ECOLOGICAL STUDIES OF A SACRED GROVE

(IRINGOLE, NEAR PERUMBAVOOR)

By

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THESIS

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requirement for the degree

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COLLEGE OF FORESTRY
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1988

DECLARATION

I hereby declare that this thesis entitled Ecological Studies of a Sacred Grove (Iringole near Perumbavoor) is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship, or other similar title, of any other University or Society.

Vellanikkara

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Certified that this thesis entitled Ecological Studies of a Sacred Grove (Iringole near Perumbavoor) is a record or research work done independently by Sri N.C. Induchoodan under our guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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INTRODUCTION

At a time when ecological degradation and deforestation has been taking place at an alarming rate throughout the globe, in India - thanks to religious beliefs - thousands of pockets of natural vegetation scattered throughout the country are preserved almost in a pristine condition. Such pockets are commonly referred as "Kavu" (in Malayalam), "Devarais" (in Marathi) and "Pavithra Vanam" or "Sindhra Vanam" (in Kannada). Their importance is manifold and they support a relict vegetation almost in a climax stage.

About a century ago, nearly one third of the global land surface was under forest cover but at present it is estimated to be one fifth and at the current rate of deforestation it will be one sixth by the turn of this century. Of this, the tropical forests cover roughly three billion hectares. Their rate of disappearance is high, between an average of 7.5 to 11.3 million hectares (F.A.O., 1986). In India, it is estimated that nearly 1.5 million hectares of forests disappear annually.

Man has a strange relationship with the biosphere - his life giving environment which through the course of history he has modified for better and for worse to meet his requirements. Very often man has modelled the harmonious productive landscapes and established a subtle equilibrium with nature. Man's impact on natural environment can be seen almost over the entire biosphere and this type of development, however, can in effect estrange man from his own environment, instead of giving him a space to live. He suffers from lonelines in the town - and his dimensions have become inhuman in an artificial environment subjected to erosion, pollution, desertification and so on.

It is an axiom that removal of forest cover in the tropics is unsustainable and is leading to the depletion of forest resources and of the products and services these forests could otherwise yield. Various international bodies have appealed to the humanity to alter the course of destruction or devastation before irreversible social and economic disruption occurs. Thus came the concept of conservation among the modern scientific community.

Governments of different countries have been trying to achieve conservation through various means like, declaring areas as Biosphere Reserves, Wildlife Reserves, National Parks, National Heritage Sites and so on, but, if conservation is to really succeed it must become a part of the humanity's adaptation to living environment, implying thereby part of the human ecosystem. It is found that prime conservation areas - National Parks, Sanctuaries and other protected areas - of the world are often seen as something "set aside" and kept remote from human affairs. For any effective conservation, it must be economically viable and socially acceptable at national and local levels. These deep links between man and nature were fully understood by the ancient wisemen of India, who have provided a network of protected areas to safeguard the original flora and fauna through Sacred Groves.

Sacred Groves are invariably associated with certain Gods or Goddesses. In Kerala, they are normally associated with Goddess "Durga" and "Nagaraja". Along with the Sacred Groves certain species are also connected. For example, <u>Ficus religiosa</u> commonly called as "Bodh Tree" or "Bodhi Vriksha" is related to

Sri Budha who attained enlightenment under this tree. In general, plants with trifoliate leaves (e.g. Crataeva religiosa) are associated with "Thrimurthis" ("Brahmma", "Vishnu" and "Siva"). Aegle marmelos, also a taxon with trifoliate leaves and Couroupita guianensis are associated with Lord "Siva"; Alstonia scholaris with "Nagaraja", species like Azadirachta indica, Butea monsoperma, Elaeocarpus tuberculatus, Mimusops elengii, Nyctanthes arbortristis, Saraca asoca are related in one way or other with the temples. Cedrus deodara ("Devadaru") is considered as a sacred tree in the Himalayas. Fruits of Syzygium cuminii and Calamus rotang are offered for puja to "Lord Ganesh". Flowers of lotus are connected with "Lord Vishnu" and "Goddess Saraswathy". Santalum album, Ocimum sanctum, Butea monosperma, and Cynodon dactylon are inevitable for all religious rites. Thus nature conservation is seen to be closely linked with religion. Our culture has provided protection to the landscape in different pockets of the country where the relict vegetation is preserved unmolested from human interference. Thus the sacred groves serve as unique example of in situ genetic resource conservation through the involvement of local people in the most economic and efficient manner. They safeguard representative examples of the main ecosystems of the biosphere by conserving the plant and animal resources and are complimentary to the already existing conservation sites. These areas are relatively less studied and understood by the scientific community.

In India, scientific investigations pertaining to the Sacred Groves are restricted only to listing of plants (floristic studies) in the States of Karnataka and Maharashtra. No detailed investigations on any other aspects have been undertaken so far and this study conducted in Iringole Sacred Grove attempts to throw light on the following aspects:

1. To enlist the floral wealth.

2. To locate any endemic or endangered taxa.

3. To ascertain whether any wild relatives of cultivars are available.

4. To conduct detailed vegetational analysis so as to understand the structure and physiognomy of the forests.

5. To investigate the regeneration status of some important species.

6. To understand the properties of the soil.

REVIEW OF LITERATURE

Literature pertaining to sacred groves are few and far in between. They are either of general nature or seen dealing with only floristic and ethnobotanical aspects. No detailed ecological investigations have so far been carried out in any of the sacred groves and since this ecological treatise deals with various aspects, literature are treated individually.

The forest of Iringole belongs to "Tropical West Coast Evergreen Forests" (Low level) according to Champion and Seth's (1968) classification and literature is naturally compared to other analogous areas.

Ecological studies in such humid forests commenced in the 19th century in the form of floras with occasional notes on ecology of the species. Notable publications are those of Beddome (1886), Blatter (1906), Bourdillon (1908), Cooke (1908), Fyson (1915), Gamble (1915-1935), Hooker (1872-1897), Rama Rao (1914) and Talbot (1909).

For sacred groves *per se* mention may be made of Buch (1987), Gadgil and Vartak (1975, 1976, 1981a, and 1981b), Gadgil and Meher-Homji (1986), Meher-Homji (1987), Nipounage (1988), Sharma and Kulkarni (1980 and 1983), Subramanyan and Sasidharan (1988), Vartak (1987), Vartak and Gadgil (1981), Vartak and Kumbhojkar (1984) and Vartak,; Kumbhojkar and Vandana (1986). Almost all these publications deal with either listing of plants or ethnobotanical aspects.

Regarding general account of vegetation, mention may be made of the works done by Davis and Richards (1934, for British Guyana), Evans (1939, Southern Nigeria), Beard (1946, Trinidad), Wyatt-Smith (1948, Malaya), Coussens (1958, Malaya), Asprey and Robins (1953, Jamaica), Aubreville (1960-1961, Ivory Coast), Takenchi (1961a and b, Amazonia), Robins (1961, New Guinea), Burgess (1961, North Borneo), Grubb, *et al*. (1963, Eucador), Bourgeron (1981, Ivory Coast), Brunig (1956, Amazonia) and Newbery, *et al*. (1986, Sarawak).

Species diversity is an indicator of the richness of the forest. Several studies have been undertaken in this direction and the most prominant ones are those of Black, et al. (1950, Amazonia), Coussens (1951 and 1958, Malaya), Pires, et al. (1953, Amazonia), Anderson (1957, Brunei), Ashton (1974, Brunei), Fox (1967, Sabah), Bourgeron (1981, Ivory Coast), Singh, et al. (1984, India), Pascal (1984, India) and Balasubramanyan (1988, India).

Quantitative methods for vegetation analysis were provided by Greigsmith, et al. (1967), Webb and Tracey (1965) and Webb, et al. (1970). Analysis of vegetation through phytosociological methods and profile diagrams were carried out by Aubreville (1951, Ivory Coast), Cain, et al. (1956, Brazil), Robyns (1959, Malaya) Wyatt-Smith (1959, Malaya), Piaymans (1970, New Guinea) and Knight (1975, Panama).

Bharucha, et al. (1941), Das and Sarup (1951), Meher-Homji (1964), Lakshmanachary and Rangaswamy Ayyengar (1970), Siddique (1972) and Balasubramanyan (1978) prepared the Biological Spectrum of various parts of the Indian Sub-continent.

Regeneration of the forest tree species constituting the wet evergreen forest is very important from the forestry point of view. Regeneration aspects have been dealt with by Symington (1933), Holmes (1956-1957), Foggie (1960), Nicholson (1960 and 1965), Fox (1962), Rai (1979), Kio (1981), Jones (1985), Brunig (1986) Newbery, et al. (1986) and Sanhai and Lamb (1986).

Soil as a factor was emphasised by de Rosayro (1942) and Wardsworth and Bonnett (1951). Emphasis on soil vegetational complex was provided by Brunig (1974b, Sarawak), Procter, et al. (1983, New Guinea), Herriera (1977, Amazonia) and Odum and Pigeon (1970, Latin America).

Following Champion and Seth's classification different Forest Officers prepared Working Plans for various parts of India and they also gnerated a lot of information on various aspects of the forests. However, Working Plans paid little emphasis on sacred groves in general and Iringole in particular.

Literature pertaining to the sacred groves are rather scanty and the available ones invariably deal with either the floristics or ethnobotanical aspects. As regards the study area, only two publications could be encountered viz; Nair (1984) dealing with the temple in general and Subramanyan and Sasidharan (1988) pertaining to a broad listing of the important taxa.

MATERIALS AND METHODS

1. Study Area

1.1. Location

The Iringole Sacred Grove is situated in Perumbavoor Municipal area of Ernakulam District and lies at $10^{\circ}10'$ North latitude and $76^{\circ}30'$ East longitude. It is located more or less at sea level. The Main Central Road, connecting Angamaly and Trivandrum is just two kilometers west of this place. The Alwaye-Munnar Road passes through this town (Fig.1).

Perumbavoor municipality is 13 Sq. km in extent with a population density of 680 persons per Sq. km. It has sixteen hospitals, two hundred saw mills, three high schools and two colleges. Iringole Bhagawathy Amman temple is three kilometers away from Perumbavoor town, enroute to Kothamangalam. The temple is sourrounded by a luxurient forest (Fig.2) and Plates I to IV).

