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(Final Report of the Research Project - KFRI 519/2006 Sponsored by the Ministry of Environment and Forests, Govt. of India)

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ABSTRACT

Iringole Sacred Grove (10°6'31"N; 76°30'28"E) located in the Perumbavur Municipal Town is perhaps the largest and the best preserved among all the sacred groves in the State with an extent of about 10.53 hectares. Topographically, it is almost a plain land covered by semi-evergreen vegetation and surrounded by human habitations, roads, homesteads and cultivated areas. The grove represents 'nature worship' where natural ecosystems are devoted to ancestral spirits and deities, thereby providing protection and conservation in its most traditional form.

KFRI conducted a multidisciplinary study of the flora and fauna of the grove. The most abundant species were *Artocarpus hirsutus, Hopea ponga, Strombosia ceylanica* and *Vateria inidca*. The girth class distribution and IVI were analysed for all the grids laid out. The flora showed a high degree of endemism; of the 210 species recorded from the grove, 39 species are endemic to India. Rare, endangered and threatened species were also recorded from the grove. Several species of lianas were also recorded. A total of 215 species of macro fungi falling in 95 genera and 28 families were encountered in the sacred grove. A total of 342 species of animals including invertebrates and vertebrates were recorded. Insects were the dominant group among the invertebrates. Eight species of amphibians, 15 species of reptiles, 65 species of birds and nine species of mammals were recorded.

The Iringole Sacred Grove, has been an integral part of the community's social and cultural life. The grove is considered valuable by the local and tribal communities and is protected for reasons that are both religious and spiritual. The ecosystem once supported luxuriant evergreen vegetation which has degraded due to various reasons both natural and man-made. Specific reasons include the complicated management and ownership patterns, loss of knowledge about sacred groves, migrations to urban areas, development interventions causing damage to remnants of sacred groves and most importantly, the community's perception about the sacred groves in today's context. The increasing tourism activities have both positive as well as negative impacts in the conservation of the sacred grove. Loss in faith and acculturation, in general, necessitates to strengthen conservation of its valuable biodiversity. The study highlights certain strategies for better management of the grove from the point of view of people and the sacred grove.

1. INTRODUCTION

1.1 Sacred groves in India

Sacred groves contain remnants of indigenous flora and fauna of the bygone pristine ecosystems, preserved by human societies owing to religious beliefs. These are dedicated to local deities or ancestor spirits and act as reservoirs of rare flora, fauna. In most localities, sacred groves are being increasingly exposed to various kinds of threats leading to degradation or total disappearance (Jayarajan, 2004). Ward and Connor (1894) had reported that there were more than one lakh sacred groves/sarpa kavu in the State of Kerala. Brandis and Grant (1897) observed the presence of numerous sacred groves in nearly all provinces of British India. Recognizing their importance Shanmukhappa (1966) even included sacred groves, while prescribing a working plan for unorganized forests of North Karnataka. Gadgil and Vartak (1976), as the pioneers of scientific study in sacred groves, evaluated the floristic and ethno-botanical aspects of sacred groves in Maharashtra and North Kanara. Sacred groves are distributed all over the world such as Africa, Australia, Asia, Latin America and North America.

Sacred groves are known under different names in different parts of India, 'Dev' in Madhyapradesh, 'Deorais' or 'Deovani' in Maharashtra, 'Sarnas' in Bihar, 'Orans' in Rajastan, and 'Sidharavana' or 'Devarkadu' or 'Pavithravana' in Karnataka. In Kerala, Sacred groves are widely distributed from West Coast to Eastern highlands. They are known by various names as Kavus, Ayyappan kavus, Sarpa kavus, Vallikettu, etc. These groves are preserved on the grounds of religious (temple), traditional (Naga) or cultural (Theyyams) aspects. Most of the sacred groves are associated with temples.

First authentic report on sacred grove is the Census Report of Travancore in 1891, and Ward and Connor (1894) reported 15,000 sacred groves in Travancore. Ramachandran and Mohan (1990) listed 239 important sacred groves. Induchoodan and Balasubramanyan (1996) estimated 761 sacred groves in Kerala with floristic wealth of over 722 species, belonging to 217 families and 474 genera. According to them, among 722 species recorded, 153 are

endemic to Peninsular India. There has been several studies highlighting the biodiversity conservation and management of the sacred groves (Ramakrishna *et al*., 1998, Chandrasekara and Sankar, 1998, Chandrasekara, 2011). Similarly, floristic comparison of sacred groves of Kannur district in Kerala was done by Deepa and Khaleel (2009) and phytosociology of Iringole Sacred grove was done by Das and Menon (2011).

Sacred groves have become biodiversity hotspots, as various species take refuge in the areas due to progressive habitat destruction and hunting. Sacred groves often contain plant and animal species that have become extinct in neighboring areas. They therefore harbor great genetic diversity. Besides this, sacred groves in urban landscapes act as "lungs" to the city as well, providing much needed vegetation cover. Sacred groves are vanishing day by day; many groves are represented by a single tree or an idol. The main threats are fragmentation, loss of faith, removal of timber or biomass, clearing of groves for developmental activities, encroachment, poaching, among others. It is now reported that there are around 15397 documented sacred groves in the 22 states of India. Among the 22 Indian States (Table 1), the largest number of documented sacred groves is reported from Himachal Pradesh with 5000 numbers followed by Maharashtra having 2837 sacred groves and Kerala State having the third place with 2000 documeted sacred groves. (Source: Envis Centre of *C.P.R. Environmental Education Centre*). Number of documented sacred grove totaling more than fifteen thousand three hundred from the 22 States in India is given in the Table 1.

Table 1. Number of documented sacred groves in the States of India

Sl.No.	State	Local name for Sacred Groves	No. of documented sacred groves
1	Himachal Pradesh	*Deo Bhumi*	5,000
2	Maharashtra	*Devrais*	2,837
3	Kerala	*Kavu*, *Kanam*	2,000
4	Karnataka	*Devara Kadu*	1,531
5	Andhra Pradesh	-	750
6	West Bengal	*Garamthan, Harithan, Jahera, Sabitrithan, Santalburithan*	670
7	Chhattisgarh	Sarna, Devlas, Mandar, Budhadev	600

8	Tamilnadu	*Kovil Kadu*	528
9	Manipur	*Gamkhap, Mauhak* (sacred bamboo reserves)	365
10	Orissa	*Jahera, Thakuramma*	322
11	Haryana	-	248
12	Pondicherry	*Kovil Kadu*	108
13	Arunachal Pradesh	*Gumpa* Forests (Sacred Groves attached to Buddhist monasteries)	101
14	Meghalaya	*Law Lyngdhoh*	83
15	Sikkim	*Gumpa* Forests	56
16	Goa	-	55
17	Assam	*Than, Madaico*	40
18	Gujarat	-	29
19	Jharkhand	*Sarana*	29
20	Madhya Pradesh	*Devkot, Matikot, Devsthali, Budhadev*	21
21	Uttaranchal	*Deo Bhumi, Bugyal* (sacred alpine meadows)	18
22	Rajasthan	*Orans, Kenkris, Jogmaya*	6
Total			**15397**

Source: Envis Centre of *C.P.R. Environmental Education Centre* (http://www.ecoheritage.cpreec.org/04_02__sacred_groves.html)
Source: "Cultural and Ecological Dimensions of Sacred Groves in India" by Malhotra *et al*., 1998)

1.2 Sacred groves in Kerala

There have been attempts to document the sacred groves of Kerala (Induchoodan, 1990; Rajendraprasad, 1995; Jayarajan, 2004). Studying the floristics of sacred groves in the fourteen disricts of Kerala, Induchoodan (1990) had listed about 361 sacred groves in the fourteen disricts of Kerala State with a total area of about 342 hectres. Table 2 gives the number of sacred groves, which are more than 200m^2. There were also some studies looking into the flora of the sacred groves of Kerala.

Table 2. Number of documented sacred groves in the districts of Kerala

Sl.No.	Districts	No. of SGs	Area (ha)
1	Thiruvanathapuram	43	1.8
2	Kollam	44	6.8
3	Pathanamthitta	33	15.9
4	Alappuzha	49	19.2
5	Kottayam	10	2.2
6	Idukki	3	6.5
7	Ernakulam	7	12.2
8	Thrissur	16	3.5
9	Palakkad	3	5.2
10	Malappuram	11	8.4
11	Kozhikode	23	27.9
12	Wayanad	5	109.3
13	Kannur	54	100.2
14	Kasaragod	60	23.8
Total		**361**	**342.9**

Source: Induchoodan (1990)

Each grove has a presiding diety generally of a mother goddess attached to it. In order to preserve both the environment and sanctity of the grove, several taboos and customs laid down way back in the past are still existent. Amirthalingam (2004) studied a total of 448 groves from 28 districts of the State of Tamil Nadu in order to understand size, cultural practices and vegetation of the groves. Sacred groves have existed in Kerala from time immemorial as patches of densely vegetated areas set aside on religious grounds and are distinct and unique in their biological diversity. Rajendraprasad, (1995) conducted a doctoral study on the floristic, structural and functional analysis of Sacred Groves of Kerala. Population pressures have led to exponentially increasing demands for natural resources resulting in the shrinkage of the area of self sustainable ecosystems.

Iringole Sacred Grove (10^0 10' to 10^0 43' N. Lat. and 76^0 15' to 76^0 53' E. Long.) is one such specialised and fragile ecosystem, located within the dense human habitations of Perumbavoor Municipal area in Ernakulam District of Kerala State, covering an area of 10.53 hectares. It is about 40 meteres above msl and falls within the midlands of the State, mostly surrounded by agricultural lands and habited area. Only scanty information is available on the

floristic, faunistic and vegetation aspects of the grove and practically no data is available on its physical components, namely soil, water and air. The human aspects of the grove, either by way of dependence or management, is also little known except for a preliminary stakeholder analysis done for three sacred groves including that of Iringole. Hence, there is no detailed and exhaustive study conducted on the total floral and faunal wealth of the grove-land vegetation structure and dynamism.The characteristics and composition of the soil that support the biodiversity on a sustainable basis, types of human influences and inputs in protecting the ecosystem over a very long period of time are not fully known. The linkages among the biological, physical and human components of the ecosystem, if worked out, the data can serve as a model to restore hundreds of degraded sacred groves in the State and country, situated in similar eco-climatic conditions. The human dimensions which operate in the sacred groves is also one of the most important aspect which decides the level of management and also degree of degradation. Therefore, a through knowledge of the biodiversity content status, structure, dynamism and functioning of the ecosystem, physical parameters and human dimensions operating in the grove will be of much applied value.

1.3 Objectives of the present stud are:

1. To analyse qualitatively and quantitatively, the biodiversity, structure, dynamism and functional aspects of the ecosystem, and to characterise the physical, chemical and microclimatic parameters of the sacred grove.
2. To generate data on the cultural, religious and traditional background of the grove and to examine the human dimensions and present management aspects which sustain the ecosystem.
3. To analyse and organize the data on a GIS platform and establish the linkages among various parameters of the ecosystem.
4. To empower the management systems of the sacred grove for further monitoring.

2. STUDY AREA DESCRIPTION

2.1 Historical Significance

The Iringole Sacred Grove (ISG) is perhaps the largest and the best preserved among all the sacred groves in the State and the country, with an extent of about 10.53 hectares, covered by semi evergreen vegetation. ISG represents a traditional 'nature worship' landscape in which natural ecosystems are devoted to ancestral spirits and deity's thereby providing protection and conservation in its most traditional form. This system of protection based on absolute belief has over a period of time undergone changes.

History of the evolution of the ISG into its present stage reveals the Grove as an age old institution with many myths and legends. It is believed that the name 'Iringole' comes from a legend in *Dwaparayuga.* The Hippocrates felon Kamsan imprisoned *Devak*i and *Vasudevan* for fear of his terminator who is to be their eighth son as destiny foretold. In fear and fury he did away with all the seven new borns. In an attempt to save his eight born, Vasudeva shifted his son to Dwaraka and replaced him with a new born baby girl. In an attempt to kill, Kamsan lifted the baby wrathfully above his head, but, to his surprise miraculously the baby ordained with supernatural powers remained in the air and proclaimed that destiny will unfold as destined and then came down to the land where she has been established as the deity in the ISG. It is further believed that the gods and goddesses surrounded her with immense power in the form of trees and climbers and that formed the beautiful thick evergreen forest centuries ago. Over a period of time the ecosystem surrounding the SG has changed drastically as a consequence of both manmade and natural factors.

Another myth connected with its origin is the cultural linkage of the grove with the traditionally associated community, namely, the '*Pulayas*'. It is believed that once a pulaya woman (labourer) while sharpening her sickle on a nearby stone noticed blood on the stone. It was realized to be a divine indication and the same is today worshipped as the ruling deity *vana durga* and there is a temple of the goddess in the central part of SG. As faith holds it is believed that the deity exists in three forms of power throughout the day, i.e., as Goddess

Saraswathy (the power of Knowledge) in the morning; as Goddess *Vana Durga* (the power of forest) at noon and as *Bhadrakali* (the power of fury and termination) at night. There are many strong beliefs associated with the Goddess. There are many restrictions put in place regarding the conduct of traditional rituals and festivities in the ISG. They are also not allowed to remove any item from the Grove, as it is believed that, in doing so ill fate will fall upon by way of diseases, death or other calamities in their family and the local population at large.

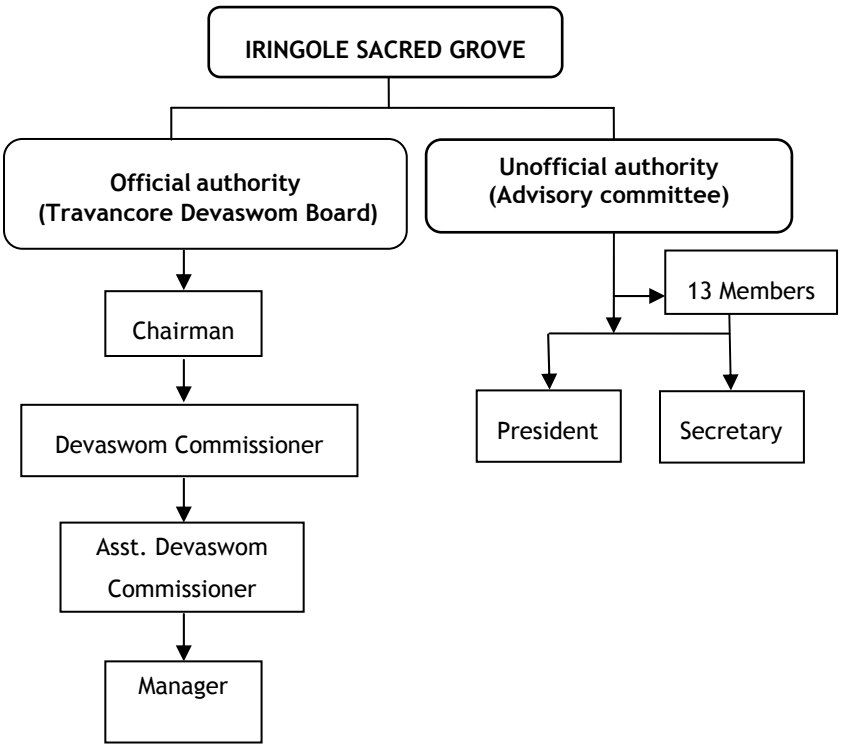
There are a few field bothy of the erstwhile Boothathankettu irrigation system which passes along the northern border and the eastern part of the sacred grove. This has a great role in maintaining the water table in the sacred grove and the peripheral areas. During February 2009 it was seen that water is let through the canal system three days in a week (i.e. Monday to Wednesday), which is sufficient enough to recharge the open well and the surrounding areas and also the ponds in the grove area.

2.2. Legal Status and Management

The ISG is managed by the Temple Trust. The temple within the ISG was once owned by 32 Illoms (*residence of Brahmins)* and they were considered the major stake holders of the SG. Now, there exists only three main Illoms, namely, *Naganchery, Pattassery* and *Orozhium*. Originally, the sacred grove belonged to a Brahmin family called Naganchery mana, the remnants of which are seen in the vicinity of the grove. Currently, although the temple is under the administration of Travancore Devaswom Board the members of the Illoms are treated with due respect and given a place of importance in all the festivals and rituals of the Grove. The area and the temple belong to a Trust formed by the local people, who manage the place of worship and protect the rich biological and physical heritage of the Grove. The Trustees of the temple are vigilant to ensure that nothing untoward, which affects the sanctity of the temple and the Grove, is happening and they are also practicing a sustainable and time-tested management system to preserve it, as evident from the overall pristine status of the ecosystem, located in the suburbs of the thickly populated Perumbavoor Municipal Town.

The ISG is currently managed under two heads (Box 1). One is the management by the Travancore Devaswom Board and the other is an Advisory Committee of the local community. The Advisory Committee acts as a representative body of the devotees. It coordinates and monitors financial aspects with respect to the festivals, functions, and also any other unauthorized activities.

Box.1. LEGAL STATUS & MANAGEMENT



The Advisory Committee has been developed on the recommendations of the High Court for every year. The manager has the sole power to decide on the committee members. The manager notifies a particular day for the election and selects a panel of 26 members from the local people who are devotees of the grove and are also willing to cooperate. Among 26, 13 members are selected by the lot method. The committee constituted decides the President and Secretary of the advisory committee. The manager himself acts as the treasurer. Assistant Commissioner and subgroup officer are the other statutory members of the committee. The Advisory Committee with its members together participate in fulfilling the objectives (Box 2)

in the conduct of day-to-day administration as well as other temple related activities. The Committee's efforts via the people in conserving the ISG is very powerful, cost-effective and socio-culturally invaluable.

Box 2. OBJECTIVES OF THE ADVISORY COMMITTEE

- to conduct all festivals/rituals other than day to day activities which are conducted by Devaswom Board.
- To point out mismanagement of any officials.
- To act as a representative body of the Devotees.
- To co-ordinate the financial support to the festivals, functions etc

In general, various castes and communities such as Namdoodiri, Nayar, Nambiar, Asari, Tiya, Pulayan, Thattan, and others, involve themselves in different ways during the religious functions and other occasions. The Board employees, (i.e., the Shanthi, Kazhakam, Vadhyakar, Watcher, Sweeper and the mahout) are on a pay roll and are engaged in the day-to-day activities of the sacred grove.

3. METHODOLOGY

3.1 Plant Diversity

For vegetation analysis complete enumeration method were followed. For convenience and systematic study site map were prepared. Area was demarcated into 50m x 50m grids for data collection on different aspects of the investigation. Based on the sampling design (50x50 m for trees, 5x5 m shrubs and 1x1 m for herbs), sample plots were laid out to gather data on species diversity. Structural data were collected from 52 plots (Fig. 1). Among 52 plots 26 are full plots of size 50 X 50 m and 26 partial plots at the periphery of the grove with varying sizes.

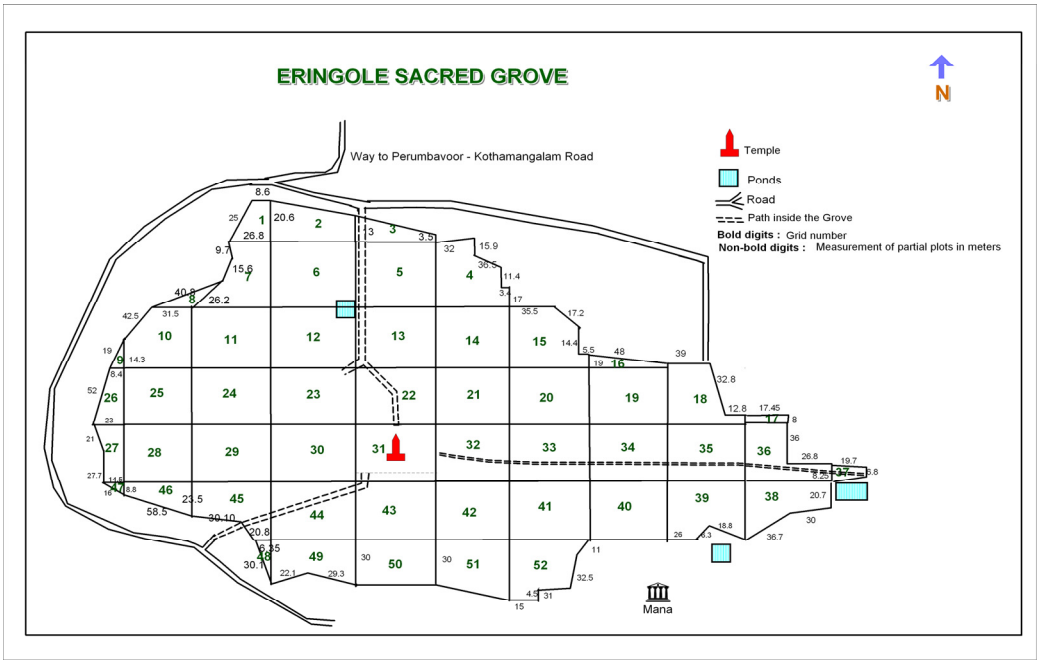


Fig. 1. Grid map of the study area with topographical details.

Following are the phyto sociological parameters worked out for each plots using the formulae (Philips, 1959; Misra, 1968) given against each. Importance Value Index (IVI) of various species was also worked out as the sum of Relative density, Relative frequency and Relative dominance of each of them.

Density = Total no. of individuals
Total area sampled in m^2

Frequency = No. of occurrence of each species x 100
Total no. of quardratrs

Abundance = Number of quadrats of occurrence
Number of individuals belonging to species i

Basal Area (BA) $=\frac{(gbh)^2}{4\pi}$ [π=3.14]

Relative density = Density of each species x 100
Total density of all species

Relative frequency = Frequency of each species x 100
Total frequency of all species

Relative dominance = BA of each species x 100
Total BA of all species

Based on the phytosociological data analyzed for the above aspects, species diversity, species dominance, species richness and species evenness were calculated using the following indices.

i. Shannon index of species diversity (Margalef, 1968)

$H' = -\sum\{(ni(ni/N) \log (ni/N)\}$

ii. Simpson's index of dominance (Simpson 1949)

$\lambda = \sum(ni(ni-1)/N(N-1)$

iii. Menhinick's index of species richness

$R = S/\sqrt{n}$

iv. Pielou's index of species evenness (1975)

$E = H'/\log S$

Where,

H' = Shannon index of species diversity

Ni = Number of individuals of species,i

N = Total number of species in the community.

λ = index of dominance

S= Total number of species in the community

R = Richness index

E = Evenness index

3.2. Sampling of insects

The study was carried out in representative grids of 50×50 m size. There were a total of 52 grids, including 26 full grids of 50 x 50 m size and 26 partial grids of various sizes (Fig.3). The sampling was done based on direct observation, photography or by collecting dead insects from shades of light since direct collection of material was not allowed. Diversity parameters were studied for the vegetation which is predominantly of semi-evergreen type.

3.3. Girth class distribution pattern

All the plants above 15 cm in girth at breast height (1.3 m), were enumerated to analyze the diameter frequency distribution and regeneration pattern.

3.4. Analysis of data

3.4.1. Diversity index

The quantification of diversity must address two statistical properties common to any mixture of different objects. The first property is the number of different classes or types of objects *i.e*., species, genera, families, different habitats and so on. The second property is the distribution of objects among classes, such as the relative abundance of individuals of different taxa or the relative area of the habitat that falls into different habitat types. In this study, only species diversity was studied. For this, the Shannon-Weiner diversity index (H) was used (Margalef, 1968):

$$H = -\sum_{i} Pi \log e (Pi)$$

Where 'H' is the Shannon's index of species diversity and Pi is the proportion of individuals in the i^{th} species.

3.4.2. Dominance index

Patterns of relative abundance of species which determine the dominance of each insect Order in a locality was estimated by calculating the dominance index using the following formula:

$$\text{Relative dominance} = ni \times \frac{100}{N}$$

Where ni = number of insects in the i^{th} Order, and N = the total number of insects in all the orders collected during the study period.

3.4.3. Evenness or equitability index

This index which measures the evenness of species abundance is complimentary to the diversity index concept and it indicates how the individuals of various species are distributed in the community.

For estimating evenness, Shannon's evenness index was calculated. Mathematically, the evenness of frequency distribution of species abundance in a community with 's' component species, is the degree to which it approximates the uniform distribution for 's' species i.e., equal abundance of all species in the sample or community (Pielou, 1977).

The Shannon's evenness index of the community (E) was calculated following Pielou (1975).

$E = H / \log e (S)$

Where 'S' is the number of species recorded and 'H' is the Shannon-Weiner index of diversity.

In a collection or in a community with 's' component species, diversity will be greater if all 's' species are well represented. In this condition, there is high evenness and low dominance. On the contrary, if a few of the species, say 't' are very common and the rest (s-t) are very rare, then it is a case of low evenness and high dominance.

3.4.4. Species richness index

The index of species richness (d) was calculated using the formula given by Menhinick (1964):

$d = S / \sqrt{N}$

Where 'S' is the number of species recorded and 'N' is the total number of individuals summed over all species.

3.4.5. Study Area and sampling structure

Iringole Sacred Grove presently extends to an area of 10.53 hectares and is located 10^{o} 06'31.20 N; 76^{o} 30' 01.54 E. Topographically, it is almost a plain land, surrounded by human habitations and cultivated areas, especially of plantation/cash crops like rubber, pineapple, jasmine, etc., as part of the homesteads. The Grove is under the administration of Travancore Dewasom Board with its headquarters at Thiruvananthapuram. Almost all around the borders of the Grove, there are roads connected to the Aluva-Munnar road, with in a distance of about

one kilometere (Fig. 2). In the central part of the Grove is located the ruling diety *Eringol Kavil Amma,* who is considered as *Vana Durga*.

Fig.2. Iringole Sacred Grove with paths around and the main entrance.

The temple complex is spread in an area of about 50x50 m with a wall all around, separating it from the natural vegetation of the grove (Fig. 3). Other constructions in the Grove include a small office building adjacent to the compound wall of the temple towards its northern side and an elephant shed, where a female elephant owned by the temple is retained for the rituals of the temple. Near to the elephant shed, there is also a public toilet facility. A small hut to store items for daily fireworks is also available on the eastern part of the compound wall of the temple. An overhead tank which stores water drawn from a well with protection wall and roof is situated towards the southern part of the grove with underground pipe line from the well to the overhead tank. It is from this well that water is taken for the rituals of the temple. There is also a perennial pond within the grove, towards its northern side, adjacent the main pathway leading to the main entrance of the temple. In addition, there are two other smaller ponds on the eastern and southern sides of the grove. A concrete channel is provided from the western part of the Grove towards the drainage facility available outside the grove. There are

trekking paths of about 2 m width on eastern, northern and south-western sides of the grove connecting the temple and the road network outside the grove. Temporary sheds are also erected from time to time for cooking and providing food to the pilgrims as part of the rituals of the temple. The North-West boundary of the grove is provided with compound wall of about 2 m height, whereas, all other sides are almost open and free to access with several ingoing foot paths.

Fig. 3. The temple in the central part of the Grove.

The approximately 10 hectare Grove area is almost plain with only slight undulations of about 1-2 m gradient from West to East. For data collection on a very systematic pattern, the whole area was divided into grids of 50m x 50m size. There were a total of 52 grids, including 26 full grids of 50 x 50 m size and 26 partial grids of various sizes towards the periphery, with varying dimensions as given in the Grid map of the area.

The grids are demarcated in the field, either by stumps or by painting on the standing trees along their boundaries and corners, for long-term data collection on the flora, fauna, human dimensions and physical parameters. The boundaries of the partial grids 1, 2, 3, 4, and 15 are with compound wall of about 2 m height and almost all other partial grids are open to the roads around. The temple is located in Grid No. 31 and the Office Building and the Elephant shed are in the Grid No. 22 . The main pond in the Grove, located near to the North-western

entrance to the temple, is situated partly in Grids 6 and 12. The two other ponds, towards the eastern and southern boundary of the Grove are included in Grid Nos. 37 and 39. The Main entrance in the North-Western part of the Grove passes through the Grids 22, 13, 5 and 3. The eastern entrance of the temple traverses the Grids 32, 33, 34, 35, 36 and 37. The South-western entrance path to the temple passes through the Grids 30, 44 and 45. The main well used for drawing water for the temple is with in Grid No. 45 and the overhead tank is located with in the Grid No. 22 (Fig. 1).

Based on the sampling design and plots of 50m x 50m for trees, 5mx5 m for shrubs and 1mx1 m for herbs; vegetation data were gathered periodically for structural and functional analysis, including the species diversity. The data gathered from 26 full sample plots of 50m x 50m were analyzed (Given in Appendix) for structural details by standard phytosociological methods (Muller-Dombois and Ellenberg, 1978).

3.5. FUNGAL DIVERSITY

3.5.1. Macrofungal sampling

The sacred grove was visited during pre-monsoon (December- May), monsoon and post-monsoon periods (June-November) frequently for documentation of the macrofungi. These activities include: collecting sporocarps at the field site, labelling them, taking photographs, chemical spot tests, setting up spore- prints, recording the macro-morphological data in the Illustrated Data Sheet, writing morphological descriptions, details on substratum, and processing the specimens for recording microscopic characters and identification of the specimens up to species level. Quantitative data on macrofungi were also recorded from the grove periodically for biodiversity analyses.

3.5.2. Data sheet

Illustrated Data Sheets (IDS) for recording the morphological and microscopic characteristics of the specimens were prepared (A4 sheet) for Polypores, Agarics and Ascomycetes separately incorporating line drawings on various characteristics of pileus (shape, size, colour, surface ornamentation), stipe (shape, size, surface characteristics), gill attachment,

lamellae, lamellulae, annulus, volva, etc. Most of the characteristics were recorded in the field during the collection. Filled in IDS for each specimen was kept as record along with spore-print slide and processed specimen for further microscopic details.

3.5.3. Protocols for sampling macrofungi

Macrofungal collection: For many taxa it is important to have data on all stages of sporocarp development. Thus, sporocarps exhibiting a range of developmental stages for each taxon were collected as far as possible. Specimens were photographed and removed from the substratum by excavating around the base of the stipe to reveal any volva, rooting base, bulb, or attachment to a sclerotium or buried substrata, e.g. wood, fruits, other fungi and insect/animal). If the specimen was on wood or litter, including some parts of the substratum was collected for facilitating its identification. Digging the substratum was done to collect the underground specimens and rhizomorphs.

Documentation: As fleshy fungi are particularly difficult to work with as the fruiting bodies dry or decompose rapidly, characteristics needed for identification often lost; many macro-morphological features such as shape and colour of sporocarps are lost with preservation. Illustrated Data Sheets (IDS) for recording the morphological and microscopic characteristics of the specimens were prepared (A4 sheet) for Polypores, Agarics and Ascomycetes separately incorporating line drawings on various characteristics of pileus (shape, size, colour, surface ornamentation), stipe (shape, size, surface characteristics), gill attachment, lamellae, lamellulae, annulus, volva, etc. Most of the characteristic were recorded in the field during the collection. Specimen documentation included details on cultures (only for potential species), data on chemical tests, photographs, spore-prints, and written descriptions. Field labels were provided for each specimen. As all taxa or specimens require equal documentation, specimens were put into priority order by taxon; within each taxon they are processed in the order, according to condition of the specimens (best to poorest). Filled in IDS for each specimen was kept as record along with spore-print slide and processed specimen for further microscopic details.

Colour photographs: Colour photographs (digital images taken with 8 megapixel digital camera) of sporocarps were taken in the field and also of specimens brought to the laboratory. Specimens were photographed on neutral grey or natural background in a way that illustrates important diagnostic features of the sporocarps and allow easy comparison.

Macromorphological features: Descriptions of macromorphological characteristics (e.g., colour, shape, size, odour, surface ornamentation, texture, etc.) of sporocarps are among the most critical data for identification of agarics, boletes and other macrofungi. These were recorded on IDS. Accurate and consistent notation of sporocarp colour, including colour changes of mature sporocarps, colour changes on bruising was also recorded. The colour guide by Kornerup and Wanscher (1978) was used for the purpose.

Spore-print: Spore deposits were prepared on microscopic slides to determine the spore print colour. Spore deposits were obtained by placing a small portion of the fruiting body with hymenial surface touching the glass slide. In the case of agarics, cap was removed from the stipe and placed on a clean slide. The setups were placed in a humidity chamber for 6 to 12 h. The colour of the spore print was noted immediately.

Processing of specimens: Most agarics and other fleshy fungi require a heat source for drying; large agarics and boletes were split in half or quartered from top to bottom before placing in a dryer. For most polypores and ascomycetes, air drying is preferable, because, the fungus is not killed but merely goes dormant. These specimens subsequently can be used for preparing cultures. For the first few months of the study, oven-drying of the specimens was done. Later, freshly collected specimens were kept in open dish/tray at 5 ^{0}C for 5-7 days and this method was found most desirable for preserving the important micro-characteristics of the specimens. After proper air drying/oven drying the specimens were stored in polythene zip-cover.

3.5.4. Culturing macrofungi

Cultures are often required in distinguishing similar taxa and identifying the species. Cultures are especially important for some groups of Ascomycetes in which the anamorph is required for accurate species identification. Cultures of macrofungi were prepared from tissues or

from germinated basidiospores or ascospores. Cultures of ectomycorrhizal fungi like Laccaria, Pisolithus, Scleroderma and potential edible and medicinal mushrooms (Ganoderma, Laetiporus, Macrocybe, Pleurotus, Lentinus, etc.) were prepared on Malt extract agar, Oatmeal agar and Potato dextrose agar medium.

Micromorphological features: Sections of the tissues from different parts of the basidiomes were cut by hand or Cryostat Microtome and observed under Research Microscope. Different stains including Melzer's reagent, Phloxin, Cresil blue, Aniline blue, etc. were used and micro-morphological features of the fungus, including hyphal system, size, colour, hymenium (fertile layer – basidia and cheilocystidia, pleurocystidia) and pileipellis or periderm (cap cuticle), hymenial trama, caulocystidia, veil remnants, pileus, stipe trama, spore wall structure and spore ornamentation, size, shape, inclusions, etc. were recorded. Line drawings of fungal structure were made by using Phototube of the Microscope. Digital photographs of the fungal structures were also made.

Colours and chemical reactions: Chemical colour reactions or spot tests have been used for identification of boletes as well as other macrofungi. Colours and chemical reactions of tissues and spores in water, KOH, NH_4OH, $FeSO_4$, HCl, Melzer's reagent, etc. were studied and used for identification of the taxa.

3.6. Invertebrate studies

The less mobile invertebrates such as three millipedes (Giant millipede, Black millipede and Pill millipede) and rare *Poeicilotheria straiata* tiger spider was observed in the grids and the abundance recorded approximately by visual encounter method. The breeding of *Poecilotheria straiata* was observed during July-Septembr 2009 from the grove.

3.7.Avian studies

Observations on birds were made on two days in each month. As the study area is small in size the method of total count was employed. The birds were identified up to species level and the location of each bird was marked in grids. Along with the species identity, the

number of birds in each sighting, the activity of the bird and any other pertinent observations on the bird were also recorded. No detailed report on the status of avifauna in the Iringole Sacred Grove is available. The objective of this study was to document the diversity of avifauna in the Iringole Sacred Grove including endemic or endangered avifauna of the grove and also to conserve it. Travancore red spur fowl (*Galloperdix spadicea*) was observed from February 2007 to February 2008 and the breeding season and behaviour was recorded.

3.8. Soil and litterfall studies

Soil samples were collected from selected plots in different regions of the grove up to a depth of 120 cm using soil auger and processed and analysed for pH, OC, K and P following standard procedures. Additional surface samples were taken from all the plots. Litter fall was also quantified from North, South, East and West regions of the grove every month.

4. RESULTS

4.1. Vegetation structure

The vegetation type of the Iringole Sacred Grove was reported as West Coast Tropical Evergreen type by Champion and Seth, 1968. The vegetation is slowly changing to semi evergreen type in which several species are common in evergreen forest and some of the tree species in the moist deciduous forest are also seen. The dominant tree species are *Artocarpus hirsutus, Hopea ponga, Vateria indica, Strombosia ceylanica, Hopea parviflora, Polyalthia fragrans, Mesua ferrea, Holigarna arnottiana, Myristica malabarica, Antiaris toxicaria, Cinnamomum malabatrum, Xanthophyllum arnottianum*, *Adenanthera pavonina, Caryota urens* and so on. *Vateria indica – Hopea parviflora - Hopea ponga* association is a notable feature of the Grove. Presence of several climber and straggler species is a conspicuous feature of the Grove. *Gnetum edule, Cissus latifolia, Combretum latifolium, Dalbergia horrida, Sarcostigma kleinii, Grewia umbellifera, Acacia caesia, Caesalpinia cucullata, Kammetia caryophyllata, etc*., are the common lianas of the Grove. The ground flora of the Grove is also quite rich with several herbaceous species along with the regeneration of the canopy species. Many wild relatives of the cultivated plants like ginger, pepper, turmeric, *Cinnamomum, Myristica, Amorphophallus, Dioscoria,* etc., are also found in the grove and this may constitute precious gene pool valuable for genetic enhancement of these cultivated species. The medicinal plants such as *Costus speciosus, Curcuma aromatica, Alstonia scholaris, Asparagus recemosus, Gloriosa superba* and so on were also found in the grove. The pioneer and fast growing species such as *Mallotus philippensis* and *Macaranga peltata* were also seen, wherever the openings due to tree fall and also along the boundaries. The weed *Mikania* is invading, especially in peripheral regions of the grove. The dense vegetation of the Grove is almost divisible into different canopy layers with species composition as described in the following paragraphs.

4.1.1. Top canopy

This layer, above 20 m high, dominates the vegetation type and is with a few emergent tree species apart from the typical species which constitute the canopy layer. The layer is composed of species like *Hopea parviflora, Hopea ponga, Vateria indica, Artocarpus hirsutus, Mesua ferrea, Polyalthia fragrans, Antiaris toxicaria, Cinnamomum malabatrum, Syzygium cumini* and *Holigarna arnottiana.* Among them *Vateria indica, Hopea parviflora, Hopea ponga, Artocarpus hirsutus, Mesua ferrea* and *Polyalthia fragrans* are the common emergent species which constitute the major components of the layer. Lianas and stragglers also reach the upper canopy layer forming a closed canopy, competing for light and space. The climbers such as *Gnetum edule, Cissus latififolia , Sarcostigma kleinii* and *Acacia caesia* are the major components of the upper canopy. Epiphytic species of orchids, ferns, fungi, lichens, etc are also common in the trunks of the trees constituting the tier. *Drynaria quarcifolia* is the common pteridophyte on *Hopea parviflora. Acampe ochracea, Luisia tristis* and *Cleisostoma tenuifolium* are the major epiphytic orchids of the top canopy.

4.1.2. Sub canopy

This stratum is within the height range of 15-20 m and is mainly composed of medium sized trees like *Strombosia ceylanica, Xanthophyllum arnottianum, Macaranga peltata, Aglaia elaeagnoidea, Myristica malabarica, Strychnos nux-vomica, Mimusops elengi, Mallotus philippensis, Ficus callosa, Litsea coriacea, Trema orientalis, Wrightia arborea, Ficus hispida, Tabernaemontana alternifolia, Celtis philippensis, Caryota urens* and *Hydnocarpus pentandra.* Different growth stages of the top canopy species are also common in this tier, when they attain pole size and above.

