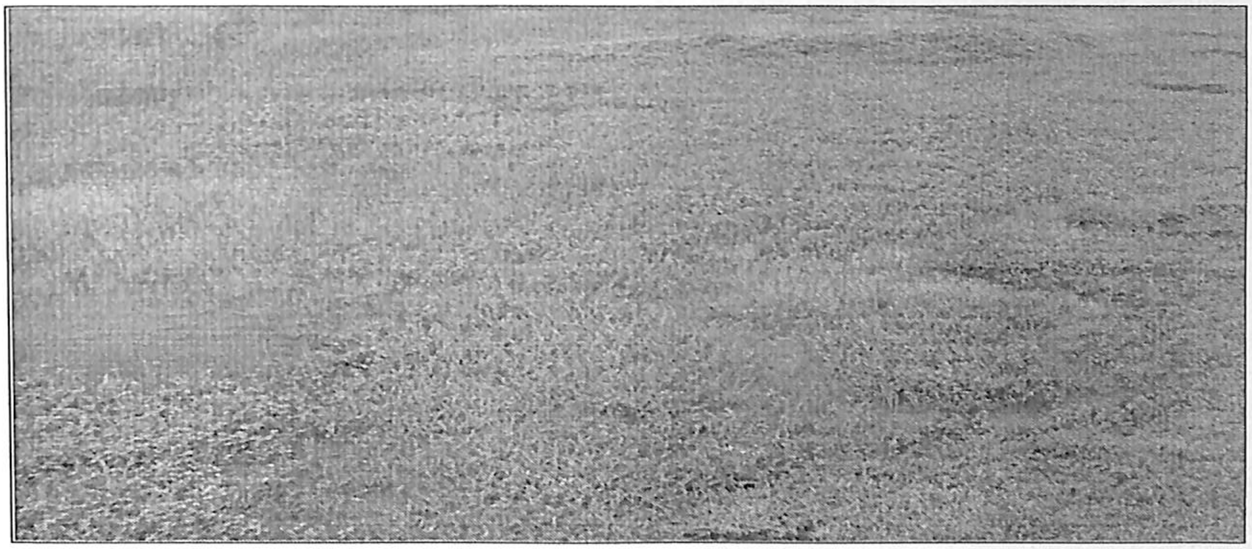
EXPOSED ROCK SURFACES

ROCK CREVICES AND FISSURES

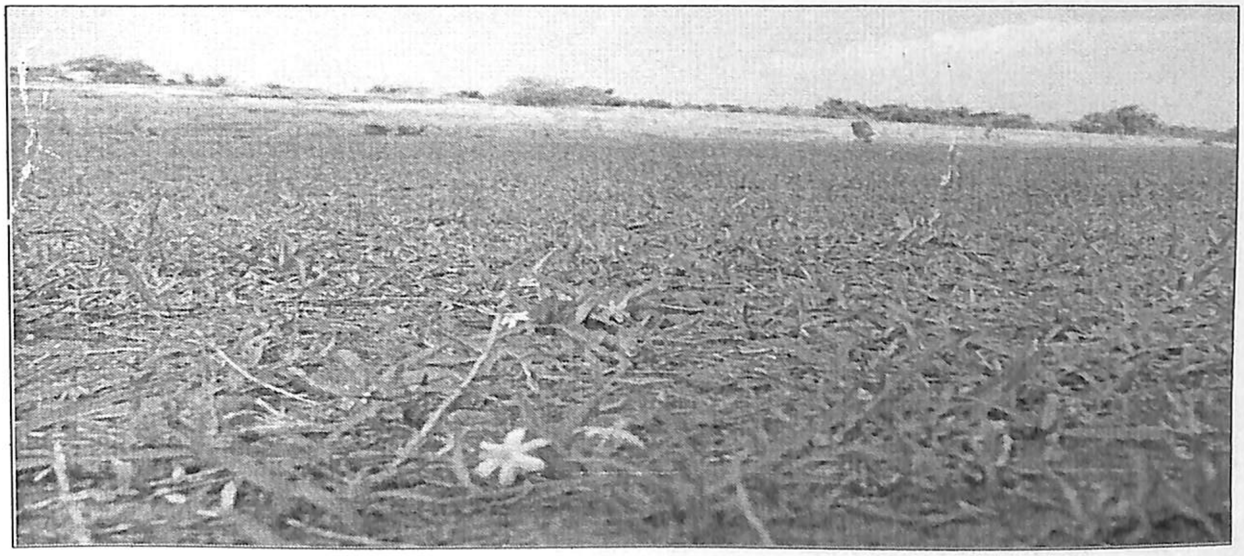
PLATE XII

MICROHABITATS OF LATAERITIC BIOTOPES IN KAVVAYI RIVER BASIN

SMALL EPHEMERAL POOL



SOIL FILLED DEPRESSIONS

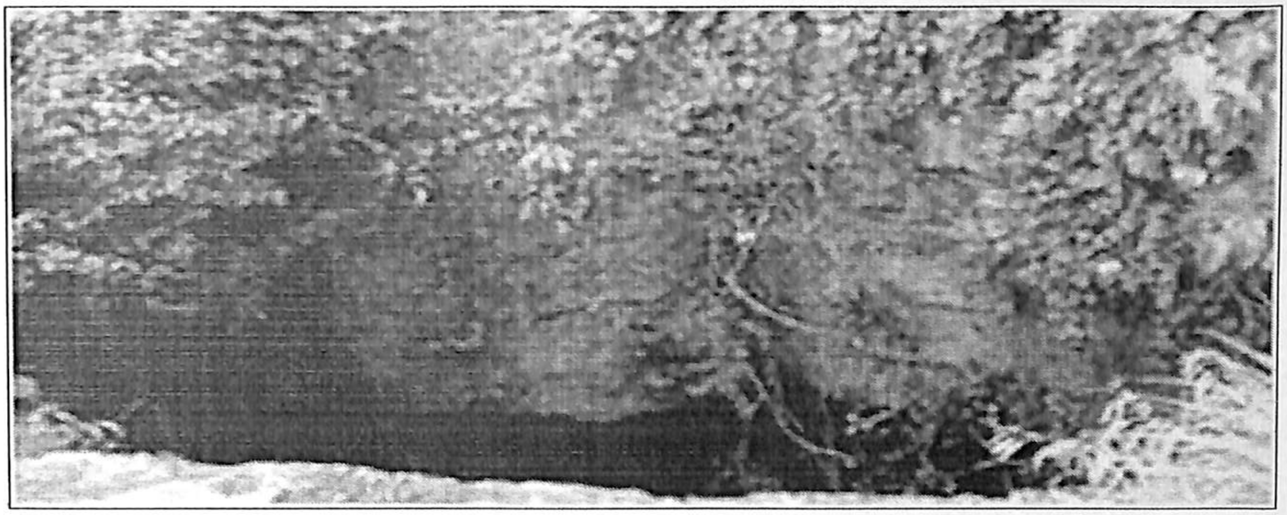