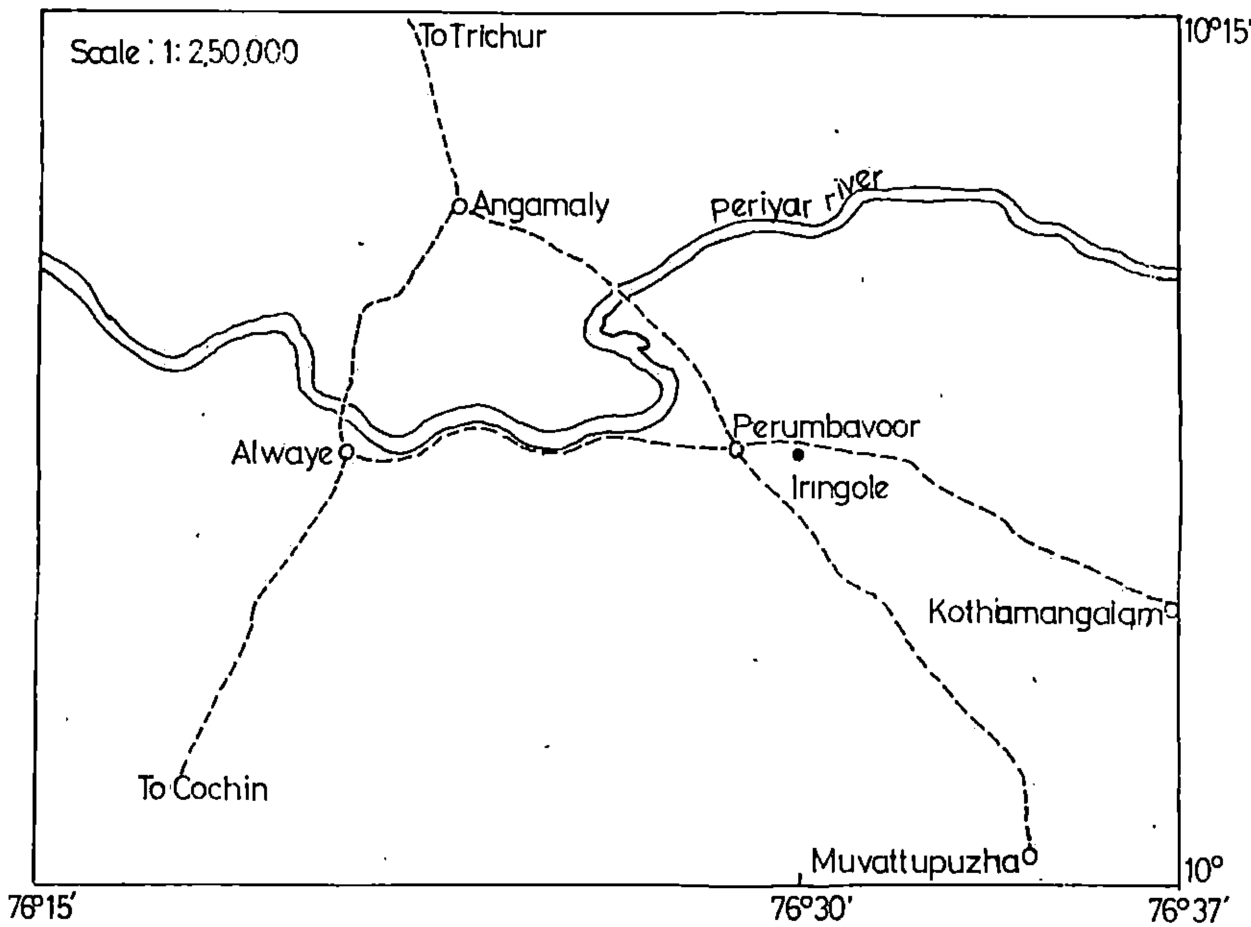


Fig 1 LOCATION OF IRINGOLE

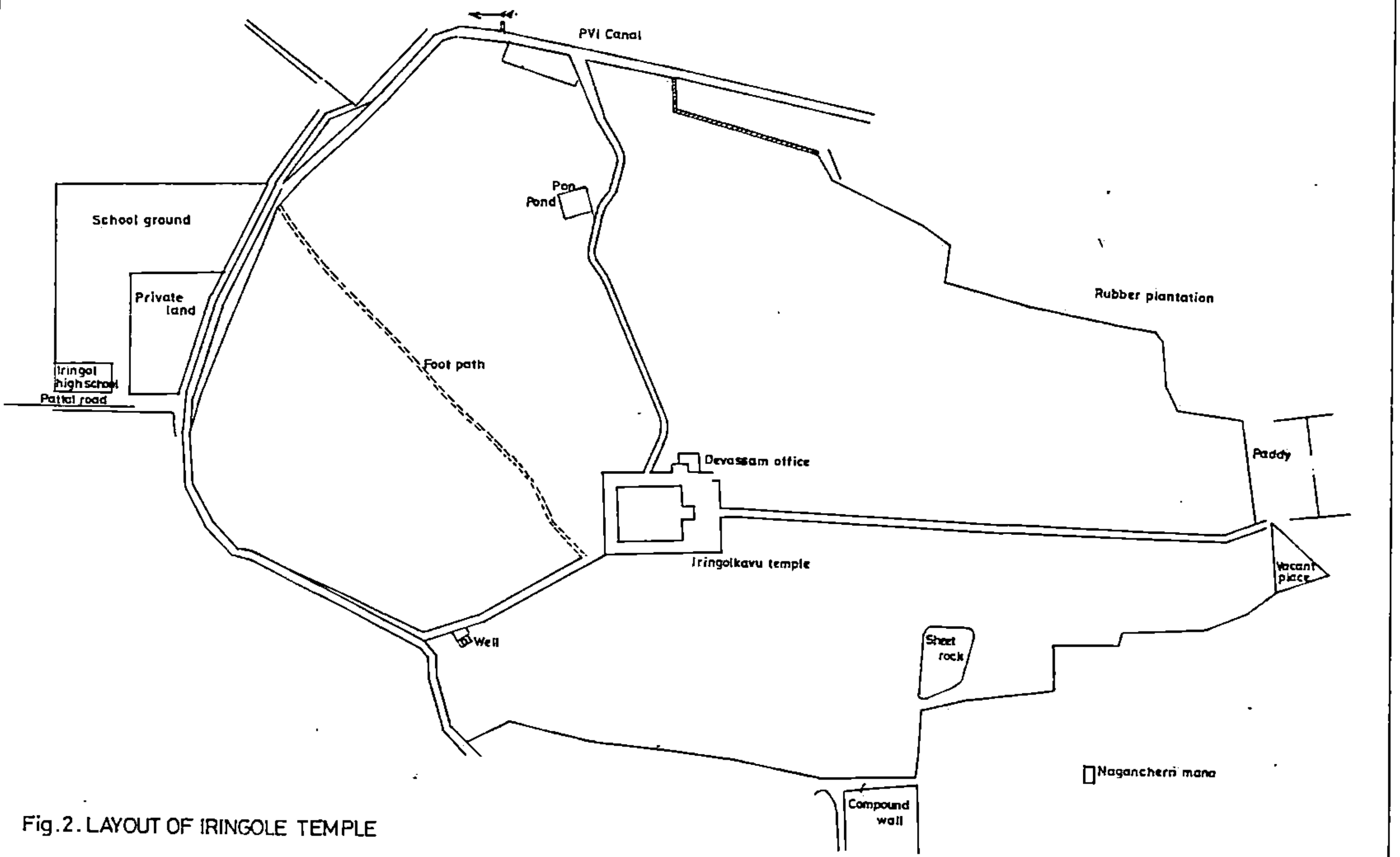


Fig. 2. LAYOUT OF IRINGOLE TEMPLE

Not to scale

Plate 1. Location of Iringole Kavu.

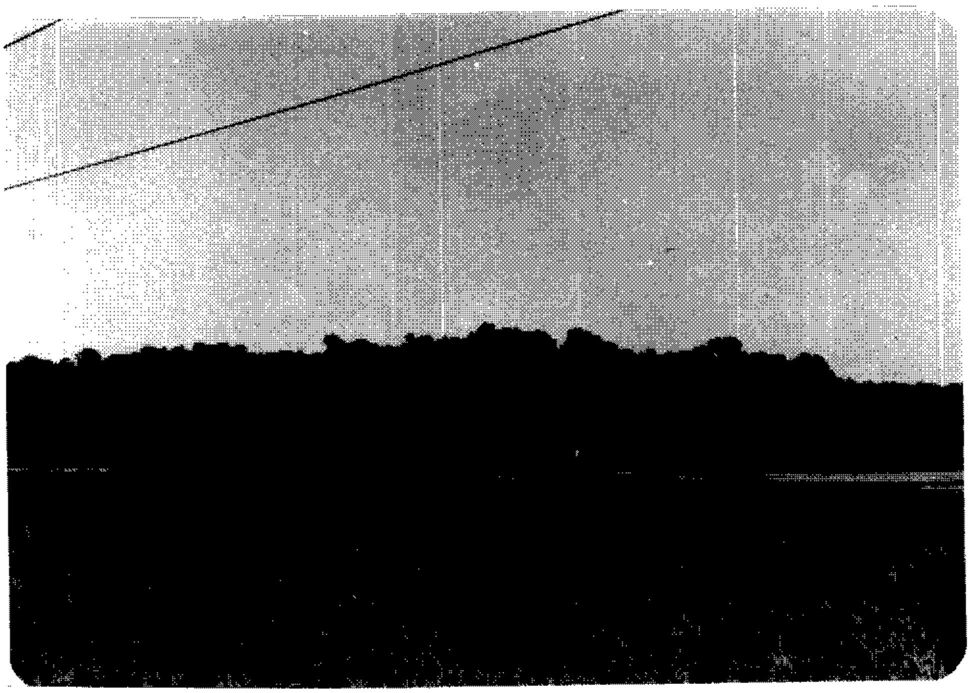


Plate 2. Forest surrounding the temple - Distant view.

Plate 3. Forest surrounding the temple - close up.

Plate 4. Iringole Bhagawathi Amman Temple.

1.2 Climate

The area is hot and humid. The principal source of precipitation is during the South-west monsoon season lasting from June to September (2243 mm.). The North-east monsoon from October to December accounts for 693 mm. The dry season lasts from January to March. Premonsoon thundershowers are encountered during April and May. The rainfall and temperature data are provided in Table 1 and represented graphically in Fig. 3.

1.3 Past History of the temple

Precise period as to when the temple was built is not known. However, majority of the local people believe that great saints like Adi Sankara, Sree Narayana Guru, Chattambi Swamigal and Villwa Mangalam had blessed this area with their holy feet. Besides, this area was the ashram of Thrinabindhu Maharishi. From these, it is presumed that the temple should be atleast 1900 years old. Chief diety of this temple is "Goddess Durga" with ten hands, armed with weapons and sitting on the lion.

Mythology goes, that while a virgin lady belonging to the Pulaya community was sharpening her sickle against a stone which

Table -1

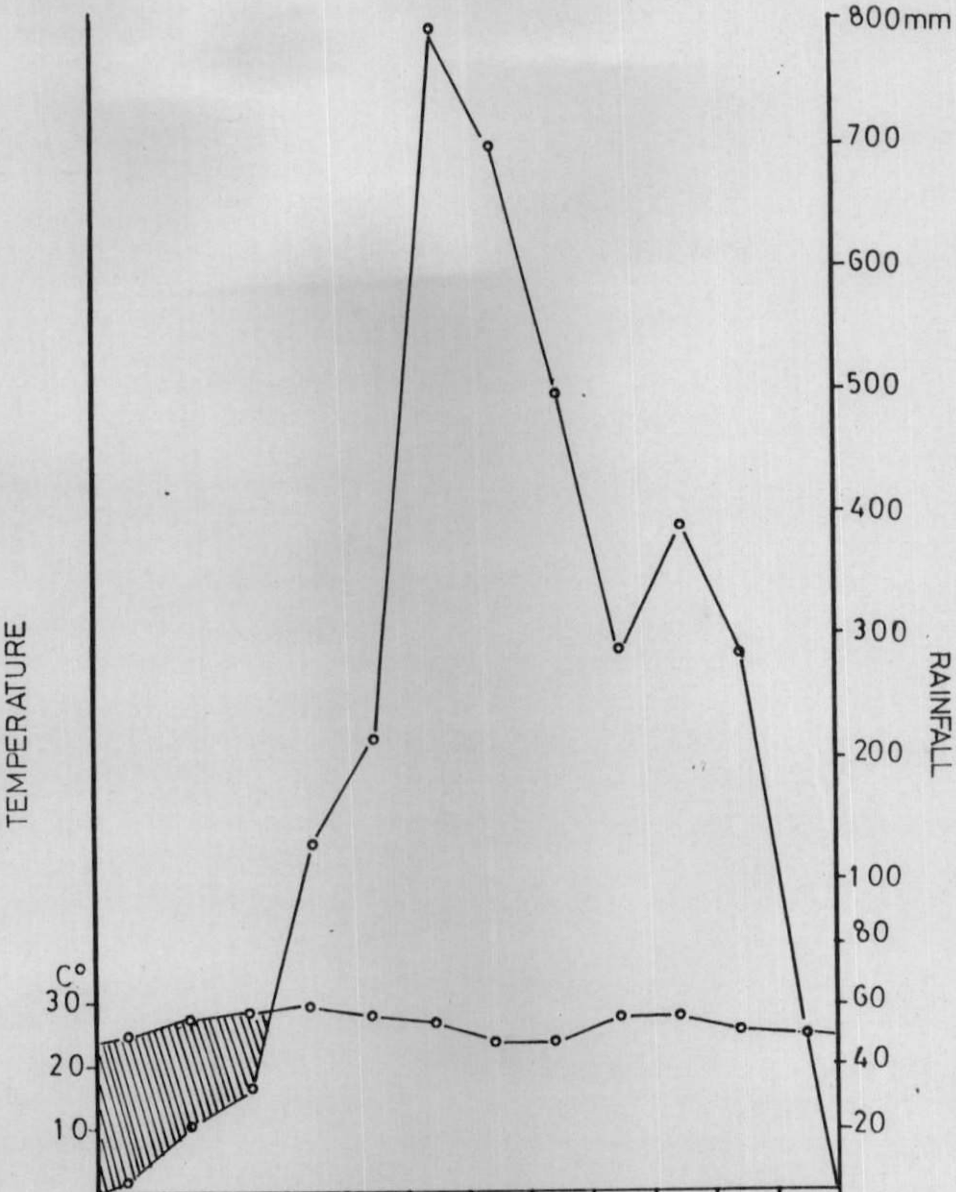
Climatic Data of Perumbavoor

Month	Average for 12 years			
	Rain fall (in mm.)	No. of Rainy Days	Mean Tempe-rature	Mean Relative Humidity
January	3	2	24.4	89
February	23	1	27.2	84
March	34	4	28.8	84
April	130	10	29.4	90
May	228	14	28.3	90
June	794	27	27.2	94
July	693	28	24.4	96
August	487	24	24.4	94
September	269	18	27.2	94
October	371	17	27.2	93
November	268	14	25.5	90
December	47	4	25.5	82
Total	3347	163		

Absolute Maximum : 37.7°C

Absolute Minimum : 16.6°C

Source : Agricultural Research Station, Odakkali.