4.1.3. Shrubaceous layer

The shrub layer of the vegetation is composed of mostly seedlings and saplings of tree species of top and sub canopy layers, apart from typical shrubs like *Memecylon molestrum, Psilanthus travancorensis, Ixora nigricans, Psychotria flavida, Antidesma acidum, Chassalia curviflora, Ixora lanceolaria, Nothopegia travancorica* and *Leptonychia caudata.* In general, typical shrubaceous species are poor in this layer and is dominated by the regenerating

saplings of tree species like *Holigarna arnottiana, Artocarpus hirsutus, Hopea ponga, Vateria indica, Mesua ferrea,* and so on. The area where top canopy is open, constitutes the rich growth of the shrub layer, *Clerodendrum paniculatum, Clerodendrum infortunatum* and *Senna tora* were showed rich growth in the open areas of a plot. Stragglers such as *Ziziphus rugosa, Zizipus oenoplia* and *Cansjera rheedei* were less frequent in the grove also were shown shrubby growth over long period of their life. In some of the disturbed grids, species content of the layer is very poor; making the vegetation very sparse, whereas in most of the grids where regeneration is good, the shrubaceous layer is species rich.

4.1.4. Ground flora

Ground flora of the Grove is rather scanty, except in areas where gaps formed by fallen trees or along the criss-cross path ways inside the grove. The herbaceous growth is prevalent during the months of June to September-October. Species common in the layer are *Geophila repens, Begonia trichocarpa, Globba sessiliflora*, *Torenia bicolor, Curcuma ecalcarata, Stachyphrynium spicatum, Amorphophallus commutatus, Impatiens minor, Murdannia japonica, Justicia wynaadensis, Spermacoce ocymoides*, *Ophiorrhiza mungos*, *Cyathula prostrata, Costus speciosus, Murdannia japonica, Pogostemon purpurascens* and *Eranthemum capense.* The major grasses such as *Allepteropsis cimicina*, *Oplismenus compositus, Centotheca lappacea, Axonopus compressus,* and *Chrysopogon aciculatus* and sedges like *Cyperus rotundus, Cyperus castaneus*. *Seidenfia rheedei* and *Zeuxine longilabris* are ground orchids, rarely occurring in the grove.

4.2. GYMNOSPERMS and ANGIOSPERMS

Exhaustive data on the gymnosperm and angiosperm flora of the Sacred Grove is practically lacking and the data generated as part of the present study is exhaustive, covering all seasons of the year. The vegetation of Iringole is of the wet evergreen type, dominated by lofty trees with their rich regeneration at ground level. Therefore, the ground flora, usually composed of herbs and shrubs, is rather very poor in the area, both in number of species and the also the population of individual species. The total number of gymnosperm species available in the

area is only two, of which *Araucaria heterophylla* is represented by only a single plant, which again is planted. It may also be noted here that *Cycas circinalis*, very common in the midland region of Kerala, wherein Iringole is also situated, is totally absent from the Grove for unknown reasons. With regard to angiosperms, the total number of species occurring in the Sacred Grove is 210 taxa, belonging to 177 genera and 80 families. Among them, 9 families, 25 genera and 30 species are monocotyledons and the remaining 173 species and 4 infraspecific taxa coming under 150 genera and 69 families are dicotyledons (Table 3.). The gymnosperm and angiosperm taxa recorded from the Sacred Grove during 2006, 2007 and 2008 are listed in Appendix I.

With regard to endemics, Induchoodan and Balasubramanian (1991) has mentioned a few such species in the sacred groves of Kerala bringing out the potential of the relict ecosystem as saviors of endemic taxa. With regard to endemic species in the Iringole Sacred Grove, the gymnosperm species *Gnetum edule* and angiosperm taxa like *Cinnamomum malabatrum, Artocarpus hirsutus, Connarus sclerocarpus, Dalbergia horrida, Holigarna arnottiana, Hopea ponga, Hydnocarpus pentandra, Kammettia caryophyllata, Litsea coriacea, Myristica malabarica, Psychotria flavida, Theriophonum infaustum, Vateria indica* and *Xanthophyllum arnottianum* are few examples with restricted distribution in the Western Ghats or Peninsular India. Details of representations of different taxonomic groups in the flora of the Sacred Grove are summarized in the Table 3.

Table 3. Details of gymnosperms and angiosperms in the flora of Iringole Sacred Grove

Plant groups	No. families	No. genera	No. species	No. sub species./vars.
Gymnosperms	2	2	2	0
Dicotyledons	69	150	173	4
Monocotyledons	9	25	30	1
Total	**80**	**177**	**205**	**5**

The dominant family was Rubiaceae with highest number of species. Eighteen taxa belonged to this family, followed by Euphorbiaceae (12); third dominant family was Poaceae consisting of 10 species, all erect herbs. The other dominant families are as follows: Moraceae (8), Asteraceae (7) Acanthaceae (6), Apocyanaceae (5) and so on (Fig. 4). With regard to dominant genera *Ficus* is the most dominant genus in the Iringole Sacred Grove with 5 species, followed by *Ixora* (4), *Curcuma* (3), *Dioscoria* (3) and *Lindernia* (3).

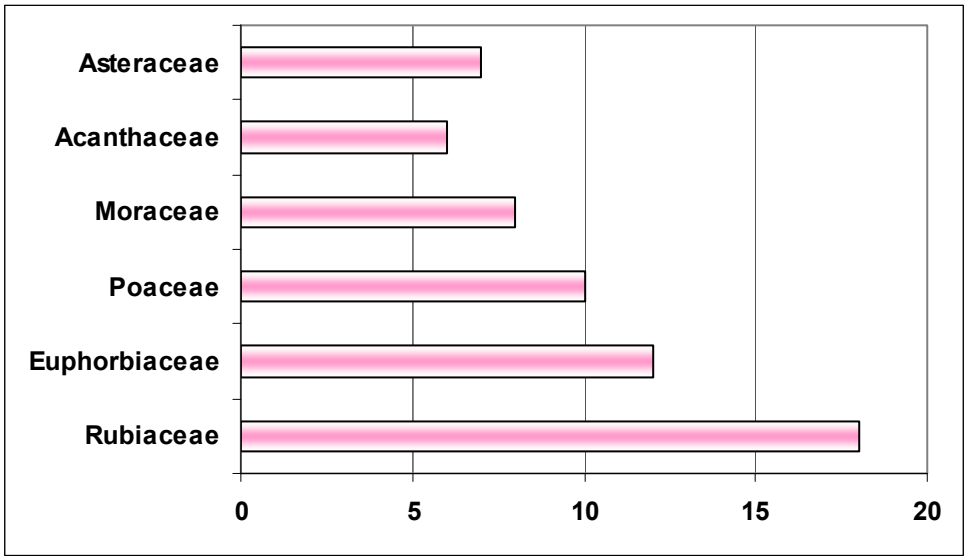
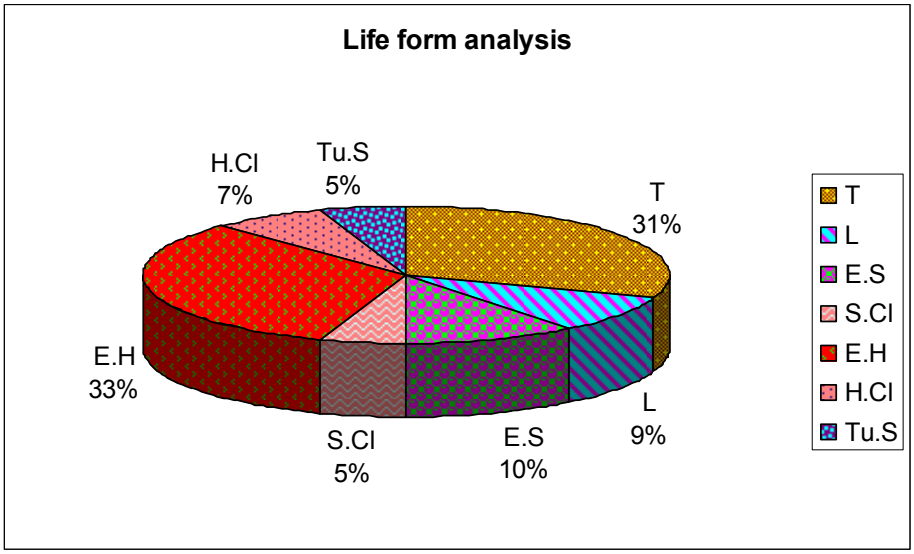


Figure 4 Distribution of flora of Iringole Sacred Grove in different families

4.2.1 Plant Lifeforms

With regard to representation of various life forms in the flora, 64 taxa are tree species (T), 18 taxa are lianas or woody climbers (L), 22 species are erect shrubs (E.S), 11 taxa are straggling or climbing shrubs (S.Cl), 68 taxa are herbs (E.H) and 11species are tuberous (TuS) plants (Fig. 5).



T – Tree, L – Liana, E.S.- Erect Shrub, S.Cl- Straggling of Climbing Shrub, E.H – Herbs, Tu.S.- Tuberous plants

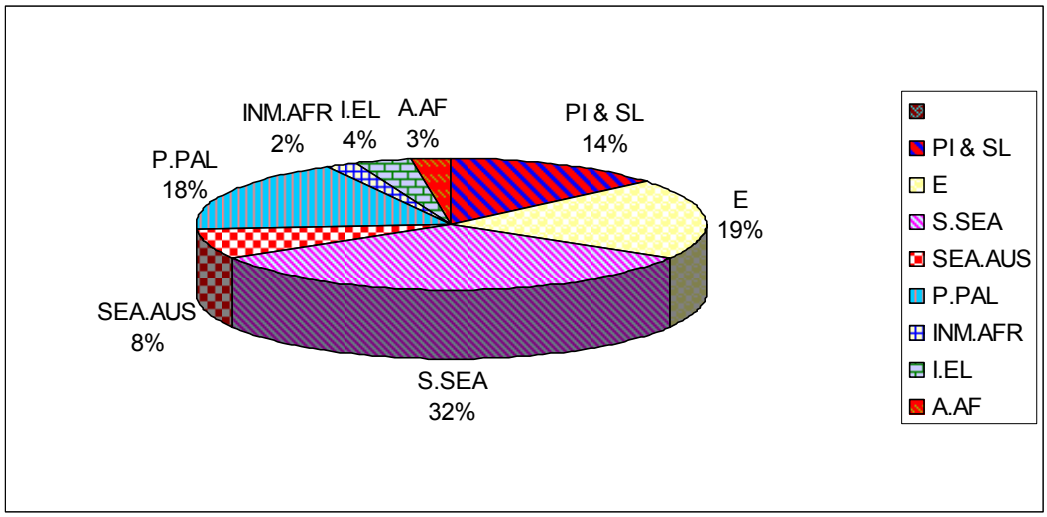
Figure 5 Life form representations in the angiosperm flora

4.2.2. Phytogeographic affinities of the flora

The analysis of flora recorded from Iringole Sacred Grove is distributed in eight phytogeographical regions. Distribution is varies from endemic which limited distribution such as Western Ghats, Peninsular India to Pantropical / Paleotropics which enjoys cosmopolitan distribution.

The presence of land connections and similarity in climatic conditions promoted the distribution of plants from one land mass to another by the natural process of dispersal. The majority of the species belongs to South to South East Asia (32%), the rest, Peninsular Indian/ Sri Lankan species, Endemics and Pantropical species were distributed in almost same pattern.

Based on pattern of distribution the species confined to each region are classified in to i. Endemic, ii. Peninsular Indian/Sri Lankan, iii. South to south East Asia, iv. Indian Elements, v. Indo- Malaya & Africa, vi. Asia to Africa, vii. South East to Australia, viii. Pantropical / Paleo tropical.



Pl & SL – Peninsular India & Sri Lanka, E – endemic, S.SEA – South to South East Asia, SEA. AUS - South East Asia to Australia, P.PAL – Pantropical/Paleotropical, INM.AFR – Indo-malayan & Africa, I.EL – Indian Elements, A.AF – Asia to Africa

Figure 6 Phyto geographical distribution of the flora

4.2.3. Peninsular India/ Sri Lanka

In the flora of Iringole Sacred Grove, there are 27 taxa of flowering plants belonging to 21 families confined to Peninsular India and Sri Lanka. This comes to 14% of the total flora in the area. The taxa confined their distribution in Indian sub continent and the nearest country Sri Lanka. Some of the typical examples are *Ampelocissus indica, Antiaris toxicaria, Aporosa cardiosperma, Begonia malabarica, Cissus latifolia, Commelina diffusa, Curcuma aromatica, Cyrtococcum trigonum, Eranthemum capense, Garcinia gummi-gutta, Gnetum edule, Impatiens minor Uvaria narum, Litsea coriacea, Jasminum angustifolium, Memecylon molestrum Molineria trichocarpa, Mussaenda frondosa, Olea dioica, Phyllanthus airy-shawii*, *Psilanthus travancorensis, Tragia involucrate* and *Macaranga peltata.*

4.2.4. Western Ghat Endemic

In the flora there are about 39 taxa (16%) of flowering plants are confined to Peninsular India. Among them most of the species are Western Ghats endemics. The species which are endemic to Western Ghats are *Amorphophallus commutatus, Artocarpus hirsutus, Canthium travancoricum, Cinnamomum malabatrum, Colubrina travancorica, Curcuma ecalcarata,*

Dalbergia horrida, Grewia umbellifera, Holigarna arnottiana, Hopea parviflora, Hopea ponga, Hydnocarpus pentandra, Ixora brachiata, Ixora lanceolaria, Justicia wyanaadensis, Kammetia caryophyllata, Memecylon randerianum, Myristica malabarica, Polyalthia fragrans, Psychotria flavida, Tabernaemontana alternifolia, *Theriophonum infaustum, Torenia bicolor, Vateria indica,Vepris bilocularis, Xanthophyllum arnottianum* and *Nothopegia travancorica*.

4.2.5. Indo-Malaya & Africa

Indo-Malayan and Africa. There are 4 (2%) species confined to this category. The major species includes *Celtis philippensis* Blanco var.*wightii* (Planch.) Soep., *Evolvulus nummularis* (L.) L, *Spermacoce ocymoides* Burm.f, *Trema orientalis* (L.) Bl.

4.2.6. Pantropical/Paleotropical

A number of species found throughout the tropics belongs to this category, which enjoy wide range of distribution. There are 35 taxa (18%) belonging to this group. The major species included in this category are *Abrus precatorius*, *Ageratum conyzoides, Alloteropsis cimicina, Artocarpus heterophyllus, Axonopus compressus, Cleome viscosa*, *Coffea Arabica, Corchorus aestuans,Cyathula prostrate, Elephantopus scaber, Eleusine indica, Ipomea pes-caprae, Mikania micrantha, Lindernia crustaceae, Oldenlandia corymbosa*, *Mukia maderaspatana, Oplismenus compositus, Peperomia pellucida, Phyllanthus urinaria, Scoparia dulcis*, *Senna tora* and *Urena lobata*.

4.2.7. South to South East Asia

There are 64 taxa (32%) confined to this región and is dominant among the phytogeographic elements of the flora. The taxa include species of South Asia, South East Asia, Indo-Malaya, China, Thailand etc. Typical examples of such plants are *Naravelia zeylanica, Myxopyrum smilacifolium*, *Tectona grandis, Adenanthera pavonina, Allophylus cobbe, Ficus benghalensis, Elaegnus kologa, Diploclisia glaucescens,* etc.

Among this group, Indo-Malesian species have the highest representation. The typical Indo-Malesian species of the flora are *Piper longum, Pongamia pinnata, Sarcostigma kleinii Sida alnifolia, Smilax zeylanica, Sterculia guttata, Strombosia ceylanica, Strychnos nux-vomica, Syzygium cumini, Wrightia arborea, Zanthoxylum rhetsa* and *Zeuxine longilabris, Acacia caesia, Bridelia retusa, Caesalpinia cucullata, Canthium coromandelicum*, *aryota urens, Cayratia pedata*, *Chassalia curviflora, Clerodendrum infortunatum, Clerodendrum paniculatum* etc.

The species such as *Streblus asper* is distributed in India, China and Malesia. Like wise *Seidenfia rheedii* is distributed in India, China, Thailand and Sri Lanka.

4.2.8. Asia to Africa

There are 6 taxa (3%) belonging to this category, they are *Centella asiatica, Centotheca lappaceae, Ipomoea obscura* and *Pouzolzia zeylanica*.

4.2.9. SE to Australia

There are 15 taxa (8%) belongs to this category, they are *Alstonia scholaris, Ailanthus tryphysa, Auracaria heterophylla* and *Chrysopogon aciculatus.*

4.2.10. Indian elements

There are 7 taxa (4%) belonging to this category, geographical regions such as India, Myanmar, and South West India are coming under this category. The including species are *Curcuma caesia, Pajanelia longifolia, Pogostemon pupurascens*, *Saraca asoca* and *Pogostemon pupurascens*.

4.2.11. Endemism

The Western Ghats in Peninsular India is one of the 18 mega biodiversity centers in the world and one of the the three endemic hotspots of the country. It stands foremost in the representation of endemic elements in the Indian flora. An equally important plant group in the flora is the peninsular indo- Sri Lankan species. Even though not strictly endemic, the

group of plants occupies only a very narrow range of distribution, separated by the Indian ocean at present. This group of plants in the flora clearly demonstrates that, in the past, Sri Lanka formed part of Indian sub continent.

4.2.12. Endemism and rarity of the flora

The flora of Iringole Sacred Grove shows high degree of endemism. Of the 210 species recorded from the grove 39 species are endemic to India. Among this 10 species are endemic to Peninsular India, 29 species are endemic to Western Ghats of India. Amonng 29 species 18 are endemic to southern Western Ghats. Among these endemic species of the Grove majority are belonging to the family Rubiaceae (6 species.) followed by Moraceae, Acanthaceae and Dipterocarpaceae, each belongs to two species each.

Table 4 Endemic species of the study area and their distribution pattern

Sl. No.	Species	Family	Endemism		
			P.I	W.G	S.W.G
1.	*Begonia trichocarpa*	Begoniaceae	*		
2.	*Cyrtococcum trigonum*	Poaceae	*		
3.	*Gnetum edule*	Gnetaceae	*		
4.	*Impatiens minor*	Balsaminaceae	*		
5.	*Laportea bulbifera*	Urticaceae	*		
6.	*Litsea coriacea*	Lauraceae	*		
7.	*Memecylon molestrum*	Melastomaceae	*		
8.	*Mussaenda frondosa*	Rubiaceae	*		
9.	*Baccaurea courtallensis*	Euphorbiaceae	*		
10.	*Briedelia stipularis*	Euphorbiaceae	*		
11.	*Grewia umbellifera*	Tiliaceae		*	
12.	*Hydnocarpus pentandra*	Flacourteaceae		*	
13.	*Ixora brachiata*	Rubiaceae		*	
14.	*Justicia wyanaadensis*	Acanthaceae		*	
15.	*Myristica malabarica*	Myristicaceae		*	
16.	*Ophiorrhiza mungos*	Rubiaceae		*	
17.	*Torenia bicolor*	Scrophulariaceae		*	
18.	*Vateria indica*	Dipterocarpaceae		*	
19.	*Xanthophyllum arnottianum*	Polygalaceae		*	
20.	*Tetrastigma sulcatum*	Vitaceae		*	
21.	*Andrographis atropurpurea*	Acanthaceae		*	
22.	*Canthium travancoricum*	Rubiaceae			*
23.	*Cinnamomum malabatrum*	Lauraceae			*

24.	*Dalbergia horrida*	Fabaceae			*
25.	*Hopea parviflora*	Dipterocarpaceae			*
26.	*Ixora lanceolaria*	Rubiaceae			*
27.	*Kammetia caryophyllata*	Apocynaceae			*
28.	*Memecylon randerianum*	Melastomacae			*
29.	*Polyalthia fragrans*	Anonaceae			*
30.	*Psychotria flavida*	Rubiaceae			*
31.	*Tabernaemontana alternifolia*	Apocynaceae			*
32.	*Theriophonum infaustum*	Araceae			*
33.	*Vepris bilocularis*	Rutaceae			*
34.	*Connarus sclerocarpus*	Connaraceae			*
35.	*Nothopegia travancorica*	Moraceae			*
36.	*Amorphophallus commutatus*	Araceae			*
37.	*Artocarpus hirsutus*	Moraceae			*
38.	*Curcuma ecalcarata*	Zingiberaceae			*
39.	*Hopea ponga*	Dipterocarpaceae			*

P.I. – Peninsular India, W.G. – Western Ghats, S.W.G. – Southern Western Ghats

4.2.13. Rare, threatened and endangered species of Iringole Sacred Grove

A total of 12 taxa (Table 5) in the flora of Iringole Sacred Grove belonged to one or other threat categories (IUCN 2008, Nayar, 1996, etc.). They include critically endangered (*Vateria indica*), Endangered (*Hopea ponga, Hopea parviflora*) Vulnerable (*Myristica malabarica, Saraca asoca, Santalum album, Begonia trichocarpa*) Rare (*Ampelocissus indica, Vepris bilocularis, Glycosmis macrocarpa*) Lower risk (*Tabernaemontana alternifolia*) and Threatened (*Molineria trichocarpa*).

Table 5 Flora of Iringole belonging to various threat categories

Species	Recorded status
Ampelocissus indica	Rare
Begonia trichocarpa	Vulnerable
Glycosmis macrocarpa	Rare
Hopea ponga	Endangered
Hopea parviflora	Endangered
Molineria trichocarpa	Threatened
Myristica malabarica	Vulnerable
Saraca asoca	Vulnerable
Santalum album	Vulnerable
Tabernaemontana alternifolia	Lower risk
Vateria indica	Critically endangered
Vepris bilocularis	Rare

4.3. Density (D) of Trees

Maximum density/ha were contributed by the tree *Artocarpus hirsutus* (475 stems) followed by species such as *Hopea ponga* (288), *Strombosia ceylanica*(139), V*ateria* i*ndica*(100), *Holigarna arnottiana* (61), *Polyalthia fragrans* (28), *Mesua ferrea* (26) and so on (Figure 7).

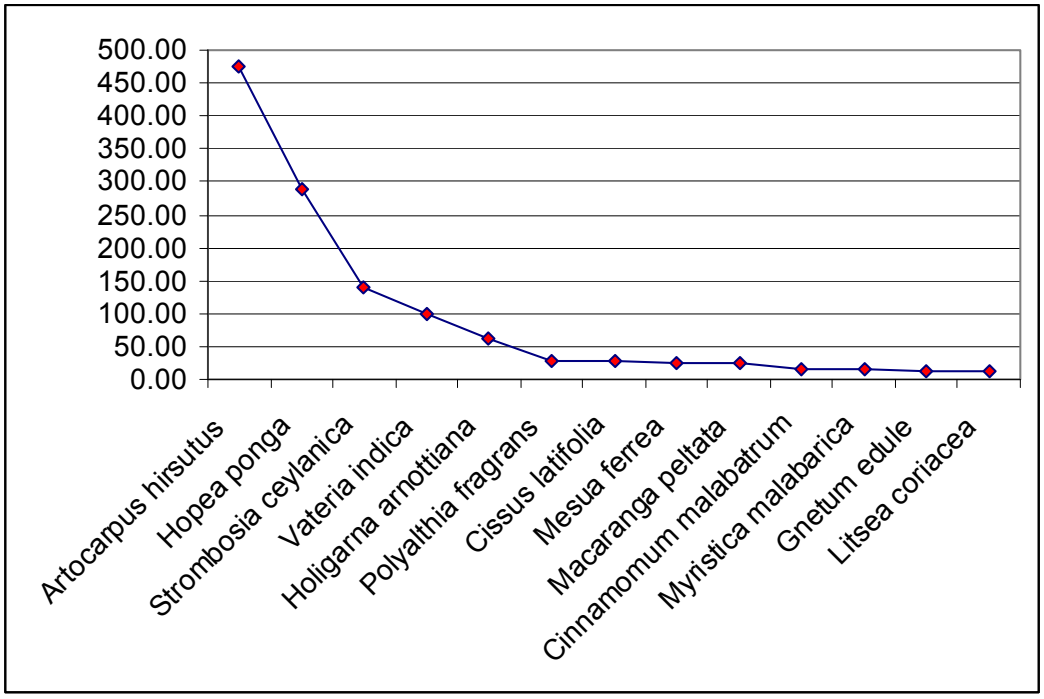


Figure 7 Graph showing the density of the dominant species of the Grove

Among this *Tectona grandis, Tamarindus indicus*, *Baccaurea courtallensis, Kammetia caryophyllata, Ficus benghalensis, Elaeagnus kologa, Carallia brachiata, Canthium travancoricum* are the least dominant species of the Grove, the value of the density of such species is 0.09. They were distributed in the grove as single individuals.

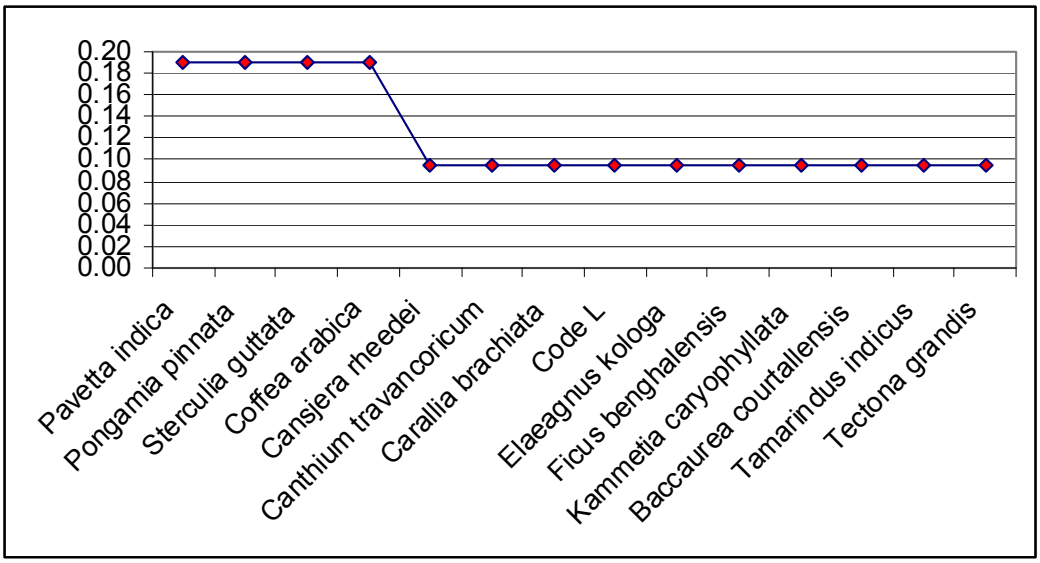


Figure 8 Graph showing the density of the dominant species of the Grove

Table 6 Phytosociological parameters of the vegetation

Species	Density	Abundance	Frequency	Basal Area	IVI
Artocarpus hirsutus	475.21	98.12	0.98	2238074117.9	0.8597
Hopea ponga	287.94	59.45	0.98	1842299160.5	0.6390
Strombosia ceylanica	139.41	34.14	0.83	94638816.0	0.2895
Vateria indica	100.28	23.47	0.87	673065217.8	0.1410
Holigarna arnottiana	61.44	13.48	0.92	53264189.9	0.1024
Polyalthia fragrans	28.30	8.28	0.69	24570023.0	0.0716
Cissus latifolia	27.07	7.31	0.75	2500383.4	0.0696
Mesua ferrea	26.12	7.86	0.67	14594309.0	0.0628
Macaranga peltata	23.46	5.74	0.83	12898247.1	0.0574
Cinnamomum malabatrum	16.52	3.95	0.85	1748295.9	0.0490
Myristica malabarica	14.91	4.49	0.67	2423351.0	0.0478
Gnetum edule	11.68	4.92	0.48	952051.3	0.0400
Litsea coriacea	11.68	4.24	0.56	1184430.7	0.0389
Acacia caesia	11.11	6.16	0.37	559538.3	0.0384
Hopea parviflora	9.78	3.55	0.56	29647628.1	0.0332
Sarcostigma kleinii	9.02	3.96	0.46	444943.9	0.0316
Combretum latifolium	7.88	4.88	0.33	297491.2	0.0287
Hydnocarpus pentandra	6.08	3.56	0.35	289542.1	0.0252
Theobroma cacao	5.22	3.44	0.31	102746.5	0.0246
Caryota urens	5.03	1.77	0.58	170178.7	0.0234
Adenanthera pavonina	3.99	2.10	0.38	178662.7	0.0216
Tabernaemontana alternifolia	3.89	1.86	0.42	68417.9	0.0205
Mallotus philippensis	2.75	1.45	0.38	69009.6	0.0196
Alstonia scholaris	2.66	1.65	0.33	95812.8	0.0185
Antiaris toxicaria	1.99	1.91	0.21	101124.9	0.0139

Aglaia elaeagnoidea	1.61	2.43	0.13	18651.0	0.0126
Unidentified Liana	1.52	2.67	0.12	7552.9	0.0115
Xanthophyllum arnottianum	1.42	1.25	0.23	26599.0	0.0114
Anamirta cocculus	1.33	2.00	0.13	5847.2	0.0103
Trema orientalis	1.33	1.40	0.19	42196.2	0.0082
Ziziphus rugosa	1.23	2.17	0.12	4662.7	0.0081
Grewia umbellifera	1.14	1.20	0.19	5016.0	0.0081
Alangium salvifolium	1.04	2.20	0.10	5933.8	0.0080
Ficus hispida	1.04	2.20	0.10	14245.9	0.0080
Wrightia arborea	1.04	1.22	0.17	5299.7	0.0070
Celtis philippensis	0.95	1.43	0.13	27997.5	0.0069
Ficus drupacea	0.95	1.43	0.13	21861.1	0.0069
Chonemorpha grandiflora	0.85	3.00	0.06	1387.3	0.0068
Caesalpinia cucullata	0.76	2.67	0.06	1560.5	0.0067
Dalbergia horrida	0.76	2.00	0.08	6975.8	0.0057
Ficus callosa	0.76	1.60	0.10	64061.2	0.0057
Lannea coromandelica	0.76	2.00	0.08	11740.1	0.0057
Streblus asper	0.76	1.33	0.12	11740.1	0.0057
Mimusops elengi	0.66	1.00	0.13	3411.5	0.0046
Strychnos nux-vomica	0.66	1.17	0.12	10147.2	0.0046
Aporosa cardiosperma	0.57	1.50	0.08	1538.3	0.0045
Mangifera indica	0.57	1.50	0.08	15837.3	0.0045
Syzygium cumini	0.57	1.00	0.12	73223.0	0.0035
Zanthoxylum rhetsa	0.47	1.00	0.10	3818.6	0.0034
Ziziphus oenoplia	0.47	2.50	0.04	1146.5	0.0034
Pajanalia longifolia	0.38	1.33	0.06	3184.7	0.0034
Vitex altissima	0.38	2.00	0.04	3994.9	0.0034
Artocarpus heterophyllus	0.28	1.00	0.06	1516.2	0.0033
Briedelia retusa	0.28	1.00	0.06	401.4	0.0033
Ficus microcarpa	0.28	1.00	0.06	2247.1	0.0033
Ficus tsjahela	0.28	1.50	0.04	2494.3	0.0023
Holoptelia integrifolia	0.28	1.00	0.06	1387.3	0.0023
Saraca asoca	0.28	3.00	0.02	561.8	0.0023
Strychnos colubrina	0.28	1.50	0.04	296.3	0.0023
Vepris bilocularis	0.28	1.00	0.06	4662.7	0.0023
Ailanthus tryphysa	0.19	1.00	0.04	3959.3	0.0022
Olea dioica	0.19	1.00	0.04	3184.7	0.0022
Pavetta indica	0.19	1.00	0.04	175.9	0.0022
Pongamia pinnata	0.19	1.00	0.04	3121.3	0.0022
Sterculia guttata	0.19	1.00	0.04	115.0	0.0022
Coffea arabica	0.19	1.00	0.04	368.2	0.0012
Cansjera rheedei	0.09	1.00	0.02	20.4	0.0011
Canthium travancoricum	0.09	1.00	0.02	161.2	0.0011
Carallia brachiata	0.09	1.00	0.02	2522.6	0.0011
Elaeagnus kologa	0.09	1.00	0.02	20.4	0.0011
Ficus benghalensis	0.09	1.00	0.02	58.0	0.0011
Kammetia caryophyllata	0.09	1.00	0.02	20.4	0.0011

Baccaurea courtallensis	0.09	1.00	0.02	23.0	0.0011
Tamarindus indicus	0.09	1.00	0.02	2466.2	0.0011
Tectona grandis	0.09	1.00	0.02	575.2	0.0011

4.4. Abundance of trees

At Iringole Sacred Grove the species with highest abundance values were almost same as the density. The most abundant species is *Artocarpus hirsutus* (98) followed by *Hopea ponga* (59), *Strombosia ceylanica* (34.14), *Vateria indica* (23), *Holigarna arnottiana* (13), *Polyalthia fragrans* (8), and Mesua ferrea (7.86). The next top value is for a climber *Cissus latifolia* (7), which was a frequent woody climber of the Grove. The values of *Macaranga peltata, Cinnamomum malabatrum* and *Myristica malabarica* are 5, 4, 4.5 respectively (Fig. 9).

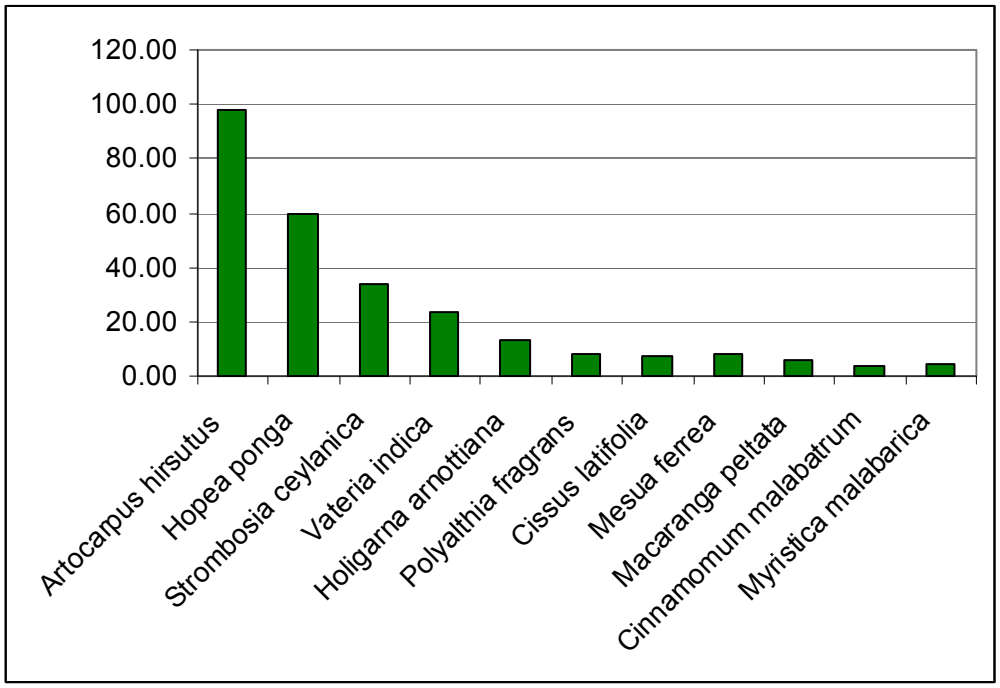


Figure 9 Most abundant tree species in the Iringole Sacred Grove

The species such as *Pavetta indica, Pongamia pinnata, Sterculia guttata, Coffea Arabica, Cansjera rheedei, Canthium travancoricum, Carallia brachiata, Elaeagnus kologa, Ficus benghalensis, Kammetia caryophyllata, Baccaurea courtallensis, Tamarindus indicus,* and *Tectona grandis* were the least dominant species possessing the abundance value of 1.

4.5. Frequency

By analyzing the frequency of the woody species, the relative frequency of the *Artocarpus hirsutus, Hopea ponga* is almost same.i.e.0.052. *Holigarna arnottiana* (0.49), *Vateria indica* (0.46), *Cinnamomum malabatrum* (0.45), *Strombosia ceylanica* (0.44) were distributed in most of the plots and the values. *Cissus latifolia* is the frequently occurring climber of the Grove, with the value of 0.44.

4.6. Basal Area

The figures obtained from the Grove indicate that majority of basal area were contributed by trees of various species of *Artocarpus hirsutus, Hopea ponga, Vateria indica, Strombosia ceylanica, Holigarna arnottiana, Polyalthia fragrans and Mesua ferrea.*It indicate that ground actually occupied by the stems of Hopea *ponga* with the value of 0.44, followed by *Hopea ponga* (0.36) *Vateria indica* (0.13) and *Strombosia ceylanica* (0.018). In the case of Density and abundance the higher values were distributed for *Artocarpus hirsutus, Hopea ponga* and *Strombosia ceylanica*. *Strombosia ceylanica* is most frequent and third position in the case of Abundance and density. Though the plants are establishing their succession, so the value of Basal Area is low.

4.7. Important Value Index

As the IVI of the tree species were analyzed, the species due to their high frequency and density were *Artocarpus hirsutus* (0.8597), *Hopea ponga* (0.6390)*, Strombosia ceylanica* (0.2895) and *Vateria indica* (0.1410) were showed high in their IVI value (Figure 10); they showed the dominance and ecological succession.

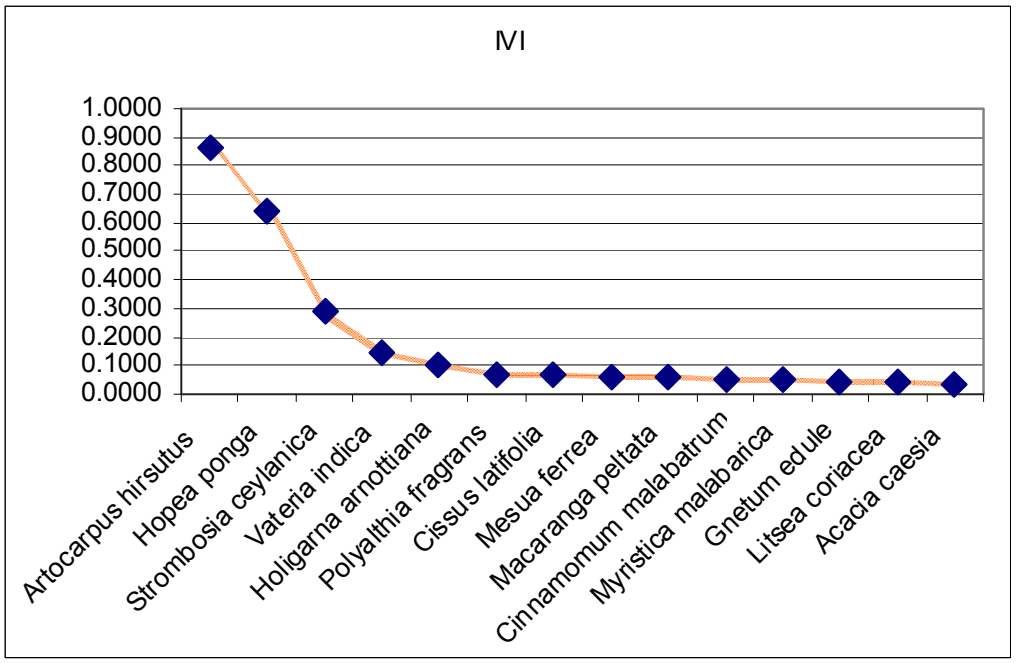


Figure 10 Graph showing the IVI of the tree species of the Grove

Tectona grandis, Tamarindus indicus, Baccaurea courtallensis,, Kammetia, Caryophyllata, Ficus benghalensis, Elaeagnus kologa, Carallia brachiata, Canthium travancoricum, Cansjera rheedei were the least dominant species and they represented very few in numbers. The IVI value was bear minimal *i.e.* 0.0011.