SOIL RICH AREAS

PLATE XIII

MICROHABITATS OF LATAERITIC BIOTOPES IN KAVVAYI RIVER BASIN

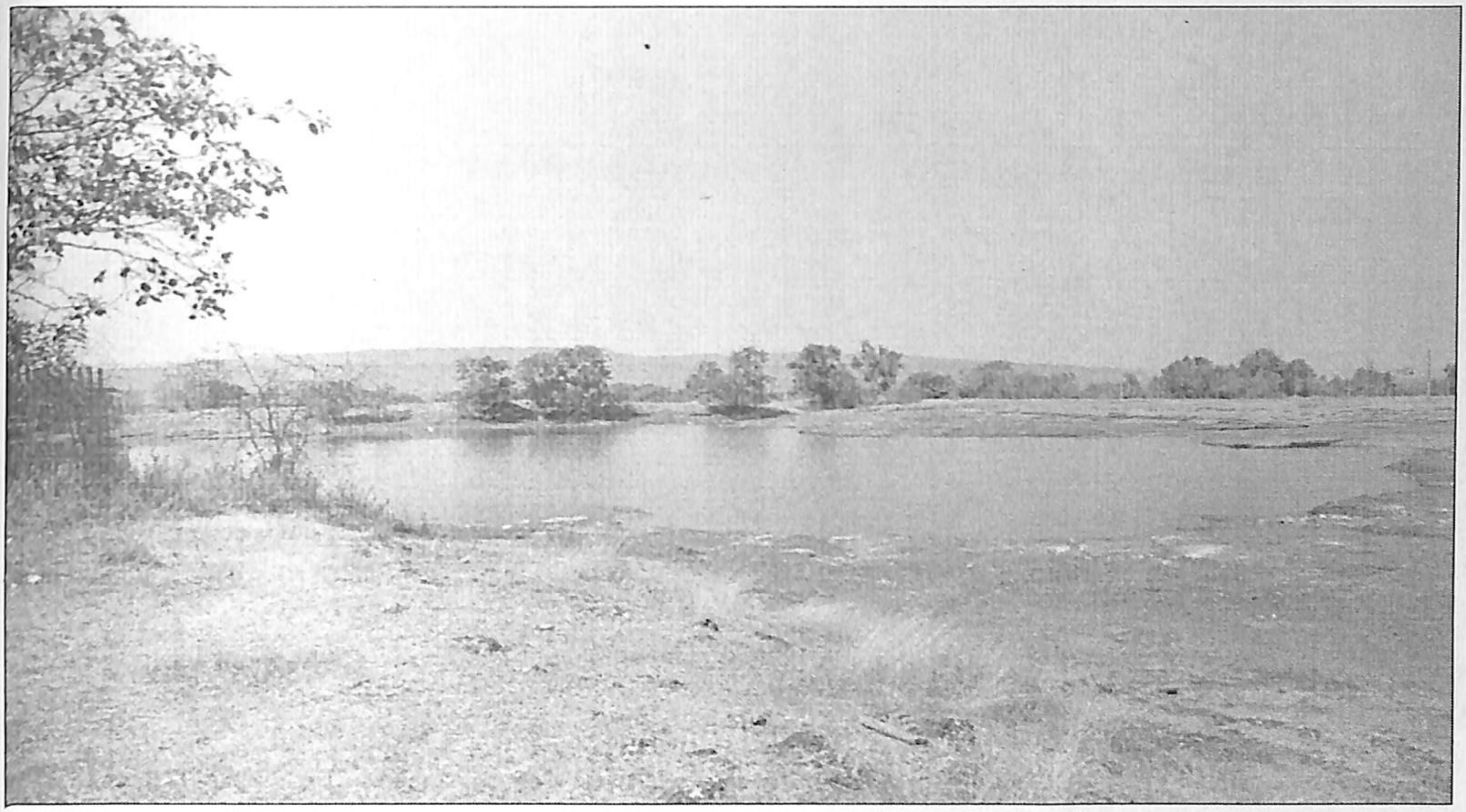
TREE COVER AND TREE ASSOCIATES



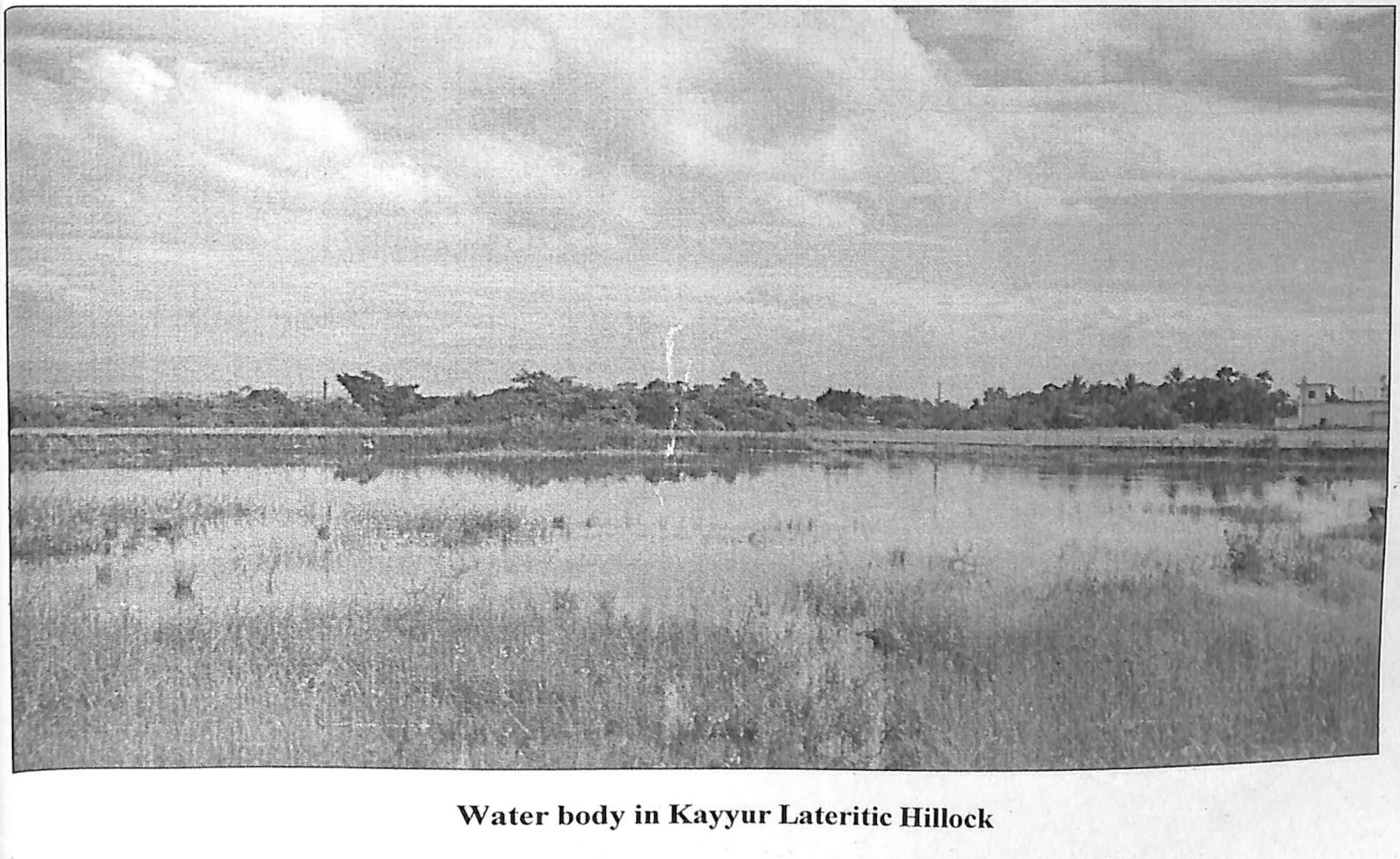
CRUST EDGES/ CLIFFS

BOULDERS

PLATE XIV