J	F	M	A	M	J	J	A	S	O	N	D	
3	23	34	130	228	194	693	487	269	371	268	47	Rainfall
24·4	27·2	28·8	29·4	28·3	27·2	24·4	24·4	27·2	27·2	25·5	25·5	Temp·
2	1	4	10	14	27	28	24	18	17	14	4	163 Rainy days
89	84	84	90	90	94	96	94	94	93	90	82	R·H·

Fig. 3. OMBROTHERMIC DIAGRAM OF PERUMBAVOOR

was protruding from the ground, blood started splashing from the stone as if from a living body. The freightened lady immediately informed the local namboothiri lady of Nagancheri Mana. The flow of blood ceased at the commencement of a "Pooja" by her. This fact was at once conveyed to all the 32 major illams of the area and they were summoned. In that meeting it was decided to construct a temple at that place and they started worshipping since then. The 32 rafters of the "Srikovil" of this temple represent the 32 illams who jointly managed this. Gradually 29 illams lost their identity and the temple was subsequently owned by three illams viz. Pattasseri Mana, Nagancheri Mana and Orozhiyam Mana. The Travancore Devaswom Board took over this temple from these three around 1860 and it is presently vested with and managed by the Board.

1.4 Forest

The forests surrounding the temple cover an area of about ten hectares (Plate V). According to the classification of Champion and Seth (1968) the forest type is of "Southern Tropical West-

Plate 5. Temple with forest in the background.

coast Evergreen". Physiognomically, three strata can be recognised. The area abodes half a dozen monkeys (Plate VI).

The top canopy of about 40 to 45 m. height, consists of species like Holigarna arnottiana, Hopea parviflora, Hopea ponga, Mesua nagassarium, Polyalthia fragrans and Vateria indica. Most of the trees are buttressed (Plates VII to X).

The second tier consists of species like Aporusa lindleyana, Casearia esculenta, Cinnamomum malabathrum, Ficus spp. Mallotus philippensis, Myristica malabarica, Strombosia ceylanica etc.

The third storey is made up of species like Alangium salvifolium, Bridelia scandens, Chasalia ophioxyloides, Coffea travancorica, Dichapetalum gelonoides, and Uvaria narum.

The ground vegetation is made up of herbs like, Begonia malabarica, Biophytum sensitivum, Centella asiatica, Desmodium triflorum, Elatostemma lineolatum, Impatiens spp., Ophiorrhiza mungos, Pouzolizia indica and others.

Plate 6. A pair of monkeys (Macaca radiata) inhabiting the forest.

Plate 7. Buttress of Holigarna arnottiana.

Plate 8. Buttress of Hopea parviflora.

Plate 9. Full tree of Polyalthia fragrans.

Plate 10. Full tree of Vateria indica.

Lianas are common and consist of Abrus precatorius, Cayratia pedata, Dalbergia spinosa, Dioscorea spp. Jasminum humile, Smilax zeylanica and Tinospora cordifolia (Plates XI and XII).

Along the periphery of the forest, the most frequent ones are Acacia intsia, Caesalpinia bonduc and Zizyphus oenoplia (Plate XIII). In gaps created by the fallen trees Colocasia antiquorum, Macaranga peltata, Mallotus philippensis and Trema orientalies are the commonest (Plate XIV).

It is commonly believed that cutting or removal of trees from the sacred grove result in the wrath of the Goddess and hence out of fear, respect and devotion even the dead standing or fallen trees are not removed (Plate XV).

2. **Methodology**

This study envisages estimation the flora wealth of the area, understanding the vegetation structure, ascertaining the regeneration status and assessing the soil properties of the locality. Details of the methodologies adopted for various aspects of the study are as follows:

Plate 11. Liana - Dalbergia spinosa.

Plate 12. Lliana - *Tinospora cordifolia*.

Plate 13. Forest along the periphery.

Plate 14. Opening in the forest with Mallotus and Colocasia.

Plate 15. Dead and standing tree - Vateria indica.

2.1 Estimation of floral wealth

Fortnightly visits were made and all the plants encountered therein were collected and processed. The preserved specimens were identified with the standard floras of Bourdillon (1908), Rama Rao (1914) and Gamble (1915-1935). Where the specimens were encountered only in sterile condition, the publications of Balasubramanyan, et al. (1986) and Pascal and Ramesh (1987) were referred. As far as possible, nomenclature of the specimens were brought up-to-date.

2.2 Location of endemics and wild relatives of cultivars

For location of endemic, endangered, threatened plants etc., Blasco (1971) and Jain (1981) were consulted besides the Red Data Book of IUCN. Experienced farmers and horticulturists were consulted to ascertain the wild relatives of cultivars. A list of medicinal plants available within the study area was also complied by referring to Nambiar, et al. (1985).

2.3 Vegetational Analysis

2.3.1 Layout of the plot

10 m x 10 m quadrats were laid out uniformly as radial strips keeping the temple as a central point. Altogether 150 quadrats were laid out, thus covering 15% of the area.

2.3.2 Counting Methods

The quadrats of 10 m x 10 m were further subdivided into 5 m x 5 m and list count method was employed. All the species over 10 cm girth at breat height were measured using Abney's Level and Multimeter.

2.3.3 Deduction of Association

Various terminologies frequently used by Ambasht (1969), Ellenberg and Mueller-Dombois (1974), Gates (1949), Krebbs (1977) Misra and Puri (1954), Misra (1969) Werger (1974 A and B) have to be defined before deducing associations. They are as follows:

$$\text{Density (D)} = \frac{\text{Total number of individuals}}{\text{Total number of quadrats studied}}$$

$$\text{Relative Density (RD)} = \frac{\text{Number of individuals of the species}}{\text{Number of individuals of all species}} \times 100$$

$$\text{Abundance (Ab)} = \frac{\text{Total number of individuals}}{\text{Number of quadrats of occurrence}}$$

$$\text{Percentage Frequency (PF)} = \frac{\text{Number of quadrats of occurrence}}{\text{Total number of quadrats studied}} \times 100$$

$$\text{Relative Frequency (RF)} = \frac{\text{Number of occurrence of the species in the quadrat}}{\text{Number of occurrence of all species}} \times 100$$

Basal Area = It is regarded as an index of dominance. Higher the basal area greater the dominance. The total basal area is the sum of individual basal areas of all trees calculated from the GBH of each tree.

$$\text{Relative Basal Area (RBA)} = \frac{\text{Basal area of the species}}{\text{Basal area of all species}} \times 100$$

Importance Value Index (IVI) = It is computed by adding the figures of Relative Frequency, Relative Density and Relative Basal Area. The Importance Value Index gives the total picture or the sociological structure of a species in a community.

All the trees encountered in 15% sample enumeration were classified into different girth classes at 30 cm interval to analyse the structural aspect.

2.3.4 Biological spectrum

Analysis of vegetation through Biological Spectrum is known as early as 1934 by Raunkiaer. This method was subsequently enlarged and to an extent modified by Ellenberg and Mueller-Dombois (1967). From the field exercises and the floristic data gathered, the Biological Spectrum of the sacred grove was prepared.

2.3.5 Species richness and species diversity

Simpson's Index was used to study the species richness and species diversity. It is derived by usding the following formula:

$$D = 1 - \sum_{i=1}^{S} \left(\frac{ni}{N}\right)^2$$

where

ni - is the number of individuals of each species.

N - is the total number of individuals in the plot.

S - is the number of species in the plot.

2.3.6 Vegetational Profiles

All the arborescent taxa enumberated were classified into first, second and third storeyed species and their distribution pattern brought out.

2.4 Regeneration studies

Two percent of the total area was subjected to regeneration survey by laying out 80 sample plots of 5 m x 5 m each. They were uniformly laid out within the sacred grove and were enumerated for:-

Unestablished seedlings	-	< 40 cm. in height.
Established seedlings	-	40 to 100 cm in height.
Advanced growth	-	> 100 cm in height but < 10 cm at GBH.
Saplings	-	Young trees of 10 to 30 cm GBH.

2.5 Soil studies

Soil pits at depths of 0-20 cm, 20-40 cm and 40 to 60 cm were taken at three different places viz; inside the sacred grove, periphery of the grove and an adjacent homestead. They were analysed for physical and chemical properties.

The soils were air dried, ground and passed through 2 mm sieve. Determination of particle size separates were done by hydrometer method. pH 1:2 in soil water suspension was determined by pH meter; organic carbon by Walkley and Black method and Cation Exchange capacity as a summation of exchangeable bases and exchange acidity derived separately (Jackson, 1973).

RESULTS

The results obtained from various investigations are presented below:

3. 1. Estimation of floral wealth

In the study area 180 species of flowering plants were recorded. Their breakup into different categories are as follows:

Trees	:	50 species
Shrubs	:	20 species
Herbs	:	80 species
Lianas	:	21 species
Epiphytes and Parasites	:	6 species

Among the trees, the dominant families are Dipterocarpaceae (62.6%) followed by Olacaceae (11.3%), Moraceae (8.6%), Anonaceae and others.

3.2 Endemism

The flora of Iringole was analysed with the publication of Blasco (1971) to ascertain the endemic taxa. It is seen that roughly 10% of the flora shows endemism to the Western coast and lower elevations of Western Ghats. The species are listed below:

Asystasia travancorica Bedd.	-	Acanthaceae
Artocarpus hirsutus Lamk.	-	Moraceae
Begonia floccifera Bedd.	-	Begoniaceae
Casearia esculenta Roxb.	-	Samydaceae
Cinnamomum malabathrum (Burm.f.) Bl.	-	Lauraceae
Coffea travancorica W. & A.	-	Rubiaceae
Dispyros humilis Bourd.	-	Ebenaceae
Garcinia indica chois.	-	Clusiaceae
Holigarna arnottiana Hook.f.	-	Anacardiaceae
Holigarna grahamii Hook.f.	-	Anacardiaceae
Hopea parviflora Bedd.	-	Dipterocarpaceae
Hopea racophloea Dyer.	-	Dipterocarpaceae
Myristica malabarica Lamk.	-	Myristicaceae

Polyalthia fragrans Bedd.	-	Anonaceae
Psychotria dalzellii Hook.f.	-	Rubiaceae
Vateria indica L.	-	Dipterocarpaceae
Vatica chinensis L.	-	Dipterocarpaceae

3.3 Wild relatives of cultivars

The area also contains a few wild relatives of cultivars. They are as follows:

Amorphophalus spp.	-	Araceae
Artocarpus hirsutus Lamk.	-	Moraceae
Begonia floccifera Bedd.	-	Begoniaceae
Colocasia antiquorum Schott.	-	Araceae
Curcuma aromatica Salisb.	-	Zingiberaceae
Diosconea oppositifolia L.	-	Dioscoreaceae
Dioscoea pentaphylla L.	-	Dioscoreaceae
Garcinia indica choisy	-	Clusiaceae
Myristica malabarica Lamk.	-	Myristicaceae
Piper longum L.	-	Piperaceae
Piper nigrum L.	-	Piperaceae