4.8. Girth class distribution of the woody species

Girth class distribution of the woody species was done, both the trees and woody climbers. 59 tree species and 20 woody climbers were occupied the woody components of the Grove. Girth class distribution indicates of the frequency of tree species in different girth classes. Trees of the grove (≥15 cm GBH) were grouped in to different girth class with 15 class width had been prepared. There were 59% individuals belonging in to 15-30cm girth class (i.e.7047 individuals). 0.7% was laid under the class of >241 i.e. 81 individuals, where only 37 individuals represented in 211-240 class. In general the vegetation is heterogeneous (Figure 11).

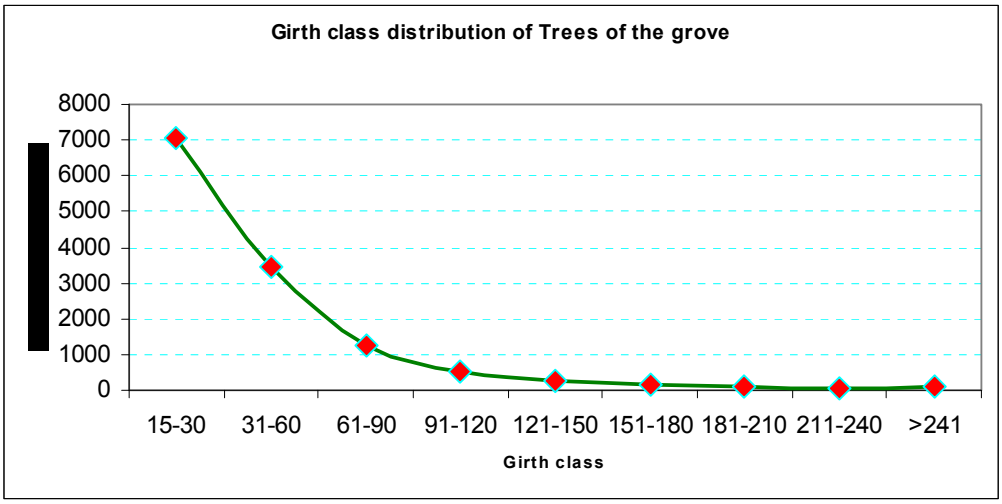


Figure 11 Girth class distribution of the trees of the Iringole Sacred Grove

Vateria indica, a critically endangered species endemic to Western Ghats was distributed well in each class (Fig. 12); 279 individuals belonged to first class and 43 individuals represented in the final class (>241). *Gnetum edule,* an endemic climber of Peninsular India was also showed its well representation in the Grove.

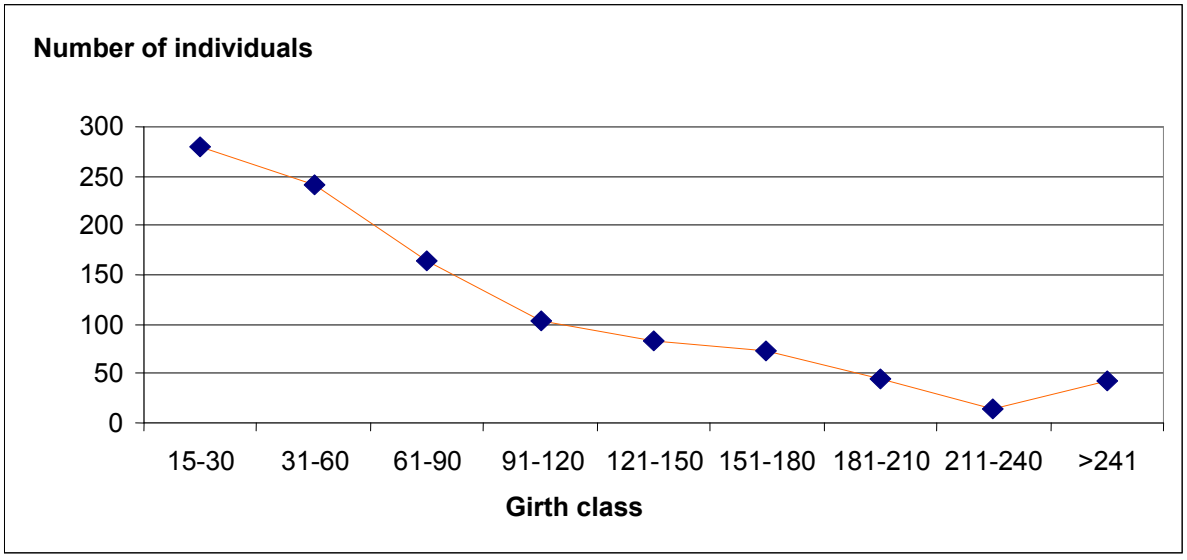


Figure 12 Girth class distribution of *Vateria indica* in Iringole Sacred Grove.

Lianas are a unique feature of Sacred Groves of Kerala and Iringole Sacred Grove was also rich with woody climbers. There were 20 species of lianas. Girth class distribution of lianas was also plotted with class width of 5cm. There were 418 individuals have been represented

from 15-20 class, 195 individuals represented from the class 21-25.Only 8 individuals were represented by the class of >55cm (Figure 13). *Gnetum edule, Dalbergia horrida, Acacia caesia* were the members of the class >55.

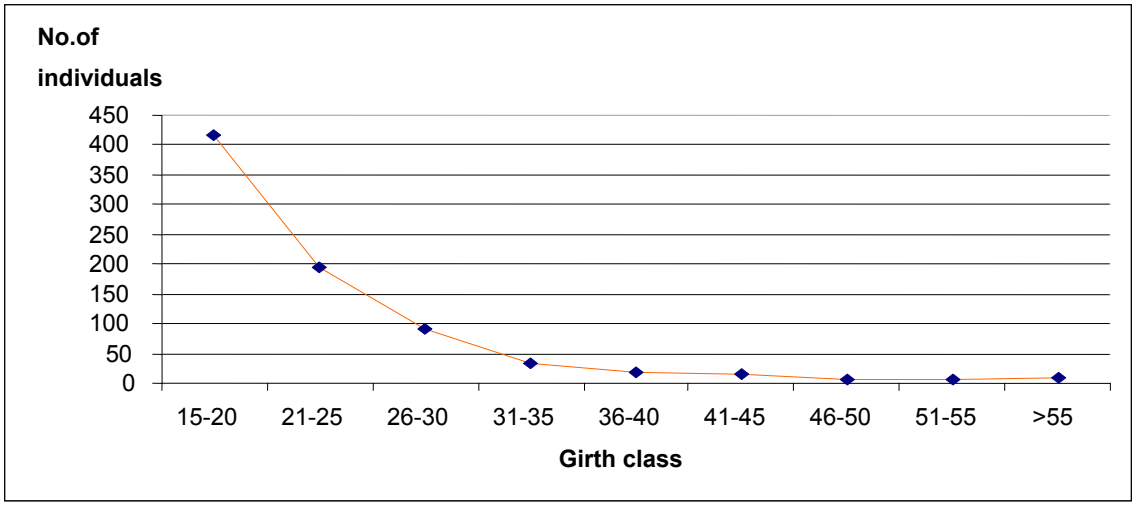


Figure 13 Girth class distribution of lianas

Representation of species in different grids was also analyzed with regard to number of species, count of individuals of each life form and total of individuals (Table 7). Grids which recorded more than 35 species are 4, 40, 14, 32, and 51. The number of species was maximum grid no. 4 (55 species), which is again a partial plot. The partial plot 9 is the least species-diverse plot (10 species), which is triangular in shape. Herb population is very high in plot number 31 (203), which surround the temple and are almost open. The plots 1, 2, 5, 12, 18, 19, 22, 24, 28, 29, 33, 45, 46 and 49 were with zero herbs population. The shrub population showed maximum in plot number 10. Plots 1, 2, 3, 7, 11, 27, 31, 37, 46, 47 and 48 were with shrubs populations are below 10. Plot number 40 (542 individuals) is a very tree-rich plot. The plots with number of individual trees >400, are 40, 42, 33, 34, 29, 20 and 30. Plot number 42 is the woody climber (liana) abundant plot where 45 individuals were recorded. Partial 9, 17, 48 plots were devoid of lianas.

Table 7 Grid-wise representation of different life forms in the flora.

Grid No.	Species	Herbs	Shrubs	Lianas	Trees	Total
1	13	--	5	3	54	62
2	20		9	4	80	93
3	28	52	9	4	57	122
4	55	51	36	7	331	425
5	29	--	43	21	375	439
6	33	24	20	19	309	372
7	27	11	9	8	175	203
8	28	25	18	9	63	115
9	10	--	17	0	11	28
10	31	--	74	9	261	344
11	25	19	9	9	397	434
12	25	--	25	22	317	364
13	27		13	16	400	429
14	36	16	32	26	451	525
15	28	--	48	25	370	443
16	25		16	11	98	125
17	17	26	45	0	23	94
18	23	--	31	33	245	309
19	22	--	64	14	359	437
20	23	--	43	33	491	567
21	30	87	12	17	370	486
22	34	--	30	9	283	322
23	24	44	16	4	289	353
24	16	--	64	3	336	403
25	27	26	27	11	317	381
26	24	--	31	7	109	147
27	18	57	4	7	135	203
28	23	--	53	14	344	411
29	23	--	14	20	414	448
30	29	39	26	17	264	346
31	28	203	4	2	21	230
32	40	103	35	34	331	503
33	22	--	17	22	438	477
34	26	13	16	34	432	495
35	25	15	45	48	393	501
36	30	59	31	26	145	261
37	21	107	7	4	13	131
38	30	174	15	14	79	282
39	23	--	36	38	479	553
40	37	27	11	7	542	587

41	28	82	49	35	357	523
42	26	20	7	45	401	473
43	27	52	30	2	263	347
44	25	31	24	4	261	320
45	25	--	23	4	233	260
46	14	--	3	2	121	126
47	16	15	4	1	25	45
48	12	85	4	0	27	116
49	17	--	36	1	133	170
50	27	76	28	7	199	310
51	34	37	28	13	252	330
52	29	168	23	24	228	443

Maximum number of individuals of all life forms is in plots 20, 39, 40 and 41, *i.e.* 567, 553, 587 and 523 individuals, respectively.

Table 8 Diversity indices Values of the woody species of the Grove

Number of species represented	78
Total Individuals	13127
Dominance_D	0.222
Shannon_H	**1.999**
Simpson_1-D	0.778
Evenness_e^H/S	0.1272
Menhinick	0.5062
Margalef	6.011
Fisher_alpha	7.808

There were 78 woody species. Shannon index of the woody species is 2. Concentration of dominance (Simpson, 1949) value of the study area is 0.77. Species richness (Menhinick, 1964) value is 0.506 and the species evenness (Pielou, 1975) value of the woody vegetation of the Grove is 0.12.

4.9. Structural status of Vegetation

The structural status of the permanent vegetation was derived by the phytosociological analysis of the grid data. The dominant species in each grid are highlighted in the tables (Given in Appendix II). A number of semi-evergreen species components are observed throughout the area. *Vateria India, Hopea ponga, Artocarpus hirsuta, Strombosia ceylanica, and Hopea parviflora* are the dominant components in most of the grids. *Holigarna arnottiana, Polyalthia fragrans*, *Mesua ferrea*, etc are also frequently met. A number of *Macaranga peltata* species is also observed in many grids, indicating the disturbed nature of the vegetation.

Phytosociology of Iringole Sacred Groves is extremely complex. Woody shrubs and lianas are of common occurrence. The Grove shows remarkable variations in physiognomic features of stratification, girth classes, presence of epiphytes and lianas distribution. The vegetation type of the area is of the West Coast Tropical Evergreen (1A/C4) of Champion and Seth (1968), dominated by tree species like *Artocarpus hirsutus, Hopea ponga, Vateria indica, Strombosia ceylanica, Hopea parviflora, Polyalthia fragrans, Mesua ferrea, Holigarna arnottiana, Myristica malabarica, Cinnamomum malabatrum, Xanthophyllum arnottianum*, *Adenanthera pavonina* and *Caryota urens.* Community wise the grve is of *Artocarpus-Hopea-Vateria* association. Frequent occurrence of several climber and straggler species is a conspicuous feature of the grove. G*netum edule, Cissus latifolia, Combretum latifolium, Dalbergia horrida, Sarcostigma kleinii* and *Acacia caesia* are the common lianas of the region. The ground flora of the grove is also quite rich with several herbaceous species along with the regeneration of the canopy tree species. The invasive weed *Mikania*, light demanding pioneers such as *Mallotus philippensis* and *Macaranga peltata*, *etc* are the major invaders, in the forest openings of tree fall, along the boundaries. The dense evergreen/ semi-vegetation vegetation of the Grove is having stratified canopy with dense canopy cover.

Top canopy of a few emergent tree species is above 20 m and is composed of species such as *Hopea parviflora, Hopea ponga, Vateria indica, Artocarpus hirsutus, Mesua ferrea, Polyalthia fragrans, Antiaris toxicaria, Cinnamomum malabatrum, Syzygium cumini* and *Holigarna arnottiana.* Among them *Vateria indica, Hopea parviflora, Hopea ponga, Artocarpus hirsutus* and *Polyalthia fragrans* are the common dominant species. Lianas and

stragglers also reach the upper canopy making it closed, thus cutting the incident light in many places, favoring the regeneration of the shade loving species in some grids. Species such as *Gnetum edule, Cissus latififoli, Sarcostigma kleinii* and *Acacia caesia* are the major climbing shrubs of the upper canopy. Epiphytic orchids, ferns, fungi and lichens are also common in the trunks of the trees in each tier. *Acampe ochracea, Luisia tristis* and *Cleisostoma tenuifolium* are the major epiphytic orchids of the top canopy.

The second stratum is within the height range of 15-20 m and is mainly composed of medium sized trees like *Strombosia ceylanica, Xanthophyllum arnottianum, Macaranga peltata, Aglaia elaeagnoide, Myristica malabarica, and Strychnos nux-vomica.* Different girth classes of the top canopy species are also observed in this stratum.

The lower stratum of the vegetation is composed mostly of seeding of shrubs and saplings of tree species of top and middle canopy layers, apart from typical shrubs like *Memecylon molestrum, Psilanthus travancorensis, Ixora lanceolaria, Psychotria flavida, Antidesma acidum, Chassalia curviflora, Ixora nigricans* and *Leptonychia caudate.* Ground flora of the grove is rather scanty, except in areas where canopy openings are more, due to fallen trees. Common species in the ground layer are *Geophila repens, Begonia trichocarpa, Globba sessiliflora*, *Torenia bicolor, Curcuma ecalcarata, Stachyphrynium spicatum, Amorphophallus commutatus, Impatiens minor, Murdannia japocica, Justicia wynaadensis* and *Spermacoce ocymoides.*

Trees on the sloppy region of the grove are mostly having exposed root system due to soil erosion. The wind fallen trees shows that most of them do not have a tap root system and was found substituted by only lateral roots (Fig 14 and 15).

Fig. 14 Exposed root system of the trees

Fig.15 Fallen trees with decayed roots

The density and abundance status of the trees were analyzed **(**Fig.16). *Artocarpus hirsutus (*475.21*), Hopea ponga, (*287.94*) Vateria indica (*139.41*), Strombosia ceylanica (*100.28*), Vateria indica (*61.44*) Holigarna arnottiana* (28.30)*, Polyalthia fragrans (*26.12*) etc are* densely populated species of the grove. *Artocarpus hirsutus* (98.12), *Hopea ponga* (59.45), *Strombosia ceylanica* (34.14), *Vateria indica* (23.47), *Holigarna arnottiana* (13.48), *Polyalthia fragrans(*8.28) and *Mesua ferrea* (7.86) are the abundant species of the Grove. On the basis of IVI (Important Value Index), the dominant species are *Artocarpus hirsutus, Hopea ponga Strombosia ceylanica, Vateria indica, Holigarna arnottiana, Polyalthia fragrans and Mesua ferrea* (Fig.17).

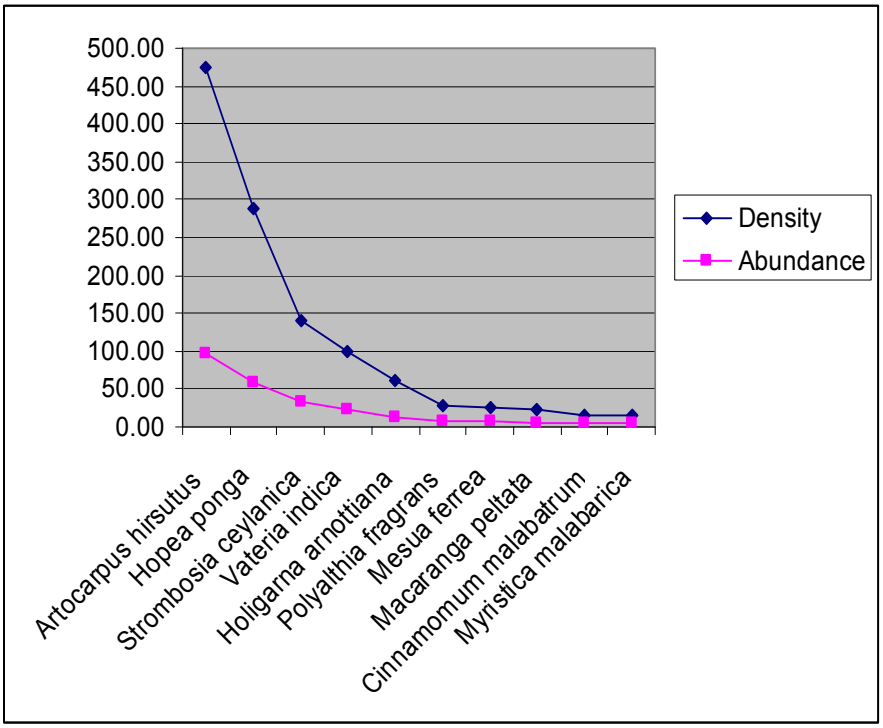


Fig. 16 Density and abundance of tree species

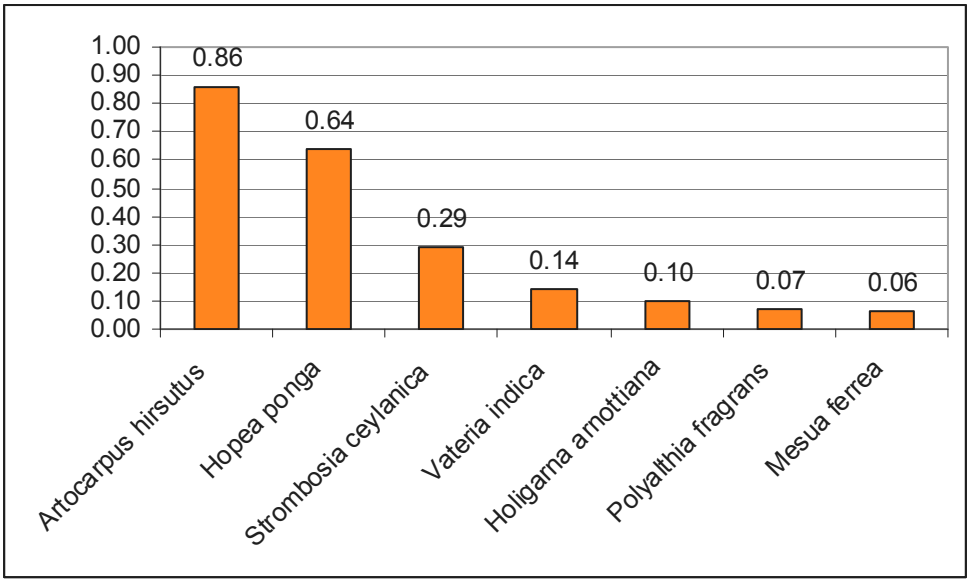


Fig.17 Importance value index (IVI)

The results of the analysis of diversity index such as Shannon index, Simpson index, Evenness_e^H/S, are given in Fig.18 and are represented by values, 2.0, 0.778, 0.12 and 0.222 respectively.

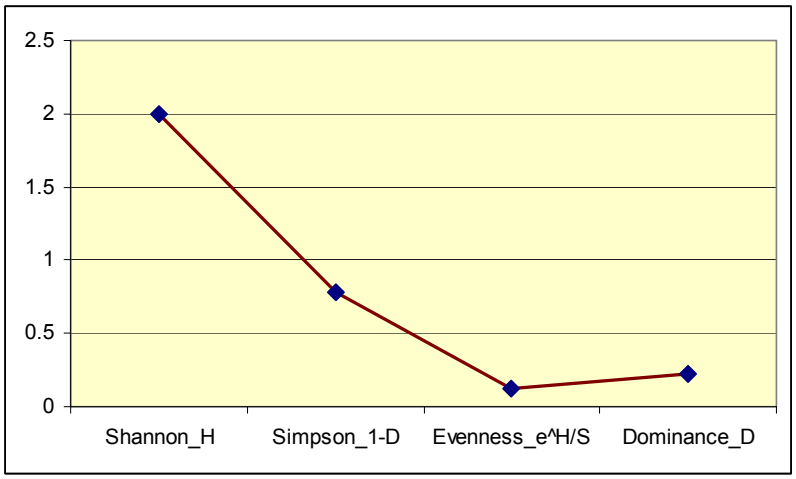


Fig. 18 showing various diversity indices

4.10. Regeneration

There is profuse regeneration of dominant tree species in the openings along with the shrubs and herbs of ground flora (Fig.19). With regard to seedling establishment, high rate of initial mortality was observed in the case of *Litsea coriacea, Mesua ferrea, Antiaris toxicara, Cinnamoum malabaricum, Strychnos nux-vomica, Caryota urens* and *Zanthoxylum rhetsa.*

Fig.19 Regeneration of trees and ground vegetation

4.11. Litter accumulation

As in any other evergreen/ semi-evergreen ecosystems, a large quantity of litter accumulation was observed in the area (Fig.20). Primary factors affecting litter decomposition are composition of the decomposer organisms, the physical environment (primarily the microclimate of the forest floor) and the chemical composition of the material (Swift *et al.* 1979). Because of the wet humid condition due to the undulating terrain features and

subsequent microclimatic factors of the grove, the decomposing activities are slow, thus forming large quantities of litter in the region. The litter dynamics of the grove need special attention.

Fig. 20 Litter accumulation in the study area

4.12. Soil aspects

It can be seen from Table 9 that the soil pH varied from 4.82 to 5.87 in various grids. Most of the values were found to be around 5.0 which is indicative of moderately acidic condition. The climate is humid tropical with high rainfall and temperature leading to quick leaching losses of bases which is reflected in the low pH. Organic carbon values were found to range from 0.54 percent to 1.83 percent indicating high variability between plots. This is also quite natural considering the variation in different vegetation strata that contribute differently towards litter addition as also the influence the canopy exerts with respect to modification of microclimate. Potassium was found to be in the range of 14ppm to 36.3ppm and Phosphorus from 1.28ppm to 8.8ppm in the various plots.

Soil samples collected from different depths of 00-23, 23-45, 45-60, 60-75, 75-90,90-105 and 105-120 revealed the following pattern in general (Table 10). Soil pH was found to be higher in the surface samples though in some plots similar values were seen to occur around 60cm depth also. This might be due to the effect of release of bases from litter decomposition in the surface soil and accumulation of bases down the profile in the B horizon. Organic carbon was also highest in the surface soil which decreased down the profile gradually. Phosphorus and Potassium did not follow any definite trend with depth though the values were always higher

in the surface soil which is attributable to nutrient release from litter decomposition and microbial activity.

Table 9 Soil properties (surface samples) in the different 50x50m grids in Iringole Sacred Grove

PLOT Nos.	pH	OC (%)	K (ppm)	P (ppm)
1	5.16	1.02	30.2	3.11
2	5.1	0.98	26.5	3.45
3	5	0.89	22.3	3.58
4	4.95	0.75	22.6	2.52
5	5.16	0.72	31.4	8.8
6	5.28	1.38	22.7	3.11
7	5.38	1	27.5	4.9
10	4.95	1.41	24.4	1.92
11	5.6	1.02	25.3	6.68
12	5.23	1.29	33.4	6.56
13	5.24	1.14	22.7	4.15
14	5.16	1.23	21.1	3.32
15	5.23	0.96	28.3	4.02
18	5.2	0.81	14	1.8
19	5.13	1.35	22	1.42
20	5.18	1.47	31	8.04
21	5.87	0.96	32.1	1.28
22	5.14	1.71	21.1	3.37
23	5.32	1.11	17.6	4.03
24	5.14	1.47	29.5	1.71
25	5.39	1.2	22	5.71
26	4.99	1.1	31.8	1.92
28	4.88	0.81	21.7	6.65
29	4.82	1.11	20.9	5.8
30	5.28	0.78	30.4	4.58
32	5.32	0.6	25.7	3.22
33	4.97	0.78	17	6.28
34	5.23	1.11	14.2	4.66
35	5.53	0.54	20.6	4.2
36	5.2	1.41	24.7	1.58
38	5.24	0.81	18	1.81
39	4.92	1.08	15.9	4.55
40	5.32	1.06	30.8	1.53
41	4.92	0.78	28.7	1.85
42	5.12	1.11	21.4	3.44

43	5.11	1.08	18	3.41
44	5.4	0.91	21.8	2.32
45	5.25	1.83	30.3	1.93
46	5.6	1.32	24.5	4.09
49	5.6	1.02	31.7	6.21
50	5.18	1.38	20	6.34
51	5.2	1.53	36.3	5.8
52	5.3	0.89	26.1	3.95

Table 10 Soil properties with varying depths in selected plots

DEPTH(cm)	pH	OC (%)	K (ppm)	P (ppm)
00-23	5.2	0.92	26.4	3.61
23-45	4.63	0.51	18.7	3.41
45-60	4.86	0.36	12.4	3.24
60-75	5.14	0.78	16.7	5.4
75-90	5.2	*0.18*	16.3	2.39
90-105	4.75	0.51	17.8	2.43
105-120	5.42	0.21	16.1	2.85
00-23	5.05	0.86	31.1	3.26
23-45	4.92	0.21	15.8	3
45-60	4.78	0.21	32.1	5.37
60-75	5.11	0.21	15	3.1
75-90	4.86	0.15	13.8	3.9
90-105	5.19	0.28	10.9	3.46
105-120	5.49	0.75	18.9	3.2
00-23	5.41	0.84	22.9	2.98
23-45	5.11	0.63	21.1	2.87
45-60	5.4	0.75	22.8	2.88
60-75	5.6	0.42	27.5	2.67
75-90	5.1	1.65	32	2.95
90-105	5.11	0.27	15.9	2.32
105-120	5.19	0.3	19.5	2.3
00-23	4.91	0.48	12.4	3.81
23-45	4.92	0.45	13.7	3.6
45-60	4.24	0.42	12.9	3.25
60-75	5.28	0.48	11.9	3.22
75-90	5.52	0.39	9.4	3.35
90-105	5.08	0.42	9.4	3.21
105-120	4.82	0.36	10.5	3.11
00-23	5.03	1.23	43.6	3.46
23-45	4.63	0.69	29.9	3.2
45-60	5.22	0.63	33.3	3.08

60-75	4.65	0.54	36.1	3.11
75-90	5.04	0.39	38	3.05
90-105	5.27	0.39	31.5	3.02
00-23	4.94	1.41	22.5	4.23
23-45	4.94	0.57	9.2	3.8
45-60	4.63	0.51	3.2	3.61
60-75	5.1	0.48	2.1	3.28
00-23	5.16	1.11	1.7	3.92
23-45	5.39	1.05	5.9	3.4
45-60	5.07	0.96	24.9	3.22
60-75	5.33	0.9	28	3.7
75-90	5.07	0.84	16	2.93
90-105	5.24	0.84	21.2	2.95
105-120	5.58	0.66	25.3	2.9
00-23	5.02	1.17	25	2.52
23-45	4.11	0.81	16.1	2.15
45-60	4.01	0.51	13.9	2.3
60-75	4.81	0.53	15.3	2.1
75-90	4.51	0.22	12.6	2.11
90-105	4.52	0.31	13.7	2.18
105-120	5.34	0.23	21.4	2.17

It can be seen that there is great variation in litterfall between plots and seasons of the year. Litterfall exhibited two peaks during the post and pre monsoon seasons, though maximum fall was found to be during the months of September-October and January which resembles the pattern usually found in the semi-evergreen forest ecosystem (Fig. 21).

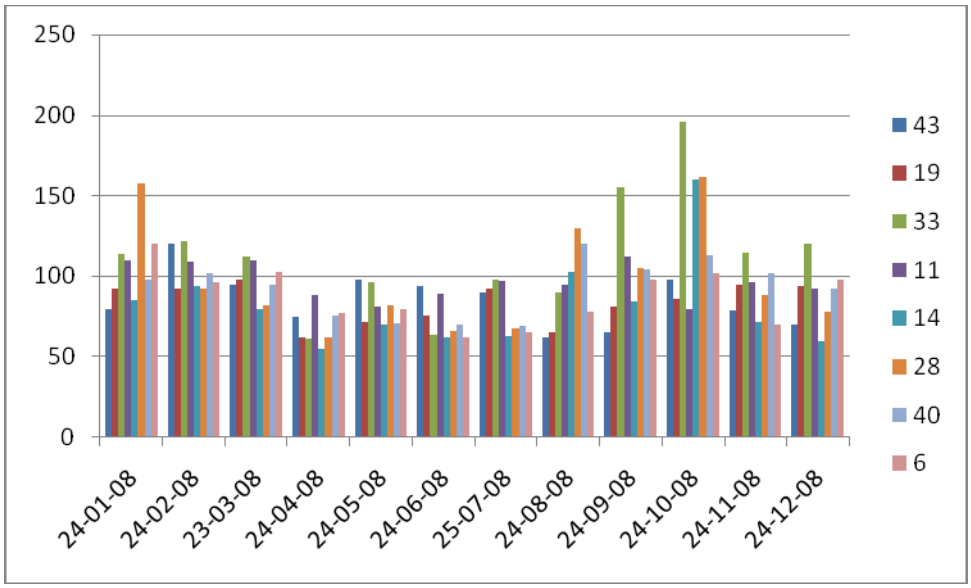


Fig. 21 Litter fall (g) in the selected plots

4.13. FUNGAL DIVERSITY

4.13.1. Diversity of Macrofungi

The Iringole Sacred Grove is endowed with a remarkably rich macrofungal flora. A total of 95 genera and 215 species of macrofungi falling in 28 families belonging to Basidiomycota and Ascomycota were encountered in the sacred grove. Among the macrofungi encountered, terricolous, humicolous and lignicolous form the major groups, while coprophilous or macrofungi inhabiting on dung of herbivores are the insignificant group. Of the 28 families, members belonging to Agaricaceae, Amanitaceae, Boletaceae, Entolomataceae, Inocybaceae, Lyophyllaceae, Marasmiaceae, Pluteaceae and Tricholomataceae are the major players in ecosystem dynamics. Photographs of selected species are provided in Appendix III

In the family Agaricaceae, 10 genera and 37 species were recorded. *Agaricus crocopeplus, A. endoxanthus, A. fiardii, A. johnstonii, A. ochraceosquamulosus, A. silvaticus, A. volvatulus*, *Chlorophyllum rhacodes*, *Clarkeinda trachodes*, *Coprinus plicatilis* var. *plicatilis, C. disseminatus* var. *disseminatus*, *Cystolepiota* sp., *Lepiota alopochroa, L. clypeolaria, L. erythrogramma, L. erythrosticta, L. flagellate, L. guatopoensis, L. phlyctaenodes, L. leprica, L. phlyctaenodes, L. plumbicolor, L. pyrrhaes, L. thrombophora, L. viridiflava, L. viriditincta, Leucocoprinus birnbaumii, L. brebissonii, L. cepistipes, L. caldariorum, L. fragilissimus, L. holospilotus, L. squamlosus, L. zeylanicus*, *Leucoagaicus rubrotinctus*, *Macrolepiota procera, Micropsalliota pleurocystidiata* are the significant members and are widely distributed in the sacred grove. In the family Amanitaceae, *Amanita angustilamellata, A. aureofloccosa, A. elata, A. griseofarinosa,* and *Limacella guttata* were recorded.

In Boletaceae, *Boletus hongoi, B. huronensis* and *Strobilomyces strobilaceus* were encountered. Members of this family form ectomycorrhizal association with trees, especially with *Vateria indica, Hopea ponga*, etc. In the family Entolomataceae, 7 species of *Entoloma, viz., E. albidoquadratum, E. allocybesimilis, E. brunneoquadratum, E. mridulum, E. serrulatum, E. shwethum, E. theekshnagandhum* were recorded.

In Hygrophoraceae, 4 species of *Hygrocybe H. alwisii, H. gregaria, H. ortoniana, H. parvula,* and *Camarophyllus umbrinus* were recorded. Most of them are terricolous and a few are humicolous and litter decomposers. In the family Inocybaceae, a total of 8 species of

Inocybe viz., *I. antillana, I. cutifracta, I. ianthinofolia, I. ingae, I. petchii, I. purpureoflavida, I. squamata,* and *I. virosa Pleuroflammula flavomarginata* were recorded. These include both poisonous and edible species. Most of the *Inocybe* species form ectomycorrhizal association with tree species.

In Lyophyllaceae, *Calocybe cyanocephala, Termitomyces clypeatus, T. microcarpus* and *T. microcarpus* f. *longipus* were encountered. Species of *Termitomyces,* the highly preferred edible macrofungi, were found widely distributed in the sacred groves.

In the family Marasmiaceae, *Campanella pustulata, Gerronema tenue, Gymnopus dryophilus, Lactocollybia epia*, *Marasmiellus ignobilis, M. subaurantiacus*, *Marasmius atrorubens, M. confertus, M. florideus, M. haematocephalus, M. hakgalensis, M. hypochroides, M. leveilleanus, M. rigidichorda, Tetrapyrgos nigripes*, *Trogia infundibuliformis* were recorded. Most of them are primary colonizers and litter decomposers. In Mycenaceae, *Filoboletus manipularis*, *Mycena auroricolor, M. pura* were encountered. *Filoboletus manipularis* is a bioluminescent fungus. In the family Pluteaceae, 3 species of *Pluteus atromarginatus, P. conizatus, P. fastigiatus* and 4 species of *Volvariella glandiformis, V. nigrodisca, V. pseudovolvacea, V.gloiocephala,* were recorded.

In Russulaceae *Lactarius ignifluus* and 8 species of *Russula* viz*., R. aciculocystis, R. atropurpurea, R. congoana, R. delicula, R. leelavathyi, R. mariae, R. martinica, R. michiganensis* were recorded. In Suilaceae, *Suillus placidus* and *S. tomentosus* were recorded. In Hydnangiaceae 3 species of *Laccaria*, *viz. Laccaria amethystine, L. laccata, L. ohiensis* were recorded. All the members of this family form ectomycorrhizal association with trees like *Vateria indica, Hopea ponga*, etc.

In Tricholomataceae, 5 species of *Collybia* viz., *Collybia aurea, C. coracicolor, C. chrysoropha, C. leucophaea, C. sublaccata*, *Lepista hyalodes, Macrocybe lobayensis,* and *Tricholoma ceriniceps* were recorded from different forest ecosystems. In the family Bolbitiaceae, *B. fissus, Conocybe crispa, C. ochracea,* were recorded. In Crepidotaceae, *Crepidotus cystidiosus, C. epicrocinus, C. melleus, C. uber* were recorded. *Macrocybe lobayensis* is a highly prized edible fungus and commercial cultivation of this edible fungus has recently been initiated in the State. In Psathyrellaceae, *Cystoagaricus trisulphuratus* and

Psathyrella candolleana, P. lucipeta, Psathyrella efflorescens were recorded. In Physalacreaceae, *Cyptotrama asprata, Oudemansiella canarii,* and *X. radicata* were recorded. Species of *Oudemanseiella* and *Xerula* are edible. In Strophariaceae, *Agrocybe retigera, Gymnopilus bryophilus, G. chrysopellus, G. dilepis, G. junonius, G. zenkeri*, *Hypholoma subviride* and *Stropharia semiglobata* were recorded.

Among the lignicolous edible macrofungi, in the family Pleurotaceae, *Hohenbuehelia aurantiocystis, H. petaloides,* and *Pleurotus djamor, P. flabellatus, P. eöus* were recorded. In Auriculariaceae, *Auricularia auricula-judae,* and *A. polytricha* were recorded.

In the family Clavariaceae, *Clavaria zollingeri*, *Clavulinopsis aurantiocinnabarina, C. corniculata, C. dichotoma, C. fusiformis, C. laeticolor, C. luteoalba*, *Ramariopsis kunzei,* and *R. pulchella* were encountered. In Dacrymycetace, *Calocera viscosa* and *Dacryopinax spathularia* were recorded from the sacred grove. In Tremellaceae, *Tremella foliacea,* and *T. reticulata* were recorded.

In Lycoperdaceae *Lycoperdon decipiens* and *L. utriforme* and in Sclerrodermataceae *Scleroderma citrinum, S. verrucosum, S. polyrhizum* were recorded. In Geatraceae *Geastrum rufescen,* and *G.triplex* were encountered.

Wood inhabiting macrofungi are the major component of the ecosystem and play a vital role in the ecosystem dynamics. Most of the large diameter trees in the sacred grove were found affected with heartrot and bearing sporocarps of the decay fungi. In the family Fomitopsidaceae, *Daedalea flavida, Fomitopsis feei,* and *Laetiporus sulphurous*, were recorded. *L. sulphurous* is a highly prized edible fungus. In Ganodermataceae, *Ganoderma lucidum* was recorded.

In Hymenochaetaceae *Cyclomyces setiporus*, *Hymenochaete rubiginosa*, *Inonotus tabacinus, Phellinus adamantinus, P. durissimus, P. fastuosus, P. ferreus, P. ferruginosus, P. gilvus, P. rimosus, P. robiniae* were encountered from the sacred grove. In Meripilaceae *Rigidoporus microporus* and *R. ulmarius* were recorded. In the family Meruliaceae *Bjerkandera adusta, Flaviporus minutisporus, Flavodon flavus, Irpex lacteus,* were recorded.