WATER BODIES ASSOCIATED WITH LATERITEIC BIOTOPES IN KAVVAYI RIVER BASIN

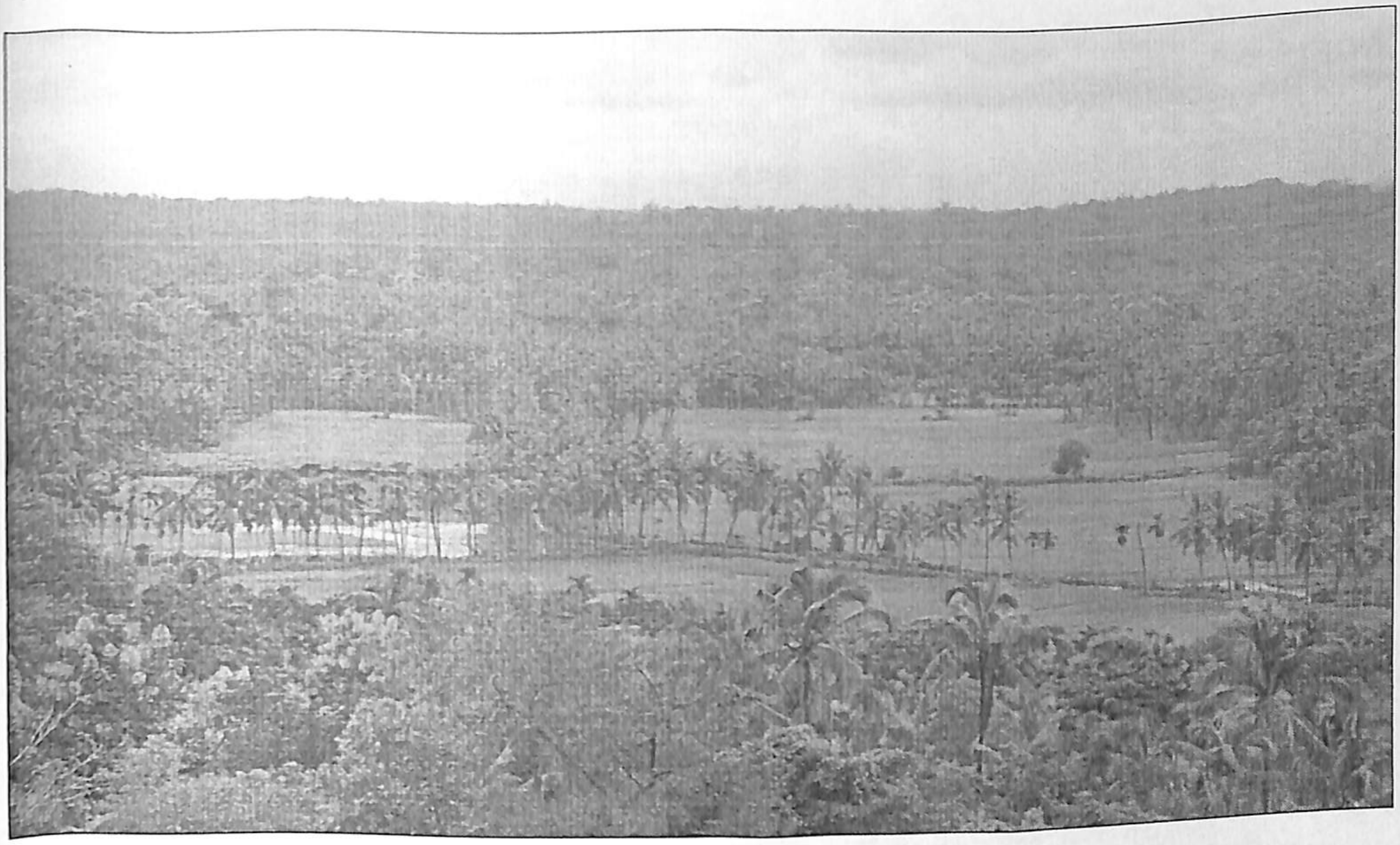


Water body in Madayipara Lateritic Hillock

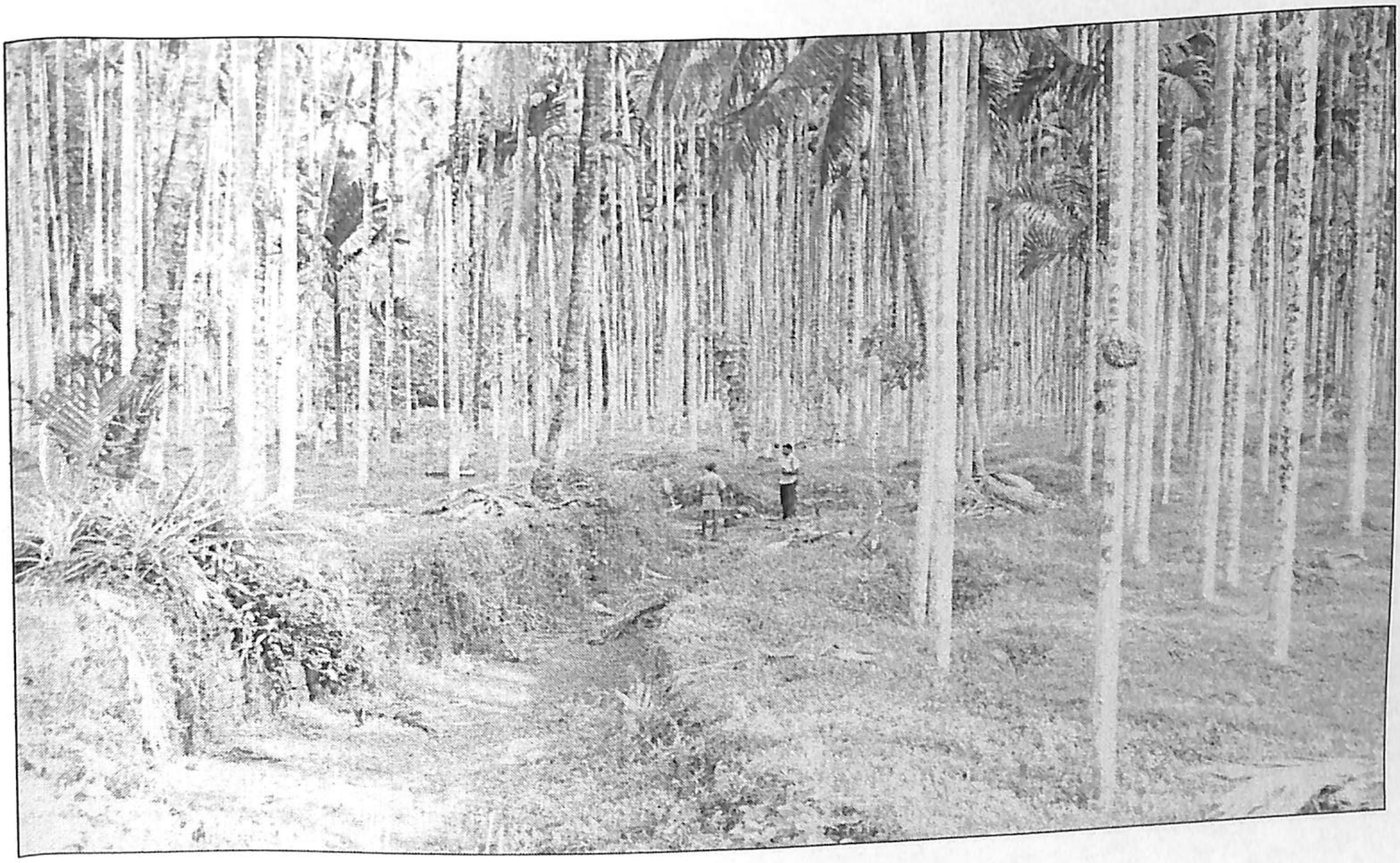


Water body in Kayyur Lateritic Hillock

PLATE XV
AGRICLUTURE LAND S ASSOCIATED WITH LATERITIC BIOTOPES IN KAVVAYI RIVER BASIN