3.4 Medicinal Plants

This area also contains a wealth of medicinal plants. A checklist of the available ones has been prepared by referring to Nambiar, et al. (1985). The species are as follows:

Abrus precatorius L.	-	Papilionaceae
Acacia intsia (L.) Willd.	-	Mimosaceae
Achyranthus aspera L.	-	Amarantaceae
Ailanthus triphysa Dennst.	-	Simaroubaceae
Allophylus cobbe (L.) Rausch.	-	Sapindaceae
Antiaris toxicaria (Pers) Lesch.	-	Moraceae
Aporusa lindleyana (Wt.) Baill.	-	Euphorbiaceae
Alstonia scholaris (L.) R. Br.	-	Apocynaceae
Artocarpus hirsutus Lamk.	-	Moraceae
Asparagus racemosus Willd.	-	Liliaceae
Biophytum sensitivum (L.) DC.	-	Oxalidaceae
Bridelia scandens Willd.	-	Euphorbiaceae
Caesalpinia bonduc (L.) Roxb.	-	Caesalpiniaceae
Carallia brachiata (Lour.) Merr.	-	Rhizophoraceae
Cardiospermum helicacabum L.	-	Sapindaceae

Casearia esculenta Roxb.	-	Samydaccae
Cassia tora L.	-	Caesalpiniaceae
Cayratia pedata (Lamk.) Juss & Gagnep.	-	Vitaceae
Centella asiatica (L.) Urban.	-	Umbelliferae
Clerodendrum viscosum Vent.	-	Verbenaceae
Coffea travancorica W. & A.	-	Rubiaceae
Colocasia antiquorum Schott.	-	Araceae
Costus speciosus (Koen.) Sm.	-	Zingiberaceae
Crotalaria retusa L.	-	Papilionaceae
Curculigo orchioides Gaertn.	-	Liliaceae
Curcuma aromatica Salish.	-	Zingiberaceae
Cyclea peltata (Lamk.) Hook.f.	-	Menispermaceae
Dioscona oppositifolia L.	-	Dioscoeaceae
Dioscoea pentaphylla L.	-	Dioscoeaceae
Diploclisia glaucescens (Bl.) Diels.	-	Menispermaceae
Entada pursaetha Dc.	-	Mimosaceae
Evodia lunuakenda (Gaertn.) Merr.	-	Rutaceae
Ficus spp.	-	Moraceae
Garcinia indica choisy	-	Clusiaceae
Gloriosa superba L.	-	Liliaceae

Glycosmis pentaphylla (Retr.) Dc.	-	Rutaceae
Holigarna arnottiana Hook. f.	-	Anacardiaceae
Hydnocarpus macrocarpus (Bedd.) Warb.	-	Bixaceae
Jasminum bignoniaceum Wall. ex Dc.	-	Oleaceae
Leea indica (Burm.f.) Merr.	-	Vitaceae
Macaranga peltata (Roxb.) M. Arg.	-	Euphorbiaceae
Mallotus philippensis (Lamk.) M. Arg.	-	Euphorbiaceae
Memecylon umbellatum Burm.f.	-	Melastomataceae
Mesua nagassarium (Burm.f.) Koster.	-	Clusiaceae
Mimosa pudica L.	-	Mimosaceae
Mimusops elengii L.	-	Sapotaceae
Myristica malabaria Lamk.	-	Myristicaceae
Olea dioica Roxb.	-	Oleaceae
Oxalis corniculata L.	-	Oxalidaceae
Phyllanthus fraternus Webst.	-	Euphorbiaceae
Piper longum L.	-	Piperaceae
Piper nigrum L.	-	Piperaceae
Pterygota alata (Roxb.) R.Br.	-	Sterculiaceae
Saraca asoca (Roxb.) De Willd.	-	Caesalpiniaceae
Sida acuta Burm.f.	-	Malvaceae
Sida cordifolia L.	-	Malvaceae

Smilax zeylanica L.	-	Liliaceae
Solanum indicum L.	-	Solanaceae
Strychnos nux-vomica L.	-	Loganiaceae
Symplocos cochinchinensis (Lour.)	-	Symplocaceae
Tinospora cordifolia (Willd.) Hk.f.ex Th.	-	Menispermaceae
Toddalia asiatica (L.) Lamk.	-	Rutaceae
Trema orientalis (L.) Bl.	-	Moraceae
Vateria indica L.	-	Dipterocarpaceae
Zanthoxylum rhetsa (Roxb.) DC.	-	Rutaceae
Ziziphus mauritiana (Lamk.)	-	Rhamnaceae

3.5 Vegetational Analysis

3.5.1 Structurtal aspect

150 quadrats, each of 10 m x 10 m size were laid out, thus covering 15% of the forested area. Listing of trees in various girth classes were done and the data are presented in Table 2 and represented in Fig.4. Analysis of girth classes of eight important species are given in Figs. 5 to 12.

Table 2

List of trees in various girth classes

Name of the species	< 30 cm	30 to 60	60 to 90	90 to 120	120 to 150	150 to 180	180 to 210	210 to 240	240 to 270	270 to 300	300 to 330	330 to 360	360 to 390	390 to 420	> 420	Total	Percentage
1. Hopea ponga	599	241	97	54	25	23	11	4	3	1	::	::	::	::	::	1058	45.8
2. Vateria indica	109	78	36	26	35	17	16	1	5	5	4	::	1	::	::	333	14.4
3. Strombosia ceylanica	254	6	1	::	::	::	::	::	::	::	::	::	::	::	::	261	11.3
4. Artocarpus hirsutus	191	12	::	1	::	::	::	::	::	::	::	::	::	::	::	204	8.8
5. Polyalthia fragrans	73	39	23	16	1	::	::	::	::	::	::	::	::	::	::	152	6.6
6. Mesua nagassarium	59	14	20	8	6	1	2	1	::	::	::	::	::	::	::	111	4.8
7. Holigarna arnottiana	45	6	7	1	3	::	::	::	::	::	::	::	::	::	::	62	2.7
8. Hopea parviflora	2	1	6	4	5	2	4	9	11	5	1	2	::	2	4	58	2.5
9. Myristica malabarica	5	2	7	::	2	1	::	::	::	::	::	::	::	::	::	17	0.7
10. Macaranga peltata	8	::	1	2	::	::	::	::	::	::	::	::	::	::	::	11	0.4
11. Cinnamomum malabathrum	8	2	::	::	::	::	::	::	::	::	::	::	::	::	::	10	0.4
12. Antiaris toxicaria	2	1	::	::	::	1	::	::	::	::	::	::	::	::	::	4	0.2
13. Strychnos nux-vomica	::	::	1	2	1	::	::	::	::	::	::	::	::	::	::	4	0.2
14. Tabernemontana heyneana	3	::	::	::	::	::	::	::	::	::	::	::	::	::	::	3	
15. Vitex altissima	1	::	1	::	::	::	::	::	1	::	::	::	::	::	::	3	
16. Adenanthera pavonina	3	::	::	::	::	::	::	::	::	::	::	::	::	::	::	3	
17. Zanthoxylum rhetsa	2	::	::	::	::	::	::	::	::	::	::	::	::	::	::	2	
18. Vatica chinensis	2	::	::	::	::	::	::	::	::	::	::	::	::	::	::	2	
19. Elaeocarpus serratus	::	::	::	1	1	::	::	::	::	::	::	::	::	::	::	2	
20. Mangifera indica	::	1	1	::	::	::	::	::	::	::	::	::	::	::	::	2	
21. Unknown	2	::	::	::	::	::	::	::	::	::	::	::	::	::	::	2	
22. Caryota urens	2	::	::	::	::	::	::	::	::	::	::	::	::	::	::	2	
23. Ailanthus triphysa	1	::	::	::	::	::	::	::	::	::	::	::	::	::	::	1	
24. Ficus hispida	1	::	::	::	::	::	::	::	::	::	::	::	::	::	::	1	
25. Trema orientalis	::	::	1	::	::	::	::	::	::	::	::	::	::	::	::	1	
26. Mallotus philippensis	1	::	::	::	::	::	::	::	::	::	::	::	::	::	::	1	
Total	1373	403	202	115	79	45	33	15	20	11	5	2	1	2	4	2310	
Percentage	59.4	17.4	8.7	5.0	3.4	1.9	1.4	0.6	0.9	0.5							