In the family Polyporaceae a total of 26 species belonging to 14 genera were recorded. *Coriolopsis caperata, C. occidentalis*, *Favolus tenuiculus, Fomes pseudosenex, Hexagonia tenuis*, *Lentinus polychrous, L. strigosus, L. squarrosulus, Panus conchatus, P. similes, Lenzites elegans, Microporellus obovatus, Microporus affinis, M. xanthopus*, *Nigroporus durus, Polyporus alveolaris, P. arcularius, P. dictyopus, P. grammocephalus, P. rugulosus, Pycnoporus sanguineus, Pyrofomes albomarginatus, Trametes cingulata, T. cotonea, T. pubescens, T. versicolor, Trichaptum biforme* were recorded.

Macromycetes belonging to Ascomycota are comparatively less represented in the sacred grove. *Aleuria aurantia, Cookeina tricholoma, Daldinia concentrica* and *Xylaria hypoxylon, X. longipes, X. nigripes, X. polymorpha* (Xylariaceae) were encountered.

4.13.2. Factors influencing the diversity of macrofungi

Macrofungal species exhibit definite patterns of distribution in the sacred grove which are highly influenced by the environmental factors, mainly rainfall and atmospheric humidity. Also, occurrence, abundance, species richness are largely depended on the nature of humus/litter load and their level of decomposition or deterioration. Most of the large diameter trees in the sacred grove are affected with butt rot and heartrot and are subjected to uprooting. Conversion of these wind-fallen trees into fire-wood for the temple feast has been initiated recently and this activity may affects the diversity of micro- and macro-organisms, especially wood inhabiting fungi in the sacred grove. Erratic rainfall, large-scale removal of forest litter and humus from the forest floor and other human interventions are also adversely affecting the diversity of terricolous, lignicolous and humicolous macrofungi.

Occurrence and distribution pattern of ectomycorrhizal macrofungi in the sacred groves depend largely on the distribution of host plant species. Ectomycorrhizal macrofungi like *Amanita, Boletus, Laccaria, Lactarius, Russula, Suillus, Scleroderma* seem to be naturalized in the groves and harbouring the native tree species and widening their mutualistic relationships.

4.14. INSECT DIVERSITY

4.14.1. Fauna: Of the 182 species belonging to 46 families were collected from Iringole Sacred Grove, 102 species have been identified which included 31 species of butterflies, 20 moths, 22 Hemiptera, 21 Hymenoptera, 20 Coleoptera, 20 Diptera, 14 Orthoptera, 14 Odonata, 10 Dictyoptera, four Phasmida, three Isoptera, two Neuroptera, and one Thysanura. A list of insects recorded in the study is presented in Appendix IV.

4.14.2. Faunal richness

Iringole kavu is one of the best conserved Sacred Groves in the State. There is teaming insect life within the area which included several very rare species. Out of the various insect orders, only a few such as Lepidoptera and Odonata could be studied in any great detail mainly because of the fact that being a religious place, collection of organisms is not permitted and hence, all the findings are based on observations made in the area. Organisms such as termites, ants, bugs and wasps were present in large numbers which included several rare and interesting ones. Among butterflies, the Tamil Lacewing, Kanishka butterfly, the Common Mime, the Clipper, etc. are species that are found only in typical undisturbed tropical forests. The Odonata fauna was also contained a number of rare and colourful species.

4.14.3. Faunal Specialties and affinities

Another interesting feature of this sacred grove is with regard to the faunal specialties. The fauna was highly specialized in that it contained several elements that were rare, endemic and having protected status besides several species that are very commonly found in homesteads. With regard to butterflies 10 species were belonging to either of these categories. The occurrence of common as well as specialized forms in the area may be attributed to the proximity of this area to human settlements while at the same time its isolation from any disturbance for a long period of time which has contributed to the survival of several rare and endemic species in the area. The fauna showed close affinities with the Sri Lankan elements.

Investigations made on the distribution of insect fauna of Iringole Sacred Grove indicate that the fauna of this area is actually a remnant of a very exhaustive fauna which was present in this area in the past. From the fauna conserved in this area, we can make assumptions on the

loss of biodiversity over years of human interference. Conservation of sacred groves will be important to conserve the remnants of gene pool in isolated patches of forests and to monitor the evolutionary changes that take place in such areas over years compared to that of the natural forests.

4.14.4. Moths (Heterocera)

Twenty species of moths belonging to 10 families were identified (Appendix IV). The families Noctuidae and Lymantriidae contained maximum number of species followed by Geometridae. The families Crambidae (*Rhymphalea* sp.), Sphingidae (*Nephele* sp.), Gelechiidae (*Dichomeris* sp.) and Thyrididae (*Microbelia* sp.) contained only one species each as indicated in the parenthesis. While some moths were quite large and colorful and majority were moderate sized with intricate wing patterns. The economic importance of a few species has been established while that of the majority is still unknown.

The moths of economic importance included primarily those that have been reported to be pests of various plants. This included *Psalis pennatula* (Arctiidae), *Cnaphalocrocis medinalis, Nymphula depunctalis, Schoenobius minutellus, Scirpophaga* sp. (Pyraloidea) and *Spodoptera mauritia* (Noctuidae) attacking rice, maize, sugar cane, etc., *Utethesia pulchellale* (Arctiidae), *Psara licarsicalis, P. basalis* (Pyraloidea), *Helicoverpa armigera* (Noctuidae) and *Euproctis* spp. (Lymantridae) attacking pulse and vegetable crops, *Pericallia ricini* (Arctiidae) attacking castor, *Thalassodes* sp. (Geometridae) attacking mango, *Eligma narcissus* (Arctiidae) attacking *Ailanthus triphysa, Hypsa* spp. (Hypsidae)attacking *Ficus, Semiothisa* sp. (Geometridae) attacking *Xylia xylocarpa, Parasa lepida* (Limacodidae) attacking palms, *Othreis fullonica* (Noctuidae) attacking fruits, *Creatonotus gangis* (Arctiidae) attacking lilly and *Asura* spp. (Arctiidae) attacking mosses. Other species of moths reported in this study included *Eumelea* sp., *Cleora* sp., *Hyposidra talaca*, *Hyposidra infixaria* (Geometridae); Mocis frugalis, Chalciope sp., Ischyja manlia, Hypophyra sp. Enmonodia vespertito, *Erebus* sp.(Noctuidae) and *Artaxa* sp. , *Calliteara* sp. *Perina nuda* Fb. (Lymantriidae).

4.14.5. Dragonflies (Order Odonata)

Odonates are one of the ancient orders of insects. They are primarily aquatic insects and their life history is closely linked to specific aquatic habitats and they use a wide range of flowing and stagnant water bodies for their life. Habitat specificity has an important bearing on the distribution and ecology of odonates which makes them a good indicator of wetland health. India with its unique geography and diverse bioclimatic regions, support a rich odonate fauna.

The ancestors of extant odonates date back to carboniferous era, about 250 million years ago. Based on wing neauration, Odonates are classified into dragonflies and damselflies. About 6,000 extant species are distributed all over the world. India is highly diverse with more than 500 known species. Kerala has over 100 species of odonates.

In this study, 14 species of odonates belonging to 4 families were identified (Appendix IV). The families Libellulidae contained maximum number of species followed by Platycnemididae. The families Coenagrionidae and Calopterygidae contained only one species each (Appendix IV). List of Odonates are given in Appendix IV with brief accounts of the various species are given in the Appendix.

4.14.6. Beetles (Coleoptera)

The beetles contained phytophagous, xylephagous, predatory and scavenger forms. The phytophagous beetles mostly belonged to the family Chrysomelidae. The latter included the pumpkin beetle *Aulacophora cincta*, and several polyphagous beetles like *Chlamys* sp., *Hoplasoma unicolor* and *Monolepta longitarsis*. The families Cerambycidae, Buprestidae, Bostrychidae, Anthribidae, Curculionidae, Platypodidae and Scolytidae contained the xylephagous forms. This included the cashew borer *Plocaederus ferrugineus* (Cerambycidae); the bamboo ghoon borer *Dinoderus minutus* (Bostrychidae), the bamboo culm borer *Mecistocerus fluctiger* (Curculionidae), as well as the shot-hole borer *Xyleborus* sp. (Scolytidae). Predatory beetles like *Derospaeras* sp., and *Coccinella* sp. belonging to Coccindelidae were also recorded. The scavenger beetles included the dung rollers *Anomala* spp., *Copris* spp. and *Maladera* sp. (Scarabaeidae). *Oryctes rhynocerus* (attacking palms),

Popillia sp. (attacking petals of flowers), and the white grub *Holotrichia serrata* attacking the roots of seedlings in the nursery have economic significance.

4.14.7. Bugs (Order: Hemiptera)

The bugs contained several species of economic significance such as the ear-head bug *Chilochoris angustatus* (Miridae) and the plantain spittlebug *Cosmocarta* sp. (Cercopidae). *Kalidasa lanata, Dictophara viridissima* (Fulgoridae), *Dindymus sanguineus, Dysdercus cingulatus, Iphita* sp. (Pyrrhocoridae), *Celtus bipuntanus* (Coriedae), *Flata* sp. (Flattidae) and 15 unidentified species of Reduvidae have been recorded from this area.

4.14.8. Wasps (Order Hymenoptera)

With regard to Hymenoptera, several species of wasps (belonging to the families Eumenidae, Sphecidae, Chrysididae and Pompilidae); parasitic wasps (belonging to the families Braconidae, Ichneumonidae and Bethylidae); bees (belonging to the families Apidae, Xylocopidae, Megachilidae and Anthophoridae) as well as ants (Formicidae) have been recorded.

4.14.9 Other insects

In addition, Thysanurans (*Lepisma saccharina* belonging to Lepismatidae), Orthopterans (**3** unidentified species each of Katydidae, Gryllidae and Acrididae) Phasmida (*Carausis morosus* and *Phyllium crurifolium* of the family phyllidae), Dictyoptera (8 unidentified species of Blattidae; and *Leptomantris parva* belonging to Mantidae), Isoptera (3 species of *Odontotermes* of the family Termitidae) and 15 unidentified species of Diptera have been recorded.

4.14.10. Faunal Specialties

4.14.10.1. Occurrence of rare and endemic species

The fauna was specialized in that it contained several elements that were rare, endemic and having protected status besides several species that are very commonly found in homesteads. With regard to butterflies 10 species were belonging to either of these categories (Table 11). The occurrence of common as well as specialized forms in the area may be attributed to the proximity of this area to human settlements while at the same time its isolation from any

disturbance for a long period of time which has contributed to the survival of several rare and endemic species in the area.

Table 11 List of endemic/ protected butterflies recorded from Iringole Sacred Grove

Family	Species	Endemic to Western Ghats	Endemic to India and Sri Lanka	Protected under Indian Wildlife Act
Papilionidae	*Pachliopta hector*		*	
Papilionidae	*Papilio polymnestor*		*	
Papilionidae	*Troides minos*	*		
Papilionidae	*Papilio dravidarum*	*		
Pieridae	*Ixias pyrene*		*	
Nymphalidae	*Parthenos sylvia*			*
Nymphalidae	*Neptis jumbah*			*
Nymphalidae	*Tanaecia lepidea*			*
Lycaenidae	*Curetis thetis*	*		

4.14.10.2. Species richness

The seasonal pattern of the number of species of insects collected during the period March 2007- February 2008 using light trap in the Semi Evergreen Forest habitat (SEF) is presented below (Table 12)

Table. 12 Seasonal trends of species richness in the habitat at Iringole Sacred Grove (Semi Evergreen Forest) during 2007-2008 (Pooled data)

	Number of insects collected in different months												
Habitat	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	**Total**
SEF	1690	1053	1804	1460	2434	13878	4504	4150	1934	3226	1886	2996	41015

The total number of species was recorded in the SEF (1389). As per the pooled data for the period 2007-2008, the species recorded from the study area was found to increase in the study area from November to June. The number of species decreased during the period from July to October. The seasonal pattern of species composition was found different in the habitat studied.

Data collected from semi evergreen plot for a period of twelve months (March - February) in 2007-2008 showed that the maximum number of insects was recorded during November-May (Table 13). Out of the 182 species, the highest number of species was recorded in November (157) followed by May (153).

4.14.10.3. Species abundance

The number of insects collected during different months from the Semi Evergreen forest is presented in Table 12. A total of 41,015 insects were recorded from the Iringole Sacred Grove in different months. The maximum number of insects was recorded during August irrespective of the habitats. The seasonal trend of the species abundance in the study area shows an increase in the number of species from August to December and a decline in the number thereafter. As far as insect species abundance is concerned January-July appeared to be the dull period.

4.14.10.4. Dominance index

The relative proportion of various insect orders is given in Fig. 22. Lepidoptera formed the major order followed by Hemiptera and Hymenoptera. The dominance indices for insect groups collected from various plots in Iringole Sacred Grove are given in Fig. 23 & 24. The dominant insect orders with respect to number of individuals in the various plots at Iringole Sacred Grove were Lepidoptera and Hemiptera followed by Hymenoptera, Coleoptera and Diptera. The orders Odonates and Orthoptera with Eight per cent of the species each were collected and Dictyoptera with Five per cent of the species followed by Phasmida and Isoptera with Two per cent of the species collected. The order Neuropteran and Thysanurans contained one per cent of the species collected. Maximum number of insects collected belonged to Lepidoptera (27%). With regard to Hemiptera and Hymenoptera, this formed 12 per cent of the insects collected followed by Coleoptera and Diptera with 11% in each.

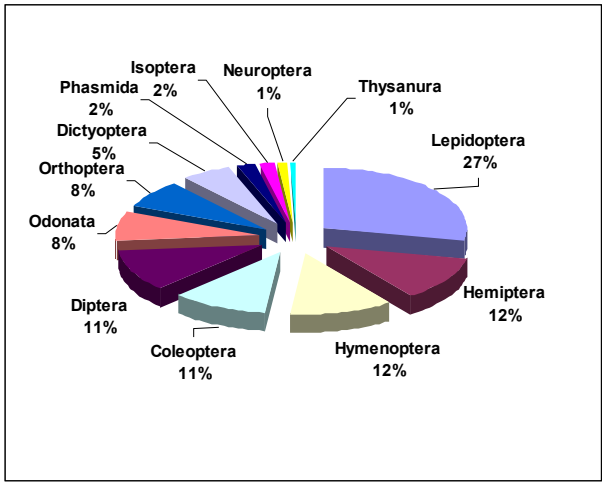


Fig. 22. Percentage of insect species belonging to various groups in Iringole Sacred Grove during 2007-08.

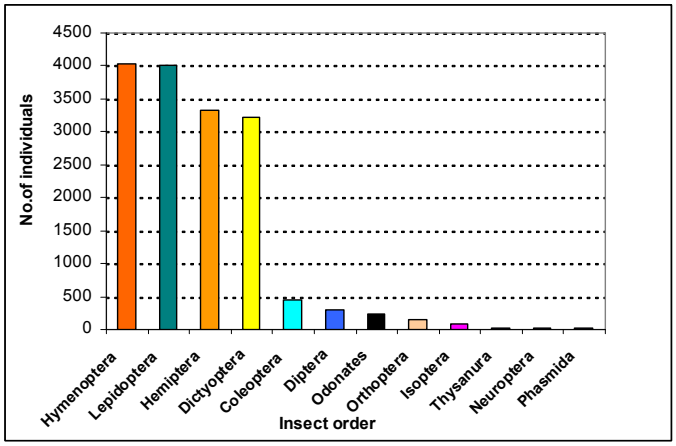


Fig.23. Dominance of insects in terms of number of individuals in the study area

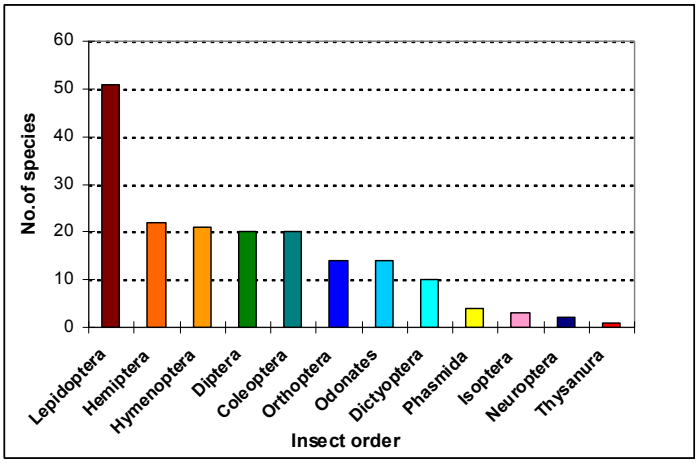


Fig.24. Dominance of insects in terms of number of species in the study area

4.14.10.5. Species diversity

Shannon's index of species diversity was calculated month-wise for various plots in Iringole Sacred Grove area. Shannon's index of insect diversity is presented in Table 13. November recorded the highest species diversity (3.611) followed by April (3.466), June (3.355) and May (3.336). July recorded the lowest value of 1.272.

Table 13 Species diversity indices for insects in the Iringole Sacred Grove

Month	Diversity Index
March	2.954
April	3.466
May	3.336
June	3.355
July	1.272
August	2.003
September	2.432
October	2.595
November	3.611
December	2.630
January	3.044
February	3.118

4.14.10.6. Evenness of equitability index

The evenness index, which measures the evenness of species abundance, is complimentary to the diversity index concept and it indicates how the individuals of various species are distributed in the community. The evenness indices obtained for the month April (0.265) was the highest followed by November (0.236) (Table 14), February (0.217) and June (0.217). The month July recorded the lowest value of 0.049.

Table 14 Evenness indices for insects in the Iringole Sacred Grove

Month	Evenness Index
March	0.2085
April	0.2646
May	0.1837
June	0.2169
July	0.04887
August	0.06929
September	0.1405
October	0.1314
November	0.2357
December	0.09251
January	0.1793
February	0.2173

4.15. Spider diversity

A rich diversity of spiders was observed in the grove. A total of 45 species different spiders have been recorded, belonging to 16 families under 28 genera. The dominant families are Araneidae with10 species, Salticidae and Sparassidae with 6 species each and Oxyopidae with 5 species followed by Thomisidae, Tetragnathidae and Nephilidae. The families Lycosidae, Theraphosidae, Zodariidae, Psechridae, Pisauridae, Liniphiidae, Theridiidae, Pholcidae and Hersiliidae contained only one species each (Appendix V). Analysis of monthly spider occurrence (Figure 25) shows that, they are very common in May (28 species) and December (27 species) when compared to other months. Like-wise the population of spiders is high in May with 126 individuals (Figure 26), followed by April with 83 individuals. The numerics shows that the species diversity is high prior to monsoon and in the post monsoon season.

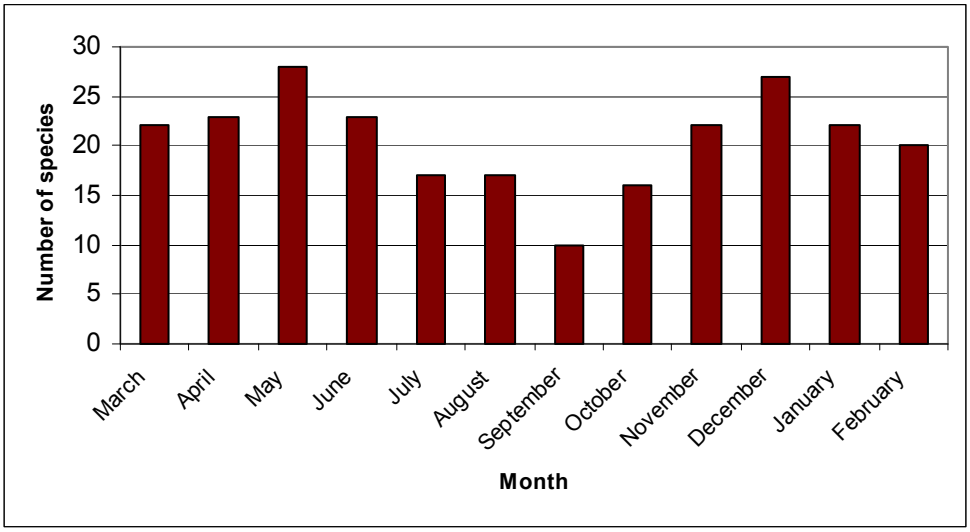


Fig.25 Monthly variability of occurrence of spider species

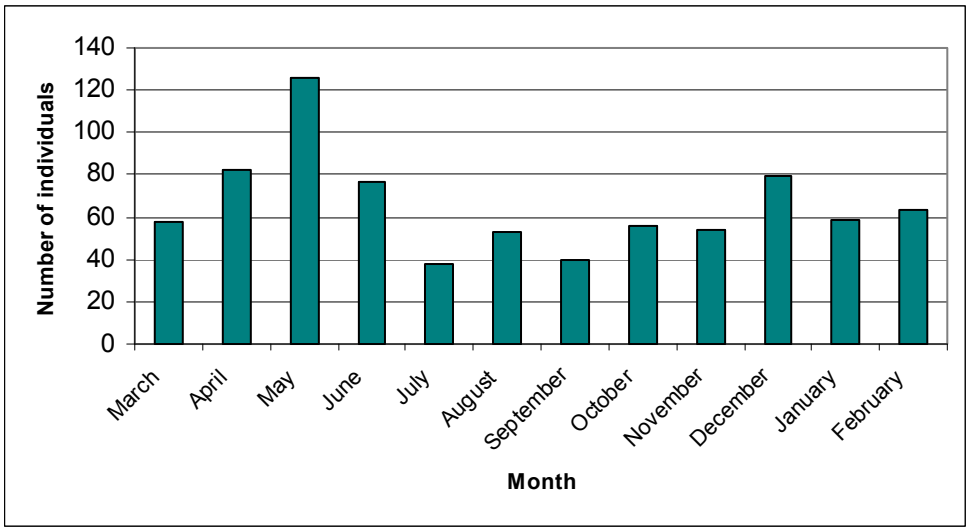


Fig.26 Monthly variability of the spider population

Of the six-teen families the highest percentage of population recorded was Oxyopidae (28%) followed by Salticidae (18%), Araneidae (16%), Sparassidae (12%), Tetragnathidae (9%), Theraphosidae (5%) and Hersiliidae (5%). Like-wise the families Thomisidae, Zodariidae, Psechridae, Pholcidae, Theridiidae, Nephilidae, Liniphiidae, Pisauridae and Lycosidae contained only one percent of each families. The family-wise variability of spider population shows that, the family Oxyopidae (163) and Salticidae (111) contained more number of individuals when compared to other families (Fig.27). The monthly occurrence of the tifer spider (*Poecilotheria striata*) is given in Figure 28. The list of endemic spiders observed in Iringole Sacred Grove is given in Table 15.

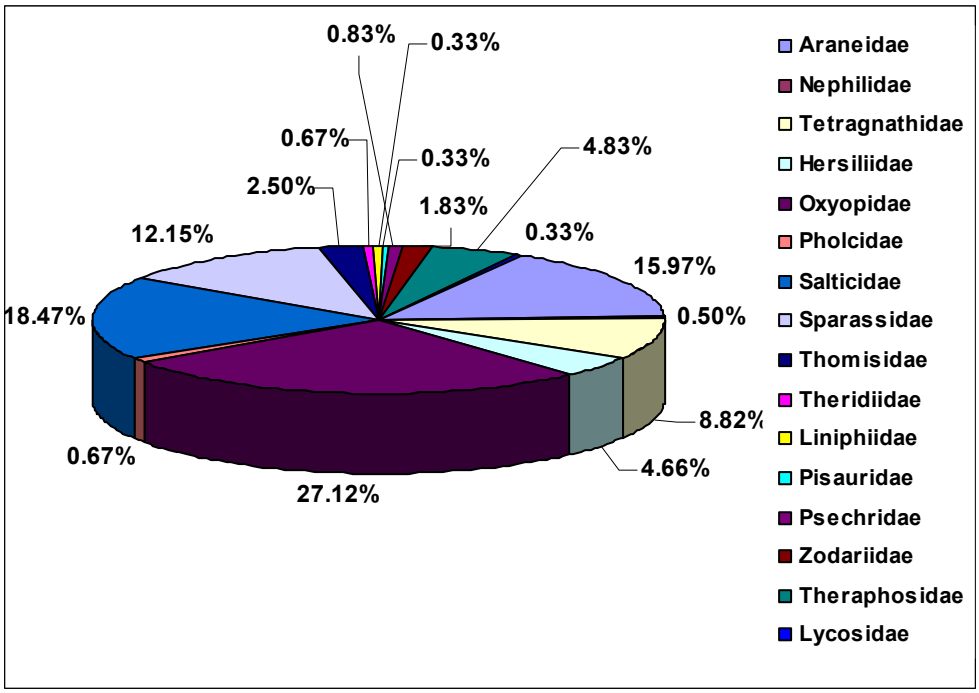


Fig. 27 Family-wise variability of the spider population

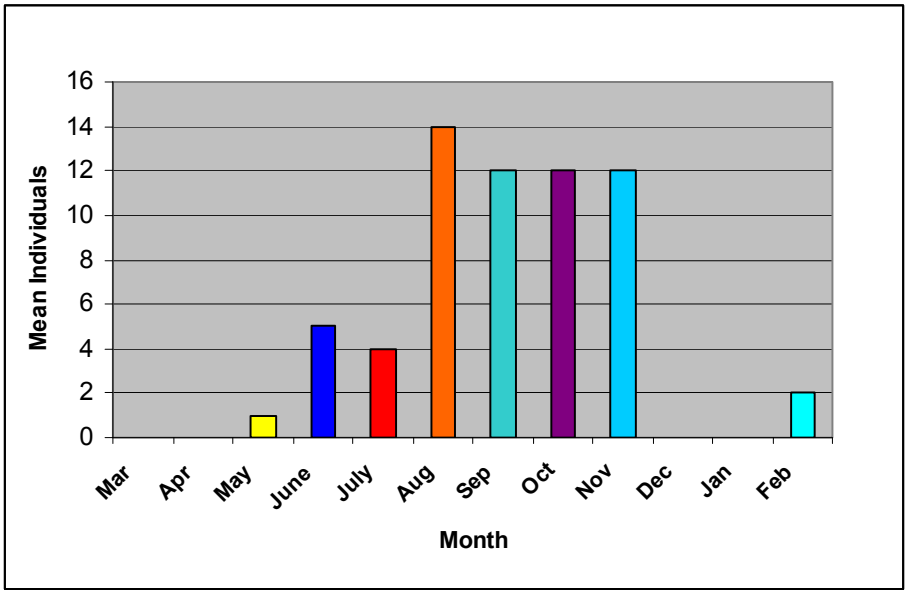


Fig.28 Monthly-wise Tiger spider population (*Poecilotheria striata*)

Table 15 List of endemic spiders recorded from Iringole Sacred Grove

Family	Species	Endemic to India	Endemic to India and Sri Lanka
Araneidae	*Gasteracantha geminata* Fabricius		#
Tetragnathidae	*Leucage pondae* Tikader	*	
Oxyopidae	*Oxyopes sunandae* Tikader	*	
Salticidae	*Bavia kairali*	*	
	Epeus indicus Proszynski	*	
Sparassidae	*Heteropoda nilgirina* Pocock	*	
Thomisidae	*Thomisus lobosus* Tikader	*	
	Thomisus pugilis Stoliczka	*	
Pisauridae	*Pisaura gitae*	*	
Zodariidae	*Hermippus arjuna*		#
Theraphosidae	*Poecilotheria striata* Pocock	*	

* Endemic to India; # Endemic to India and Sri Lanka;

4.16. Amphibian diversity

The amphibians constitute a class of vertebrates, which include frogs and toads, salamanders and caecilians. The word 'amphibian' is derived of two Greek words, amphi in old Greek means 'both' and 'bios' is for the word 'life'. The amphibians are so named because most members have aquatic larval stages that metamorphose (transform) into terrestrial adults. Because the life history of Amphibians involves both land and water, most of amphibians have behaviour patterns built around a seasonal movement between breeding sites and other places. Amphibians are subject to enormous predation. From egg to adult they form a part of diet of innumerable vertebrate species. The basic element in the ecology of amphibians is their need for a moist environment. They are very susceptible to drying out. Although a few

species spend their entire life in water, most live at least part of the time on land, either moist debris or not far from water. A few such as toads, which live even in semi desert conditions, are not entirely independent of water.

They are 215 species of amphibians known from India (Easa, 2003). Nearly 63 percent of the amphibians are endemic to India. Ninety-three species of amphibians are reported from Kerala. Out of these, 40 species are Western Ghats endemics.

A number of field studies in different parts of Kerala resulted in a wealth of information on the distribution (George, 1995, Radhakrishnan, 1996a, b and 1999: Radhakrishnan et al., 1996: Zacharias and Bhardwaj, 1996: Daltry and Martin, 1997: Easa, 1998and 2003: Abraham and Easa, 1999 and Abraham et al., 2001). Shaji and Easa (1999) have reviewed the amphibian studies in Kerala.

Random surveys were conducted in almost all parts of the sacred grove area to identify the amphibian species. The small streams, ponds and marshy areas were specially surveyed for amphibians. The calls during the night time helped to locate and collect the amphibian species. During the study period eight species of amphibians identified belonging to three families were identified (Appendix VI). The families Rhacophoridae and Ranidae containing maximum number of species followed by Bufonidae. Four species of amphibian recorded in this study were found to be of high conservation status being either endemic or protected species.

Diversity index of amphibian is presented in Fig. 29. Overall amphibian diversity in the Iringole Sacred Grove showed that maximum species diversity was observed during south west monsoon (June-Aug) and north east monsoon (Nov) periods. Amphibians were not recorded in the quadrats during the summer months (Feb-April).

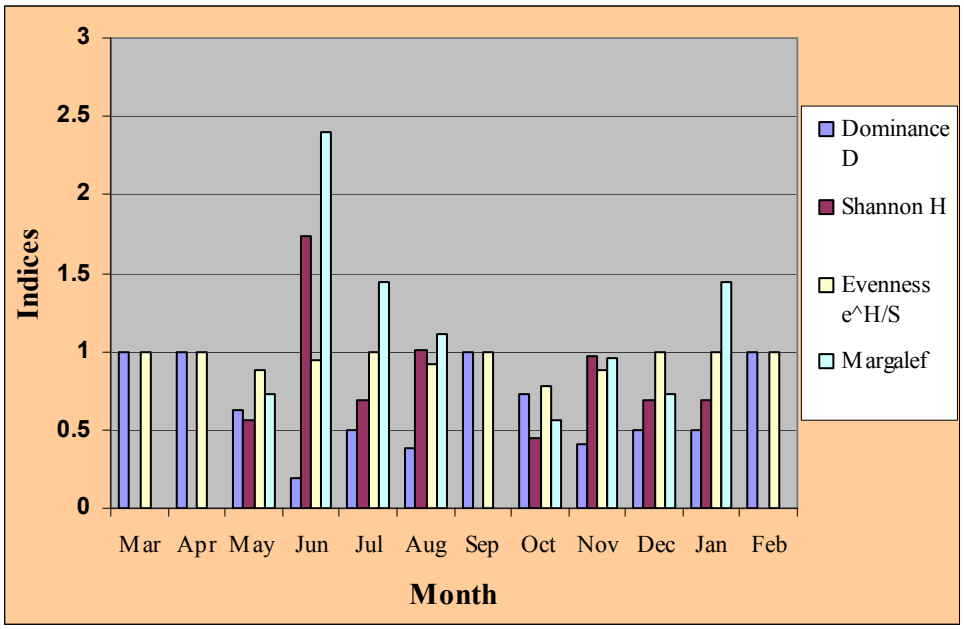


Fig.29 Overall diversity indices of Amphibian in the Sacred Grove during 2007-2008

4.17. Reptilian diversity

Random surveys were conducted in almost all parts of the sacred grove area to record the reptile species. The small streams, ponds, leaf letters and tree barks were specially surveyed for reptiles. During the study period were the fifteen species of reptiles identified belonged to seven families (Appendix 4). These include two species of turtle, six species of snakes, three species of geckos, two species of agamids, and two species of scincids. The families Colubridae and Geckonidae containing maximum number of species followed by Agamidae and Scincidae. The families Geoemydidae, Trionychidae and Uropeltidae both are having one species each.

The two species of turtles recorded were Indian pond terrapin *(Melanochelys trijuga)* and the Indian flap-shelled turtle *(Lissemys punctata).* Indian pond terrapin and Indian flap-shelled turtle were common and widely distributed in ponds in the study area.

Six species of snakes were recorded from the study area. These include five species of colubrids and one species of shield-tails. Of the above, The Uropeltids or shield-tails collected (*Uropeltis sp*) were from loose moist soils. *Ahaetulla nasutus* and *Dendrelaphis tristis* are arboreal snakes observed mostly on bushes and tree branches. *Xenochrophis*

piscator were found to have a strong preference for riparian vegetation. *Ptyas mucosus* was the commonest among the snakes of forest area. *Elaphe helena* was seen in the decayed fallen logs, heap of stones and decayed leaves were the study area. None of these species are venomous.

Three species of geckos were recorded during the study period. *Cnemaspis kandiana,* the common forest dwelling gecko was usually seen on tree barks. *Hemidactylus brooki* and *H. frenatus* were seen both in the sacred grove area as well as in the buildings. Two species of Agamids were recorded from the study area. Calotes versicolor and Calotes calotes were seen both in the sacred grove area as well as in the tree branches, fallen logs and rocky regions. Two species of skinks were recorded. *Mabuya macularius* was the common, widely distributed forest skink, sighted in almost all habitats. *Mabuya carinata* was seen mainly near habitations.

4.18 FAUNAL ASSEMBLAGE OF IRINGOLE SACRED GROVE

A total of 379 species of animals including inverterbrates and vertebrates were recorded from the Iringole Sacred Grove (Table 16). The invertebrates other than insects included three species of earthworms, five species of Millipedes, two species of centipedes, 49 species of spiders, and eleven species of mollusks. Insect recorded from the grove include one species of Thysanura, 14 species of Odonates, 14 species of Orthoptera, five species of Phasmida, ten species of Dictyoptera, three species of termites, 22 species of Hemipterans, two species of Neuroptera, 21 species of Hymenoptera, 20 species of Coleoptera, 21 species of Diptera and Twenty nine butterflies belonging to seven families and twenty species of moths belonging to 10 families were identified from the Iringole Sacred Grove. Eight species of amphibians (Appendix VI), the fifteen species of reptiles (Appendix VII), 65 species of birds (Appendix VIII) and nine species of mammals (Appendix IX) were recorded from the sacred grove.

Table 16 Fauna recorded from Iringole Sacred Grove

Animal groups	No. of species
INVERTEBRATES	
Annelida	3
Myriapoda-Millipedes	5
Myriapoda Centipedes	2
Arachnida	49
Thysanurans	1
Odonata	14
Orthoptera	14
Phasmida	5
Dictyoptera	10
Isoptera	3
Hemiptera	22
Neuroptera	2
Coleoptera	20
Diptera	21
Butterflies	55
Moths	20
Hymenoptera	21
Gastropoda	11
VERTEBRATES	
Pisces	4
Amphibia	8
Reptilia	15
Aves	65
Mammalia	9
	379

4.19. Avifauna

A total of 65 species of birds were recorded from the sacred grove. The details of species recorded from the area are given in Appendix VIII. Among the birds recorded, seven are wetland species and another five are owls. Presence of paddy field surrounding the grove and the presence of a pond inside the grove supported the wetland species. No trans-continental migrant species were recorded. Over all diversity indeces are given in Table 17 an diversity across different months are given in Figure 31. Shannon diversity index is 3.13. On an average, twenty five individual birds were recorded during any given day. Limited observations on, feeding revealed that most of the bird species were dependent on trees for

their food, followed by the pond in the premises and also the surrounding paddy fields. The total number of birds recorded was highest in July. The trend in the number of species recorded across the months is given in Figure 30. December and January recorded maximum number of species.

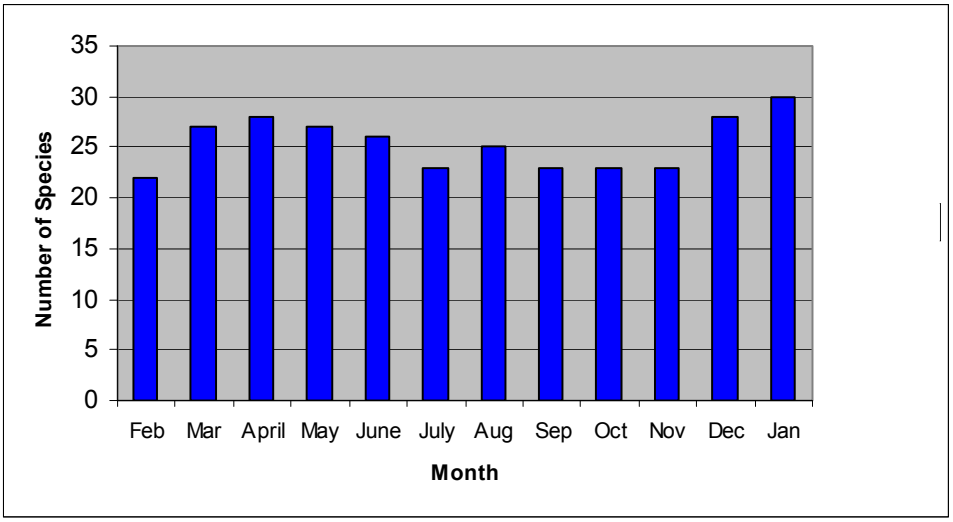


Fig. 30 Distribution of number of species of birds in different months.

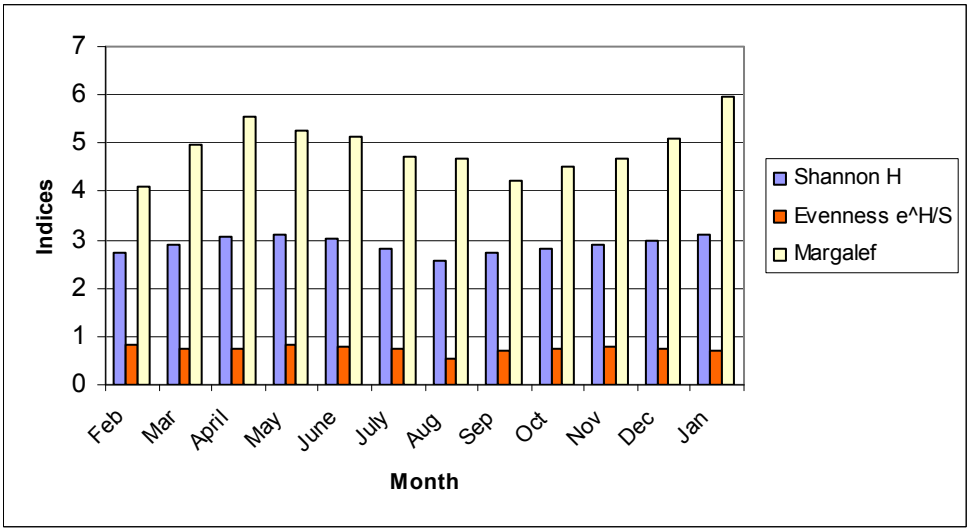


Fig. 31 Diversity indices during different months

Table 17 Diversity parameters of birds in the sacred grove

Total birds sighted	Dominance Index (D)	Shannon diversity index (H)	Evenness index	Equitabilities (J)
1536	0.05692	3.13	0.63	0.8737

4.19.1 Breeding of Red spur fowl

Red spur fowl is one of the three species of the genus *Galloperdix* which is distributed throughout the Indian subcontinent and endemic to the country. The species includes three subspecies in India (*G. s. spadicea, G. s. stewarti and G. s. caurina*). Travancore red spur fowl *G. s. stewarti* is a resident bird of Kerala found commonly in the forest areas excluding the Wayanad Wildlife Sanctuary. It prefers moist deciduous forests dominated by *Lantana* scrubs and undergrowth in the bamboo plantations (Ali and Ripley, 1983). Information on the ecological and behavioural aspects of this elusive and shy bird is scarce even though the species is reported from throughout the State (Easa and Jayson, 2004).