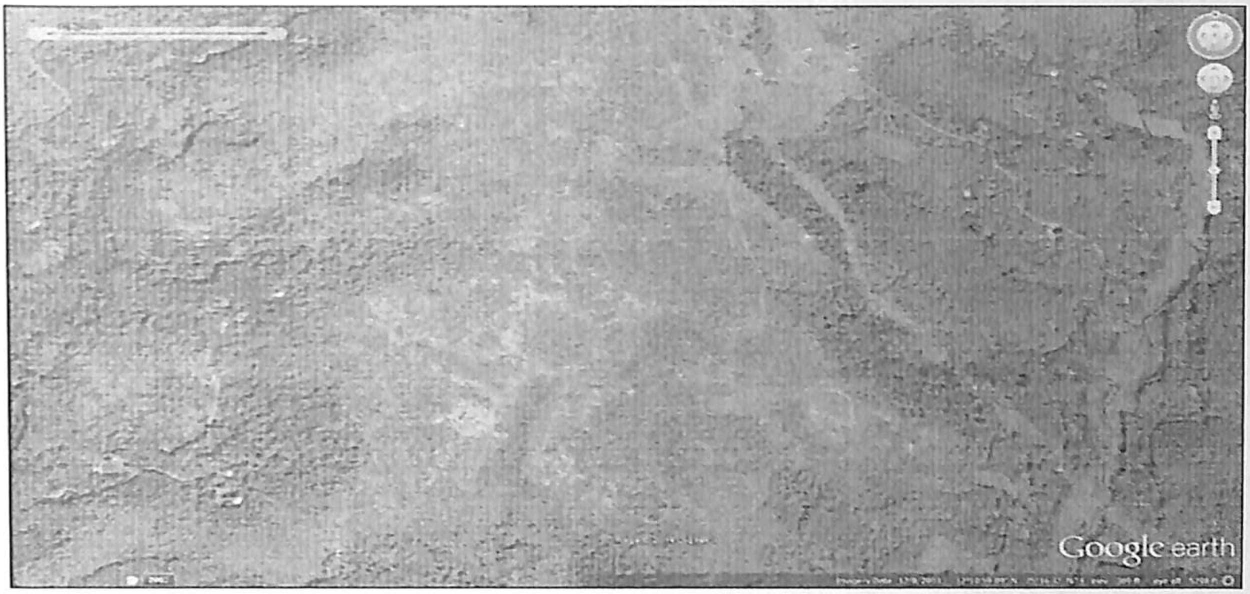


Agriculture Land near Mappidicheri



Agriculture Land near Cheemeni

PLATE XVI
SATELLITE IMAGES OF DEPLETION PROCESS IN KAVVAYI RIVER BASIN



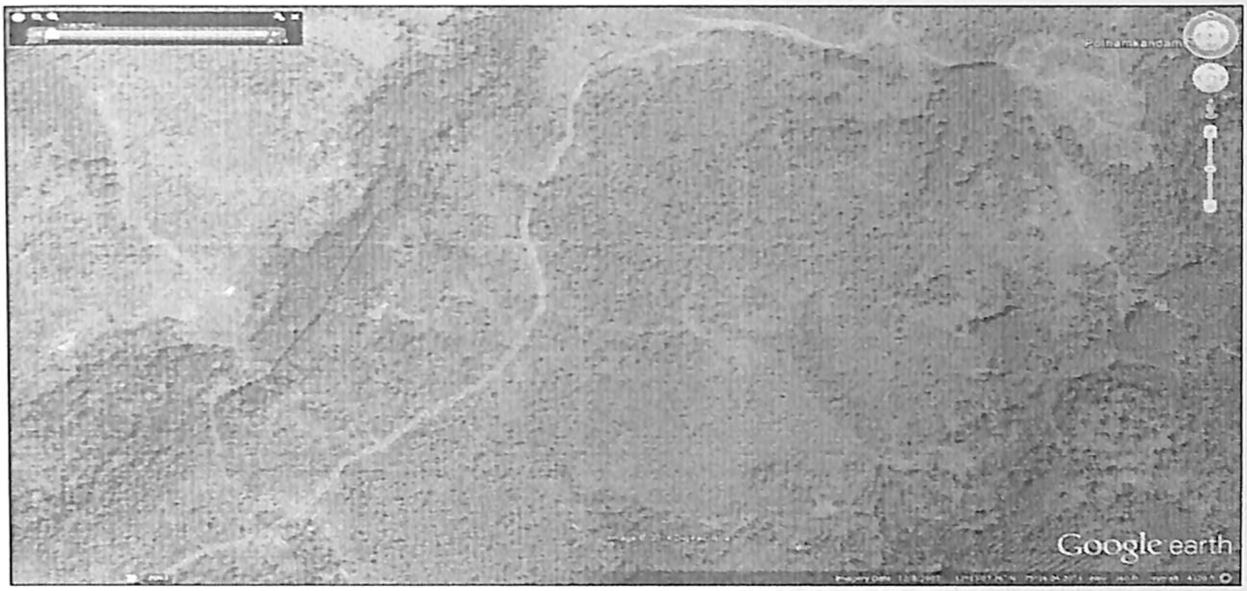
Satellite image of Aravanchal in 2003