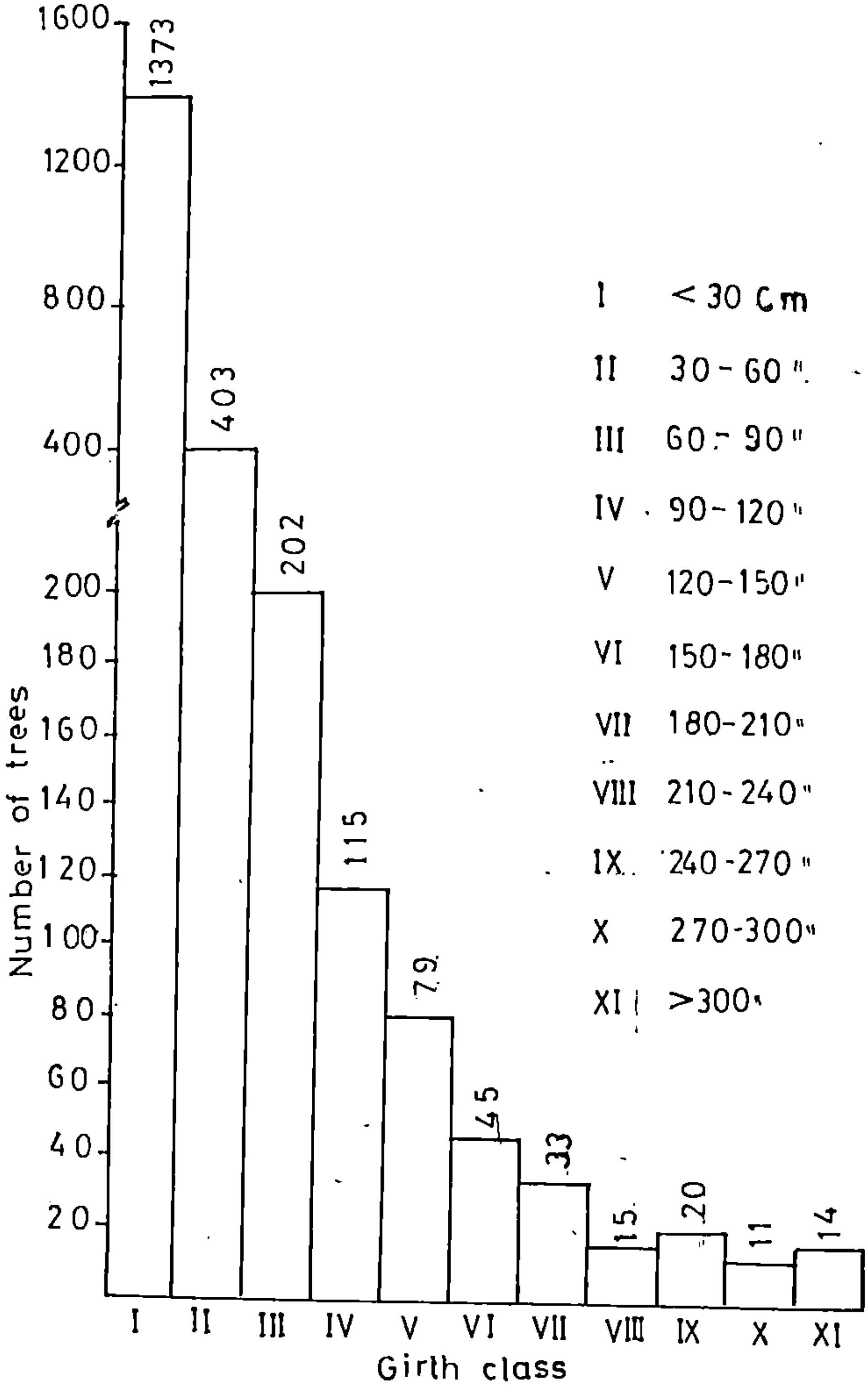


Fig.4. DISTRIBUTION OF TREES IN VARIOUS GIRTH CLASSES

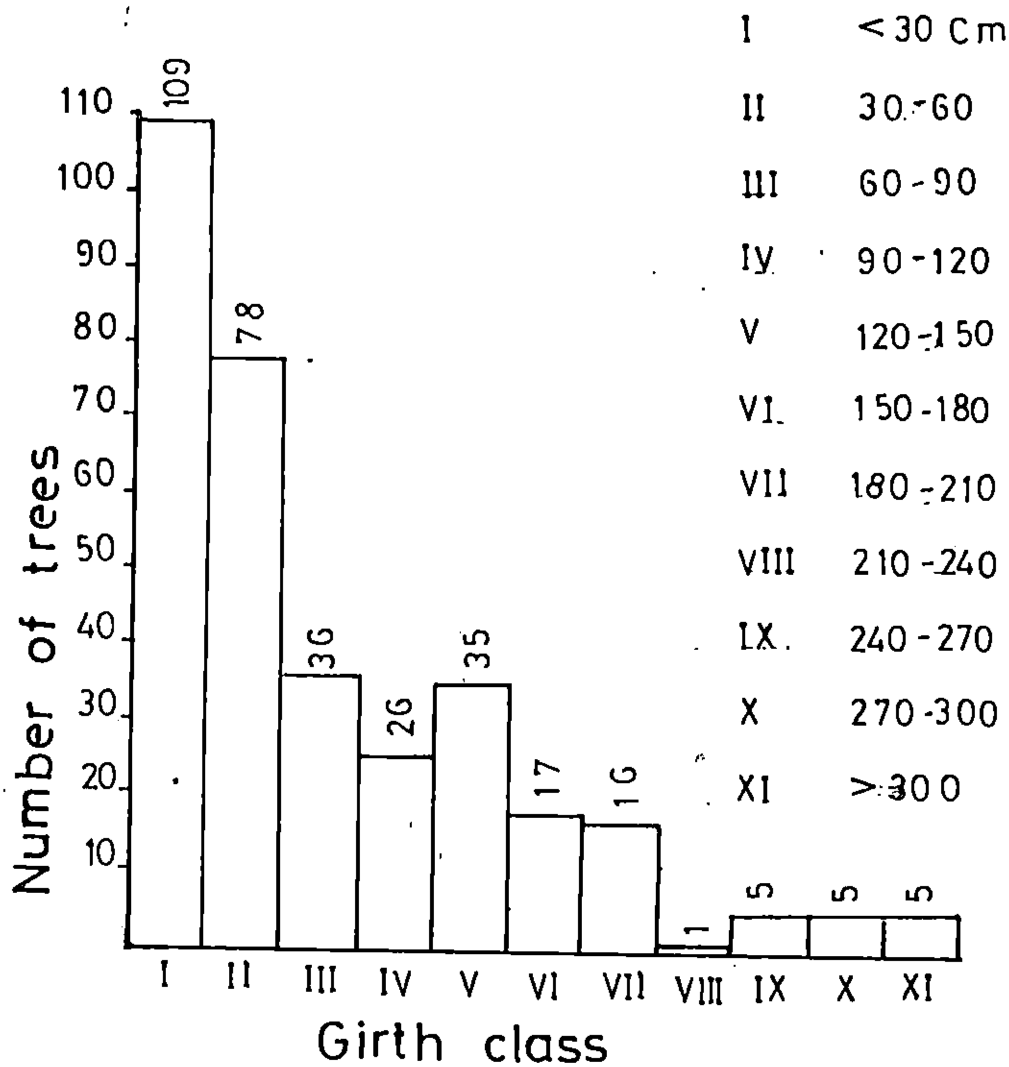


Fig. 5. GIRTH CLASS OF VATERIA INDICA

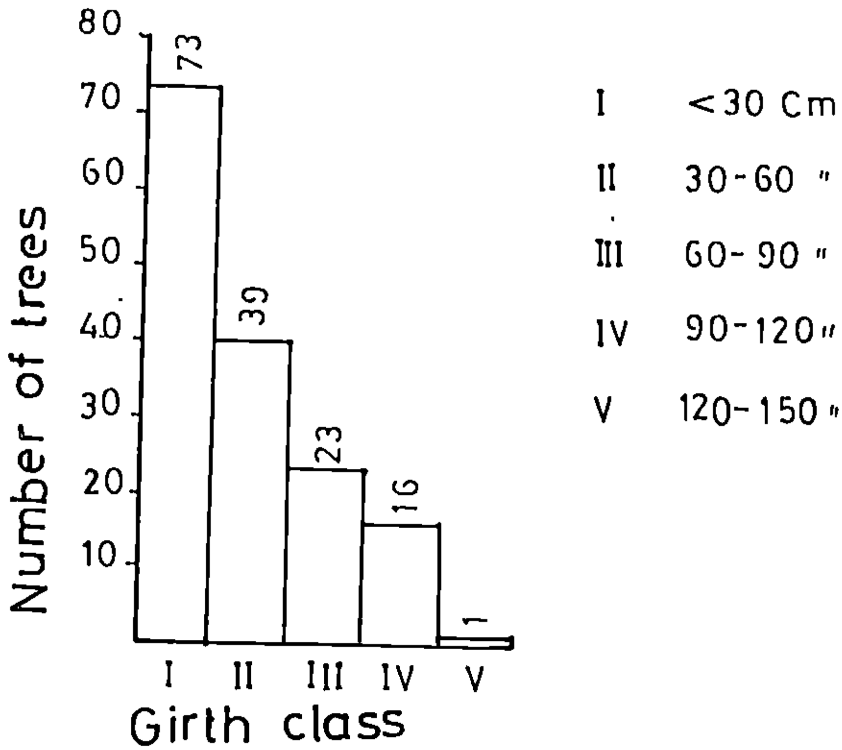


Fig.6. GIRTH CLASS OF POLYALTHIA FRAGRANS

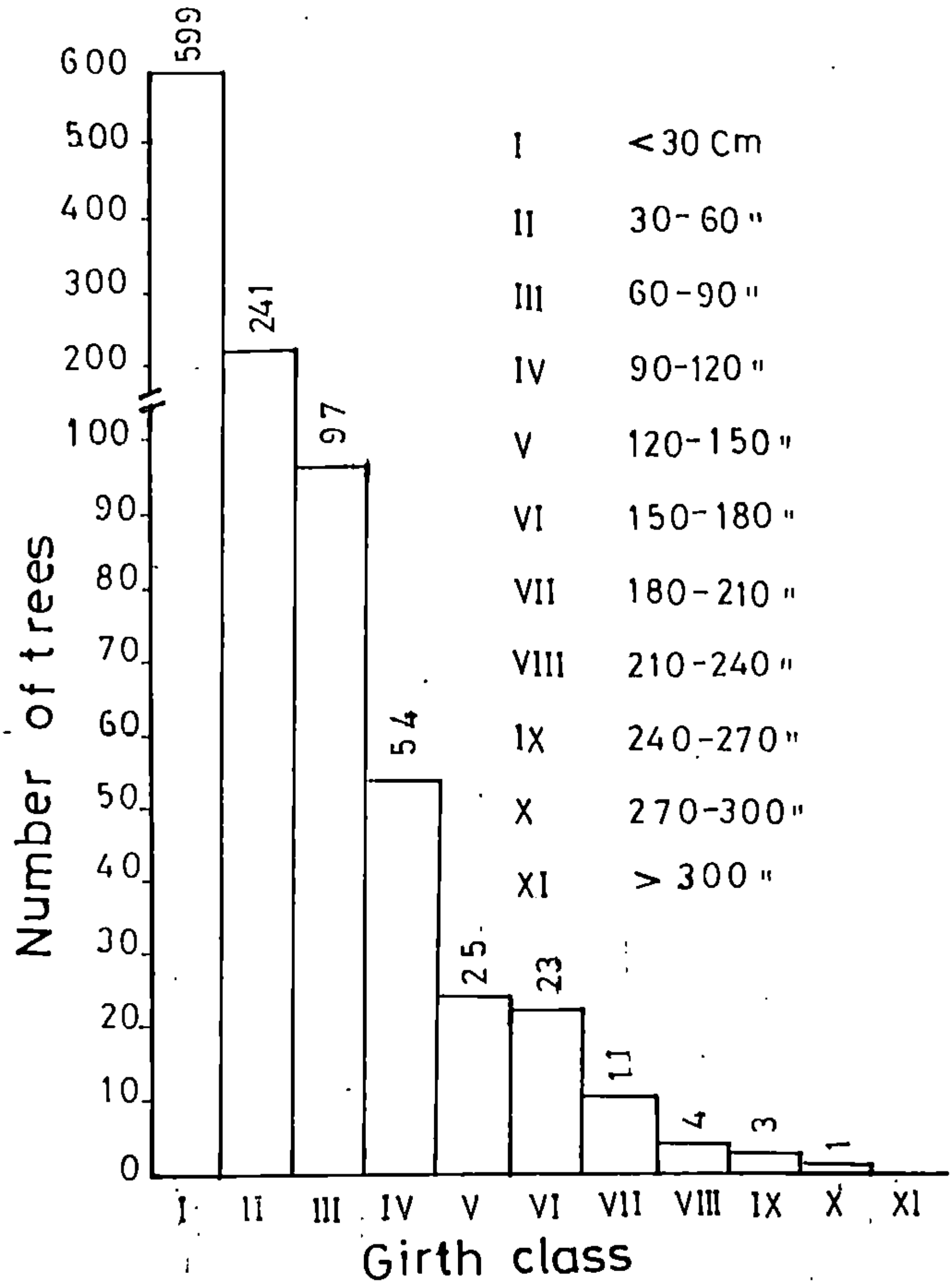


Fig.7. GIRTH CLASS OF HOPEA PONGA

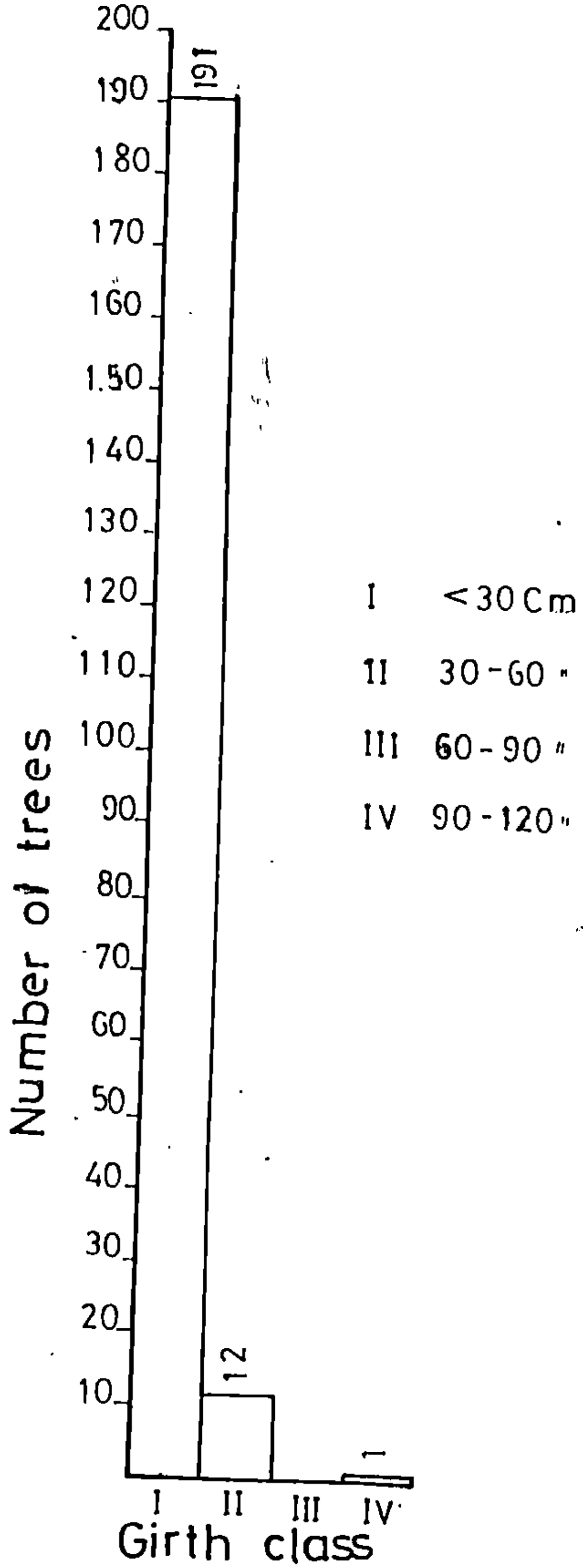


Fig.8. GIRTH CLASS OF ARTOCARPUS HIRSUTUS

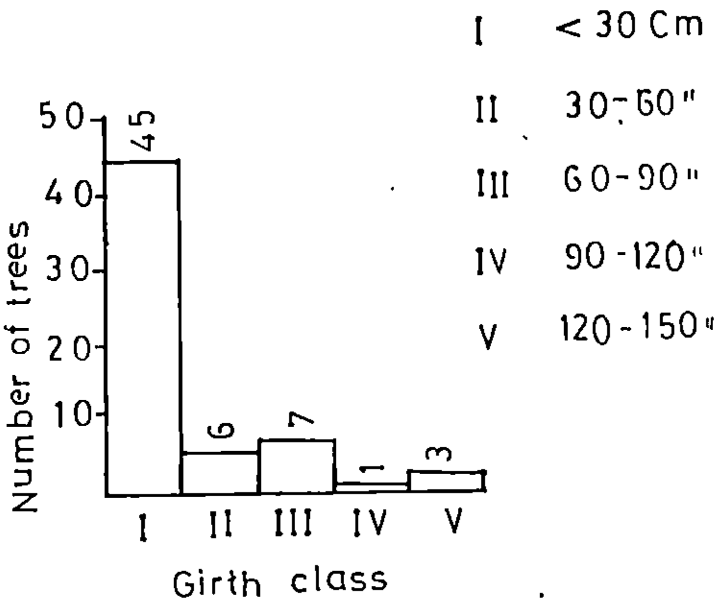


Fig.9. GIRTH CLASS OF HOLIGARNA ARNOTTIANA

Fig.

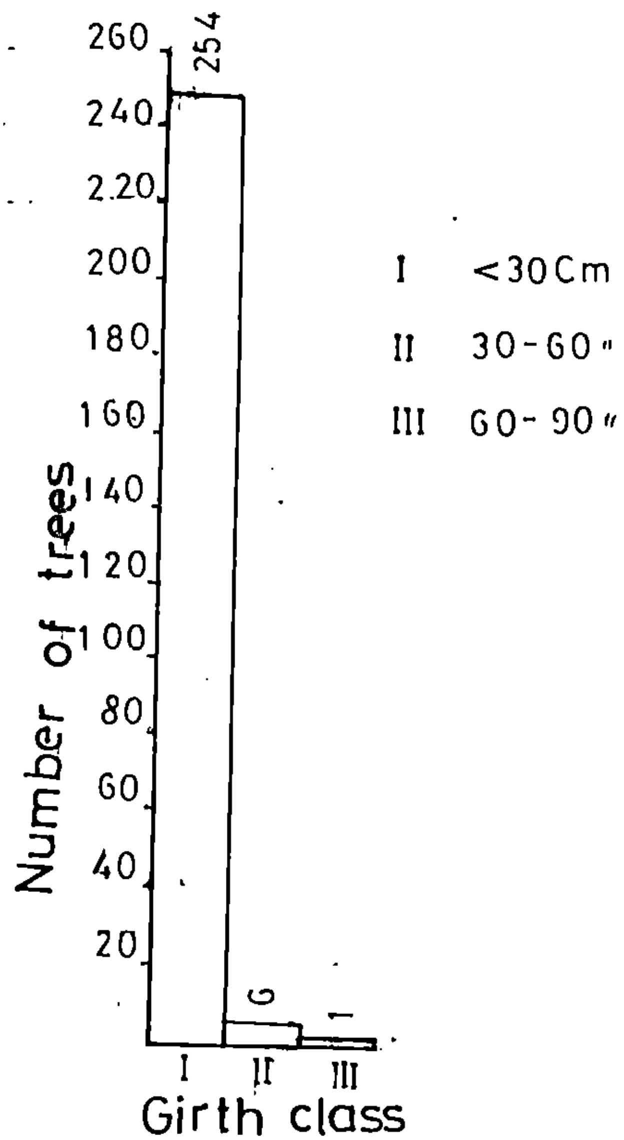


Fig .10. GIRTH CLASS OF STROMBOSIA CEYLANICA

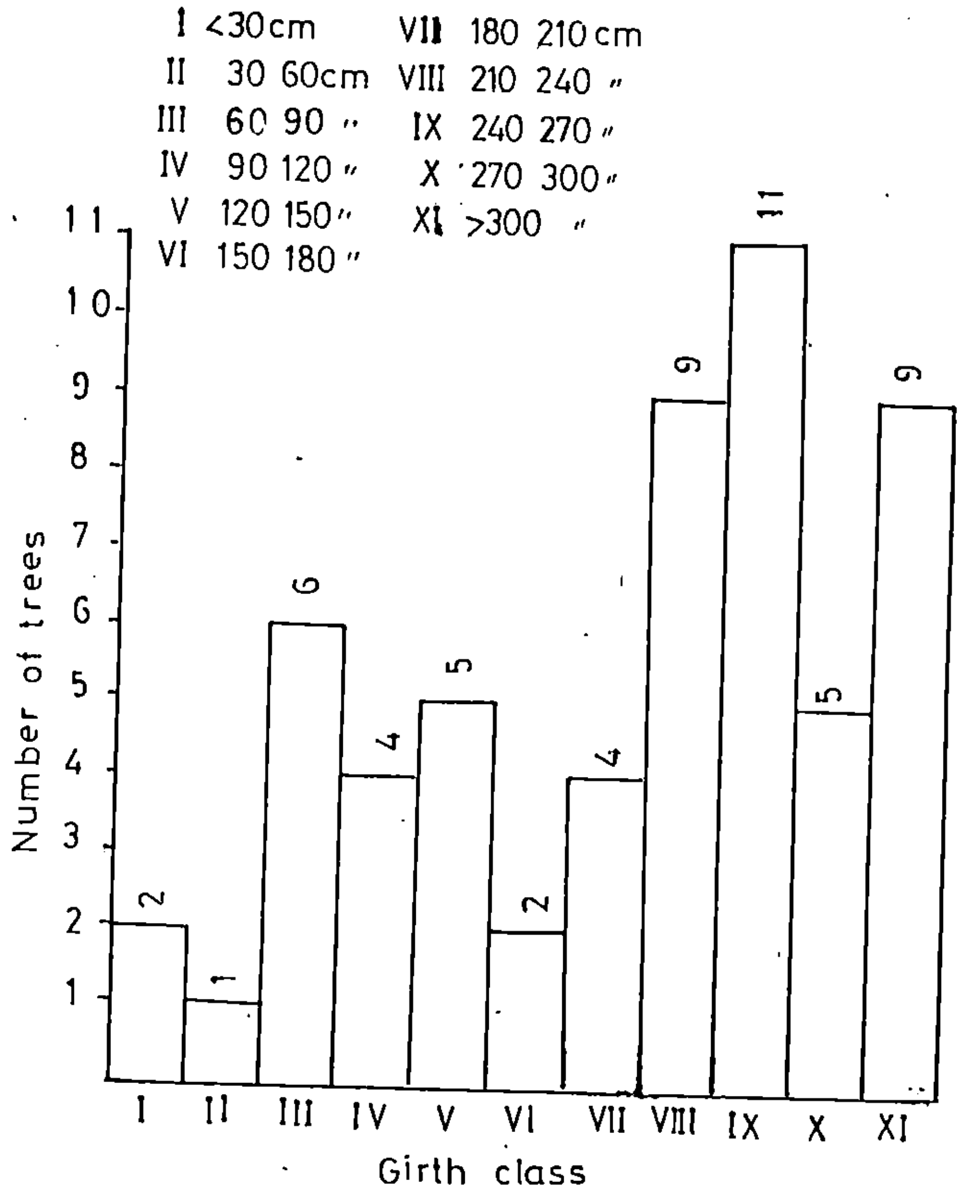


Fig. 11. GIRTH CLASSES OF HOPEA PARVIFLORA

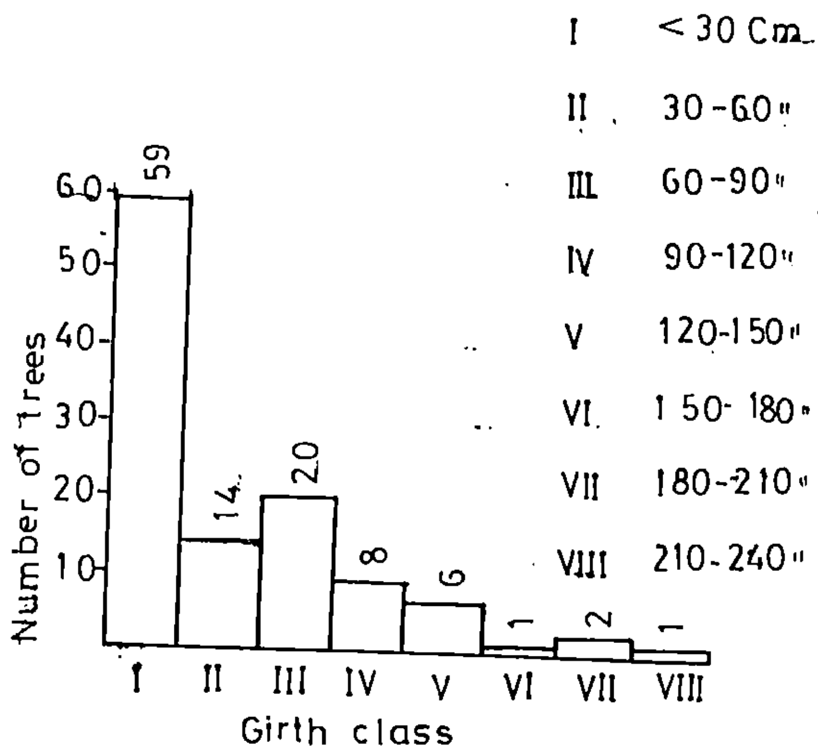


Fig. 12. GIRTH CLASS OF MESUA NAGASSARIUM

Besides, structural data on relative density, relative frequency, and relative basal area, Importance Value Index were also worked out. From the IVI figure obtained it is seen that the association at Iringole is made up of Hopea ponga and Vateria indica. The structural data are presented in Table 3.

3.5.2 Vegetational profile

The fifteen percent enumeration carried out for analysing the vegetation lead to a total number of 2310 individuals of over 10 cm. gbh. These individuals falling under twenty species were categorised into three groups viz: less than 15 m., 15-30 m. and above 30 m. in height. The analysed data are presented in Table 4 and Figs. 13 to 16.

Percentage didstribution of individuals in different families was also calculated and it is represented in Table 5, Fig. 17.

Table 3

Structural data of the Vegetation

Number of Quadrats: 150 (10 m x 10 m.)