Three eggs were found in a nest, which was built on the ground near the base of a tree. The occurrence of the bird in a sacred grove surrounded by houses and roads in the middle of a city is worth mentioning. Nearest natural forest is 18 km away from the site as the crow flies (Thattekkad Bird Sanctuary) and there is also no continuity of forest. The nesting site has a canopy height of 8 m and a canopy cover of 50%. Distance to the nearest road was 75 m and distance to the water body was 20 m.

The species breeds during April-May months and January-February months (Table 18). It was also observed that it breeds on ground, with out any hiding (have seen sitting over the eggs in an open place with out any hide or canopy cover and easily seen to others or beneath the trees). This type of breeding behaviour of the species in a sacred grove, surrounded by houses and roads in the middle of a city is worth reporting. Usually, there are 2 to 3 eggs, looking like local hen eggs and have almost same size. It did not make a nest like other bird

species. It simply lay their eggs among litters and sit over it and does not move until humans disturb it with a stick or other things.

Table 18 Breeding season of Travancore red spur foul in the sacred grove

Months	Number breeding sites found
January-2007	2
February-2007	2
March-2007	2
April-2007	1
May-2007	1
June-2007	-
July-2007	-
August-2007	-
September-2007	-
October-2007	-
November-2007	-
December-2007	-
January-2008	4
February-2008	4

As per the reports, the subspecies Travancore red spur fowl usually nest throughout the year except during the monsoon months from June to August (Ali and Ripley, 1983). Regarding the nest site, Travancore red spur fowl is a well-known ground nesting species and known to build nest on ground in dense bamboo or scrub jungle, some times sparsely lined with leaves and grasses (Ali and Ripley, 1983).

As recorded from other tropical forests, the highest species richness and number of birds was recorded during the month of January and December. This is mainly due to the influx of migrants to the area. Diversity indices also showed higher values during these months. The lowest species richness and diversity indices were recorded during the month of south west monsoon i.e., June and July. All the species are in Least Concern (LC) status of IUCN. The occurrence of a population of the ground nesting fowl the Red spur fowl in an isolated forest patch (Sacred grove) of 10 ha extent showed the birds ability to sustain within this limited space. Proper protection of the area is needed for the preservation of birds species in the area.

4.20. HUMAN DIMENSIONS OF THE IRINGOLE SACRED GROVE

Religious / Cultural and Traditional Practices:

Box 3. THE MAJOR FESTIVALS AND TRADITIONAL PRACTICES AT ISG

- ***Pooram*** - annual festival usually held in months of March-April every year
- **Thrikarthika** - The day is celebrated as *the deity's birthday*
- **Vithidal chadangu -** It is a traditional ritual is being held by Pulaya community on Kumbha sankranthi.
- Monthly **oottu** (festivity) on Karthika days

The temple conducts various cultural and religious festivals (Box 3), besides their daily rituals. *Pooram,* an annual festival usually held in during the months of March-April every year, starts with *Kodiyettum* – day 1 (Figures 31 & 32). It is a flag hoisting ceremony with a trunk of areca tree garlanded with flowers and tender coconut leaves. From kodiyettu to nine days are celebrated as utsav. The eighth day is a traditional ceremonial day with drumbeat*, Kazhcha sreebali* and *Pooram ezhunellippu.* The ninth day is *Aratu.* On all the Utsav days the diety has Aratu at the Neelan kulangara temple, near the grove, it is a peculiarity of the grove. The day of kodiyettum, main pooram and arattu days have illustrated maximum people participation. During March-April 2009, approximately 1600 people participated on day one and on Pooram day about 7000 individuals were recorded in the primary investigations.

It may be recollected that the surrounding area around the sacred grove in earlier times was being cultivated with rice. The "*Vithidal chadangu*" reminds of the days when the jamindary system was prevalent and rice was being cultivated in the surrounding areas. Though the sacred grove was earlier times built by the Nambuthiri illams, they had a cultural linkage with the pulaya community (scheduled castes) who were at that time working as agricultural labourers of the landlords. The pulaya community was involved in the traditional vithidal which is being conducted outside the temple on the Sankranthi day of the Malayalam month of Kumbham. That day marks the first harvesting of the rice and offering it first to the diety for the thanks giving offer.

Figure 32 Pooram (festival)

Figure 33. Pooram (another view)

The conduct of the rituals and festivities in ISG highlight the following: The Grove has no sub-deity, the use of scented bright flowers or perfumed incense sticks prohibited. Only Chethi (*Ixora*), Thulasi (*Ocimum*) and Tamara (*Nelumbo*) can be used, only female elephants are to be used in temple festivities, and the conduct of social functions like marriage etc. prohibited.

'**Thrikkarthika**' (the birth star of the deity) of 'Vrishchikam'(Malayalam month) is a monthly ritual supposed to be deity's birthday i.e., the day on which the divine stone is exposed. *Karthika vilakku* and *karthika Oottu (temple lunch)* is the speciality of the day, where in people from far and wide come and participate. **Makarasamkramam**' (Makaram 30th) or is the day on which the 'pulaya woman' saw the divine stone.

Vithidal chadangu is a traditional ritual held by the traditionally linked Pulaya community on Kumbha sankranthi. They offer seeds and money with *Kudakali* (Fig 34) and *Mudiyattu* (Fig 35) to their deity Iringole Kavil Amma. *'Kudakali'* is a special ritual of Iringole, where "Kuda" is made of palm leaves and ornamented with tender leaves of coconut (*Kuruthola*) (Fig. 36). This Kuda is considered as 'Stana kuda' which is required and has to be placed in the corner of temple before starting *Pooram*. *Kudathullal* is always accompanied with rhythmic '*Thudikottpattu*' (a rhythmic drum beating). While the males sing the devotional song of the deity, the females start *'Mudiyattu'* with an inflorescence of areca palm in their hands. There are three *Mudiyettu* groups namely Iruvichira, Pattal and Chundakuzhi-Mudakuzha group. On the previous day of the ritual, the women assemble near the *pathi* and

visit and receive seeds and offerings from nearby settlements. The three groups then assemble in one place and proceed to the grove. They enter the grove premises through the eastern side. The folklore and folkmusic tell us the traditional links to this specific community. This ritual is being performed from their forefathers time; however there is no written record assigning their right for performing the ritual. They often find it difficult to convey their rights to the changing administrative and management setup of the ISG.

Fig. 34 Kudakali

Fig. 35 Mudiyattu

Figure 36 Traditional 'Kuda' made of palm leaves

Monthly **oottu** (festivity) on Karthika days, is a feast given to the devotees on all Karthika days of the Malayalam month. It was interesting to note that there were many sponsors for each month of the Oottu and reservations are made well in advance and almost up to a year

ahead. This indicates the immense faith and devotion of the people. Other important offerings include *sarkkaranivedyam, kaddumpayasm*, *neypayasm*, *chathussatham* and *koottupayasm.*

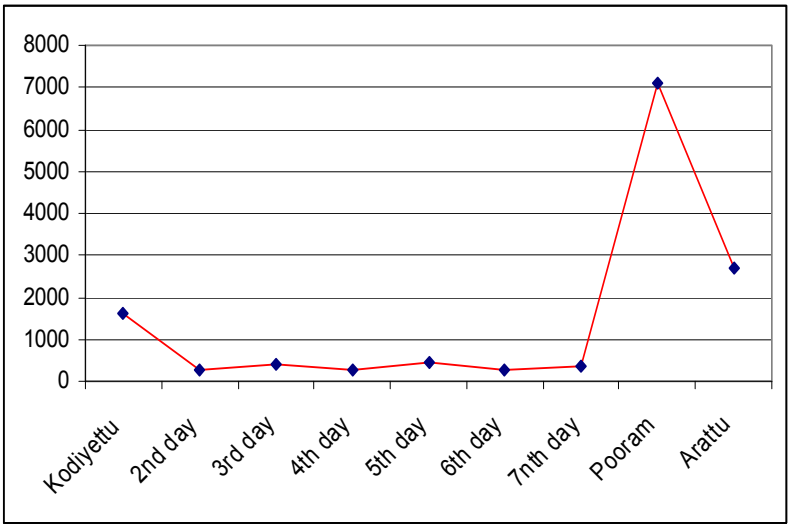
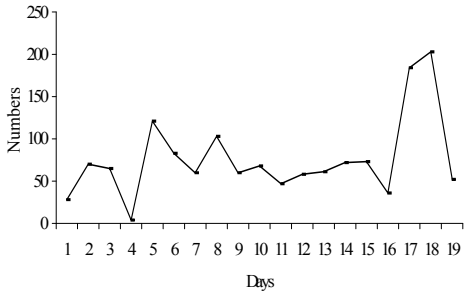


Figure 37. People's participation in Pooram (2009)

4.20.1 Profile Studies

Local people believe that they reveive blessings of the diety and therefore devote human resources and money and they consider grove as a community-based property (Chandrasekhara & Sanker, 1998). The study identified multiple stakeholder groups in the sacred grove, *i.e.* local community, students and teachers, tourists, pilgrims, photographers, researchers, management officials and local governance. Large number of people from different walks of life visit the SG for various interests, from worship to archeological interests. The number of devotees, visitors, and local people's participation in the functions and festivals is definitely increasing year by year. The average visitor flow to the SG is 76 per day (Figure 38).

Figure 38. Visitors flow



The study area consists of the wards 13 and 14 of Perumbavoor Municipality, where the population has a sexratio of 1021: 1000 males, at par with State figures. The sample survey covered 144 households in the peripheral area of the sacred grove out of a total of 496 houses. The family size of the respondent varies between 1 and 8 with an average family size of 4 members. The monthly income of the sample ranges between Rs. 1500 and Rs. 3500, with an average monthly household income of Rs.7370/-. Employment is the major source of income and the number of employed persons of the sample households varies between 1 and 4. The monthly expenditure of the sample varies between 1200 and 10000 with an average monthly expenditure of Rs.4530/-. The household savings varies between zero and Rs.27,000 with an average monthly saving of Rs.3418/-.

4.20.2. Revenue and Expenditure

The average revenue collection per day is Rs.740 and the average donation per person per visit is approximately 9.7. Maximum revenue is obtained during the months of December (12.31 %) and November (9.88 %) (Figure 39).

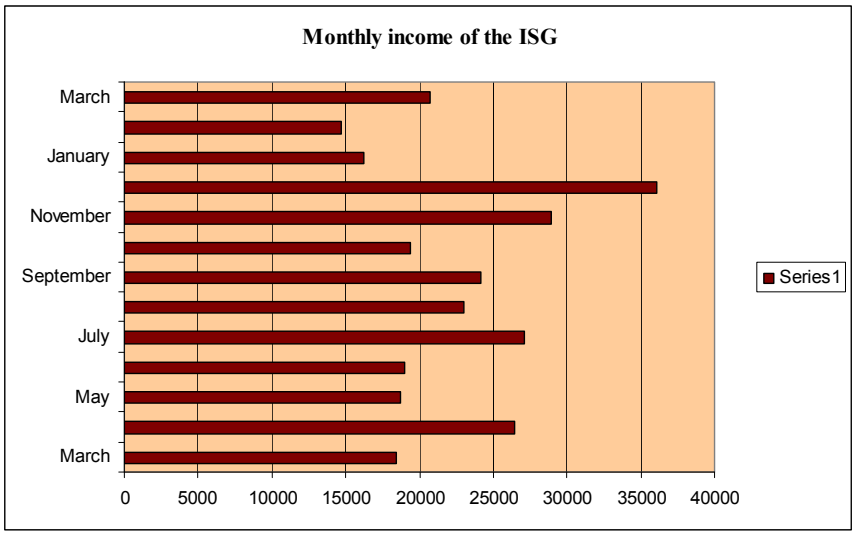


Figure 39 Monthly income from the Iringole sacred grove

This could be attributed to the Sabarimala Pilgrim season, which has a positive effect on the income of the grove. The ISG has a prominent position in the pilgrimage map of Kerala and apart from the local devotees, there are large number of devotees visiting the temple from different parts of the state. The increase in revenue during April is due to the annual pooram

festival held in the grove during which large number of devotees provide offerings to the deity. Based on the available data, it was observed that the monthly expenditure as salary for the ISG employees amount to Rs.29,190. The amount is paid by the Travancore Devaswom Board.

4.20.3. Human Disturbance

Human disturbance in the plots were assessed in terms of reduction in a) numner of plants per hectare, b) number of trees per hectare and c) total saplings per hectare. Mean total individuals in the plots, excluding the temple plot, is 2341.17, mean total trees is 1476.73 and mean total saplings is 307.39. In the temple plot the total individuals is 920.00, total trees is 84 and total saplings is 112. For comparing the disturbance in and around the temple plot with the far away plots, independent t-test was carried out (Table 19).

Table 19. Comparison of number of plants in around temple plot with that of plots away from the temple plot

Variables	Plots in and around the temple plot (N=9)	Plots away from the temple plot (N=43)	t-value
Total No. of plants per ha	1502.2 (122.3)	2483.7 (268.3)	3.329**
Total No. of trees per ha	1103.6 (143.9)	1522.5 (74.6)	2.378*
Total No. of saplings per ha	116.9 (6.7)	342.7 (76.2)	2.951**

Values in the brackets are standard error of the mean
*** significant at 1% level; * significant at 5 % level*

Total number of individuals and saplings per hectare are significantly different between the nearby plot and far away plot at 0.01 level and total number of trees also indicate significance at 0.05 level. Higher values in the far way plots in all the three variables is indicative of the fact that disturbance is more in the plots which is very nearer to temple plot mainly due to human disturbances and interactions.

4.20.4. Actual and Potential Threats

The threats to the grove are both natural and manmade. The Grove is subjected to various anthropogenic disturbances, some of which are commercial. Temple visitage frequencies are positively related to the growing religious and cultural tourism in the Grove. The increased quantities of pollutants especially plastic waste (after each religious function or festivity) and antisocial activities are the major threats to the grove.

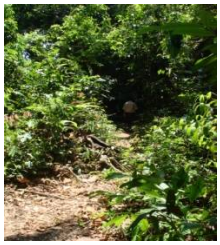
Although the proposed tourism development activities in the grove has the potential to make an economic impact via income generation and creating new avenues for employment, such propositions also create threats resulting in an acculturisation process. Growing visitation and various developmental activities is at the cost of their deep routed traditions, culture and age old relationship with the environment.

Already high rate of deforestation is observed in and around the temple plots as well as the large number of entry paths to the grove. The grove is an open access area with no control over the peoples' entry into the premises. These commercial threats if not controlled in time can adversely affect both the pristine ecosystem, sanctity of the grove and the people at large.

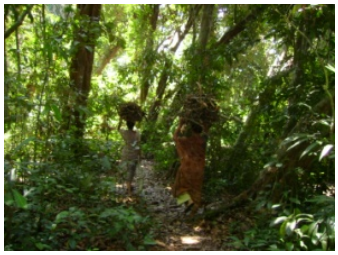
4.20.5. Threats

THREATS FACING THE GROVE:

The ISG known for its unique stance today faces anthropogenic threats besides natural causes. Besides the main two entrances there are large numbers of entry paths. Although based on the principles of sacredness this has made the grove an open access area. This threatens the very existence and conservation of the grove. The demographic pressures exert demand on land resulting n the reduction in the size and partial clearing of the grove for various agricultural purposes.




Unauthorized collection and removal of biomass from the grove. Fuel wood collection too is seen which is often ignored by the authorities. This also causes heavy disturbances to the groves ecology supporting life. The movement of large crowds during festivals or rituals further destroys the ground vegetation which affects the regeneration of plant species.




Furthermore, developmental programmes such as construction of pathways, canals, fence; which lead to fragmentation of forest patch and adversely affect the ecosystem. Waste

accumulation/ solid waste dumping has further degraded the ecosystem as a consequence of the festivities being conducted regularly in the Grove.

Weakening of the faiths, beliefs and taboos relating to the sacred grove, lack of awareness among the people regarding biodiversity and its conservation, endemism, among others are also adding the given scenario. Besides these manmade causes for the deterioiration is the natural factors such as strong winds resulting in the uprooting of age old trees as a result of soil erosion…..Invasion of exotic weeds such as *Mikania micrantha,* consequent succession and further degradation of sacred grove forests.

5. DISCUSSION

Iringole Sacred Grove (ISG) is about 10.53 hectres in extent and one of the major sacred grove existing in Kerala, located amidst the thickly human populated landscape having cultivation and urban households (Google earth map of Iringole Sacred Grove dated 28th March 2009, given in the back cover of the report). *Vateria indica – Hopea parviflora - Hopea ponga* association is the speciality of the Grove with frequent occurrence of several climber and straggler species.The floral life forms of ISG is represented by 64 tree species 18 woody climbers, 22 species of erect shrubs, 11 species of climbing shrubs. The ground flora includes 68 species of herbs and 11 species of tuberous plants. A total of 215 species of macrofungi belonging to 95 genera falling under 28 families was recorded from the sacred grove which shows the remarkable richness of the macrofungal flora also. This study has generated exhaustive baseline information on the flora in systematically laid plots of 50mx50m in the sacred grove. There are 13482 trees in the Iringole Sacred Grove which is recorded from 26 full plots of 50x50m size and 26 partial plots. Tree abundance varied from 11 trees (Plot No. 9) to 642 trees (Plot No. 44). There are a total of 819 woody climbers distributed from one (Plot 47) to 48 woody climbers in Plot No.35.

Semi-evergreen species such as *Vateria indica, Hopea ponga, Artocarpus hirsuta, Strombosoa ceylanica* and *Hopea parviflora* are the dominant trees in most of the grids. *Artocarpus hirsuta* is more dominant in the eastern side of the grove having more than 200 individuals in plots 20, 33, 34, 35, 40 and 39. The occurrence of pioneers like *Macranga peltata* is seen in grids 35, 39, 5 and 13 indicating canopy opening due to fall of trees in those grids. Similarity of vegetation with that of evergreen forest with lot of semi-evergreen elements is evident from the litter fall which exhibited two peaks during the post and pre monsoon seasons, though maximum litter fall was found to be during the months of September-October and January which resembles the pattern usually found in the semi-evergreen forest ecosystem. In moist deciduous forest litter fall shows single peak after the December to Febraury period. Presence of *Strombosia ceylanica* is seen in most grids and grid nos 11, 24 and 29 have more than 100 individuals.

More plant lifeforms are seen towards the eastern side of the temple (Figure 40). This area contains one of the main paths to the temple. Though the area is rich in trees and lianas (Figure 41 and Figure 42) the ground is much tramped and there is very little regeneration (Figure 43). If sufficient care is not taken for the younger trees to establish, either side of the path may widen and canopy may become discountinuous.

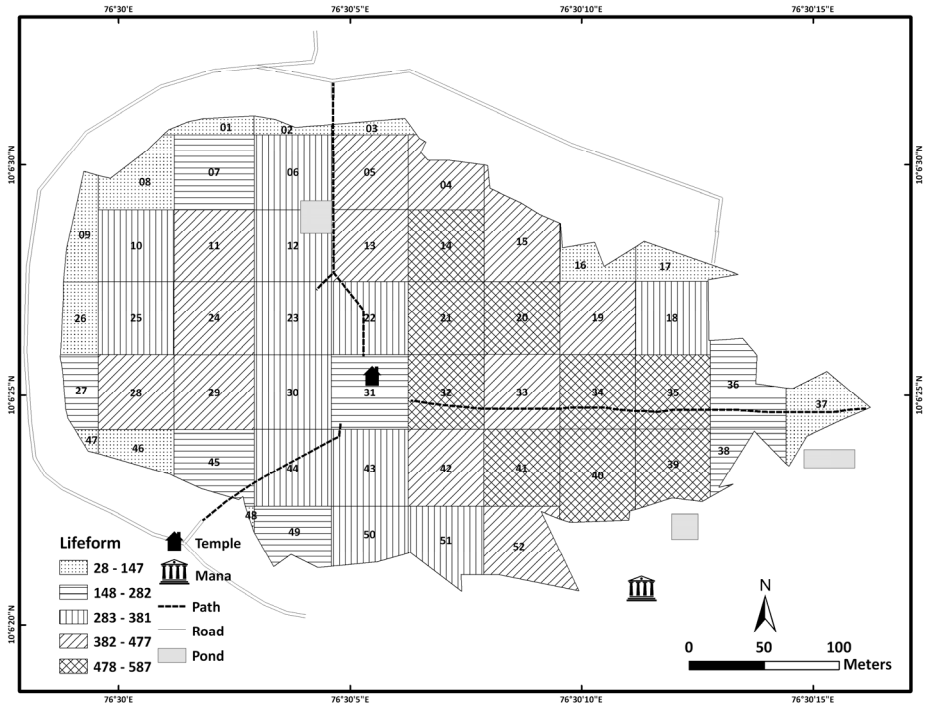


Figure 40 Thematic map showing the spatial distribution of plant life forms in Iringole Sacred Grove.

Most of the large diameter trees in the grove are affected with butt rot and heart rot and are therefore subjected to uprooting. The use of the wind-fallen trees as fire-wood for the temple feast may affect the diversity of micro and macro organisms, especially wood borne fungi.

Tree regeneration in the height class <40 cm is found in all the grids and range between 3 and 122. The regeneration class 40-100cm height is found in 48 grids with one individual to 22 individuals. The height class 100-130cm is represented in 45 grids varying from one individual to 13 individuals. The height class >130cm is represented in 49 grids with a maximum of 22 individuals in Grid No. 24 which is in the western side of the grove and grid

no.31 having no individuals as the temple is located there. Therefore the regeneration is fairly good for the tree species.

The iringole sacred grove has a rich assemblage of invertebrates consisting of millipedes, insects, spiders, etc. A total of 332 species of animals were recorded from the grove. The semi-evergreen nature of the vegetation and large accumulation of litter and humus and moisture in the soil there are large number of millipedes: giant millipede, black millipede, pill millipede, yellow spotted millipede. The pill millipedes are common in almost all the grids and their number varied from 50 to 1500 or more, wherever there is accumulation of leaf litter. The giant millipede was also found in the litter with their number varying from 10 to 150 in the litter accumulated grids.

From ISG a total of 65 species of birds most of which are the common birds found in the country side. The bird fauna included five species of owls; roosting of Mottled wood owl, an endemic owl species of the peninsular India was also observed. The mammal species included rats, palm squirrel, hare, palm civet and fishing cat. A few sightings of bat species was also recorded in the grove.

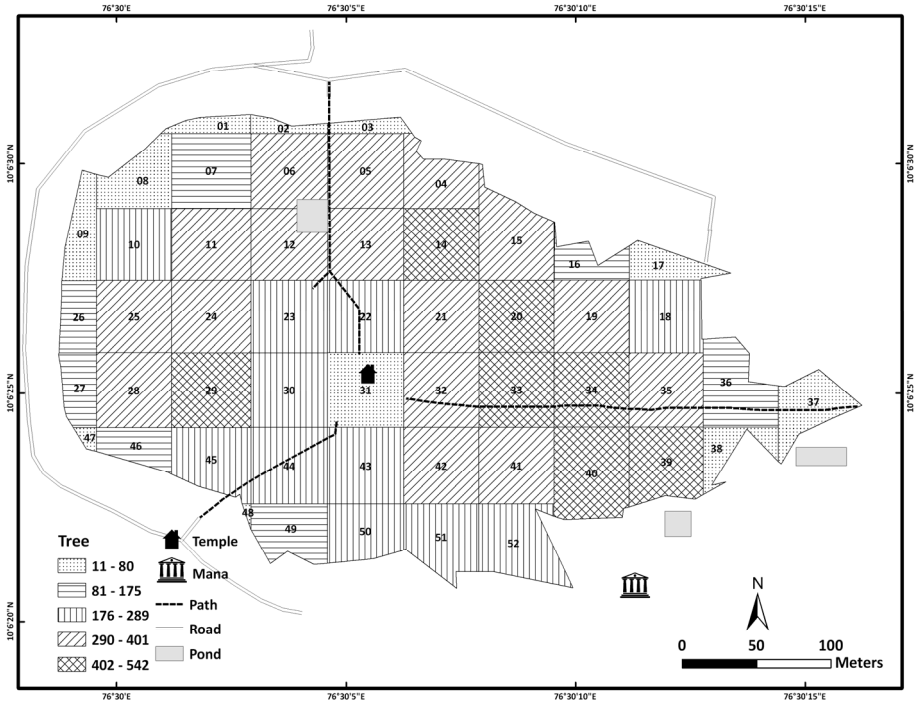


Figure 41 Thematic map showing the spatial distribution of number of trees in Iringole Sacred Grove.

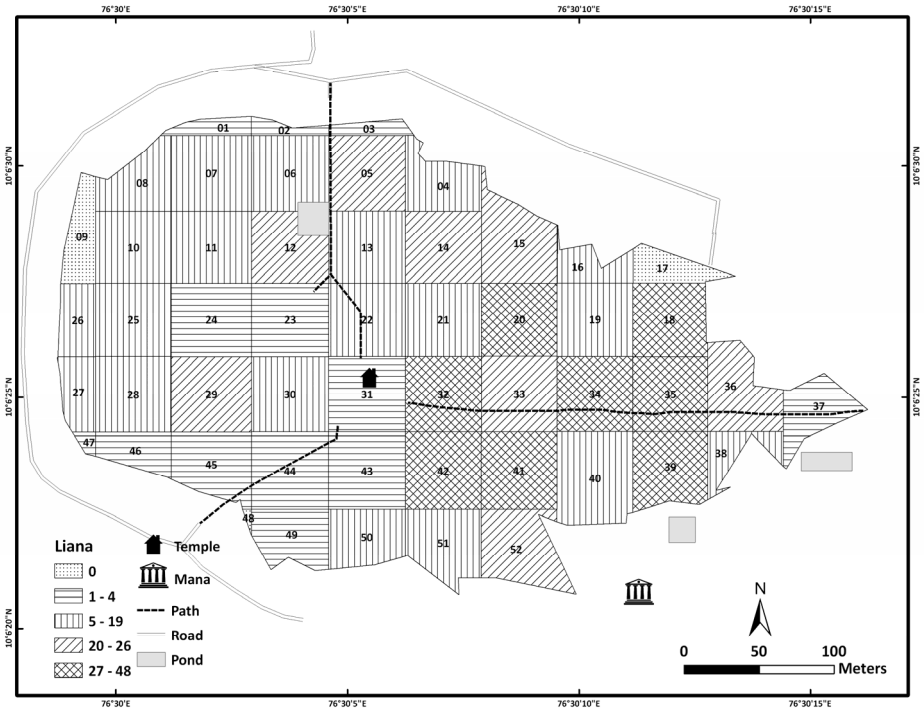


Figure 42 Thematic map showing the spatial distribution of number of Lianas in Iringole Sacred Grove.

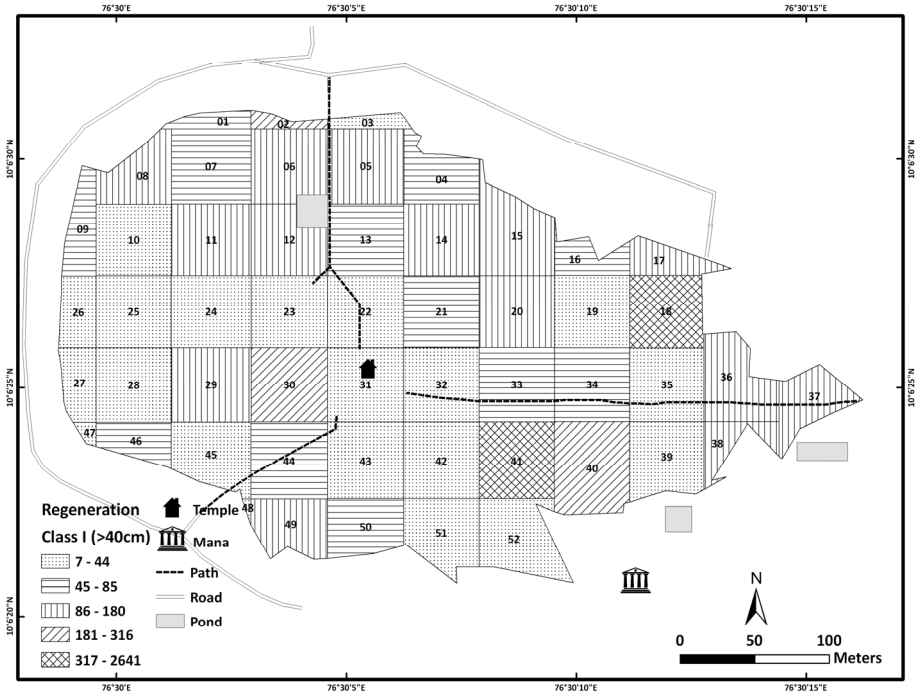


Figure 43 Thematic map showing the spatial distribution of regeneration of trees belonging to >40 cm GBH in Iringole Sacred Grove.

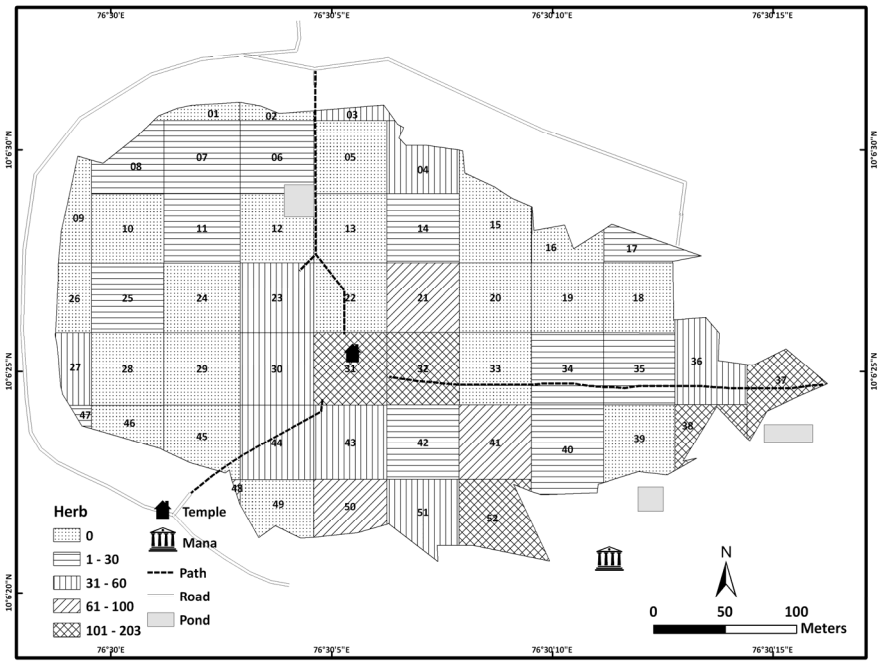


Figure 44 Thematic map showing the spatial distribution of number of herbs in Iringole Sacred Grove.

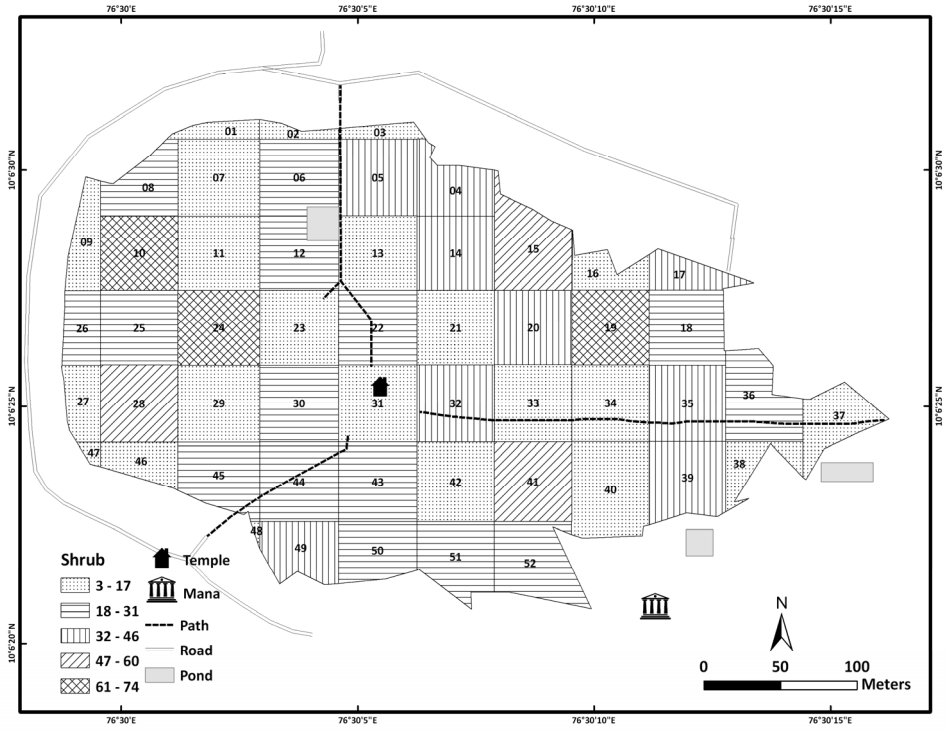
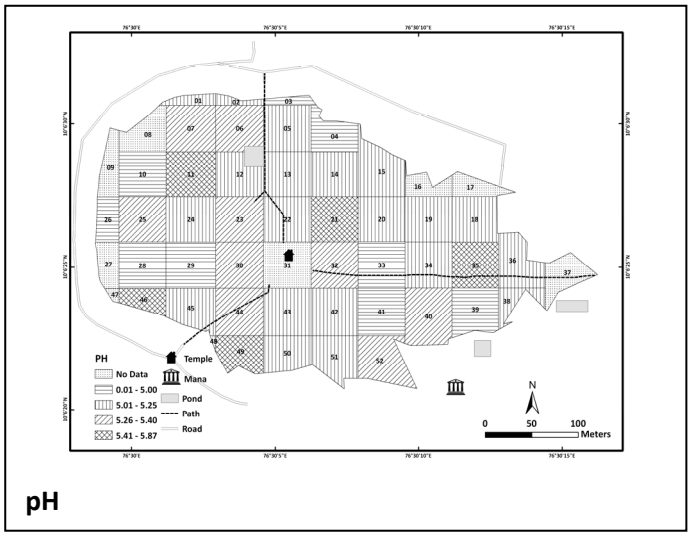
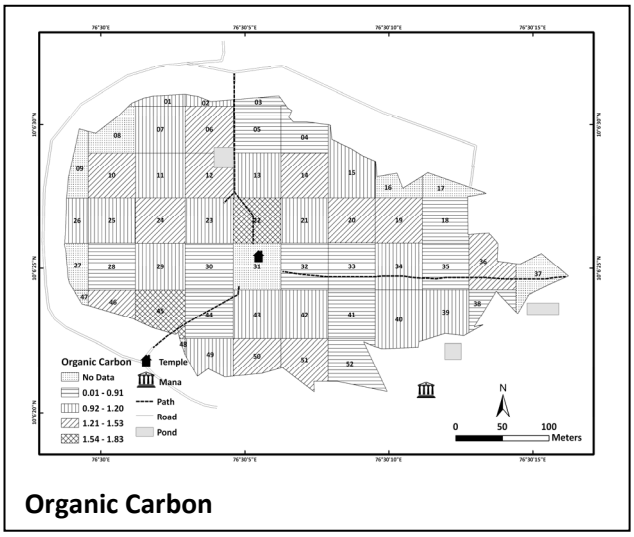


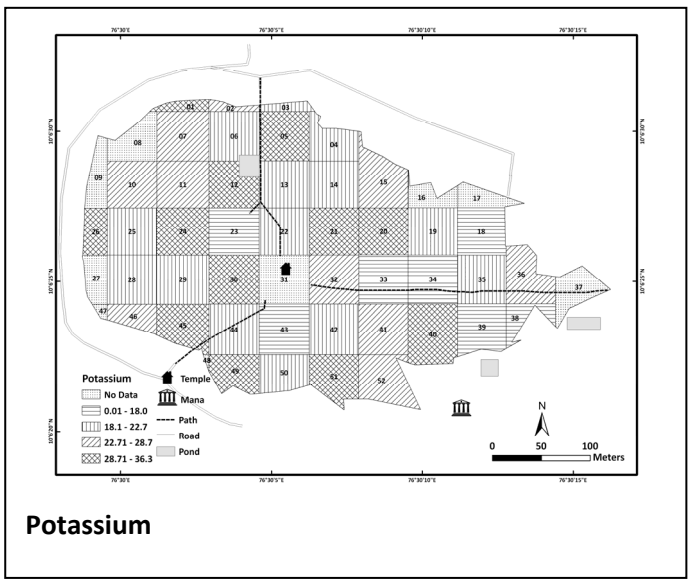
Figure 45 Thematic map showing the spatial distribution of number of shrubs in Iringole Sacred Grove.