Satellite image of Aravanchal in 2010

Satellite image of Aravanchal in 2014

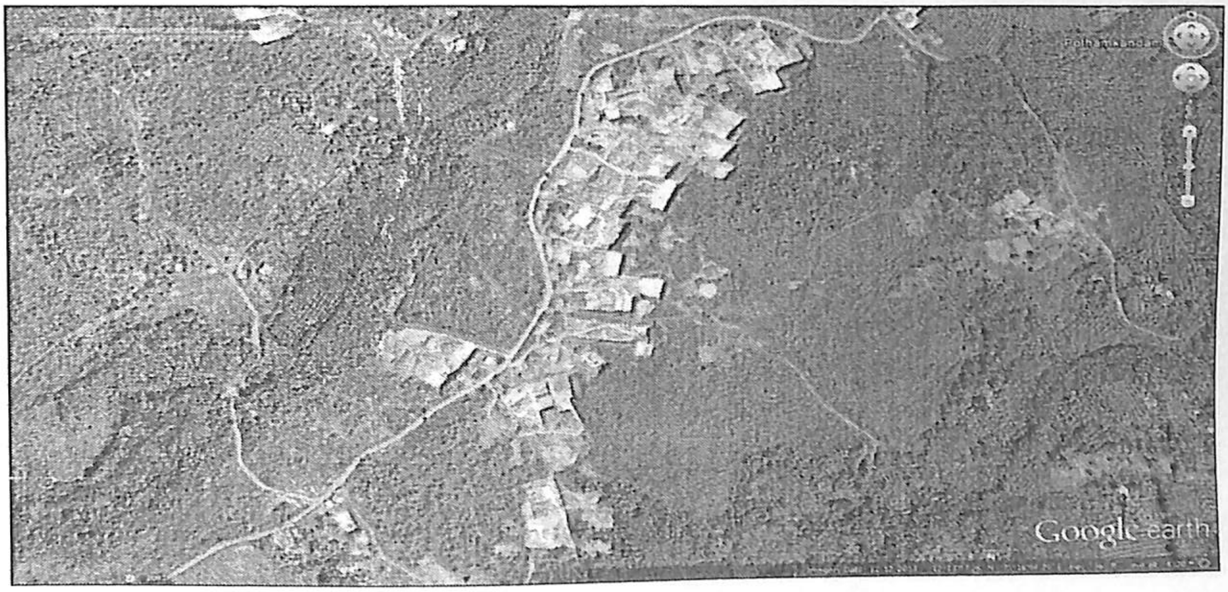
PLATE XVII

SATELLITE IMAGES OF DEPLETION PROCESS IN KAVVAYI RIVER BASIN



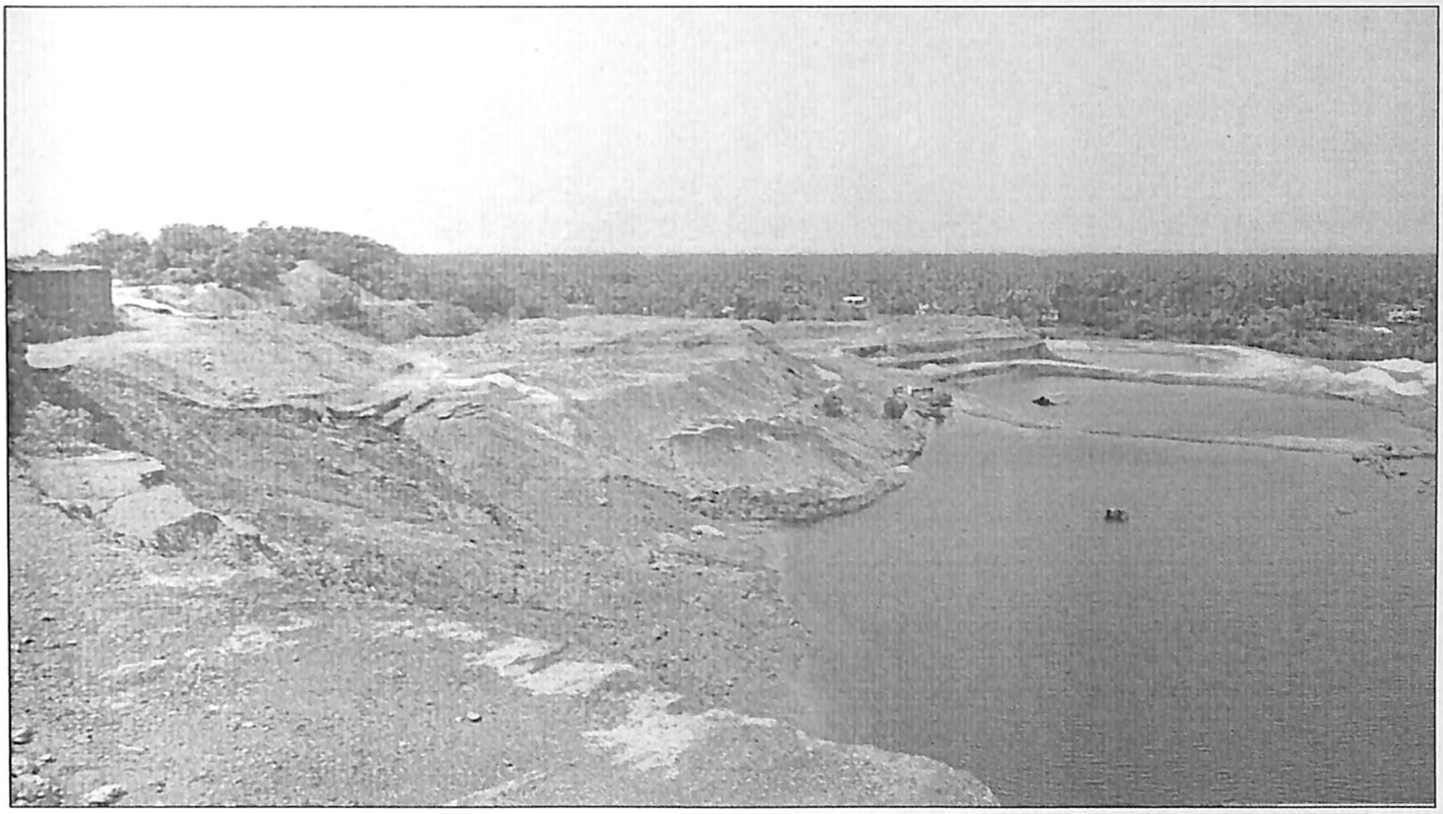
Satellite image of Velichamthodu in 2003