Sl. No.	Name of the species	D	Ab	%	R.D.	R.F.	R.B.A.	IVI
1.	Hopea ponga	3.1	3.3	92.0	49.0	33.8	30.2	113.0
2.	Vateria indica	1.5	3.1	48.7	23.9	17.9	29.0	70.8
3.	Hopea parviflora	0.4	1.2	30.7	6.0	11.3	28.7	46.0
4.	Polyalthia fragrans	0.5	1.3	40.7	8.4	14.9	3.4	26.7
5.	Mesua nagassarium	0.3	1.3	26.7	5.6	9.8	3.7	19.1
6.	Holigarna arnottiana	0.1	1.0	11.3	1.8	4.2	1.2	7.2
7.	Myrstica malabarica	0.1	1.3	6.0	1.3	2.2	0.9	4.4
8.	Artocarpus hirsutus	0.1	1.4	6.0	1.4	2.2	0.2	3.8
9.	Strombosia ceylanica	0.1	1.0	4.7	0.7	1.7	0.1	2.5
10.	Strychnos nux-vomica	:::	1.0	1.3	0.4	0.5	0.4	1.3
11.	Elaeocarpus serratus	:::	1.0	1.3	0.2	0.5	0.3	1.0
12.	Cinnamomum malabathrum	:::	1.0	1.3	0.2	0.5	:::	0.7
13.	Macaranga peltata	:::	3.0	0.7	0.3	0.3	0.1	0.7
14.	Vitex altissima	:::	1.0	1.3	0.2	0.5	:::	0.7
15.	Antiaris toxicaria	:::	1.0	1.3	0.2	0.5	:::	0.7
16.	Unknown	:::	1.0	0.7	0.2	0.5	:::	0.7
17.	Mangifera indica	:::	1.0	0.7	0.1	0.1	0.2	0.4
18.	Trema orientalis	:::	1.0	0.7	0.1	0.1	0.2	0.4
						Total		300.1

Table 4

Distribution of trees in different strata

	I stratum (> 30 m.)		II stratum (15.30 m)		III stratum (< 15 m.)	
	No. of trees	%	No. of trees	%	No. of trees	%
Hopea ponga	83	36.7	376	62.5	599	40.4
Vateria indica	66	29.2	110	18.3	157	10.6
Strombosia ceylanica	::	::	::	::	261	17.6
Artocarpus hirsutus	::	::	3	0.5	201	13.6
Polyalthia fragrans	7	3.1	41	6.8	104	7.0
Mesua nagassarium	15	6.6	32	5.3	64	4.3
Holigarna arnottiana	3	1.3	11	1.8	48	3.2
Hopea parviflora	49	21.7	7	1.2	2	0.1
Myristica malabarica	1	0.4	10	1.7	6	0.4
Unknown	::	::	::	::	13	0.9
Macaranga peltata	::	::	3	0.5	9	0.6
Cinnamomum malabathrum	::	::	1	0.2	9	0.6
Antiaris toxicaria	::	::	1	0.2	3	0.2
Strychnos mux-vomica	::	::	4	0.7	::	::
Vitex altissima	1	0.4	1	0.2	1	0.1
Zanthoxylum rhetsa	::	::	::	::	3	0.2
Elaeocarpus serratus	1	0.4	1	0.2	::	::
Trema orientalis	::	::	1	0.2	::	::
Alstonia scholaris	::	::	::	::	1	0.1
Mangifera indica	::	::	::	::	1	0.1
Total	226	100.0	602	100.0	1482	100.0
Percentage	9.8		26.1		64.1	

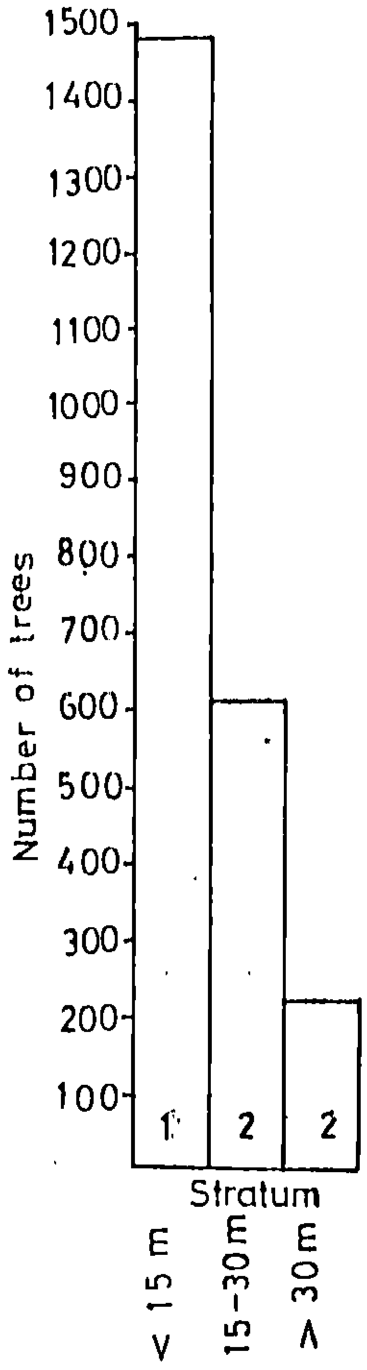


Fig. 13. DISTRIBUTION OF TREES IN DIFFERENT STRATA

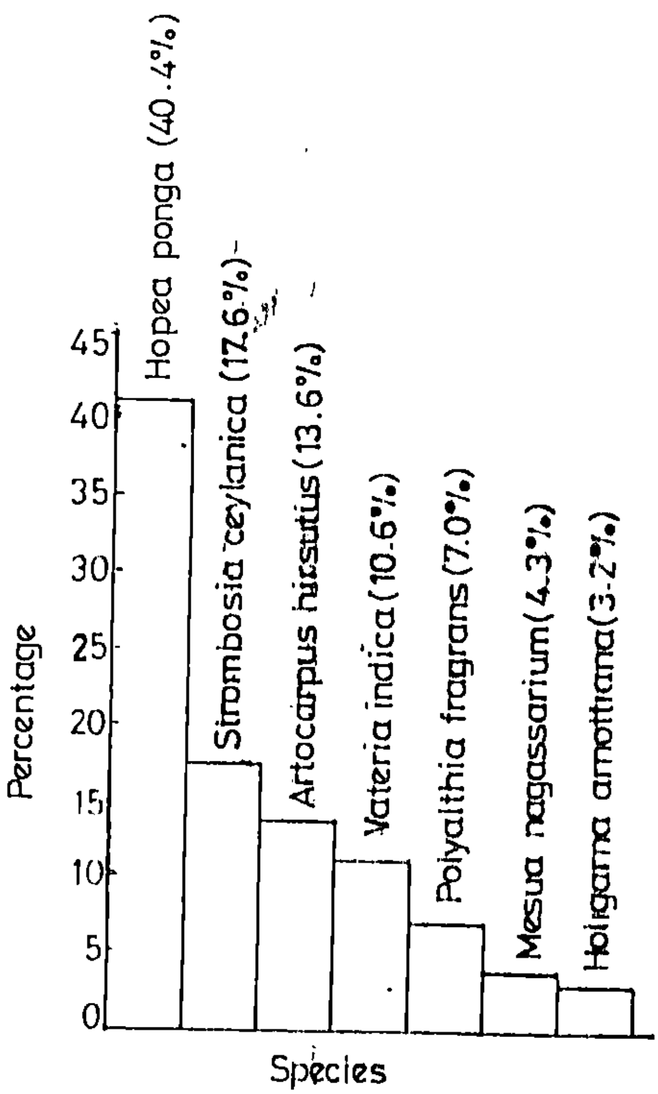


Fig.14 % DISTRIBUTION OF SPECIES IN THIRD STRATUM

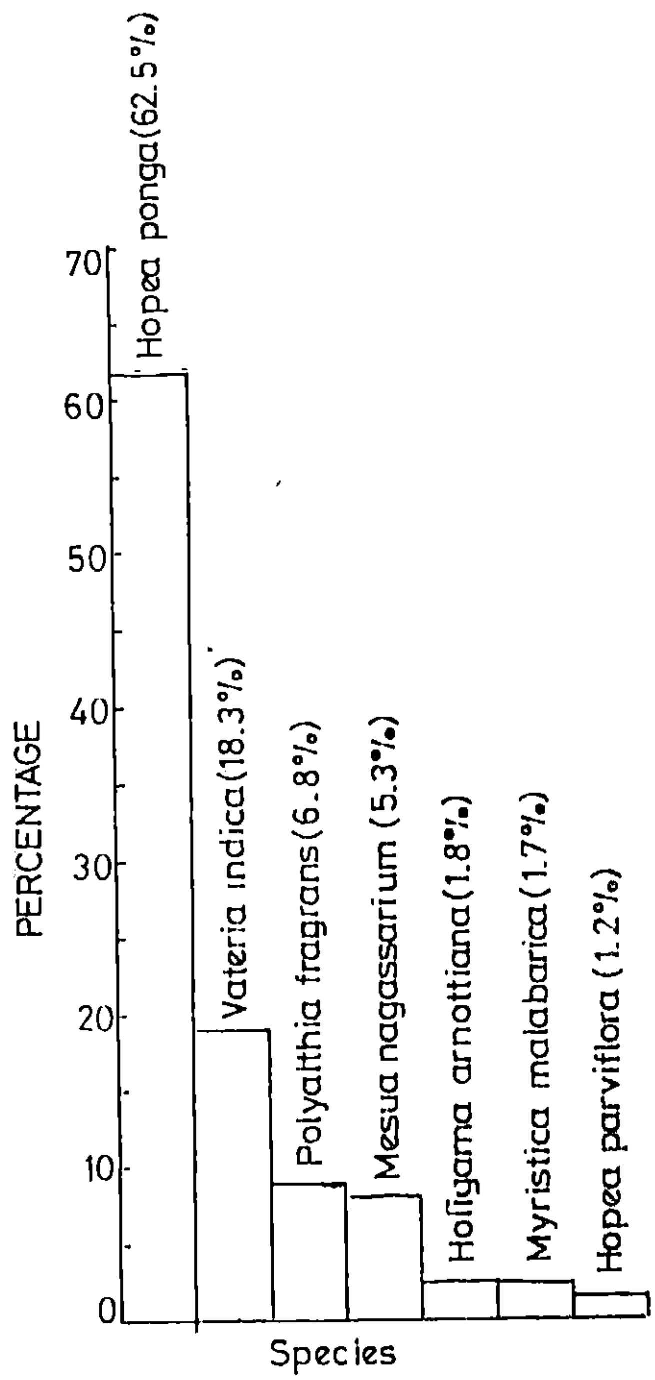


Fig 15 % DISTRIBUTION OF SPECIES IN SECOND STRATUM

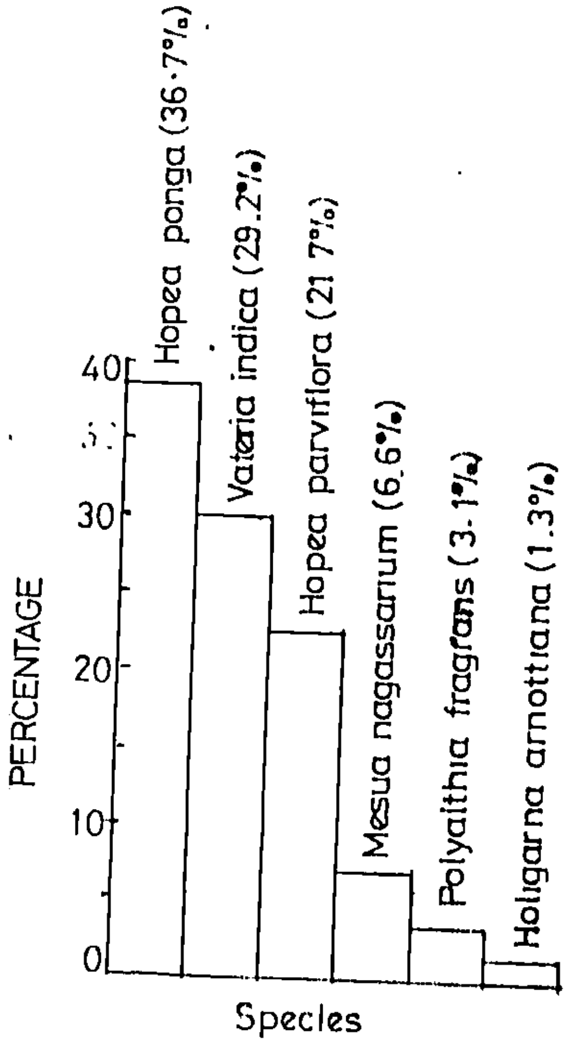


Fig.16. % DISTRIBUTION OF SPECIES IN FIRST STRATUM

Table 5

<u>Percentage distribution of individuals in different families</u>

	Family	Percentage of individuals
1.	Dipterocarpaceae	62.6
2.	Olacaceae	11.3
3.	Moraceae	8.5
4.	Annonaceae	6.6
5.	Clusiaceae	4.8
6.	Anacardiaceae	2.7
7.	Myristicaceae	0.7
8.	Miscellaneous (Meliaceae, Euphorbiaceae, Rutaceae, Verbanaceae, Ulmaceae, Loganiaceae, Apocynaceae	2.8