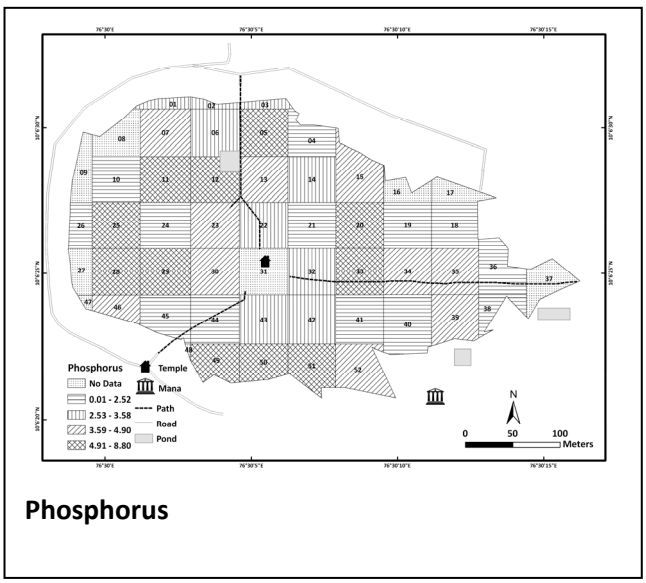
pH



Organic Carbon

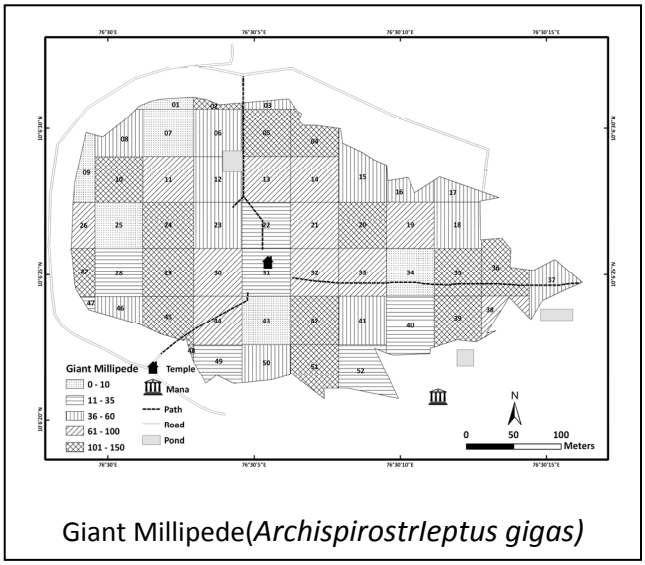


Potassium

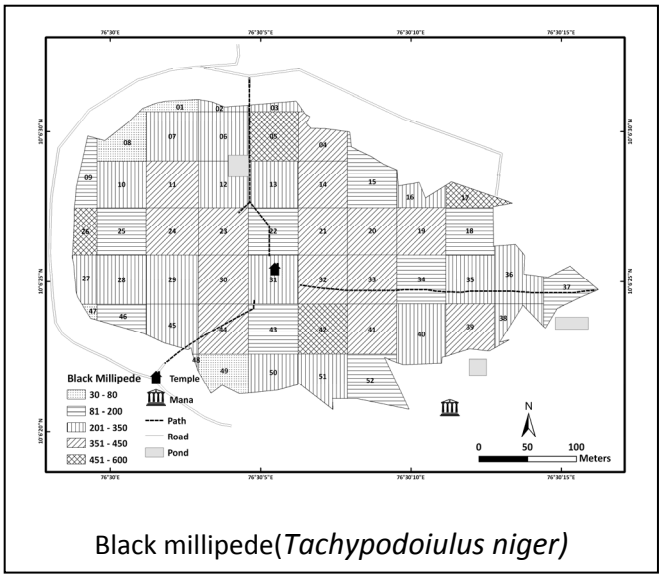


Phosphorus

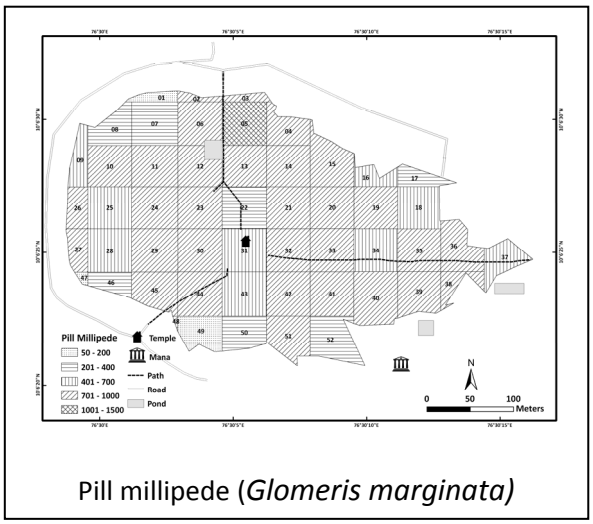
Fig 46 Soil parameters



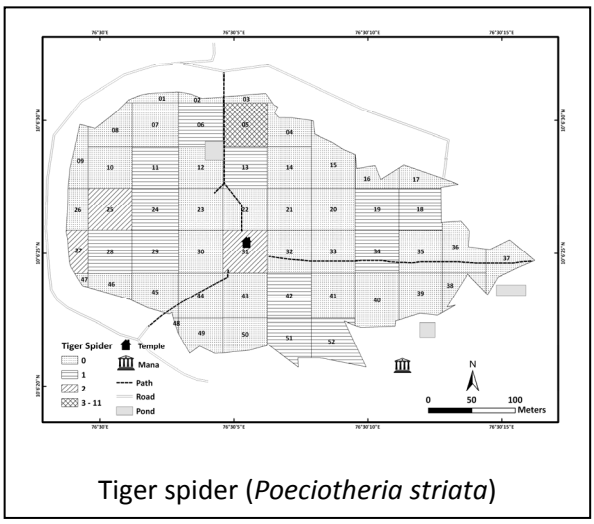
Giant Millipede(*Archispirostrleptus gigas)*



Black millipede(*Tachypodoiulus niger)*



Pill millipede (*Glomeris marginata)*



Tiger spider (*Poeciotheria striata*)

Fig 47 Distribution of selected invertebrates

This religious ecosystem once supported luxuriant evergreen vegetation but has dwindled tremendously over a period of time due to various reasons both natural and manmade. Deterioration due to various threats and developmental processes has changed the scenario. Increase in tourism activities had both positive as well negative impacts in the conservation

of the Grove. However, the Advisory Committee's efforts via the people in conserving the Grove is very powerful, cost-effective and socio-culturally invaluable. From this situation of a well-protected and well-preserved sacred grove, there are several lessons to learn for the rehabilitation of the many degraded sacred groves in the State and the country and also to improve upon the present management strategies of the Grove itself for its sustained improvements in the years ahead.

The survival of the unique flora and fauna is a very good example of how tradition is conserving a unique ecosystem which does not have any continuity with forests of the region in the recent past. The human dimensions and their linkages to the Iringole Sacred Grove clearly indicates a typical community conserved biodiversity rich area with deep ecological and socio-cultural dimensions. The Iringole Sacred Grove, a traditional institution has been an integral part of the community's social and cultural life. The Grove is considered valuable by the local communities and the traditionally linked community and protected by the community for reasons that are both religious and spiritual.

6. SYNTHESIS

Since time immemorial there existed a tradition of sacred groves based on the principles of sacredness and communities contributing to their conservation. Iringole Sacred Grove (ISG) played a key role in community management on the belief that gods and goddesses safeguard the grove. The grove has been studied mainly from the point of view of biodiversity and it is only off late the human dimensions of the grove are being emphasized upon. The traditional institution, the ISG, however faces many threats in today's modernization era. Although the management of the system and its are well defined the grove is undergoing serious changes and biodiversity maintained for over hundreds of years is fast depleting. Loss of faith in divine beliefs and culture has resulted into deterioration of this age-old institution. This is result of impact of complex management and ownership patterns, loss of knowledge about sacred groves, migrations to urban areas, development interventions and community's perception about the sacred groves in today's context.

Changing patterns of administration, advent of development and commercialization are putting enormous pressure on sacred grove land and vegetation. A structural analysis of its ecosystem functions is essential to develop a framework for participatory conservation and management of the ISG. Such monitoring will provide basis to understand issues hampering protection and ways and means to revive this valuable tradition of biodiversity conservation. Due to its small size, ISG has not come within the gambit of legal forest protection framework of protected area network of the country. At the same time considering its biological and socio-cultural significance in protecting the SG it cannot be ignored and should be conserved and protected.

The ownership and management of the sacred grove is with the temple trust although currently it is under the administration of the Travancore Devaswom Board. The standing vegetation and its protection has been a duty of the temple trust and the Board. Therefore the protection and management is largely fully dependent on the local people and their perspective to look at sacred groves today. Over a period of time there are many changes in the management framework, which are directly affecting the ecosystem functions of the sacred groves. These changes include:

1. Maintenance of the temple has gained importance over the protection of vegetation and water resources in the grove.
2. Change in the principle of sacredness i.e., weakening of the faiths, beliefs and taboos relating to Sacred Grove
3. The movement of large crowds during festivals or rituals destroys the ground vegetation which affects the regeneration of plant species.
4. Large number of entry paths to the temple, (i.e., open access area)
5. Demographic demands exerting pressure on land resulting in the reduction in the size and partial clearing of the sacred grove
6. Use of fallen timber and branches for temple purposes which was not permitted earlier
7. Unauthorized collection and removal of biomass from the Grove
8. ISG being used for various unauthorized activities especially since the wall has come up.
9. Invasion of exotic weeds such as *Mikania micrantha*, consequent succession and further degradation of the grove.

Our study and intervention has proved that these changes in management pattern could be improved by conscious awareness generation and developing action plan for better participatory conservation of these traditional places with biological and religious importance.

6.1. Ecosystem services of ISG and community benefits

It is also highly important to create awareness among the people about the social and ecological functions of the ISG. It is important to look at the rationale of the principle of sacredness and to involve the primary and other stakeholders in their protection and maintenance.

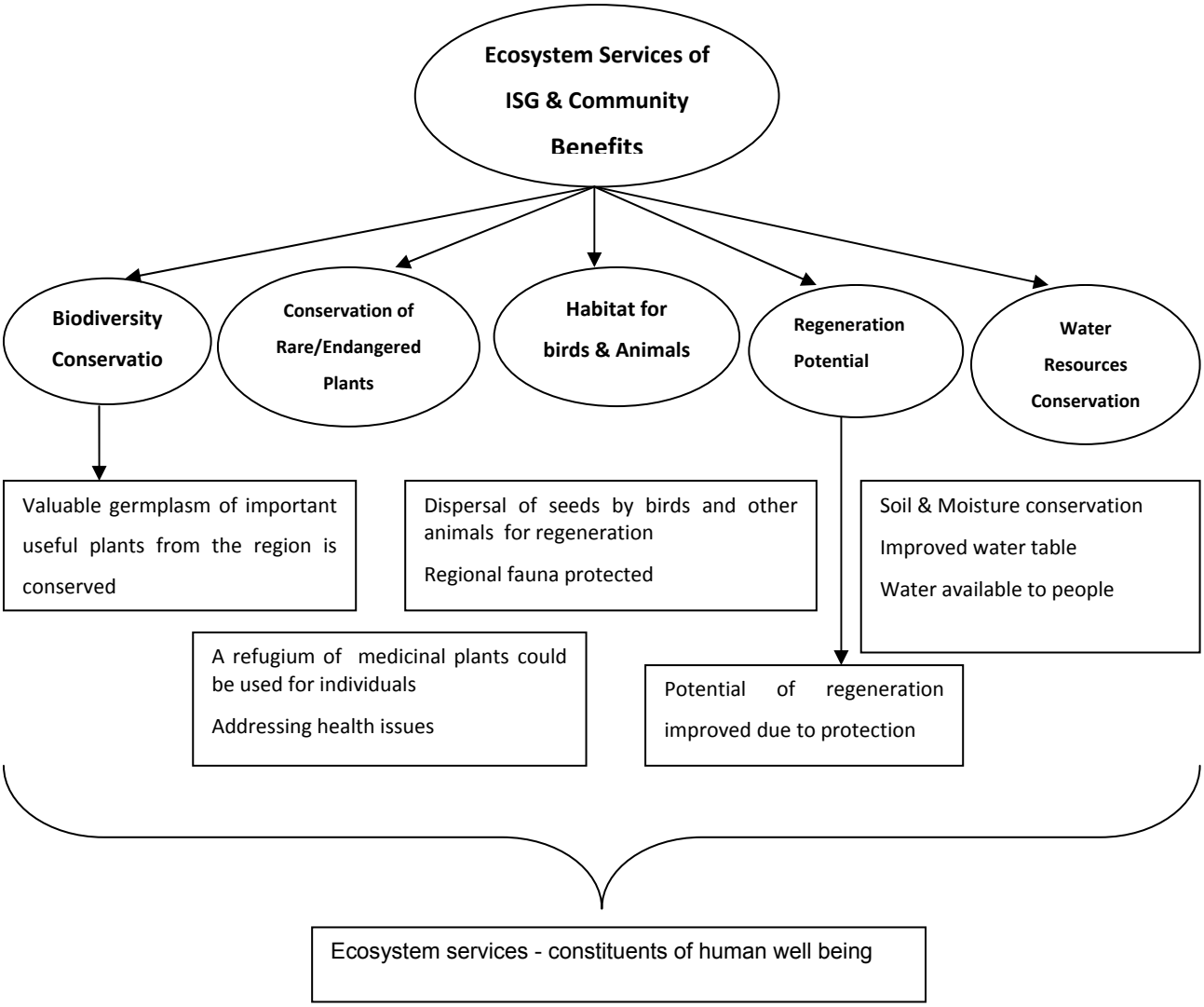


Figure 48. Ecosystem functions of ISG

6.2. Biodiversity conservation: The ISG has been a well protected Grove with various life forms although the processes of modernization and urbanization have caught up as elsewhere. Main reasons include the terrain of the sacred grove, various legends regarding the sacred grove's protecting deity, its religious importance and fame. From such diverse plant forms present in the grove it is evident that they are relictual forest patches. Therefore, the most important ecosystem function is biodiversity conservation.

The ISG harbor large number of plant species clearly indicating the diversity maintained within. The plants seen here were once common in the area, and have now disappeared from the non-sacred habited landscapes.

6.3. Conservation of Rare/endangered plants: ISG harbors a total of 12 taxa in the flora that belong to one or the other threatened categories. They include critically endangered (*Vateria indica*), endangered (*Hopea ponga, Hopea parviflora*), vulnerable (*Myristica malabarica, Saraca asoca, Santalum album, Begonia trichocarpa*), Rare (*Ampelocissus inidca, Vepris bilocularis, Glycosmis macrocarpa*), lower risk (*Tabernaemontana alternifolia*) and threatened (*Molineria trichocarpa*). Most of the endemic and rare species are best protected / preserved only through this traditional system of conservation and management based on the principle of sacredness.

6.4 Habitat for birds and animals: ISG offers habitats to the regional fauna. A total of 379 species of animals including invertebrates and vertebrates were recorded form the ISG. A total of 65 species of birds were recorded from Iringole. The list of bird species recorded clearly indicates the presence of forest dwelling species. The presence of paddy fields surrounding the grove and a pond within the premises supports the wetland species. The red spur fowl found here is one of the three species of the genus *Galloperdix*, is endemic to the country. Birds play a significant role in the dispersal of seeds. Thus, the grove providing a habitat for birds and animals is an important ecosystem function and must be considered very important for maintaining the biological balance.

6.5. Regeneration potential: Natural regeneration of plants mainly tree species is a difficult process. If priority is not given to the protection of vegetation and water resources in the grove it will become highly degraded with hardened soil and eventually will be

devoid of any regenerating tree species. Enough soil moisture for generation of seeds fallen through dispersal is essential. In ISG the soil is not yet hardened, there is enough soil moisture for the germination and further establishment of saplings. There are better chances of regeneration of tree species within the sacred groves.

In the case of many forest tree species it is difficult to raise the seedlings artificially in nurseries. In such cases the regeneration potential of sacred groves could be used positively. These saplings could be collected from the grove at right time for plantating on other wastelands or for eco restoration of sacred groves using indigenous species.

6.6. Water resources conservation: Presence of paddy field around and a pond within the SG contribute to ground water recharging and enhancing ground water level in the area. Water resources within the grove also help to maintain the soil moisture. With soil erosion many small streams within have dried up. To maintain water in a sustainable manner, it is necessary to rejuvenate these streams through eco-restoration of the grove which will in turn lead to improvement of water resources and enhance water recharging. However there is need of awareness generation to develop the understanding of linkage of health of sacred groves and water resource within them. Such awareness generation should follow the collective action for restoration of sacred groves and maintenance of traditional water harvesting systems within the sacred groves. There is a lot of potential to make best use of this opportunity in participatory conservation of ISG and to link it to ongoing development programmes like watershed management and soil conservation.

6.7. Threats to ISG

The Institution of sacred grove has been an integral part of the community's social and cultural life. Deterioration due to various threats and processes of development has changed the scenario. Loss in faith and acculturation in general has further increased the magnitude of the issue of revival of this institution and conservation of valuable biodiversity.

The existing diversity within the groves is also under constant threat due to certain unauthorized activities, commercialization of festivals and other religious functions, among others. These developmental activities definitely provide employment to local people and revenue to the government and but many a time at the cost of biodiversity within the grove.

Many a government intervention is not always negative. Marking the ISG on the tourist map of the state is further going to open the area to more and more disturbances in future. This is a strong case that developmental strategies planned without consulting local people are the major causes of treat to traditional institution like sacred grove. The following are the major factors that pose a threat to the ISG.

a. Loss of forest land (encroachment of sacred grove area/ erosion of forest fringe)

b. Degradation of forest land (unauthorized collection and removal of biomass/ deposition of solid waste)

c. Abuse of forest land (Dumping of solid wastes/Unauthorized activities by anti-social elements/ invasion of light demanding exotic weeds)

d. Acculturation & loss of faith in traditions

e. Long-term intervention programme for participatory conservation framework is not available.

f. Government machinery lacks initiative and awareness and is not empowered to take sacred groves conservation seriously

Conservation and development cannot be achieved in isolation nor can it be without considering the sustainable use aspect (i.e. biodiversity conservation and protection with community participation). The principle of sacredness, worship, and protection in many respects go hand in hand with the agenda of conservation and development and can thus lead to participatory action. Conservation of biodiversity and cultural diversity preserved in sacred groves for generations will be dependent on various factors like extent of the grove, role and functions of the grove, ownership and management patterns, awareness levels of the communities and internal and external participation available for conservation initiative.

6.8. Recommendations

The State and central government efforts to implement schemes for conservation and management of SGs should be location specific as each SG has its own specific problems and threats.

Regional and district level networks to discuss the natural resource management issues in general and protection of sacred groves in particular should be encouraged.

Sacred groves should be considered as part of any conservation and development activity at the village and community must be consulted for any intervention in the sacred groves.

Awareness generation local capacity building, training and coalition approach among the organizations engaged in sacred grove conservation is utmost important.

Integrated approach for rural development programmes like watershed development programmes will cover elements of cultural landscapes including the sacred at village/panchayath level.

Preparation of management plan for ISG by adopting participatory approach.

A physical chain link or barb wire fence is appreciated would be highly protective.

Future biodiversity documentation should encompasses a broad range of representative organisms including below ground flora and fauna.

The inventory of angiosperms, birds and butterflies in ISG generated in this study indicates the direction in which one needs to work to document and organize comprehensive programs of maintaining biodiversity.

Government of India – under its scheme – '*Protection and Conservation of Sacred Groves*' may make use the data generated in this study and add the ISG to the Sacred Grove Biodiversity Network of Kerala for biodiversity monitoring.

An Iringole Sacred Grove Conservation Committee (ISGCC) should be constituted to protect and conserve forest and water bodies and also restore or enrich biodiversity.

The ISGCC should also essentially monitor and regulate the various religious/cultural and developmental activities of the grove so as to address the actual commercial threats facing the SG.

6.9. Management Options

Efforts are needed for reviewing and strengthening the existing institutional setup in relation with the empowerment of the local communities in order to protect, preserve and maintain the sanctity of the Grove. 'Participatory conservation strategy' efforts are essential to reduce if not eliminate any adverse impacts of escalating visitations and other commercial threats. Some of the key management options are listed below.

1. Awareness creation activities
2. Protective measures
3. Forest restoration measures
4. Restoration of water bodies

6.10 Role of KFRI in Conservation and Protection of ISG

The Kerala Forest Research Institute (KFRI) shall be *an active member* in the ISG conservation committee mainly concentrating on habitat protection and biodiversity conservation, watershed management and participatory management. Our interactions with the various stakeholders have highlighted that management and protection of the grove is totally dependent on the understanding and strategies followed traditionally by the local communities. Thus, it is imperative to identify the main development issues that could prove pivotal to the existence of the grove. Strong policy support is necessary to bring in the effective development framework for better participation of local people in the conservation of this tradition, revival of culture and sustainable resource use.

7. STRATEGIES FOR SUSTAINABLE MANAGEMENT OF THE IRINGOLE SACRED GROVE

1. Measure and demarcate the outer boundary of the sacred grove. This is very essential to avoid future disputes of the land being claimed by the people in nearby areas.
2. Construct chain link fence around the grove where the boundary wall is not present there, as this will act as a deterrent in unsocial/illicit activities which is being done at the areas where boundary wall is at present.
3. Restrict entry through the three main paths in the Grove and provide social fencing.
4. Throwing litter accumulated plastic bags inside the periphery of the sacred grove should be prohibited.
5. Prohibit all unauthorized activities.
6. Provide necessary financial and legal support to the managers to afford total protection of Grove from encroachment, unauthorized biomass harvest, trespassing, unscientific developmental programmes which are detrimental to associated biological diversity of Grove and effective managements.
7. Earlier the dead and fallen trees were not taken for any commercial purpose. Now the present temple management committee has decided to use the dead trees for the temple purpose such as “prasada oottu”. The dead and disintegrating trees of the sacred grove had a unique role to play in the preservation and sustenance of the grove ecosystem. The impact of the removal of dead trees should be monitored and if there is a visble adverse effect further removal should be banned. As the temple is under the Travancore Devaswam Board, it is advisable that the extraction of dead trees should be prohibited. Decomposition of vegetative parts is an integral part of the ecosystem function of the Iringole Sacred Grove.
8. Importance of the maintenance of the three ponds associated with the sacred grove. Each pond in the temple has its own role. The pond inside in the sacred grove must be used for the rituals associated with the temple. One of the other pond near temple must have been used by the local community coming for a visit to the temple. Third one is associated with the Nagalacherry Mana. The original function of these three

ponds may not be all that relevant in todays context, but they have a vital role to play in recharging ground water of the grove and the nearby areas.

9. Desilting of the ponds associated with the sacred grove. Providing maintenance of the embankment and bathing ghats in the ponds of near the Nagalancherry Mana area. Water tank may be provided which supplies water to the toilets in the ecotourism area.
10. Local bodies such as Panchayath should be involved in the conservation and management of Sacred Groves.
11. Conduct and create awareness among the local communities about the importance of the Grove with regard to its social, biological and ecological values and impacts of its degradation.
12. The area allotted to Nagalamcherry mana area to the museum should be taken over by the Devaswam Board and masterplan should be made in view of the importance of the sacred grove.
13. As the temple is getting publicity, pilgrims are increasing year after year and there should be an appropriate package to mitigate the bad effects of the tourism.
14. The grid-wise information of the floral biodiversity of the Iringole sacred grove may be used for lon-term monitoring the flora and vegetation.

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APPENDIX I

CHECKLIST OF GYMNOSPERMS AND ANGIOSPERMS OF IRINGOLE SACRED GROVE

GYMNOSPERMS

1. *Araucaria heterophylla* (Salisb.)Franco ARAUCARIACEAE).
2. *Gnetum edule* (Willd.)Bl. (GNETACEAE).

ANGIOSPERMS

1. *Abrus precatorius* L. (PAPILIONACEAE)
2. *Acacia caesia* (L) Willd. (MIMOSACEAE)
3. *Adenanthera pavonina* L. (MIMOSACEAE)
4. *Ageratum conyzoides* L. (COMPOSITAE)
5. *Aglaia elaeagnoidea* (A. Juss.)Benth. (MELIACEAE)
6. *Ailanthus triphysa* (Dennst.) (SIMAROUBACEAE)
7. *Alangium salvifolium* (L.f) Wang. ssp. *hexapetalum* (Lam.) (ALANGIACEAE)
8. *Allophylus cobbe* (L.) Raeusch. (SAPINDACEAE)
9. *Alloteropsis cimicina* (L.) (POACEAE).
10. *Alstonia scholaris* (L.) (APOCYNACEAE).
11. *Amorphophallus commutatus* (Schott) (ARACEAE).
12. *Ampelocissus indica* (L.) Planch (VITACEAE).
13. *Anamirta cocculus* (L.) Wt. *et* Arn. (MENISPERMACEAE).
14. *Antiaris toxicaria* (Pers.) Lesch (MORACEAE).
15. *Antidesma acidum* Retz. (EUPHORBIACEAE).
16. *Aporosa cardiosperma* (Gaertn.)Merr. (EUPHORBIACEAE).
17. *Artocarpus heterophyllus* Lamk. (MORACEAE).
18. *Artocarpus hirsutus* Lamk. (MORACEAE).
19. *Asparagus racemosus* Willd. (ASPARAGACEAE).
20. *Axonopus compressus* (Sw.) (POACEAE).
21. *Begonia malabarica* Lamk. (BEGONIACEAE).
22. *Biophytum sensitivum* (L) DC. (OXALIDACEAE).

23. *Brachiaria remota* (Retz.)Haines (POACEAE).
24. *Bridelia retusa* (L.) A. Juss. (EUPHORBIACEAE).
25. *Bridelia stipularis* (L.) Blume (EUPHORBIACEAE).
26. *Caesalpinia cucullata* Roxb. (CAESALPINIACEAE).
27. *Calycopteris floribunda* Lam. (COMBRETACEAE).
28. *Cansjera rheedei* Gmel. (OPILIACEAE).
29. *Canthium coromandelicum* (Burm.f.) (RUBIACEAE).
30. *Canthium travancoricum* (Bedd.) (RUBIACEAE).
31. *Carallia brachiata* (Lour.) Merr. (RHIZOPHORACEAE).
32. *Carica papaya* L. (CARICACEAE).
33. *Caryota urens* L (PALMAE).
34. *Casearia ovata* (Lam.) Willd. (FLACOURTIACEAE).
35. *Cayratia pedata* (Lamk.) (VITACEAE).
36. *Celtis philippensis* Blanco var. *wightii* (Planch.) (ULMACEAE).
37. *Centella asiatica* (L.) (UMBELLIFERAE).
38. *Centotheca lappacea* (L.)Desv. (POACEAE).
39. *Chassalia curviflora* (Wall. *et* Kurz) Thw. var. *longifolia* (Dalz.) (RUBIACEAE).
40. *Chrysophyllum cainito* L. (SAPOTACEAE).
41. *Chrysopogon aciculatus* (Retz..)Trin (POACEAE).
42. *Cinnamomum malabatrum* (Burm.f.) (LAURACEAE).
43. *Cissus heyneana* Steud. (VITACEAE).
44. *Cissus latifolia* Lam. (VITACEAE).
45. *Cleome viscosa* L. (CAPPARIDACEAE).
46. *Clerodendrum infortunatum* L. (VERBENACEAE).
47. *Clerodendrum paniculatum* L. (VERBENACEAE).
48. *Coffea arabica* L. (RUBIACEAE).
49. *Colubrina travancorica* Bedd. (RHAMNACEAE).
50. *Combretum latifolium* Bl. (COMBRETACEAE).
51. *Commelina diffusa* Burm.f. (COMMELINACEAE).
52. *Connarus sclerocarpus* (Wt. *et* Arn.) (CONNARACEAE).
53. *Corchorus aestuans* L. (TILIACEAE).

54. *Costus speciosus* (Koen.) (ZINGIBERACEAE).
55. *Curcuma aromatica* Salisb. (ZINGIBERACEAE).
56. *Curcuma caesia* Roxb. (ZINGIBERACEAE).
57. *Curcuma ecalcarata* Sivar. *et* Indu (ZINGIBERAEAE).
58. *Cyanotis axillaris* (L.) (COMMELINACEAE).
59. *Cyanotis cristata* (L.) (COMMELINACEAE).
60. *Cyathula prostrata* (L.) Bl. (AMARANTHACEAE).
61. *Cyprus rotundus* L. (CYPERACEAE).
62. *Cyrtococcum trigonum* (Retz.) (POACEAE).
63. *Dalbergia horrida* (Dennst.) Mabb. (PAPILIONACEAE).
64. *Desmodium triflorum* (L.) (PAPILIONACEAE).
65. *Diospyros buxifolia* (Bl.) (EBENACEAE).
66. *Diploclisia glaucescens* (Bl.) (MENISPERMACEAE).
67. *Elaeagnus kologa* Schult.(ELAEAGNAC- EAE).
68. *Elephantopus scaber* L. (COMPOSITAE).
69. *Eleusine indica* (L.)Gaertn. (POACEAE).
70. *Eranthemum capense* L. (ACANTHACEAE).
71. *Evolvulus nummularis* (L.) (CONVOLVULACEAE).
72. *Ficus amplissima* J.E. Smith (MORACEAE).
73. *Ficus benghalensis* L. (MORACEAE).
74. *Ficus drupacea* Thunb. var. *pubescens* (Roth) Corner (MORACEAE).
75. *Ficus hispida* L. (MORACEAE).
76. *Ficus tsjahela* Burm. (MORACEAE).
77. *Garcinia gummi-gutta* (L.) Robs. (CLUSIACEAE).
78. *Geophila repens* (L.) (RUBIACEAE).
79. *Globba sessiliflora* Sim. (LILLIACEAE).
80. *Glycosmis macrocarpa* Wt. (RUTACEAE).
81. *Hibiscus surattensis* L. (MALVACEAE).
82. *Holigarna arnottiana* Hook. (ANACARDIACEAE).
83. *Holoptelea integrifolia* (Roxb (ULMACEAE).
84. *Hopea parviflora* Bedd. (DIPTEROCARPACEAE).

85. *Hopea ponga* (Dennst.) (DIPTEROCARPACEAE).
86. *Hydnocarpus pentandra* (Buch.-Ham.) (FLACOURTIACEAE).
87. *Ichnocarpus frutescens* (L.) APOCYNACEAE).
88. *Impatiens minor* (DC.) (BALSAMINACEAE).
89. *Ipomoea obscura (*L.) (CONVOLVU-LACEAE).
90. *Ipomea pes-caprae* (L.) (CONVOLVULACEAE).
91. *Ixora brachiata* Roxb. (RUBIACEAE).
92. *Ixora lanceolaria* Colebr. (RUBIACEAE).
93. *Ixora nigricans* R.Br. (RUBIACEAE).
94. *Jasminum angustifolium* (L.) Willd. (COMMELINACEAE).
95. *Justicia wyanaadensis* (Nees) (ACANTHACEAE).
96. *Kammetia caryophyllata* (Roxb.) (APOCYNACEAE).
97. *Lannea coromandelica* (Houtt.) (SAPINDACEAE).
98. *Laportea bulbifera* (Sieb. *et* Zucc.) (URTICACEAE).
99. *Leea indica* (Burm.f) (LEEACEAE).
100. *Leptonychia caudata* (Wall.*ex* G. Don) (STERCULIACEAE).
101. *Leucas aspera* (Willd.) (LABIATAE).
102. *Lindernia ciliata* (Colsm.) (SCROPH-ULARIACEAE).
103. *Lindernia crustacea* (L.) (SCROPHULARIACEAE).
104. *Lindernia viscosa* (Hornem.) (SCRO-PHULARIACEAE).
105. *Litsea coriacea* (Heyne *ex* Meisner) (LAURACEAE).
106. *Ludwigia octovalvis* (Jacq.)Raven ssp. s*essiliflora* (Michx)Raven (ONAGRACEAE).
107. *Macaranga peltata* (Roxb.) (EUPHORBIACEAE).
108. *Mallotus philippensis* (Lamk.) (EUPHORBIACEAE).
109. *Mangifera indica* L. (ANACARDIACEAE).
110. *Memecylon molestrum* (Clarke) (MELATOMATACEAE).
111. *Memecylon randerianum* S. M. *et* M. R. Almeida (MELATOMATACEAE).
112. *Mesua ferrea* L. (CLUSIACEAE).
113. *Mikania micrantha* Kunth (COMPOSITAE).
114. *Mimusops elengi* L. (SAPOTACEAE).
115. *Molineria trichocarpa* (Wt.) (HYPOXIDACEAE).

116. *Murdannia crocea* (Griff.) (COMMELINACEAE).
117. *Murdannia japonica* (Thunb.) (COMMELINACEAE).
118. *Mukia maderaspatana* (L.) (CUCURBITACEAE).
119. *Mussaenda frondosa* L. (RUBIACEAE).
120. *Myristica malabarica* Lamk. (MYRISTICACEAE).
121. *Myxopyrum smilacifolium* (Wall.) (OLEACEAE).
122. *Naravelia zeylanica* (L.) (RANUNCULACEAE).
123. *Nothopegia colebrookeana* (Wt.) (ANACARDIACEAE).
124. *Nothopegia travancorica* Bedd. (ANACARDIACEAE).
125. *Oldenlandia auricularia* (L.) (RUBIACEAE).
126. *Oldenlandia corymbosa* L. (RUBIACEAE).
127. *Olea dioica* Roxb. (OLEACEAE).
128. *Ophiorrhiza brunonis* Wt. *et* Arn. (RUBIACEAE).
129. *Oplismenus compositus* (L.) (POACEAE).
130. *Oryza sativa* L. (POACEAE).
131. *Pajanelia longifolia* (Willd.) (BIGNONIACEAE).
132. *Pavetta indica* L. (RUBIACEAE).
133. *Peperomia pellucida* (L.) (PIPERACEAE).
134. *Peristrophe paniculata* (Forssk.) (ACANTHACEAE).
135. *Piper nigrum* L. (PIPERACEAE).
136. *Pogostemon purpurascens* Dalz. (LABIATAE).
137. *Phyllanthus airy-shawii* Brunel *et* Roux (EUPHORBIACEAE).
138. *Phyllanthus urinaria* L. (EUPHORBIACEAE).
139. *Piper longum* L. (PIPERACEAE).
140. *Piper nigrum* L. (PIPERACEAE).
141. *Pogostemon purpurascens* Dalz (LABIATAE).
142. *Polyalthia fragrans* (Dalz.) (ANNONACEAE).
143. *Pongamia pinnata* (L.) (PAPILIONACEAE).
144. *Pouzolzia zeylanica*(L.) (URTICACEAE).
145. *Psilanthus travancorensis* (Wt. *et* Arn.) (RUBIACEAE).
146. *Psychotria flavida* Talbot (RUBIACEAE).

147. *Puthranjiva roxburghii* Wall. (EUPHORBIACEAE).
148. *Santalum album* L. (SANTALACEAE).
149. *Saraca asoca* (Roxb.) (CAESALPINIACEAE).
150. *Sarcostigma kleinii* Wt. *et* Arn. (ICACINACEAE).
151. *Scoparia dulcis* L. (SCROPHULARIACEAE).
152. *Seidenfia rheedei* (Sw.) (ORCHIDACEAE).
153. *Senna tora* (L.) (CAESALPINIACEAE).
154. *Sida alnifolia* L. (MALVACEAE).
155. *Smilax zeyalnica* L. (SMILACACEAE).
156. *Spermacoce ocymoides* Burm. (RUBIACEAE).
157. *Spilanthus clava* (COMPOSITAE).
158. *Sterculia guttata* Roxb. (STERCULIACEAE).
159. *Streblus asper* Lour. (MORACEAE).
160. *Strombosia ceylanica* Gardn. (OLACACEAE).
161. *Strychnos nux-vomica* L. (POTALIACEAE).
162. *Synedrella nodiflora* (L.) (COMPOSITAE).
163. *Syzygium cumini* (L.) (MYRTACEAE).
164. *Tabernaemontana alternifolia* L. (APOCYNACEAE).
165. *Tamarindus indica* L. (CAESALPINIACEAE).
166. *Tectona grandis* L. (VERBENACEAE).
167. *Theobroma cacao* L. (STERCULIACEAE).
168. *Theriophonum infaustum* N. E. Br. (ARACEAE).
169. *Thunbergia erecta* (Benth.) (THUNBERGI-ACEAE).
170. *Torenia bicolor* Dalz. (SCROPHULARIACEAE).
171. *Tragia involucrata* L. (EUPHORBIACEAE).
172. *Trema orientalis* (L.) (ULMACEAE).
173. *Urena lobata* L. (MALVACEAE).
174. *Urena lobata* L. (MALVACEAE).
175. *Uvaria narum* (Dunal) (ANNONACEAE).
176. *Vateria indica* L. (DIPTERO-CARPACEAE).
177. *Vepris bilocularis* (Wt. *et* Arn.) (RUTACEAE).

178. *Vitex altissima* L (VERBENACEAE).

179. *Wrightia arborea* (Dennst.) (APOCYNACEAE).

180. *Xanthophyllum arnottianum* Wt. (XANTHOPHYLLACEAE).

181. *Xenostegia tridentata* (L.) (CONVOLVULACEAE).

182. *Zanthoxylum rhetsa* (Roxb.) (RUTACEAE).

183. *Zeuxine longilabris* (Lindl.) (ORCHIDACEAE).

184. *Ziziphus oenoplia* (L.) (RHAMNA-CEAE).

185. *Ziziphus rugosa* Lamk. (RHAMNACEAE).