Satellite image of Velichamthodu in 2010



Satellite image of Velichamthodu in 2014

PLATE XVIII
HUMAN IMPACT AND THREATS IN LATERITIC BIOTOPES

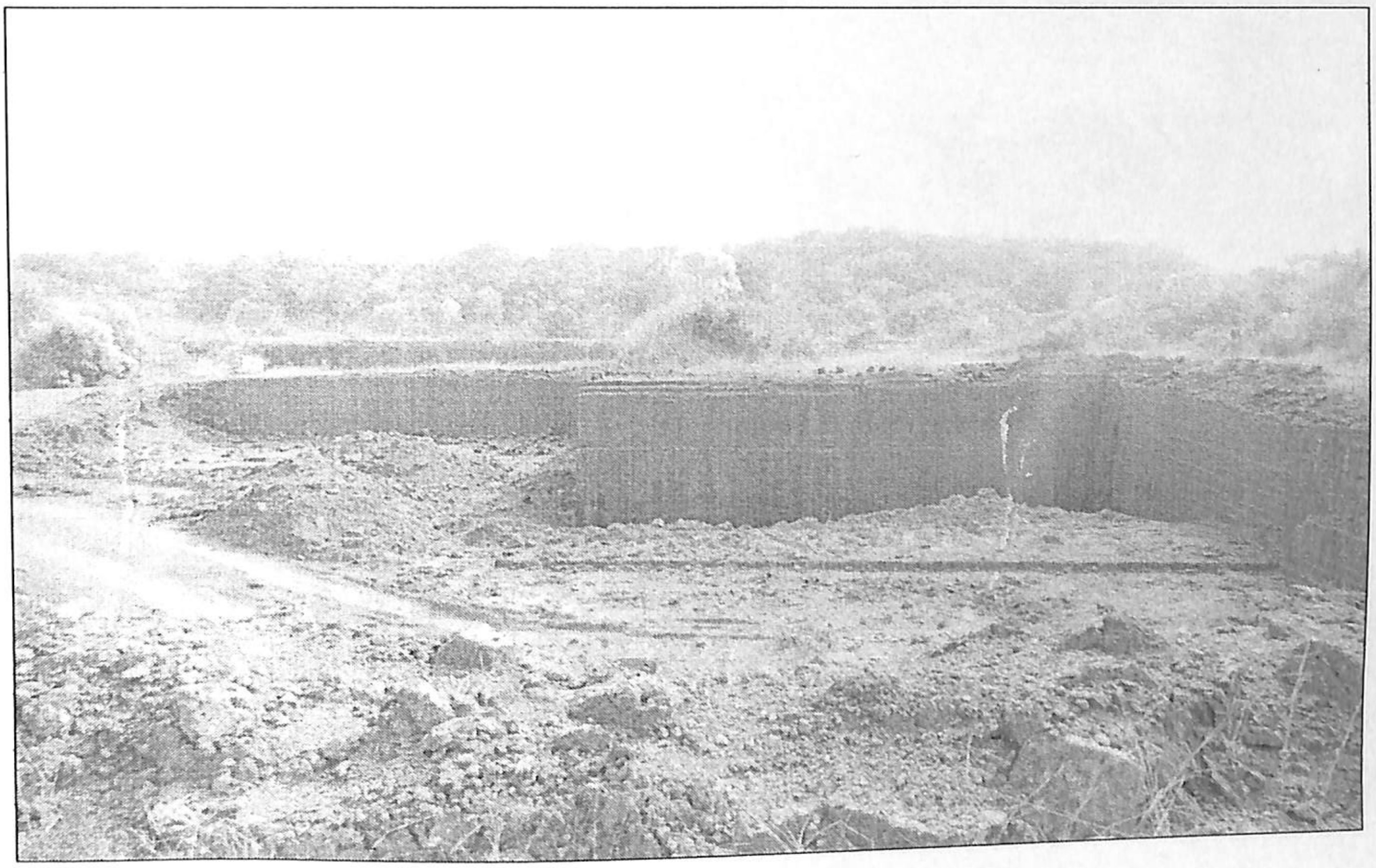


China Clay Mining at Madayipara

Laterite Mining at Velichamthodu

PLATE XIX
HUMAN IMPACT AND THREATS IN LATERITIC BIOTOPES

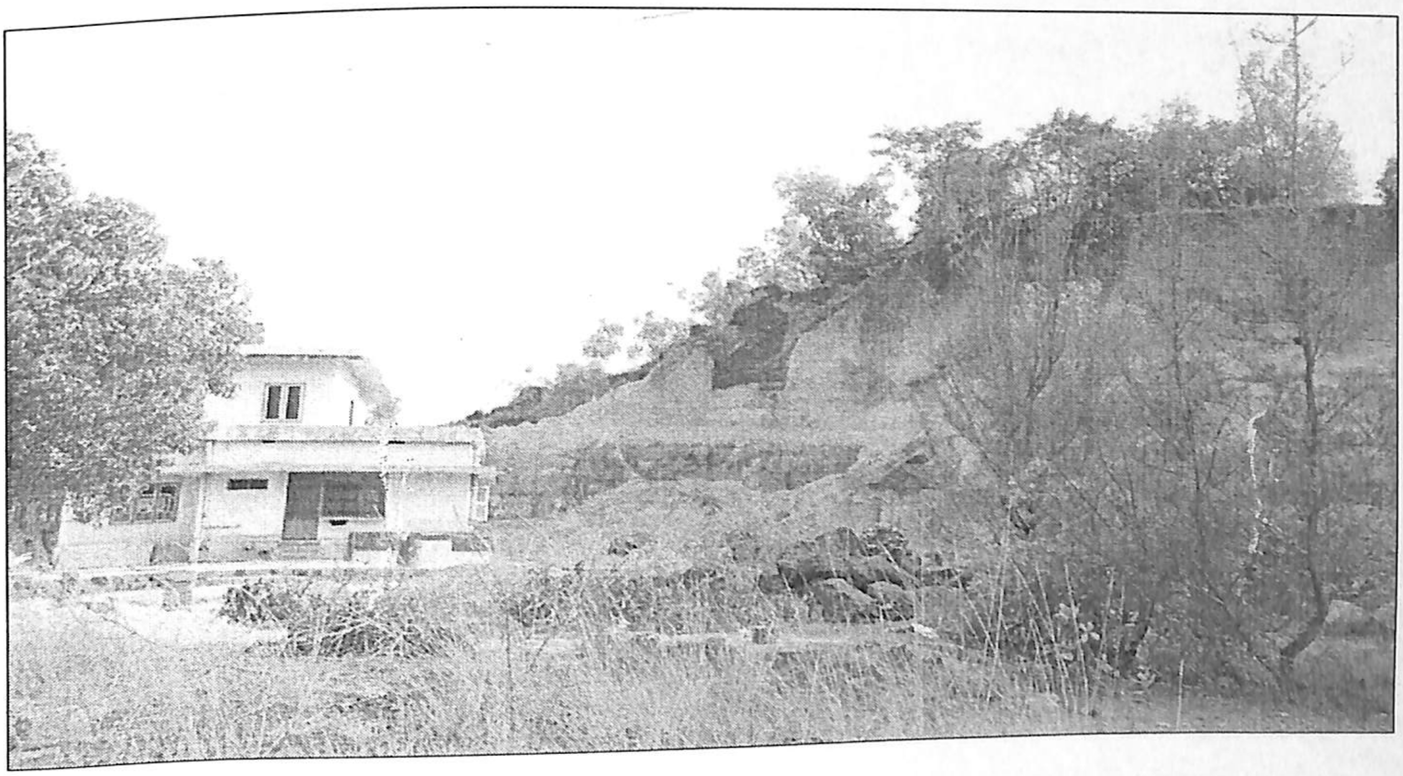
Laterite Mining at Mappidicheri



Laterite Mining at Aravanchal

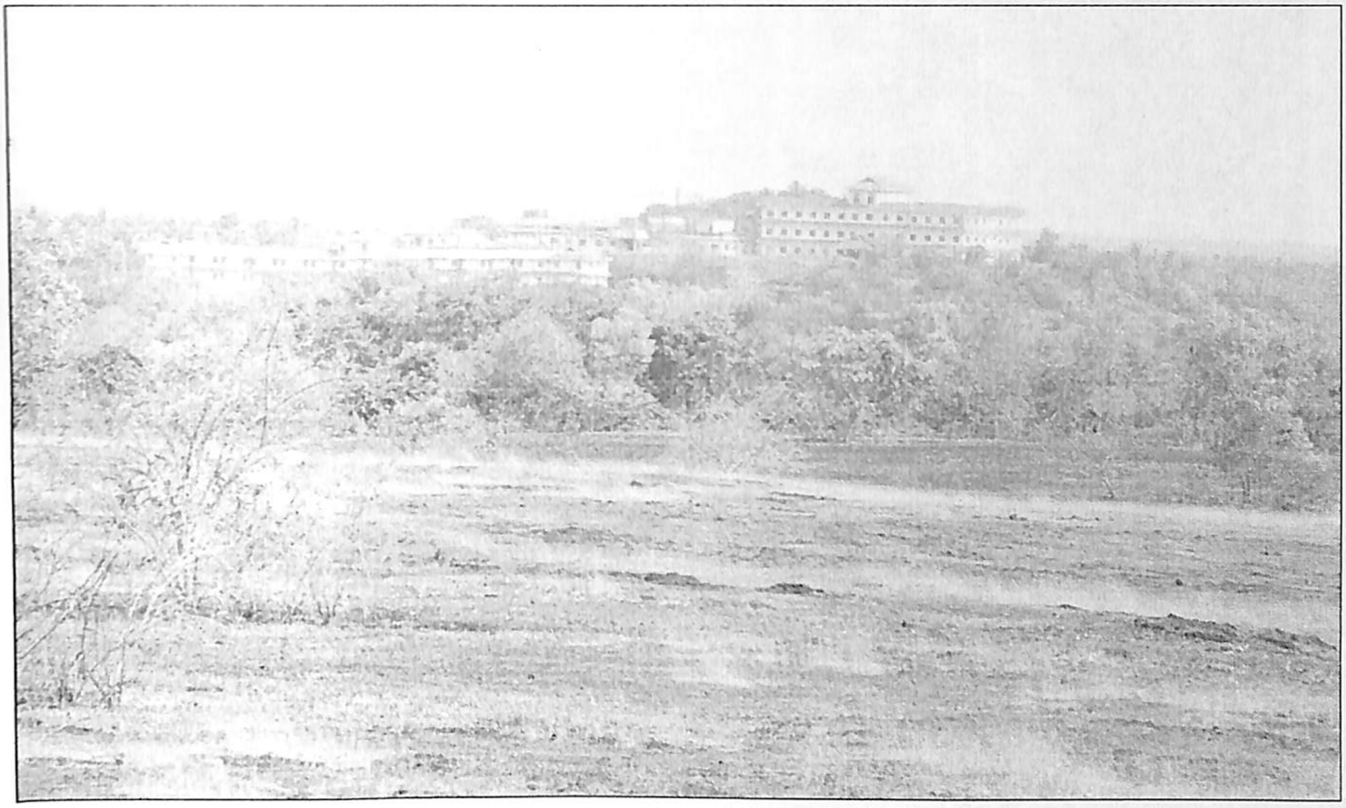