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APPENDIX II

GRID-WISE STRUCTURAL DATA ANALYSIS OF TREES IN THE 26 FULL PLOTS OF 50m X 50m

Grid Number 5				
Total no. of species encountered	24			
Total no. of individuals observed	396			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Acacia caesia	10	40	10	0.071700
Adenanthera pavonina	2	8	2	0.047093
Aglaia elaeagnoidea	3	12	3	0.050237
Antiaris toxicaria	1	4	1	0.044569
Artocarpus hirsutus	**191**	**764**	**191**	**0.668594**
Caryota urens	2	8	2	0.047367
Cinnamomum malabatrum	1	4	1	0.044604
Cissus latifolia	9	36	9	0.066720
Holigarna arnottiana	4	16	4	0.053217
Hopea parviflora	4	16	4	0.496996
Hopea ponga	**84**	**336**	**84**	**0.460068**
Macaranga peltata	20	80	20	0.118666
Mesua ferrea	5	20	5	0.060871
Myristica malabarica	5	20	5	0.055966
Polyalthia fragrans	5	20	5	0.073655
Sarcostigma kleinii	3	12	3	0.051596
Streblus asper	1	4	1	0.044803
Strombosia ceylanica	**24**	**96**	**24**	**0.111356**
Strychnos nux-vomica	1	4	1	0.044941
Tabernaemontana alternifolia	2	8	2	0.047237
Tamarindus indicus	1	4	1	0.068344
Trema orientalis	1	4	1	0.049182
Vateria indica	**16**	**64**	**16**	**0.176846**
Zanthoxylum rhetsa	1	4	1	0.045378

Grid Number 6				
Total no. of species encountered	24			
Total no. of individuals observed	328			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Adenanthera pavonina	2	8	2	0.048850

Alstonia scholaris	1	4	1	0.045105
Antiaris toxicaria	4	16	4	0.057852
Artocarpus hirsutus	**98**	**392**	**98**	**0.486279**
Caryota urens	1	4	1	0.045276
Celtis philippensis	1	4	1	0.052411
Cinnamomum malabatrum	3	12	3	0.053449
Cissus latifolia	9	36	9	0.072758
Combretum latifolium	7	28	7	0.067085
Ficus callosa	3	12	3	0.059199
Gnetum edule	7	28	7	0.068010
Grewia umbellifera	1	4	1	0.046270
Holigarna arnottiana	4	16	4	0.062926
Hopea parviflora	4	16	4	0.081175
Hopea ponga	**52**	**208**	**52**	**0.329763**
Litsea coriacea	2	8	2	0.049086
Mallotus philippensis	1	4	1	0.045276
Mesua ferrea	2	8	2	0.063380
Myristica malabarica	5	20	5	0.059059
Polyalthia fragrans	9	36	9	0.189099
Saraca asoca	3	12	3	0.053356
Strombosia ceylanica	**58**	**232**	**58**	**0.243432**
Theobroma cacao	5	20	5	0.058739
Vateria indica	**46**	**184**	**46**	**0.662170**

Grid Number 11				
Total no. of species encountered	20			
Total no. of individuals observed	406			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Adenanthera pavonina	1	4	1	0.053343
Anamirta cocculus	1	4	1	0.052768
Antiaris toxicaria	1	4	1	0.052768
Areca spp.	3	12	3	0.058002
Artocarpus hirsutus	**76**	**304**	**76**	**0.277881**
Caryota urens	5	20	5	0.065543
Cinnamomum malabatrum	5	20	5	0.063809
Cissus latifolia	1	4	1	0.052634
Combretum latifolium	3	12	3	0.061614
Dalbergia horrida	4	16	4	0.067714
Holigarna arnottiana	4	16	4	0.063156
Hopea ponga	**54**	**216**	**54**	**0.254388**
Litsea coriacea	1	4	1	0.052768

Macaranga peltata	1	4	1	0.052939
Mesua ferrea	1	4	1	0.055485
Polyalthia fragrans	12	48	12	0.126487
Strombosia ceylanica	**156**	**624**	**156**	**0.512371**
Tabernaemontana alternifolia	2	8	2	0.055950
Theobroma cacao	5	20	5	0.064128
Vateria indica	**70**	**280**	**70**	**0.956250**

Grid Number 12				
Total no. of species encountered	23			
Total no. of individuals observed	339			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Acacia caesia	1	4	1	0.048064
Adenanthera pavonina	2	8	2	0.052483
Anamirta cocculus	2	8	2	0.050136
Antiaris toxicaria	3	12	3	0.059761
Artocarpus hirsutus	**86**	**344**	**86**	**0.389952**
Caryota urens	1	4	1	0.047108
Cinnamomum malabatrum	3	12	3	0.057442
Cissus latifolia	2	8	2	0.050000
Combretum latifolium	17	68	17	0.104572
Holigarna arnottiana	6	24	6	0.088114
Hopea parviflora	2	8	2	0.078264
Hopea ponga	**67**	**268**	**67**	**0.407808**
Litsea coriacea	1	4	1	0.047896
Macaranga peltata	2	8	2	0.053746
Mesua ferrea	3	12	3	0.094260
Mimusops elengi	1	4	1	0.058215
Polyalthia fragrans	**19**	**76**	**19**	**0.216622**
Sterculia guttata	1	4	1	0.046837
Streblus asper	1	4	1	0.046837
Strombosia ceylanica	**54**	**216**	**54**	**0.228466**
Theobroma cacao	2	8	2	0.050284
Unidentified sp.	1	4	1	0.058215
Vateria indica	**62**	**248**	**62**	**0.664915**

Grid Number 13				
Total no. of species encountered	25			
Total no. of individuals observed	416			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**

Acacia caesia	4	16	4	0.051424
Adenanthera pavonina	4	16	4	0.054351
Alstonia scholaris	2	8	2	0.046094
Artocarpus heterophyllus	1	4	1	0.047240
Artocarpus hirsutus	**207**	**828**	**207**	**0.810448**
Caryota urens	1	4	1	0.042826
Cinnamomum malabatrum	2	8	2	0.045422
Cissus latifolia	9	36	9	0.064666
Holigarna arnottiana	1	4	1	0.049152
Hopea parviflora	3	12	3	0.309811
Hopea ponga	**76**	**304**	**76**	**0.351811**
Litsea coriacea	4	16	4	0.052338
Macaranga peltata	21	84	21	0.192579
Mallotus philippensis	1	4	1	0.042671
Mesua ferrea	4	16	4	0.110311
Myristica malabarica	3	12	3	0.067481
Polyalthia fragrans	8	32	8	0.088212
Sarcostigma kleinii	3	12	3	0.049313
Strombosia ceylanica	**39**	**156**	**39**	**0.157260**
Strychnos nux-vomica	1	4	1	0.042613
Tabernaemontana alternifolia	4	16	4	0.051301
Trema orientalis	2	8	2	0.052382
Vateria indica	**13**	**52**	**13**	**0.127625**
Vepris bilocularis	1	4	1	0.046316
Wrightia arborea	2	8	2	0.046357

Grid Number 14				
Total no. of species encountered	30			
Total no. of individuals observed	477			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Acacia caesia	5	20	5	0.045943
Adenanthera pavonina	3	12	3	0.047695
Alstonia scholaris	2	8	2	0.038298
Anamirta cocculus	1	4	1	0.035624
Antiaris toxicaria	1	4	1	0.037698
Artocarpus hirsutus	**178**	**712**	**178**	**0.629525**
Briedelia retusa	1	4	1	0.035786
Caryota urens	1	4	1	0.035624
Cinnamomum malabatrum	8	32	8	0.052695
Cissus latifolia	8	32	8	0.052027
Ficus hispida	3	12	3	0.042151

Gnetum edule	8	32	8	0.053604
Holigarna arnottiana	**33**	**132**	**33**	**0.129880**
Hopea parviflora	2	8	2	0.200147
Hopea ponga	**95**	**380**	**95**	**0.565798**
Hydnocarpus pentandra	7	28	7	0.053415
Litsea coriacea	9	36	9	0.062538
Macaranga peltata	12	48	12	0.095984
Mesua ferrea	12	48	12	0.072910
Myristica malabarica	13	52	13	0.072693
Polyalthia fragrans	8	32	8	0.086133
Strombosia ceylanica	**43**	**172**	**43**	**0.139082**
Syzygium cumini	1	4	1	0.111140
Tabernaemontana alternifolia	2	8	2	0.038096
Theobroma cacao	6	24	6	0.048194
uk liana	1	4	1	0.035958
Vateria indica	4	16	4	0.048263
Vepris bilocularis	1	4	1	0.043009
Xanthophyllum arnottianum	5	20	5	0.046497
Ziziphus oenoplia	4	16	4	0.043578

Grid Number 19				
Total no. of species encountered	18			
Total no. of individuals observed	373			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Acacia caesia	7	28	7	0.078191
Alstonia scholaris	1	4	1	0.058598
Artocarpus hirsutus	**196**	**784**	**196**	**0.838110**
Cissus latifolia	2	8	2	0.061380
Combretum latifolium	2	8	2	0.061613
Dalbergia horrida	2	8	2	0.062347
Gnetum edule	1	4	1	0.059483
Holigarna arnottiana	**14**	**56**	**14**	**0.104028**
Hopea parviflora	4	16	4	0.185971
Hopea ponga	**89**	**356**	**89**	**0.600274**
Litsea coriacea	13	52	13	0.107069
Macaranga peltata	1	4	1	0.068328
Mesua ferrea	13	52	13	0.096879
Myristica malabarica	6	24	6	0.075289
Polyalthia fragrans	3	12	3	0.073768
Strombosia ceylanica	6	24	6	0.074846
Vateria indica	**12**	**48**	**12**	**0.335239**

Xanthophyllum arnottianum	1	4	1	0.058598

Grid Number 20				
Total no. of species encountered	17			
Total no. of individuals observed	524			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Acacia caesia	10	40	10	0.082798
Artocarpus hirsutus	**246**	**984**	**246**	**0.842335**
Caryota urens	1	4	1	0.061125
Cinnamomum malabatrum	10	40	10	0.083882
Cissus latifolia	18	72	18	0.097852
Gnetum edule	5	20	5	0.072577
Holigarna arnottiana	11	44	11	0.093912
Hopea parviflora	6	24	6	0.355037
Hopea ponga	**125**	**500**	**125**	**0.498183**
Litsea coriacea	27	108	27	0.135042
Macaranga peltata	4	16	4	0.074792
Mesua ferrea	**34**	**136**	**34**	**0.204504**
Myristica malabarica	7	28	7	0.087407
Polyalthia fragrans	2	8	2	0.063790
Strombosia ceylanica	13	52	13	0.092848
Tabernaemontana alternifolia	1	4	1	0.061125
Vateria indica	4	16	4	0.092800

Grid Number 21				
Total no. of species encountered	22			
Total no. of individuals observed	387			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Cissus latifolia	1	4	1	0.048492
liana kaitha	1	4	1	0.048323
Acacia caesia	1	4	1	0.048294
Antiaris toxicaria	2	8	2	0.079506
Artocarpus hirsutus	**161**	**644**	**161**	**0.675922**
Cinnamomum malabatrum	5	20	5	0.060119
Cissus latifolia	10	40	10	0.074469
Elaeagnus kologa	1	4	1	0.048228
Ficus drupacea	1	4	1	0.055443
Holigarna arnottiana	9	36	9	0.146307
Hopea parviflora	6	24	6	0.269761
Hopea ponga	**54**	**216**	**54**	**0.438132**

Litsea coriacea	12	48	12	0.087645
Macaranga peltata	4	16	4	0.061790
Mallotus philippensis	1	4	1	0.048531
Mesua ferrea	14	56	14	0.162277
Mimusops elengi	1	4	1	0.048294
Myristica malabarica	4	16	4	0.057093
Polyalthia fragrans	7	28	7	0.096668
Sarcostigma kleinii	5	20	5	0.061649
Strombosia ceylanica	**82**	**328**	**82**	**0.304817**
Vateria indica	5	20	5	0.078252

Grid Number 22				
Total no. of species encountered	29			
Total no. of individuals observed	292			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Adenanthera pavonina	3	12	3	0.050482
Aglaia elaeagnoidea	3	12	3	0.046594
Antiaris toxicaria	2	8	2	0.042936
Artocarpus heterophyllus	1	4	1	0.038961
Artocarpus hirsutus	**49**	**196**	**49**	**0.237504**
Carica papaya	2	8	2	0.044132
Caryota urens	1	4	1	0.038545
Cinnamomum malabatrum	3	12	3	0.048505
Cissus latifolia	6	24	6	0.056882
Combretum latifolium	1	4	1	0.039144
Ficus drupacea	1	4	1	0.038457
Holigarna arnottiana	4	16	4	0.058643
Hopea parviflora	4	16	4	0.307461
Hopea ponga	**68**	**272**	**68**	**0.546772**
Macaranga peltata	12	48	12	0.094347
Mallotus philippensis	3	12	3	0.048162
Mesua ferrea	6	24	6	0.08601
Myristica malabarica	8	32	8	0.078450
Polyalthia fragrans	22	88	22	0.196136
Sarcostigma kleinii	2	8	2	0.041889
Strombosia ceylanica	**43**	**172**	**43**	**0.203707**
Strychnos nux-vomica	1	4	1	0.042358
Syzygium cumini	1	4	1	0.106258
Tabernaemontana alternifolia	2	8	2	0.042137
Trema orientalis	3	12	3	0.045507
Vateria indica	**35**	**140**	**35**	**0.285948**

Wrightia arborea	1	4	1	0.038301
Zanthoxylum rhetsa	1	4	1	0.046199
Ziziphus rugosa	4	16	4	0.049582

Grid Number 23				
Total no. of species encountered	18			
Total no. of individuals observed	293			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Adenanthera pavonina	1	4	1	0.060011
Aglaia elaeagnoidea	1	4	1	0.059160
Artocarpus hirsutus	**44**	**176**	**44**	**0.221360**
Celtis philippensis	1	4	1	0.063701
Cinnamomum malabatrum	1	4	1	0.059295
Cissus latifolia	3	12	3	0.078292
Ficus callosa	2	8	2	0.162582
Holigarna arnottiana	2	8	2	0.073480
Hopea parviflora	4	16	4	0.309929
Hopea ponga	**53**	**212**	**53**	**0.386395**
Litsea coriacea	2	8	2	0.062794
Mallotus philippensis	1	4	1	0.059230
Mesua ferrea	8	32	8	0.111326
Polyalthia fragrans	**32**	**128**	**32**	**0.214178**
Sarcostigma kleinii	1	4	1	0.059353
Strombosia ceylanica	**53**	**212**	**53**	**0.254298**
Syzygium cumini	1	4	1	0.060692
Vateria indica	**83**	**332**	**83**	**0.703932**

Grid Number 24				
Total no. of species encountered	13			
Total no. of individuals observed	339			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Artocarpus hirsutus	**63**	**252**	**63**	**0.333103**
Caesalpinia cucullata	2	8	2	0.083430
Cansjera rheedei	1	4	1	0.080129
Cinnamomum malabatrum	1	4	1	0.080237
Holigarna arnottiana	3	12	3	0.086993
Hopea ponga	**57**	**228**	**57**	**0.432700**
Phandanas sp.	3	12	3	0.088344
Mesua ferrea	1	4	1	0.088880

Myristica malabarica	2	8	2	0.087586
Polyalthia fragrans	15	60	15	0.171822
Strombosia ceylanica	**149**	**596**	**149**	**0.604163**
Theobroma cacao	1	4	1	0.080237
Vateria indica	**41**	**164**	**41**	**0.782378**

Table 13 (Grid Number 25)				
Total no. of species encountered	20			
Total no. of individuals observed	328			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Aporosa cardiosperma	1	4	1	0.053548
Artocarpus hirsutus	**75**	**300**	**75**	**0.384570**
Caryota urens	1	4	1	0.053340
Chonemorpha grandiflora	1	4	1	0.053229
Cinnamomum malabatrum	2	8	2	0.056716
Cissus latifolia	3	12	3	0.059866
Holigarna arnottiana	13	52	13	0.094643
Hopea ponga	**71**	**284**	**71**	**0.351960**
liana apocyan	2	8	2	0.056425
Litsea coriacea	5	20	5	0.068363
Macaranga peltata	6	24	6	0.074039
Mallotus philippensis	1	4	1	0.053251
Myristica malabarica	4	16	4	0.062968
Polyalthia fragrans	**14**	**56**	**14**	**0.161186**
Sarcostigma kleinii	6	24	6	0.071155
Strombosia ceylanica	**60**	**240**	**60**	**0.268207**
Tabernaemontana alternifolia	1	4	1	0.053240
Vateria indica	**59**	**236**	**59**	**0.913483**
Vitex altissima	1	4	1	0.053208
Wrightia arborea	2	8	2	0.056606

Grid Number 28				
Total no. of species encountered	19			
Total no. of individuals observed	358			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Anamirta cocculus	1	4	1	0.055642

Artocarpus hirsutus	**117**	**468**	**117**	**0.489599**
Caesalpinia cucullata	5	20	5	0.067912
Caryota urens	1	4	1	0.056141
Cinnamomum malabatrum	11	44	11	0.109074
Cissus latifolia	8	32	8	0.076877
Holigarna arnottiana	13	52	13	0.101702
Hopea parviflora	1	4	1	0.059548
Hopea ponga	**54**	**216**	**54**	**0.298349**
Litsea coriacea	2	8	2	0.059401
Macaranga peltata	2	8	2	0.062486
Polyalthia fragrans	12	48	12	0.135863
Sarcostigma kleinii	13	52	13	0.094924
Strombosia ceylanica	**71**	**284**	**71**	**0.290871**
Tabernaemontana alternifolia	2	8	2	0.058961
Unidentified liana	2	8	2	0.058628
Vateria indica	**41**	**164**	**41**	**0.810896**
Wrightia arborea	1	4	1	0.056026
Xanthophyllum arnottianum	1	4	1	0.057108

Grid Number 29				
Total no. of species encountered	20			
Total no. of individuals observed	434			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Adenanthera pavonina	2	8	2	0.055953
Artocarpus hirsutus	**145**	**580**	**145**	**0.531413**
Caryota urens	1	4	1	0.052916
Celtis philippensis	1	4	1	0.055471
Cinnamomum malabatrum	2	8	2	0.055161
Cissus latifolia	10	40	10	0.078059
Gnetum edule	8	32	8	0.077894
Holigarna arnottiana	17	68	17	0.115651
Hopea ponga	**71**	**284**	**71**	**0.383182**
liana apocyan	1	4	1	0.052479
Liana small spine	1	4	1	0.052595
Litsea coriacea	1	4	1	0.052656
Macaranga peltata	3	12	3	0.059277
Mesua ferrea	4	16	4	0.082491
Mimusops elengi	1	4	1	0.052514
Myristica malabarica	2	8	2	0.055057
Polyalthia fragrans	11	44	11	0.104938
Strombosia ceylanica	**112**	**448**	**112**	**0.359064**
Unidentified sp.	1	4	1	0.053712

Vateria indica	**40**	**160**	**40**	**0.669515**

Grid Number 30				
Total no. of species encountered	20			
Total no. of individuals observed	281			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	IVI
Ailanthus tryphysa	1	4	1	0.101236
Artocarpus hirsutus	**57**	**228**	**57**	**0.363721**
Briedelia retusa	1	4	1	0.054635
Celtis philippensis	4	16	4	0.070219
Chonemorpha grandiflora	3	12	3	0.062697
Cinnamomum malabatrum	1	4	1	0.054492
Cissus latifolia	7	28	7	0.080210
Combretum latifolium	1	4	1	0.053974
Grewia umbellifera	2	8	2	0.058481
Holigarna arnottiana	4	16	4	0.069290
Hopea parviflora	1	4	1	0.061751
Hopea ponga	**87**	**348**	**87**	**0.686072**
Macaranga peltata	2	8	2	0.067981
Mesua ferrea	5	20	5	0.104593
Myristica malabarica	1	4	1	0.054789
Polyalthia fragrans	16	64	16	0.154257
Sarcostigma kleinii	4	16	4	0.069567
Strombosia ceylanica	**52**	**208**	**52**	**0.298646**
Tabernaemontana alternifolia	2	8	2	0.061789
Vateria indica	**30**	**120**	**30**	**0.471602**

Grid Number 31				
Total no. of species encountered	12			
Total no. of individuals observed	23			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Ailanthus tryphysa	1	4	1	0.128562
Antiaris toxicaria	1	4	1	0.197046
Artocarpus hirsutus	2	8	2	0.175708
Cissus latifolia	2	8	2	0.174590
Hopea parviflora	**7**	**28**	**7**	**1.069028**
Hopea ponga	**3**	**12**	**3**	**0.276223**
Lannea coromandelica	1	4	1	0.134780
Macaranga peltata	2	8	2	0.219637
Mesua ferrea	1	4	1	0.154362

Polyalthia fragrans	1	4	1	0.145880
Strombosia ceylanica	1	4	1	0.135031
Vateria indica	1	4	1	0.189149

Grid Number 32				
Total no. of species encountered	22			
Total no. of individuals observed	365			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Acacia caesia	3	12	3	0.058415
Adenanthera pavonina	3	12	3	0.054884
Artocarpus hirsutus	**133**	**532**	**133**	**0.585924**
Cinnamomum malabatrum	1	4	1	0.048602
Cissus latifolia	12	48	12	0.083332
Ficus callosa	1	4	1	0.055782
Ficus drupacea	4	16	4	0.064186
Holigarna arnottiana	6	24	6	0.104687
Hopea parviflora	3	12	3	0.117008
Hopea ponga	**72**	**288**	**72**	**0.625421**
Litsea coriacea	3	12	3	0.055762
Macaranga peltata	10	40	10	0.106293
Mesua ferrea	5	20	5	0.075311
Myristica malabarica	6	24	6	0.151197
Polyalthia fragrans	7	28	7	0.093890
Sarcostigma kleinii	19	76	19	0.111592
Strombosia ceylanica	**51**	**204**	**51**	**0.236719**
Tabernaemontana alternifolia	1	4	1	0.048800
Trema orientalis	1	4	1	0.051919
Vateria indica	**22**	**88**	**22**	**0.162749**
Wrightia arborea	1	4	1	0.048664
Xanthophyllum arnottianum	1	4	1	0.058875

Grid Number 33				
Total no. of species encountered	20			
Total no. of individuals observed	460			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Artocarpus hirsutus	**230**	**920**	**230**	**0.873547**
Caryota urens	1	4	1	0.052472

Cinnamomum malabatrum	4	16	4	0.061920
Cissus latifolia	10	40	10	0.074002
Dalbergia horrida	1	4	1	0.052472
Gnetum edule	10	40	10	0.075530
Holigarna arnottiana	**39**	**156**	**39**	**0.217250**
Hopea parviflora	3	12	3	0.134272
Hopea ponga	**83**	**332**	**83**	**0.483152**
Hydnocarpus pentandra	1	4	1	0.052377
Litsea coriacea	6	24	6	0.068767
Macaranga peltata	3	12	3	0.059825
Mallotus philippensis	1	4	1	0.052365
Mesua ferrea	14	56	14	0.114521
Myristica malabarica	11	44	11	0.082879
Polyalthia fragrans	3	12	3	0.069226
Sarcostigma kleinii	1	4	1	0.052443
Strombosia ceylanica	17	68	17	0.099451
Trema orientalis	1	4	1	0.055822
Vateria indica	**21**	**84**	**21**	**0.267713**

Grid Number 34				
Total no. of species encountered	20			
Total no. of individuals observed	466			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Aglaia elaeagnoidea	1	4	1	0.052387
Artocarpus hirsutus	**257**	**1028**	**257**	**0.973226**
Caryota urens	1	4	1	0.052357
Cinnamomum malabatrum	1	4	1	0.052402
Cissus latifolia	23	92	23	0.106885
Combretum latifolium	4	16	4	0.060606
Holigarna arnottiana	**28**	**112**	**28**	**0.135765**
Hopea ponga	73	292	73	0.508095
liana kaitha	1	4	1	0.052357
Litsea coriacea	4	16	4	0.062764
Macaranga peltata	2	8	2	0.057199
Mesua ferrea	**22**	**88**	**22**	**0.138147**
Mimusops elengi	1	4	1	0.052387
Myristica malabarica	8	32	8	0.092432
Polyalthia fragrans	1	4	1	0.052402
Sarcostigma kleinii	5	20	5	0.064050
Strombosia ceylanica	**11**	**44**	**11**	**0.089854**
Strychnos nux-vomica	2	8	2	0.056421

Vateria indica	**19**	**76**	**19**	**0.285478**
Ziziphus rugosa	2	8	2	0.054788

Grid Number 35				
Total no. of species encountered	18			
Total no. of individuals observed	441			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Acacia caesia	16	64	16	0.107942
Artocarpus hirsutus	**245**	**980**	**245**	**1.072258**
Cinnamomum malabatrum	4	16	4	0.068257
Cissus latifolia	9	36	9	0.079579
Combretum latifolium	12	48	12	0.089024
Gnetum edule	11	44	11	0.086804
Holigarna arnottiana	**57**	**228**	**57**	**0.301859**
Hopea ponga	**53**	**212**	**53**	**0.460781**
Hydnocarpus pentandra	3	12	3	0.063728
Litsea coriacea	2	8	2	0.067440
Macaranga peltata	**15**	**60**	**15**	**0.156775**
Mallotus philippensis	1	4	1	0.059811
Mesua ferrea	5	20	5	0.081769
Myristica malabarica	1	4	1	0.058158
Streblus asper	1	4	1	0.058118
Strombosia ceylanica	1	4	1	0.058347
Vateria indica	4	16	4	0.070960
Xanthophyllum arnottianum	1	4	1	0.058400

Grid Number 40				
Density and diversity measures				
Plot shape	Square			
Plot size (m)	50			
Total area sampled (sq m)	2500			
Total no. of species encountered	29			
Total no. of individuals observed	549			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Acacia caesia	4	16	4	0.043549
Adenanthera pavonina	1	4	1	0.037362
Alstonia scholaris	2	8	2	0.038629
Anamirta cocculus	1	4	1	0.037078
Artocarpus hirsutus	**224**	**896**	**224**	**0.756482**

Cinnamomum malabatrum	5	20	5	0.045638
Cissus latifolia	**26**	**104**	**26**	**0.088363**
Combretum latifolium	1	4	1	0.036541
Ficus hispida	1	4	1	0.039119
Holigarna arnottiana	**26**	**104**	**26**	**0.133909**
Hopea parviflora	5	20	5	0.150877
Hopea ponga	**184**	**736**	**184**	**0.742159**
Hydnocarpus pentandra	1	4	1	0.036480
Lannea coromandelica	1	4	1	0.040101
Litsea coriacea	3	12	3	0.041932
Macaranga peltata	14	56	14	0.092348
Mallotus philippensis	1	4	1	0.036799
Mangifera indica	1	4	1	0.036568
Mesua ferrea	9	36	9	0.057432
Myristica malabarica	4	16	4	0.045433
Pajanalia longifolia	3	12	3	0.043508
Phandanas sps	2	8	2	0.038614
Polyalthia fragrans	2	8	2	0.042210
Sarcostigma kleinii	1	4	1	0.036627
Strombosia ceylanica	2	8	2	0.050321
Tabernaemontana alternifolia	2	8	2	0.039393
Trema orientalis	1	4	1	0.038520
Unidentified liana	1	4	1	0.036726
Vateria indica	**21**	**84**	**21**	**0.137283**

Grid Number 41				
Total no. of species encountered	20			
Total no. of individuals observed	392			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	IVI
Acacia caesia	20	80	20	0.111248
Artocarpus hirsutus	**154**	**616**	**154**	**0.673574**
Caryota urens	1	4	1	0.052894
Cissus latifolia	**10**	**40**	**10**	**0.081001**
Ficus benghalensis	1	4	1	0.053217
Ficus drupacea	1	4	1	0.060584
Ficus tsjahela	2	8	2	0.066788
Hopea parviflora	4	16	4	0.199322
Hopea ponga	**141**	**564**	**141**	**0.860005**
Lannea coromandelica	5	20	5	0.073021
Litsea coriacea	1	4	1	0.053193
Macaranga peltata	3	12	3	0.059911

Mallotus philippensis	2	8	2	0.081378
Mesua ferrea	**20**	**80**	**20**	**0.157444**
Phandanas sp.	4	16	4	0.061675
Polyalthia fragrans	2	8	2	0.056915
Sarcostigma kleinii	5	20	5	0.064765
Tabernaemontana alternifolia	6	24	6	0.068807
Vateria indica	6	24	6	0.095483
Xanthophyllum arnottianum	4	16	4	0.068773

Grid Number 42				
Total no. of species encountered	21			
Total no. of individuals observed	426			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	IVI
Acacia caesia	4	16	4	0.058659
Adenanthera pavonina	1	4	1	0.050897
Aglaia elaeagnoidea	1	4	1	0.065338
Artocarpus hirsutus	**175**	**700**	**175**	**0.603399**
Cinnamomum malabatrum	1	4	1	0.050261
Cissus latifolia	6	24	6	0.063687
Holigarna arnottiana	1	4	1	0.050261
Hopea parviflora	6	24	6	0.292930
Hopea ponga	**80**	**320**	**80**	**0.465220**
Litsea coriacea	2	8	2	0.053117
Macaranga peltata	7	28	7	0.075946
Mesua ferrea	**12**	**48**	**12**	**0.111807**
Myristica malabarica	5	20	5	0.073760
Pajanalia longifolia	1	4	1	0.050897
Polyalthia fragrans	10	40	10	0.099937
Sarcostigma kleinii	10	40	10	0.077032
Strombosia ceylanica	**49**	**196**	**49**	**0.191873**
Syzygium cumini	1	4	1	0.060674
Trema orientalis	1	4	1	0.055220
Unidentifed liana	5	20	5	0.063016
Vateria indica	**48**	**192**	**48**	**0.386066**

Grid Number 43				
Total no. of species encountered	15			
Total no. of individuals observed	265			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Artocarpus hirsutus	**70**	**280**	**70**	**0.409869**

Cinnamomum malabatrum	2	8	2	0.077993
Holigarna arnottiana	1	4	1	0.070722
Hopea parviflora	4	16	4	0.238432
Hopea ponga	**65**	**260**	**65**	**0.552806**
Litsea coriacea	1	4	1	0.070837
Macaranga peltata	5	20	5	0.118482
Mesua ferrea	18	72	18	0.299888
Myristica malabarica	4	16	4	0.087110
Polyalthia fragrans	**14**	**56**	**14**	**0.155829**
Sarcostigma kleinii	1	4	1	0.070758
Strombosia ceylanica	**52**	**208**	**52**	**0.295792**
Unidentified liana	1	4	1	0.075965
Vateria indica	**26**	**104**	**26**	**0.404097**
Wrightia arborea	1	4	1	0.071427

Grid Number 44				
Total no. of species encountered	18			
Total no. of individuals observed	285			
Species	**No. of individuals**	**Density (No./ha)**	**Abundance**	**IVI**
Artocarpus heterophyllus	1	4	1	0.059768
Artocarpus hirsutus	**81**	**324**	**81**	**0.434104**
Caryota urens	1	4	1	0.059991
Cinnamomum malabatrum	4	16	4	0.071740
Cissus latifolia	3	12	3	0.067026
Holigarna arnottiana	2	8	2	0.063187
Hopea parviflora	3	12	3	0.124094
Hopea ponga	**106**	**424**	**106**	**0.917570**
Macaranga peltata	4	16	4	0.072016
Mesua ferrea	**10**	**40**	**10**	**0.161338**
Myristica malabarica	7	28	7	0.088698
Polyalthia fragrans	7	28	7	0.097863
Sarcostigma kleinii	1	4	1	0.060115
Strombosia ceylanica	**33**	**132**	**33**	**0.235817**
Theobroma cacao	2	8	2	0.064049
uk chandhanam	1	4	1	0.061379
Unidentified sp.	1	4	1	0.059532
Vateria indica	**18**	**72**	**18**	**0.301722**

***

APPENDIX III

MACRO FUNGI COLLECTED FROM IRINGOLE SACRED GROVE

	
Agaricus endoxanthus	*Chlorophyllum rachodes*
	
Clarkeinda trachodes	*Coprinus disseminatus*
	
Strobilomyces strobilaceus	*Laetiporus sulphureus*

	
Inocybe virosa	*Filoboletus manipularis*
	
Russula atropurpurea	*Scleroderma citrinum*
	
Tremella foliacea	*Aleuria aurantia*

	
Amanita angustilamellata	*Coltricia sp.*
	
Dacryopinax spathularia	*Hoenbuehelia testudo 1*
	
Laccaria laccata 1	*Lentinus giganteus*

	
Leucocoprinus zelanicus1	*Lycoperdon pyriforme*
	
Mcrocybe lobayensis 2	*Microporus xanthopus*

	
Oudemansiella canarii 1	*Phellinus adamantinus*
	
Pleurotus flabellatus1	*Russula leelavathyi 1 (2)*
	
Termitomyces microcarpus f. longipus	*Termitomyces microcarpus f. longipus 1*

	
Volvariella pseudovolvacea	*Xylaria polymorpha*

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APPENDIX IV

INSECTS OF INRINGOLE SACRED GROVE

3.1.1. Order: Lepidoptera
Butterflies (Rhopalocera)
Family: Papilionidae

1. Troides minos Cramer, 1779 The Southern Birdwing

Status: Common.

2. *Pachliopta aristolochiae* Fabricius, 1775 The Common Rose

Status: Common.

3. *Pachliopta hector* Linnaeus, 1758 Crimson Rose

Plate:

Status: Common. Protected under Schedule 1 of the Indian Wildlife Protection Act, 1982.

4. *Chilasa clytia* Linnaeus, 1758 The Common Mime

Host: The larva develops on *Cinnamomum zeylanicum, C. camphora, C. macrocarpum, Persea macrantha, Alseodaphne semicarpifolia* and *Litsea chinensis*.

Status: Common in localities having the larval host plant. Protected under Schedule 1 of the Indian Wildlife Protection Act, 1982

5. *Papilio dravidarum* Wood-Mason, 1880 The Malabar Raven

Hosts: *Glycosmis arborea.*

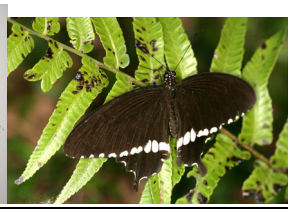
Status: Rare, endemic to the Western Ghats.

6. *Papilio helenus* Linnaeus, 1758 The Red Helen


Status: Common.

7. Papilio polytes polytes Linnaeus, 1758 *The Common Mormon*





Status: Common.

8. *Papilio polymnestor* Cramer, 1775 The Blue Mormon



Status: Common.

9. *Graphium sarpedon teredon* Felder & Felder The Common Bluebottle

Plate:

Pieridae

10. *Leptosia nina* (Fabricius) The Psyche

Status: Very common.

11. *Ixias pyrene* Fabricius The Yellow Orange Tip

12. *Pareronia valeria* Fabricius The Common Wanderer

Status: Restricted in distribution.

13. *Eurema hecabe* Moore The Common Grass Yellow

Plate:

♂ *R*

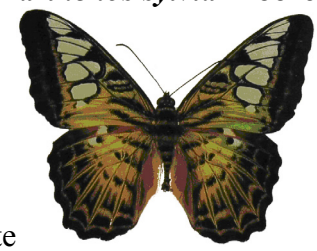
♀ *R*

♂ *R*

Status: Very common.

Nymphalidae

14. *Parthenos sylvia* Moore The Clipper



Plate

♂R

Status: Rare.

15. *Neptis jumbah* Moore, 1857 The Chestnut Streaked Sailor

Status: Common.

16. *Tanaecia lepidea* Fruhstorfer The Grey Count

Status: Rare.

17. *Hyplolimnas bolina* Drury The Great Eggfly

Plate:

♂R

♀R

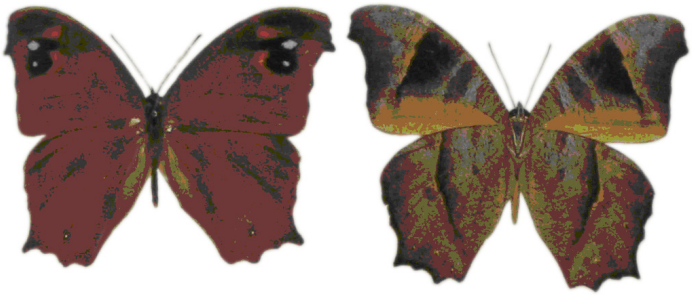
Status: Very common.

18. *Junonia iphita* Fruhstorfer The Chocolate Pansy

Satyridae

19. Melanitis leda leda Drury The Common Evening Brown

Plate:



♂R ♂V

Status; very common.

20. *Ypthima ceylonica* Kirby
(*Ypthima huebneri huebneri* Kirby) **The Common Fourring**

Status: Common.

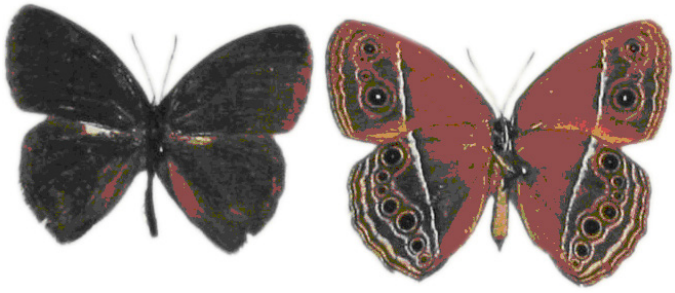
21. *Elymnias hypermnestra* Butler The Common Palmfly

Plate:

♂R ♂V

Status: Rare.

22. *Mycalesis perseus* Frubstorfer **The Common Bushbrown**



♂ R ♀ V

Status: Common.

Danaidae

23. Parantica aglea Cramer **The Glassy Blue Tiger**

♂ R

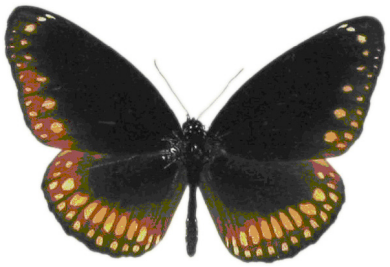
Status: Fairly common.

24. Tirumala limniace Gmelin **The Blue Tiger**

♀ R

Status: Very common

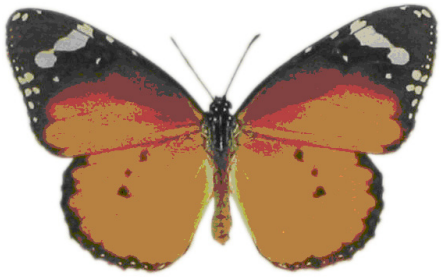
***25. Euploea core* Cramer** The Common Indian Crow



♂ R

Status: Very common.

***26. Danaus chrysippus* Linnaeus** **The Plain Tiger**



♀ R

Status: Very common.

Lycaenidae

***27. Curetis thetis* Drury** **The Indian Sun Beam**

♂ *R* ♀ *R* ♂ *V*

Status: Rare.

***28. Loxura atymnus* Cramer** *The Yam Fly*

Status: Common.

Hesperiidae

29. Psolos fuligo Moore *The Coon*

Status: Common.

3.1.2. Moths (Heterocera)

Twenty species of moths belonging to 10 families were identified (Appendix.1.). The families Noctuidae and Lymantriidae contained maximum number of species followed by Geometridae. The families Crambidae (*Rhymphalea* sp.), Sphingidae (*Nephele* sp.), Gelechiidae (*Dichomeris* sp.) and Thyrididae (*Microbelia* sp.) contained only one species each as indicated in the parenthesis. While some moths were quite large and colorful and

majority were moderate sized with intricate wing patterns. The economic importance of a few species has been established while that of the majority is still unknown.

The moths of economic importance included primarily those that have been reported to be pests of various plants. This included *Psalis pennatula* (Arctiidae), *Cnaphalocrocis medinalis, Nymphula depunctalis, Schoenobius minutellus, Scirpophaga* sp. (Pyraloidea) and *Spodoptera mauritia* (Noctuidae) attacking rice, maize, sugar cane, etc., *Utethesia pulchellale* (Arctiidae), *Psara licarsicalis, P. basalis* (Pyraloidea), *Helicoverpa armigera* (Noctuidae) and *Euproctis* spp. (Lymantridae) attacking pulse and vegetable crops, *Pericallia ricini* (Arctiidae) attacking castor, *Thalassodes* sp. (Geometridae) attacking mango, *Eligma narcissus* (Arctiidae) attacking *Ailanthus triphysa, Hypsa* spp. (Hypsidae)attacking *Ficus, Semiothisa* sp. (Geometridae) attacking *Xylia xylocarpa, Parasa lepida* (Limacodidae) attacking palms, *Othreis fullonica* (Noctuidae) attacking fruits, *Creatonotus gangis* (Arctiidae) attacking lilly and *Asura* spp. (Arctiidae) attacking mosses. Other species of moths reported in this study included *Eumelea* sp., *Cleora* sp*., Hyposidra talaca*, *Hyposidra infixaria* (Geometridae); Mocis frugalis, Chalciope sp., Ischyja manlia, Hypophyra sp. Enmonodia vespertito, *Erebus* sp.(Noctuidae) and *Artaxa* sp. , *Calliteara* sp. *Perina nuda* Fb. (Lymantriidae).

3.1. 3. Dragonflies (Order Odonata)

Odonates are one of the ancient orders of insects. They are primarily aquatic insects and their life history is closely linked to specific aquatic habitats and they use a wide range of flowing and stagnant water bodies for their life. Habitat specificity has an important bearing on the distribution and ecology of odonates which makes them a good indicator of wetland health. India with its unique geography and diverse bioclimatic regions, support a rich odonate fauna.

The ancestors of extant odonates date back to carboniferous era, about 250 million years ago. Based on wing neauration, Odonates are classified into dragonflies and damselflies collectively called About 6,000 extant species are distributed all over the world. India is highly diverse with more than 500 known species. Kerala has over 100 species of odonates.

In this study, 14 species of odonates belonging to 4 families were identified (Appendix.1). The families Libellulidae contained maximum number of species followed by Platycnemididae. The families Coenagrionidae and Calopterygidae contained only one species each (Appendix 1). Brief accounts of the various species recorded in this study are given below.

Dragonflies (Anisoptera)

Libelluidae

1. ***Trithemis pallidinervis*** **(Long legged marsh glider)**

It is a medium sized yellowish brown dragonfly, with long spider like legs. Abdomen of the male is 28-32mm in length, but in females it is 26-28 mm. Male hind wing is 30-36mm in Expanse, in the case of female it measures about 30-32mm. Wings of the males are

transparent with reddish venation. The forewings have a golden sheen when viewed from certain angle. Females may resemble the males and the wings are often tinted with yellow or reddish brown. Base of their abdomen is broadly black. They are very common in the marshes and weedy ponds. Usually perches on tall aquatic weeds or bare ends of shrubs. Their long legs are very noticeable at this time. They are distributed throughout the oriental region.

2. *Trithemis festiva* (Black stream glider)

Face of this dragonfly is dirty brown in front and changes to brown above. Their fronses are dark in front and iridescent violet above. Abdomen of the male is 22-28mm in length, in female it is 21-24mm. Hind wing of the male 26-32mm in Expanse, but in female it is 29 mm. They are very common in slow flowing streams and canals, usually perches on boulders and aquatic plants. They are distributed throughout the Oriental region.

3. *Neurothemis tullia* (Pied paddy skimmer)

Face of this dragonfly is black in colour. Abdomen of the male is 16-20mm in length, but in female it is 16-19mm. Male hind wing is 19-23mm in wide, in the case of female it is 30-23mm. It is a conspicuous species of ponds, marshes and paddy fields. Their Flight is very slow and weak. Usually perches on twigs, aquatic weeds and other plants. This species are very common along irrigation canals in paddy fields. They are distributed throughout the Oriental region.

4. *Neurothemis fulvia* (Fulvous forest skimmer)

It is a medium sized rusty coloured dragonfly with transparent wing tips. Face of the male is reddish brown. Many forms of females are found, colour of head thorax and abdomen paler than males or rusty brown. Wings are clear amber yellow with a dark ray extending to the tip in fore wing. Abdomen of the male shows 21-26mm length, but in female it is 20-24mm. Hind wings of the male is 27-32mm in expanse, in the case of females it is 26-24mm. It is a dragonfly of wet forests, usually perches on fallen logs and shrubs. A large number of them can be found together in canopy gaps and forest edges. They are distributed throughout the forested areas of the Oriental region.

5. ***Palpopleura sexmaculata* (Blue-tailed yellow skimmer)**

This is a small dragonfly with greenish yellow thorax and blue abdomen. Abdomen of the male is 14-16mm in length, but in females it is 13-14mm. Male hind wing is 15-21mm in expanse, but in female it is 18-21mm.Their transparent wings have wing spots, black with central white streaks. This dragonfly is usually found in marshes associated with bamboo brakes. It resembles wasps in appearance and with slow, circling flight. They are distributed through out the Oriental region.

6. *Diplocodes trivialis* (Ground skimmer)

It is a small yellow or blue dragonfly with black markings**.** Abdomen of the male is 19-22mm in length, in female it is 18-20mm.Wings are transparent with dark black wing spots. Male hind wing is 22-23mm in expanse, but in female it is 22-24mm. Female resemble young or sub adult male, and their abdominal markings are Broader and continued on to segments 8-10. They are one of the commonest dragonflies in gardens, fields, playgrounds, etc. This

dragonfly usually perches on the ground and rarely flies above 1m. They are distributed throughout the Oriental region and Pacific islands.

7. *Aethrimanta* brevipennis (Scarlet marsh hawk)

It is a small dragonfly with black thorax and scarlet yellow abdomen. Face of the male is covered with short and stiff hairs. Their wings are transparent and tinted with deep golden amber at the base. In the hind wings the amber tint encircles a black opaque area. The venation within this regions are bright golden yellow. Abdomen of the male shows 17-20mm length, but in female it is 16mm. Hind wing of the male is 23-26mm in expanse, in the case of female it is 23mm. Found in weed covered ponds, tanks and ditches. They have adapted to urban environment and could be seen in garden ponds in cities. Widely distributed in the Western Ghats and North eastern India.

8. *Cratilla lineate* (Emerald-banded skimmer)

A medium sized cream yellow dragonfly having iridescent green thoracic stripes. Their fronses are creamy white in front, iridescent blue or green above. Wings are transparent and tips occasionally brown. In adults wings are smoky brown. Abdomen of the male is 30-32mm in length, but in females it is 31-32mm. Hind wings of the male is 35-38mm in expanse, in females it is 37-41mm. Large number of these dragonflies can be seen perched on forest under story, often in association with Fulvous Forest Skimmer. Sunlit forest paths and canopy gaps are preferred locations for this species. Forested areas of Oriental region.

9. *Orthetrum sabina* (Green marsh hawk)

Face of the male is yellowish green. Inner edge of their hind wing is tinted with yellow. Females are very similar to the males. Abdomen of the male is 30-36mm in length, but in females it is 32-35mm. Male hind wing is 30-36mm in wide, in females it is 31-35mm. It is a common dragonfly of gardens and fields. This dragonfly perches motionless on shrubs and dry twigs for a long time. Hawks flying insects such as flies, small butterflies and dragonflies. This species can be seen far way from water and occasionally enters houses at night attracted by the light. Widely distributed in Ethiopian, Oriental and Australian region. It is found throughout Indian subcontinent up to an altitude of 2000m ASL.

Damselflies (Zygoptera)

Coenagrionidae

1. *Ceriagrion cerinorubellum* (Orange-tailed Marsh Dart)

:It is a medium sized pale green damsel fly with orange coloured segments at the base and end of the abdomen. Abdomen of the male is 31-33mm in length.while in females it is 31-35mm in length. Hind wings of both the male and female shows 20-21mm in expanse. Females are very similar to male however, the red abdominal segments 7-10 are much duller. They are very common on the banks of ponds, rivers and canals. Sits on dry twigs and vegetation over water. They are distributed throughout the oriental region.

Platycnemididae

2.*Copera marginipes* (Yellow bush dart)

They have a black band, which extends from eye to eye. Abdomen of the male is 28-31 mm long while in the female, it is 29-30 mm. Hind wing of the male is 16-18 mm wide, while in the female, it is only 20 mm. They are commonly seen along the ponds, puddles, canals and streams**.** They fly very close to the ground (<1m). They are distributed throughout the Oriental region.

3. *Copera vittata* (Blue bush dart)

They have a black band, which extends from eye to eye. Abdomen of the male is 28-34 mm in length, but in females, it is 28-30 mm. Male hind wing is 16-18mm wide, where as in female 18mm in expanse. They are found along the ponds, puddles, canals and streams and flies very close to the ground (<1m). They are distributed throughout the Oriental region.

Calopterigidae

4. *Vestalis gracilis* (Clear-winged forest glory)

It is a large iridescent green damselfly with transparent wings**.** Abdomen of the male is 45-46mm in length, but in females it is 43-50mm. They are very common along the hilly regions and streams. Large numbers usually rest among bushes in forest paths in association with Black-tipped Forest Glory. They are distributed throughout the Oriental region.

3.1.4. Beetles (Coleoptera)

The beetles contained phytophagous, xylephagous, predatory and scavenger forms. The phytophagous beetles mostly belonged to the family Chrysomelidae. The latter included the pumpkin beetle *Aulacophora cincta*, and several polyphagous beetles like *Chlamys* sp., *Hoplasoma unicolor* and *Monolepta longitarsis*. The families Cerambycidae, Buprestidae, Bostrychidae, Anthribidae, Curculionidae, Platypodidae and Scolytidae contained the xylephagous forms. This included the cashew borer *Plocaederus ferrugineus* (Cerambycidae); the bamboo ghoon borer *Dinoderus minutus* (Bostrychidae), the bamboo culm borer *Mecistocerus fluctiger* (Curculionidae), as well as the shot-hole borer *Xyleborus* sp. (Scolytidae). Predatory beetles like *Derospaeras* sp., and *Coccinella* sp. belonging to Coccindelidae were also recorded. The scavenger beetles included the dung rollers *Anomala* spp., *Copris* spp. and *Maladera* sp. (Scarabaeidae). *Oryctes rhynocerus* (attacking palms), *Popillia* sp. (attacking petals of flowers), and the white grub *Holotrichia serrata* attacking the roots of seedlings in the nursery have economic significance.

3.1.4. Bugs (Order: Hemiptera)

The bugs contained several species of economic significance such as the ear-head bug *Chilochoris angustatus* (Miridae) and the plantain spittlebug *Cosmocarta* sp. (Cercopidae). *Kalidasa lanata, Dictophara viridissima* (Fulgoridae), *Dindymus sanguineus, Dysdercus cingulatus, Iphita* sp. (Pyrrhocoridae), *Celtus bipuntanus* (Coriedae), *Flata* sp. (Flattidae) and 15 unidentified species of Reduvidae have been recorded from this area.

3.1.5. Wasps (Order Hymenoptera)

With regard to Hymenoptera, several species of wasps (belonging to the families Eumenidae, Sphecidae, Chrysididae and Pompilidae); parasitic wasps (belonging to the families Braconidae, Ichneumonidae and Bethylidae); bees (belonging to the families Apidae,

Xylocopidae, Megachilidae and Anthophoridae) as well as ants (Formicidae) have been recorded.

3.1.6. Other insects

In addition, Thysanurans (*Lepisma saccharina* belonging to Lepismatidae), Orthopterans (**3** unidentified species each of Katydidae, Gryllidae and Acrididae) Phasmida (*Carausis morosus* and *Phyllium crurifolium* of the family phyllidae), Dictyoptera (8 unidentified species of Blattidae; and *Leptomantris parva* belonging to Mantidae), Isoptera (3 species of *Odontotermes* of the family Termitidae) and 15 unidentified species of Diptera have been recorded.

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APPENDIX V

Inventory of Spiders in Iringole Sacred Grove

Family: Araneidae

Argiope anasuja Thorell 1887 (Giant cross spider)

Argiope pulchella Thorell 1881 (Garden cross spider)

Parawixia dehaani Doleschall 1859 (Abandoned web spider)

Cyrtophora cicatrosa Stoliczka 1869 (Garden tent web spider)

Eriovixia excelsa Simon 1889 (Dark bird dropping spider)

Eriovixia laglaizei Simon 1877 (Grey bird dropping spider)

Gasteracantha geminata Fabricius 1798 (Garden spiny spider)

Family: Nephilidae

Nephila kuhlii Doleschall 1859(Black wood spider)

Nephila pilipes Fabricius 1793 (Giant wood spider)

Family: Tetragnathidae

Leucage pondae Tikader 1970 (Pond leucauge spider)

Leucauge tessellata Thorell 1887 (Silver leucauge spider)

Opadometa fastigata Simon 1877 (Humped silver spider)

Family: Hersiliidae

Hersilia savignyi Lucas 1836 (Two-tailed spider)

Family: Oxyopidae

Oxyopes javanus Thorell 1887 (Striped lynx spider)

Oxyopes lineatipes CL Koch 1847 (Lined lynx spider)

Oxyopes sunandae Tikader 1970 (Orange lynx spider)

Family: Salticidae

Hasarius adansoni Audouin 1826 (Adanson's house jumper)

Bavia kairali (Scorpion jumper)

Asemonea tenuipes OP Cambridge 1869 (Tailed jumper)

Epeus tener Simon 1877 (Orange crested jumper)

Epeus indicus Proszyn ski 1992 (White spotted green jumper)

Telamonia dimidiata Simon 1899 (Two-striped jumper)

Family: Sparassidae

Heteropoda venatoria Linnaeus 1767 (Common house spider)

Heteropoda nilgirina Pocock 1901 (Giant litter spider)

Family: Thomisidae

Thomisus lobosus Tikader 1965 (White crab spider)

Thomisus pugilis Stoliczka 1869 (Common rose spider)

Family: Pisauridae

Pisaura gitae Tikader 1970 (Common nursery web spider)

Psechrus torvus OP Cambridge 1869 (Fence tube web spider)

Family: Zodariidae

Hermippus arjuna 1798 (Tube wolf)

Family: Theraphosidae

Poecilotheria striata Pocock 1895 (Tiger spider)

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APPENDIX VI

AMPHIBIANS OBSERVED IN IRINGOLE SACRED GROVE

Sl. No	Order	Family	Scientific Name	Common Name	IUCN status
1.	Anura	Bufonidae	*Bufo melanostictus*	Common Indian toad	*LC*
2.	Anura	Rhacophoridae	*Philautus pulcherrimus*	Pretty bush frog	
3.	Anura	Rhacophoridae	*Philautus variabilis*	Tinkling Frog	
4.	Anura	Rhacophoridae	*Philautus charius*	Sesachar's Bush Frog	EN
5.	Anura	Rhacophoridae	*Polypedates psuedocruciger*	Common Tree Frog	
6.	Anura	Ranidae	*Euphlyctis cyanophlyctus*	Skipper frog	
7.	Anura	Ranidae	*Hoplobatrachus tigerinus*	Indian Bull frog	*LC*
8	Anura	Ranidae	*Rana temporalisis*	Bronzed frog	

3 Families, 5 Genera, 8 Species

1.Common Indian Toad (*Bufo melanostictus*)

The common Indian Toad is identified by its medium to large size and the numerous black-tipped, horny warts spread all over the body. Its color is highly variable, ranging from plain brick red to almost black. The most common color pattern is one of pale yellow-brown marked boldly with dark or reddish-brown streaks and spots.

Distribution: This species is found all over India and the adjacent countries till about Indonesia. It is the commonest of Indian amphibians.

Status: Vulnerable

2.Pretty Bush Frog (*Philautus pulcherrimus*)

The Pretty Bush Frog is a very small, bright, leafy-green frog with orange-red eyes and translucent limbs. The limbs are variably patterned, having large green spots on the forearms in some cases. The underside is whitish. Some individuals are marked with a yellow band along the sides.

Distribution: The species is endemic to the Western Ghats and is known mainly from kerala.

Status: Vulnerable, Endemic to the Western Ghats.

3.Tinkling Frog (*Philautus variabilis*)

The Tinkling Frog is a small to very small-sized, variably colored species. It varies in color from pale to dark brown above. Some individuals may sport a darker inverted 'V' mark on the back that extends from about the forelimbs to the groin. This mark is further extended over the neck in the form of a crown. The under parts are white, finely flecked with black/brown, being the darkest on the throat.

Distribution: This species is widely distributed in Southern India and Sri Lanka. In South India, the species is common throughout the Western Ghats, from about Goa till Kanyakumari. It is also known in the Eastern Ghats of Tamilnadu and Andhra Pradesh.

4.Sesachar's Bush Frog (*Philautus charius*)

The Sesacher's Bush Frog is very small and bright yellow-dark brown in color. There is a distinct dark hour-glass shaped mark extending from the eyes to the anus on the back. Additionally there is a conspicuous 'V" mark on the anal region. The lower lip is white, bearing dark cross bands.

Distribution: This species is endemic to the Western Ghats of Karnataka, Kerala and Tamilnadu.

Status: Threatened, Endemic to the Western Ghats.

5.Common Tree Frog (*Polypedates psuedocruciger*)

The Yellow Tree Frog is a medium- to large-sized tree frog readily identified by its bright yellowish coloration and the distinct brown hour-glass mark on the back. The rear edge of the hourglass is in the form of a blunt trident or an inverted crown. The under parts are white.

Distribution: The Yellow Tree Frog is endemic to the Western Ghats and is known from Tamilnadu, Kerala and Karnataka.

Status: Vulnerable.

6.Indian Bull frog (*Hoplobatrachus tigerinus*)

The Indian Bullfrog is the largest frog in India. It is readily identified by its large size and the bold tiger-like stripes and spots on the pale skin. The overall coloration is yellowish, and some individuals have traces of green on the sides, A broad white band runs along the side separating the darker color pattern of the back from the unmarked white belly.

Distribution: India, Sri Lanka, Nepal, Bangladesh and Pakistan.

Status: Vulnerable.

7.Bronzed Frog (*Rana temporalis*)

The Bronzed Frog is a medium-sized to largish, partly land species with enlarged discs on fingers and toes. It is bronze-brown-tan in color with deep chocolate colored sides. The back is marked with small, black spots in some individuals.

Distribution: This species is fairly widely distributed in peninsular India occurring throughout the Western Ghats and in parts of the Eastern Ghats. It occurs in Sri Lanka and there are recent reports of the species from Bangladesh.

Status: Vulnerable, Endemic to the Western Ghats.

8. Skipper frog (*Euphlyctis cyanophlyctus*)

This species is closely related to E.hexadactylus. It is distinguished by the presence of single porous warts on flanks from behind the shoulder to the groin. Toes are fully webbed and tympanum distinct. Skin is generally smooth. It is brown olive with greenish black spots on back and limbs.

Distribution: Throughout India.

Status: Threatened.

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APPENDIX VII

REPTILES RECORDED FROM IRINGOLE SACRED GROVE

Sl. No.	Order/ Family	Scientific Name	Common Name
	Testudines		
1	Geoemydidae	*Melanochelys trijuga coronata*	Indian pond terrapin
2	Trionychidae	*Lissemys punctata punctata*	Indian Flap-shelled turtle
	Squamata		
3	Colubridae	*Elaphe* helena.	Trinket snake
4		*Ptyas mucosus*	Common Rat Snake
5		*Xenochrophis piscator*	Chequered keel back
6		*Ahaetulla nasutus*	Common green whip snake
7		*Dendrelaphis tristis*	Common Indian Bronze snake
8	Geckonidae	*Hemidactylus frenatus*	Southern house gecko
9		*Hemidactylus* brooki	Brook's house gecko
10		*Cnemaspis kandiana*	Dwarf gecko
11	Agamidae	*Calotes calotes*	Southern green calotes
12		*Calotes versicolor*	Indian Garden lizard
13	Scincidae	*Mabuya macularius*	Little skink
14		*Mabuya carinata*	Brahminy skink
15	Uropeltidae	*Uropeltis* sp.	

Geckonidae

1. *Hemidactylus brooki* Gray, 1845 (Brook's house gecko)

This moderately large gecko described from Borneo is with a light to dark-brown spotted dorsum, dirty white belly and with a dark streak along the side of head. Head is large, ovate, and prominent. Eye is moderately large with a vertical pupil. Ear opening is oval and head is covered with small granular and larger scales. Snout is covered with small convex scales. Upper labials are 8-12 and lower labials 7-9.
Distribution: Throughout India

2.*Hemidactylus frenatus* Schlegel, 1836 (Southern House gecko)
The type locality of this species is Java. It is with pinkish or tobacco-brown, pale grey or absolutely brown dorsal side. Faint brown longitudinal stripes are seen on the dorsum. A dark streak generally emerges from near the eyes and extends up to groin. Tail is reddish. Belly is whitish or light yellow. Head is quite large and covered above with small granular scales which become larger on the snout. Ear opening is sub circular. Upper labials are 10-12 and lower labials 8-10.
Distribution: Throughout India

3. *Cnemaspis kandiana* Kelart, 1852 (Dwarf gecko)
This is a small brown gecko with transversely arranged variegations and a faint vertebral stripe or spots. Throat is dark-brown and ventrum light-brown. Tubercles on the flanks are white. Head is covered above with minute keeled scales which are largest on the snout. Upper labials are 6-9 and lower labials 6-8.
Distribution: Karnataka, Tamil Nadu and Andaman Islands.

Colubridae

4.*Elaphe helena* Daudin, 1803 (Trinket snake)
Described from Vizagapatanam, the species is light or dark brown above with black crossbars containing white ocelli. A black vertical streak is present below the eye. Loreal is present. Supralabials are 9 or 10. Scales are in 25 rows at midbody. Ventrals are 217-265, subcaudals 73-100 and anal 1.
Distribution: Throughout India, Sri Lanka, Myanmar and Pakistan

5.*Ptyas mucosus* Linnaeus, 1758 (Common Rat Snake)
This species is olive brown above with irregular but strongly marked black cross bars on the posterior half of the body. Maxillary teeth are 20-25. Scales are in 18 or 19 rows at midbody. Ventrals are 190-213, caudals 100-146 and anals 2.
Distribution: Throughout India

6.*Xenochrophis piscator* Schneider, 1799 (Chequered keel back)
The colour is variable. Head is with two oblique black streaks, one below and the other behind the eye and frequently with a cheveron-shaped marking on the neck. Maxillary teeth are 22 to 28.

Supralabials are 9. Scales are in 19 rows at midbody. Ventrals are 122-158 and subcaudals 58-97.
Distribution: Throughout India

7.*Ahaetulla nasutus* Anderson, 1898 (Common green whip snake)

This species was described from Sri Lanka. It is greenish with a yellow stripe on the lateral sides. Snout ends in a pointed dermal appendage with a median groove above, usually formed by the rostral alone and rarely by the rostral. There is no loreal. Supralabials are in contact with the internasals and the prefrontals. Ventrals are 166-207, subcaudals 127-180 and anals 2.
Distribution: Sri Lanka, Peninsular India, Bengal, Indo-Chinese, Burma, Thailand, Cambodia and Cochin-China.

8. *Dendrelaphis tristis* Daudin, 1803 (Common Indian Bronze snake)

Tanjavoor is the type locality of this species which is bronze or purplish brown above and light yellowish below. Head is with an indistinct black temporal stripe. Maxillary teeth are 17-22, the posterior ones usually shorter than the others. Scales are in 15 rows at midbody. Ventrals are 163-205, subcaudals 105-150 and anals 2.
Distribution: Throughout India and Sri Lanka.

Agamidae

9.*Calotes calotes* Linnaeus, 1758 (Southern green calotes)

It was first described from Sri Lanka. The body is compressed. It is with bright green dorsum and with 5-6 dark green stripes on the back and tail. The head is yellowish-green. Throat is red. Belly is light green and tail dull brown. Head scales are unequal and smooth. Upper labials 9-11 and as many lower labials.
Distribution: Found in the Eastern and Western Ghats and the Andaman and Nicobar Islands.

10.*Calotes versicolor* Daudin, 1802 (Indian Garden lizard)

The species was first described from India and the exact locality was not known. The body is compressed and the dorsal colour light-brown grayish. Transverse spots are present on back and sides and a dark streak from eyes. Head scales are irregular and juxtaposed. Upper labials 10-13 and lower 11-14.
Distribution: Throughout India

Scincidae

11.*Mabuya macularius* Blyth, 1853 (Little skink)

The skink is brown, olive or bronzy, with or without longitudinally arranged black spots. Light dorsolateral stripe is always present. The side of neck and flanks are dark-brown, generally spotted with white. There are 28-34 scales round the middle of the body.

Distribution: Throughout India

12.*Mabuya carinata* Schneider, 1801 (Brahminy skink)

The skink is with olivaceous-brown or shining bronze coloured dorsal side. The back and anterodorsal portion of the tail is with dark-brown to black spots or longitudinal lines along the lateral margin of the scales. The lateral aspects are dark brown or slightly lighter in colour, generally with brown spots. Two somewhat lighter dorsolateral stripes are present. Belly is yellowish-white. There are 30-34 scales round the middle of the body.
Distribution: Throughout India

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APPENDIX VIII

BIRDS RECORDED FROM THE IRINGOLE SACRED GROVES

No	Order	Family	Genus	Scientific Name	Common Name	IUCN status
1.	Passeriformes	Corvidae	*Dicrurus*	*Dicrurus aeneus*	Bronzed drongo	LC
2.	Passeriformes	Corvidae	*Dicrurus*	*Dicrurus macrocercus*	Black drongo	LC
3.	Passeriformes	Corvidae	*Dicrurus*	*Dicrurus paradiseus*	Greater racket-tailed drongo	LC
4.	Passeriformes	Corvidae	*Dendrocitta*	*Dendrocitta vagabunda*	Indian Tree pie	LC
5.	Passeriformes	Corvidae	*Corvus*	*Corvus splendens*	House crow	LC
6.	Passeriformes	Corvidae	*Corvus*	*Corvus macrorhynchos*	Jungle crow	LC
7.	Passeriformes	Corvidae	Oriolus	*Oriolus xanthornus*	Blackheaded oriole	LC
8.	Passeriformes	Corvidae	Oriolus	*Oriolus oriolus*	Golden oriole	LC
9.	Passeriformes	Corvidae	Pericrocotus	*Pericrocotus flammeus*	Scarlet minivet	LC
10.	Passeriformes	Corvidae	Terpsiphone	*Terpsiphone paradisi*	Asian Paradise flycatcher	LC
11.	Passeriformes	Corvidae	Aegithina	*Aegithina tiphia*	Common iora	LC
12.	Passeriformes	Corvidae	Tephrodornis	*Tephrodornis pondicerianus*	Common wood shrike	LC
13.	Passeriformes	Irenidae	Chloropsis	*Chloropsis cochinchinensis*	Goldmantled chloropsis	LC
14.	Passeriformes	Irenidae	*Irena*	*Irena puella*	Asian Fairy blue-bird	LC
15.	Passeriformes	Sylviidae	*Turdoides*	*Turdoides affinis*	White- headed babbler	LC
16.	Passeriformes	Sylviidae	Turdoides	*Turdoides striatus*	Jungle babbler	LC
17.	Passeriformes	Sylviidae	*Phylloscopus*	*Phylloscopus trochiloides*	Green leaf warbler	LC
18.	Passeriformes	Sylviidae	*Acrocephalus*	*Acrocephalus dumetorum*	Blyth's reed warbler	LC
19.	Passeriformes	Sylviidae	*Orthotomus*	*Orthotomus sutorius*	Common Tailor bird	LC
20.	Passeriformes	Muscicapidae	*Copsychus*	*Copsychus saularis*	Oriental Magpie-Robin	LC
21.	Passeriformes	Muscicapidae	*Zoothera*	*Zoothera citrina*	White-throated thrush	LC
22.	Passeriformes	Muscicapidae	Muscicapa	*Muscicapa*	Asian Brown	LC

				dauurica	flycatcher	
23.	Passeriformes	Nectariniidae	*Nectarinia*	*Nectarinia asiaticus*	Purple Sunbird	LC
24.	Passeriformes	Nectariniidae	Nectarinia	*Nectarinia zeylonica*	Purple rumped sunbird	LC
25.	Passeriformes	Pycnonotidae	*Pycnonotus*	*Pycnonotus jocosus*	Red-whiskered bulbul	LC
26.	Passeriformes	Pycnonotidae	Pycnonotus	*Pycnonotus cafer*	Redvented bulbul	LC
27.	Passeriformes	Sturnidae	*Acridotheres*	*Acridotheres tristis*	Common myna	LC
28.	Passeriformes	Sturnidae	*Acridotheres*	*Acridotheres fuscus*	Jungle myna	LC
29.	Passeriformes	Pittidae	Pitta	*Pitta brachyura*	Indian pitta	LC
30.	Passeriformes	Passeridae	Dendronanthus	*Dendronanthus indicus*	Forest wagtail	LC
31.	Passeriformes	Passeridae	Motacilla	*Motacilla cinerea*	Grey wagtail	LC
32.	Passeriformes	Passeridae	Lonchura	*Lonchura Malacca*	Black-headed munia	LC
33.	Passeriformes	Passeridae	Passer	*Passer domesticus*	House sparrow	LC
34.	Strigiformes	Strigidae	*Strix*	*Strix ocellata*	Mottled wood-owl	LC
35.	Strigiformes	Strigidae	*Glaucidium*	*Glaucidium radiatum*	Barred jungle owlet	LC
36.	Strigiformes	Strigidae	*Ninox*	*Ninox scutulata*	Brown hawk-owl	LC
37.	Strigiformes	Strigidae	*Otus*	*Otus bakkamoena*	Collared scops owl	LC
38.	Strigiformes	Tytonidae	*Tyto*	*Tyto alba*	Barn owl	LC
39.	Cuculiformes	Centropodidae	*Centropus*	*Centropus sinensis*	Greater coucal	LC
40.	Cuculiformes	Cuculidae	*Eudynamys*	*Eudynamys scolopacea*	Asian Koel	LC
41.	Cuculiformes	Cuculidae	*Cuculus*	*Cuculus micropterus*	Indian cuckoo	LC
42.	Columbiformes	Columbidae	*Streptopelia*	*Streptopelia chinensis*	Spotted dove	LC
43.	Columbiformes	Columbidae	Chalcophaps	*Chalcophaps indica*	Emerald dove	LC
44.	Columbiformes	Columbidae	*Treron*	*Treron phoenicoptera*	Yellow-footed Green pigeon	LC
45.	Columbiformes	Columbidae	*Columba*	*Columba livia*	Blue rock pigeon	
46.	Ciconiiformes	Ardeidae	*Bubulcus*	*Bubulcus ibis*	Cattle egret	LC
47.	Ciconiiformes	Ardeidae	*Egretta*	*Egretta garzetta*	Little egret	LC
48.	Ciconiiformes	Accipitridae	*Haliastur*	*Haliastur indus*	Brahminy kite	LC
49.	Ciconiiformes	Phalacrocoracidae	Phalacrocorax	*Phalacrocorax niger*	Little cormorant	LC
50.	Coraciiformes	Halcyonidae	*Halcyon*	*Halcyon smyrnensis*	White-breasted kingfisher	LC
51.	Coraciiformes	Halcyonidae	*Halcyon*	*Halcyon capensis*	Brownheaded	LC

					storkbilled kingfisher	
52.	Coraciiformes	Cerylidae	*Ceryle*	*Ceryle rudis*	Pied kingfisher	LC
53.	Coraciiformes	Alcedinidae	*Alcedo*	*Alcedo atthis*	Small blue kingfisher	LC
54.	Coraciiformes	Meropidae	*Merops*	*Merops orientalis*	Small green bee-eater	LC
55.	Coraciiformes	Coraciidae	*Coracias*	*Coracias benghalensis*	Blue jay	LC
56.	Galliformes	Phasianidae	*Perdicula*	*Perdicula erythrorhyncha*	Painted Bush-quail	LC
57.	Galliformes	Phasianidae	*Galloperdix*	*Galloperdix spadicea*	Red spur fowl	LC
58.	Piciformes	Megalaimidae	*Megalaima*	*Megalaima viridis*	White-cheeked barbet	LC
59.	Piciformes	Picidae	*Dinopium*	*Dinopium benghalense*	Lesser Golden-backed Wood pecker	LC
60.	Piciformes	Picidae	*Dinopium*	*Dinopium javanense*	Indian goldenbacked threetoed woodpecker	LC
61.	Psittaciformes	Psittacidae	Psittacula	*Psittacula krameri*	Roseringed parakeet	LC
62.	Psittaciformes	Psittacidae	Psittacula	*Psittacula cyanocephala*	Blossomheaded parakeet	LC
63.	Psittaciformes	Psittacidae	Loriculus	*Loriculus vernalis*	Lorikeet	LC
64.	Upupiformes	Upupidae	*Upupa*	*Upupa epops*	Hoopoe	LC
65.	Apodiformes	Apodidae	Apus	*Apus melba*	Alpine swift	LC

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APPENDIX IX

CHECKLIST OF MAMMALS PRESENT IN IRINGOLE SACRED GROVE

Sl. No	Order	Family	Scientific Name	Common Name	IUCN status
1.	Rodentia	Muridae	*Bandicota bengalensis*	Lesser bandicoot rat	LC
2.	Rodentia	Muridae	*Rattus rattus*	House rat	LC
3.	Rodentia	Muridae	*Rattus norvegicus*	Brown rat	LC
4.	Rodentia	Sciuridae	*Funambulus palmarum*	Three striped palm Squirrel	LC
5.	Lagomorpha	Leporidae	*Lepus nigricollis*	Indian hare	LC
6.	Chiroptera			Bat	
7.	Carnivora	Viverridae	*Paradoxurus hermaphroditus*	Common palm civet or toddy cat	LC
8.	Carnivora	Felidae	*Prionailurus viverrinus*	Fishing cat	VL
9.	Primates	Cercopithecidae	*Macaca radiata*	Bonnet macaque	LC

Mammalia - 7 Families, 8 Genera, 9 Species

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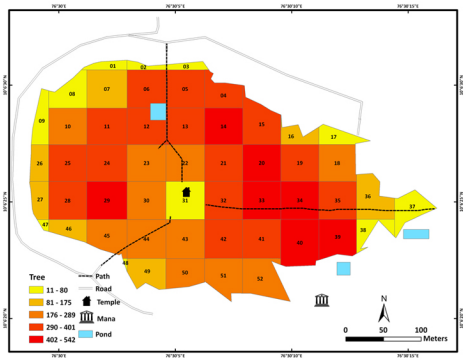
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81 - 175
176 - 289
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Temple
Mana
Pond
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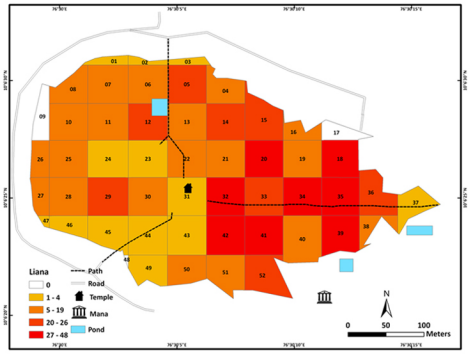
Liana
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1 - 4
5 - 19
20 - 26
27 - 48
Path
Road
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Mana
Pond
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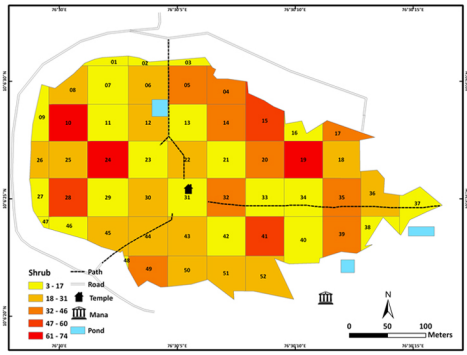
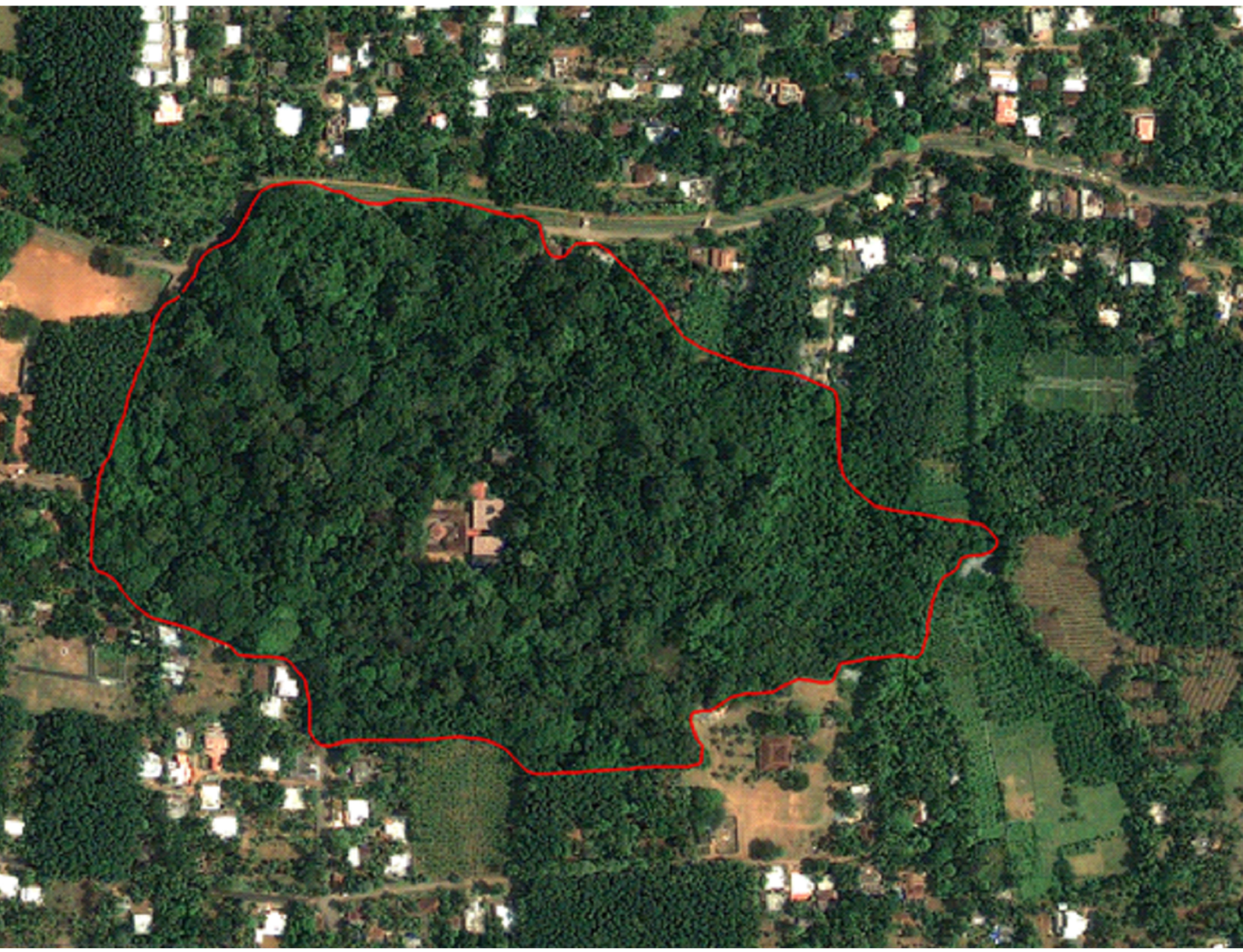
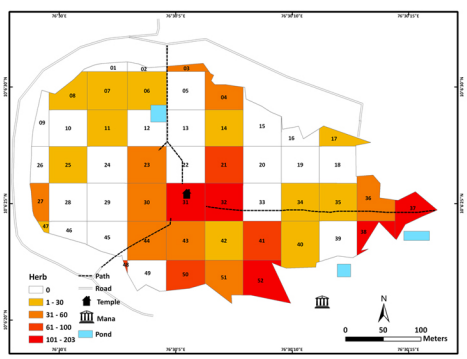
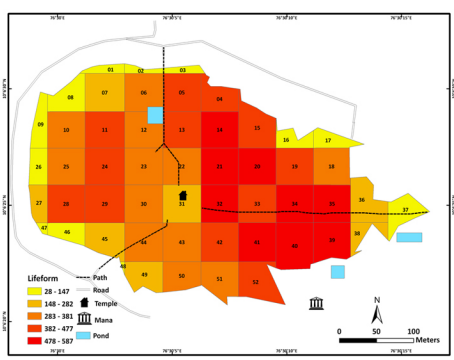
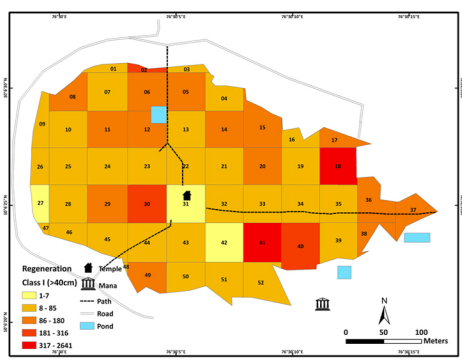
0 50 100
Meters


Shrub
3 - 17
18 - 31
32 - 46
47 - 60
61 - 74
Path
Road
Temple
Mana
Pond
N
0 50 100
Meters




Herb
0
1 - 30
31 - 60
61 - 100
101 - 203
Path
Road
Temple
Mana
Pond
N
0 50 100
Meters


Lifeform
28 - 147
148 - 282
283 - 381
382 - 477
478 - 587
Path
Road
Temple
Mana
Pond
N
0 50 100
Meters


Regeneration
Class I (>40cm)
1-7
8 - 85
86 - 180
181 - 316
317 - 2641
Temple
Mana
Path
Road
Pond
N
0 50 100
Meters