PLATE XX
HUMAN IMPACT AND THREATS IN KAVVAYI RIVER BASIN

Infrastructure Development- IT Park at Cheemeni

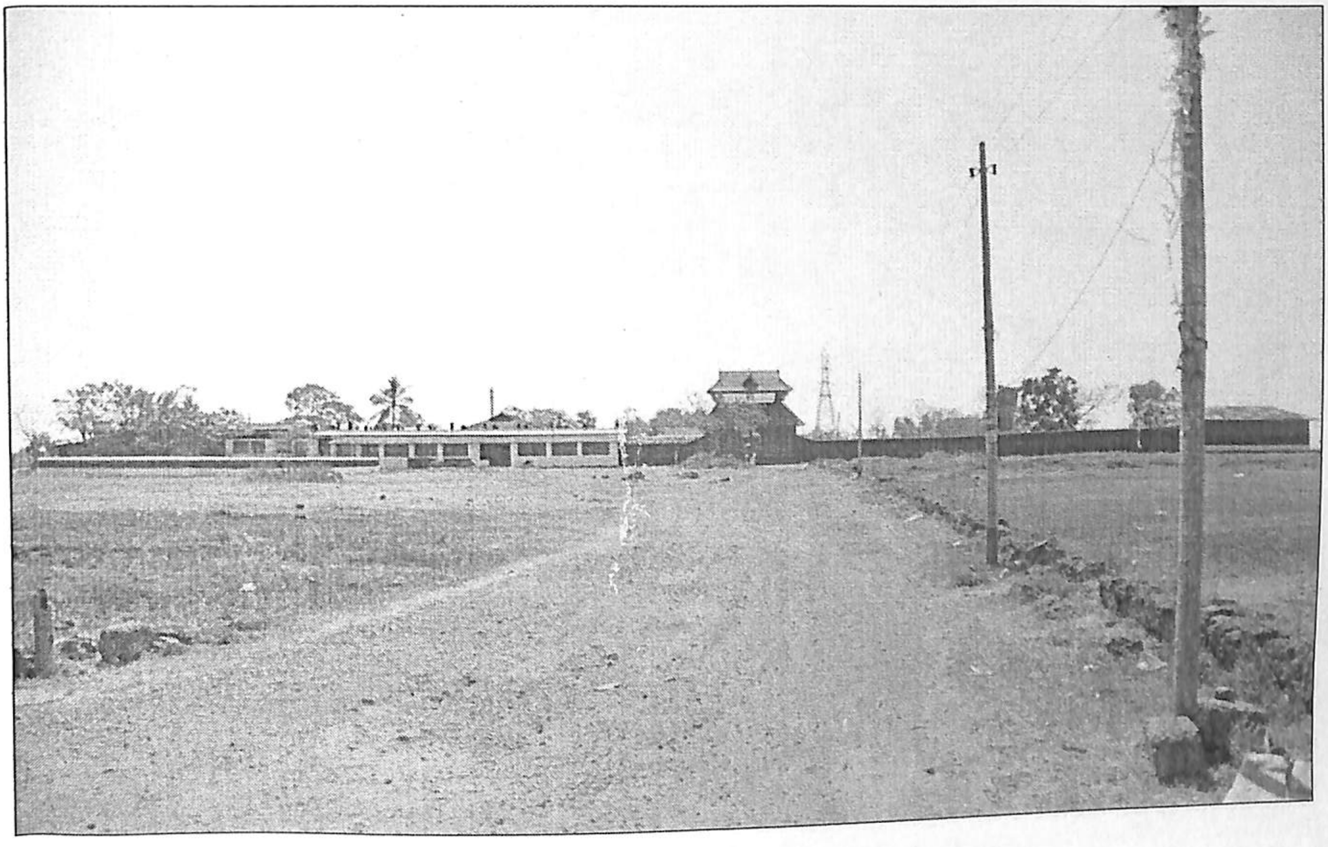


Infrastructure Development- Residential buildings at Mappidicheri

PLATE XXI
HUMAN IMPACT AND THREAT IN KAVVAYI RIVER BASIN



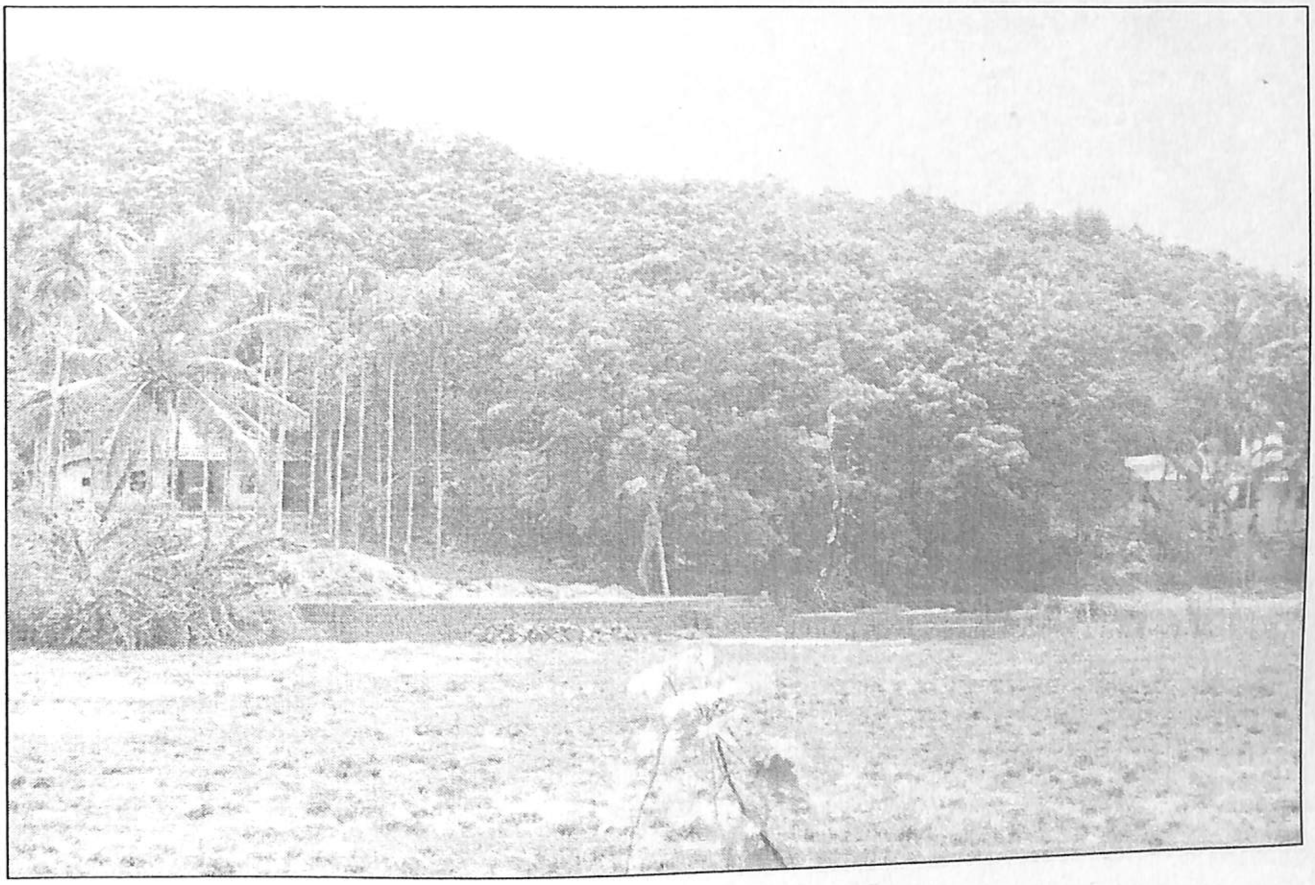
Infrastructure Development near Mappidicheri



Infrastructure Development- Temple at Madayipara

PLATE XXII
HUMAN IMPACT AND THREATS IN KAVVAYI RIVER BASIN

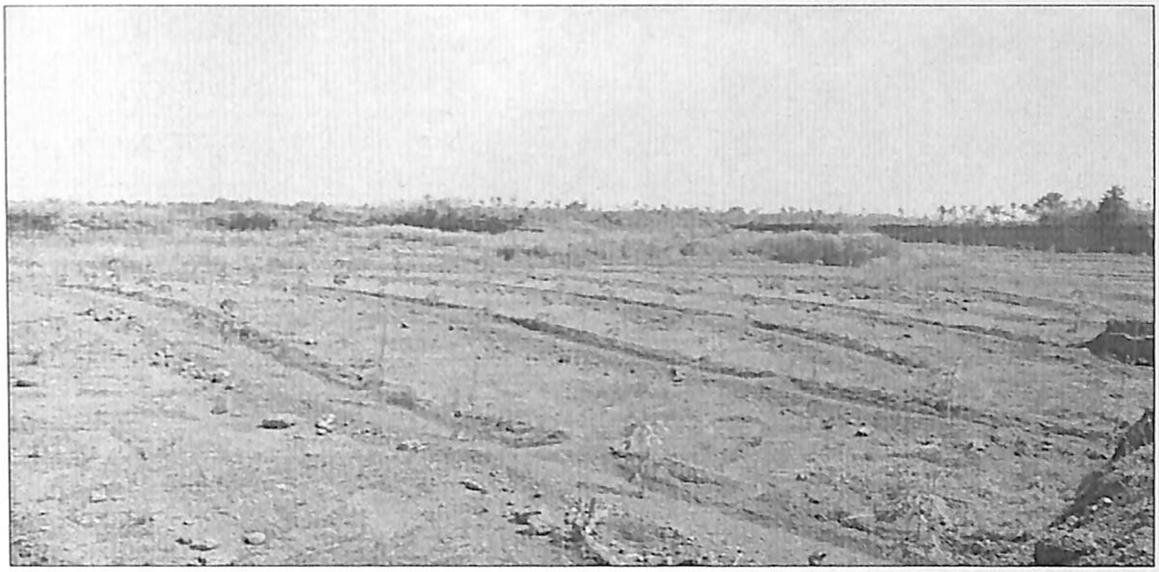
Reclamation of land with Laterite soil at Cheruvathur



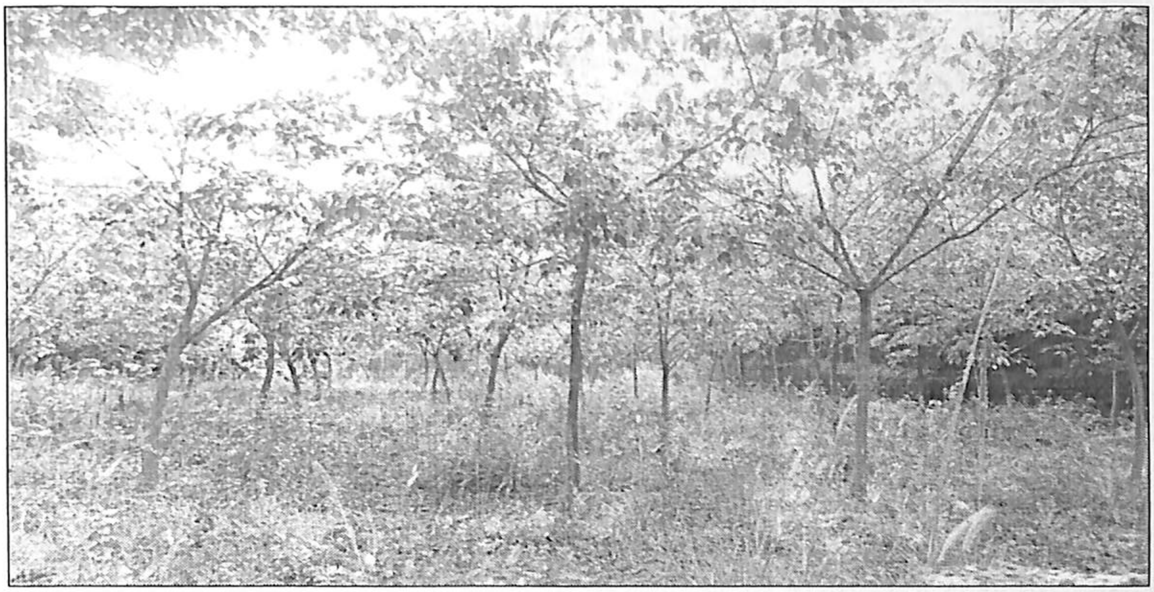
Reclamation of Paddy field with Laterite soil near Puthur

PLATE XXIII

RESTORATION PROCESSES IN DEGRADED LANDS



Mining site restored with Rubber at Velichamthodu



Mining site restored with Rubber at Velichamthodu

Mining site restored with Banana at Velichamthodu