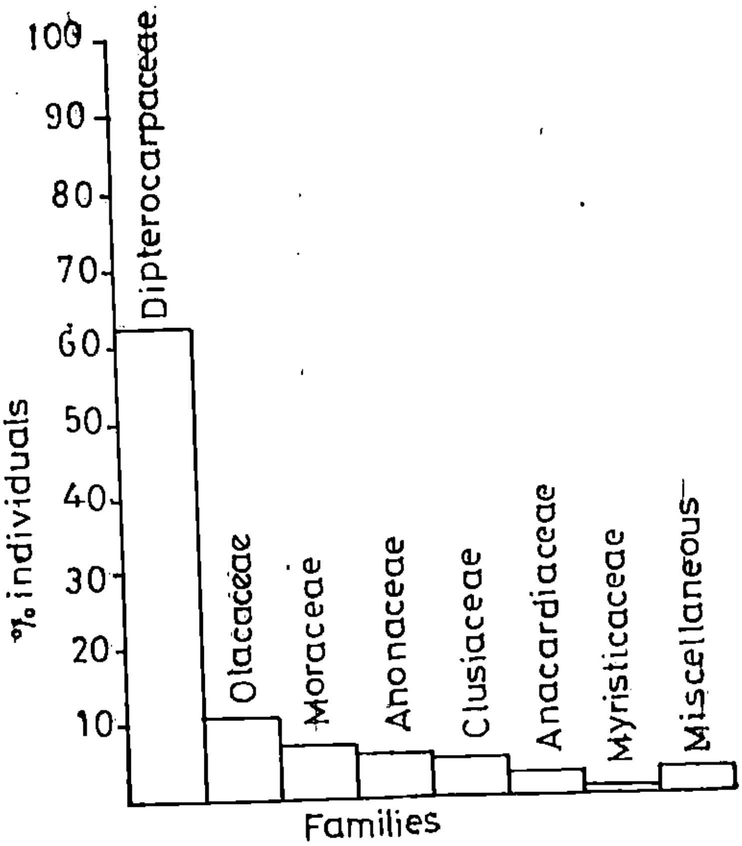


Fig 17. % DISTRIBUTION OF DIFFERENT FAMILIES

3.6 Biological spectrum

The forest at Iringole was studied from the point of view of Raunkiaer's (1934) Biological spectrum which was subsequently modified by Ellenberg and Muller - Dombois (1967) using the abbreviated symbol as follows:

Ph - Phanerophytes

Ch - Chamaephytes

H - Hemicryptophytes

G - Geophytes

HH - Hydrophytes and Helophytes

Th - Therophytes

L - Lianas

P & E - Parasites and Epiphytes

Raunkiaer defined the phytoclimate as "climate for a certain type of vegetation, expressed by statistical proportion between the life forms of all species, determined by the adaptation to survive the unfavourable conditions. On the basis of extensive investigations of the life forms of various floras he attempted to define the main phytoclimate of the earth according to the percentage of vartious life forms. Thus the main phytoclimate of the earth was devided as follows:

1. Phanaerophytes - climate in the tropics.
2. Therophytes - climate in the deserts.
3. Hemicryptophytes - climate in the greater part of the cold temporate zones.
4. Chamaephytes - Climate in the cold zones.

According to him the percentage distribution of species among the life forms of a flora is called the "Biological spectrum" or "Phytoclimatic spectrum". He defined the normal spectrum as the "percentage relations between the life forms of all phaneaerogams of the world".

Following are the Raunkiaer's modified life form types based mainly on the position of the highest perennating buds in relation to the surface of the soil (ELLENBERG & MUELLER-DOMBOIS, 1967).

I. PHANAEROPHYTES (Ph). Woody or herbaceous evergreen perennials that grow taller than 50 cm. or whose shoots do not die back periodically to that height.

(a)	Megaphanaepophytes (Mg)	– $>$ 50 m
(b)	Mesophanaerophytes (Ms)	– 5 – 50 m
(c)	Microphanaerophytes (Mi)	– 2 – 5 m
(d)	Nanophanaerophytes (N)	– $<$2 m

II. CHAMAEPHYTES (Ch) Plants that are broomy or bunchy from the ground with a sprawling habit; the mature branch or shoot system remains periodically within 50 cm above the ground level or plants that grow taller than 50 cm but whose shoots die back periodically to that height limit.

III. HEMICRYPTOPHYTES (H) Perennial herbaceous plants with periodic shoot reduction to a remnant shoot system that lies relatively flat on the ground surface during the unfavourable season and often protected by dead shoot remains.

IV. GEOPHYTES (G) (Cryptophytes) — Perennial herhaceous plants with periodic reduction of complete shoot system to storage organs that are embedded in the soil. (This group embraces the Hydrophytes of Raunkiaer).

V. THEROPHYTES (Th) — Annual plants whose shoot or root system dies after seed production and which complete their life cycle within one year.

VI. LIANAS (L) — Plants that grow by supporting themselves on others, germinating either on ground and maintaining contact with the soil or germinate on other plants and then establish their roots in the ground or germinate on the ground, grow up the trees and disconnect their soil contact. (This group is treated specially since they depend for their support on other self supporting plants or artificial props).

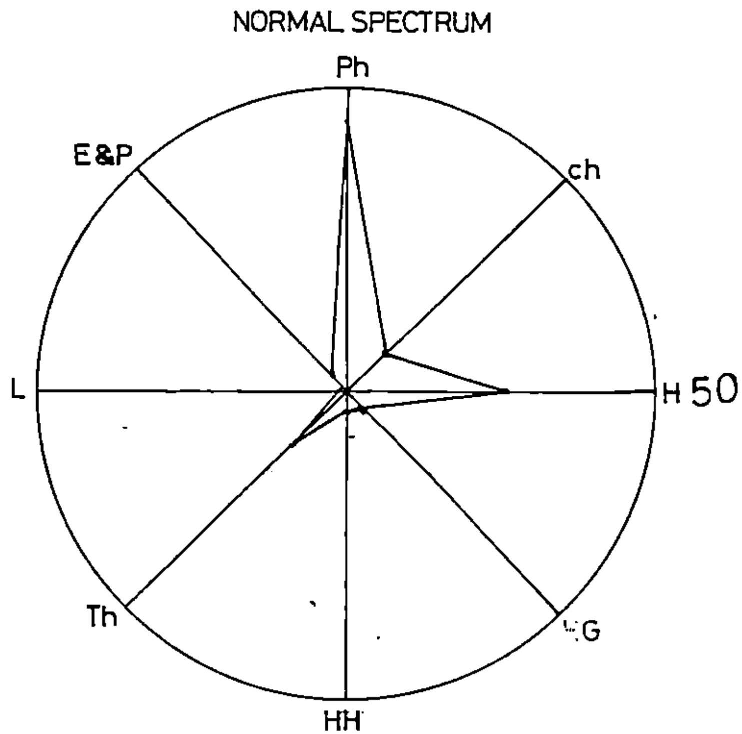
VII. EPIPHYTES (E) and PARASITES (P) — Plants that germinate and root on other plants (This incidentally includes parasites also).

As floristic and climatic data are available for the study area its biological spectrum has been prepared and the same is presented in Table 6 and Fig.18.

Table 6

Biological Spectrum

		Percentage of normal spectrum	No. of species at Iringole	Percentage of Iringole spectrum
Phanerophytes	Megaphanerophytes (Mg)	:::	:::	:::
	Meso phanerophytes (Ms)		26	14.4
	Microphanerophytes (Mi)	43	24	13.3
	Nanophanerophytes (N)	:::	20	11.1
	Chamaephytes (Ch)	9	::	:::
	Hemicryptophytes (H)	26	12	6.7
	Geophytes (G)	4	13	7.2
	Hydrophytes and Helophytes (HH)	2	::	:::
	Therophytes (Th)	13	58	32.2
	Lianas (L)	::	21	11.7
	Epiphytes and Parasites (E and P)	3	6	3.3



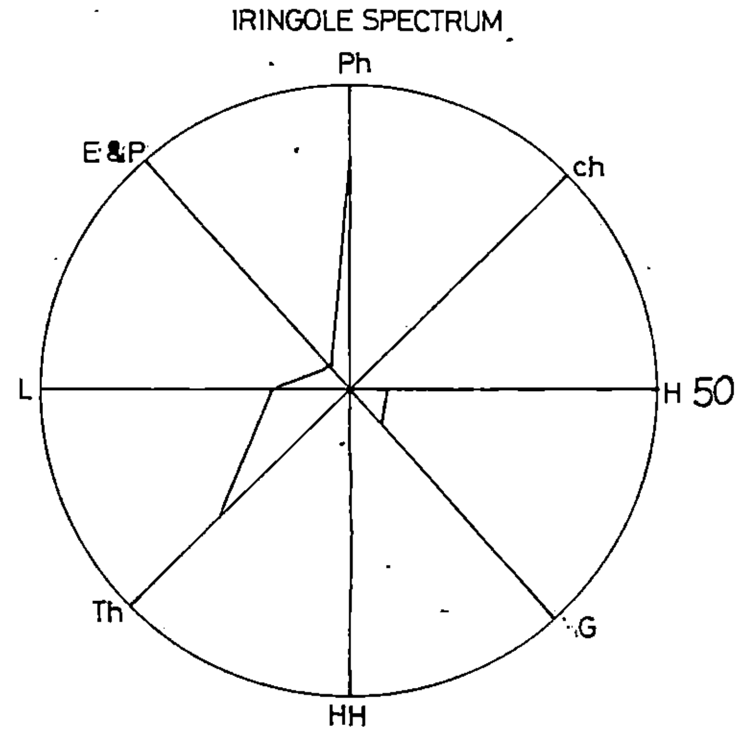


Fig 18 BIOLOGICAL SPECTRUM

3.7 Species richness and diversity

For determining the species richness and diversity Simpson's Index was calculated . It worked out to 0.74.

3.8 Regeneration studies

Two percent regeneration survey was carried out by laying out 80 plots each of 5 m x 5 m size. Number of unestablished and established seedlings, seedlings of advance growth and saplings were recorded. The analysed data are given in Table 7. Graphs depicting the regeneration status of eight important species are given in Figs. 19 to 26. Plates XVI to XIX show the profuse regeneration of *Artocarpus hirsutus*, *Mesua nagassarium*, *Strombosia ceylanica* and *Holigarna arnottiana* respectively.

3.9 Soil studies

Soils were collected from pits struck at three locations viz., forest, ecotone and surrounding agricultural ecosystem from 0-20, 20-40 and 40 to 60 cm layers. The soils were air dried, ground and passed through a 2 mm sieve and analysed for pH in

Table 7

Abstract of regeneration enumeration

Total number of Quadrats = 80 (5 m x 5 m)

Sl. No.	Name of the species	U.E	E.	A.G.	S	Percentage
1.	Artocarpus hirsutus	1948	1083	997	26	21.8
2.	Hopea ponga	2338	337	506	80	17.6
3.	Cinnamomum malabathrum	2426	306	111	1	15.3
4.	Mesua nagasaarium	1528	424	317	8	12.3
5.	Hopea parviflora	1769	300	94	1	11.7
6.	Polyalthia fragrans	1410	123	44	9	8.6
7.	Holigarna arnottiana	433	264	306	6	5.4
8.	Strombosia ceylanica	187	199	259	38	3.7
9.	Vateria indica	142	176	100	11	2.3
10.	Mallotus philippensis	52	40	11	::	0.6
11.	Garcinia indica	30	52	16	::	0.5
12.	Myristica malabarica	10	7	4	1	0.1
13.	Hydnocarpus pentandra	1	2	6	::	::
14.	Adenanthera pavonina	2	3	1	::	::
15.	Drypetus roxburghii	::	1	3	::	::
16.	Clerodendrum viscosum	::	3	::	::	::
17.	Alstonia scholaris	::	1	::	1	::

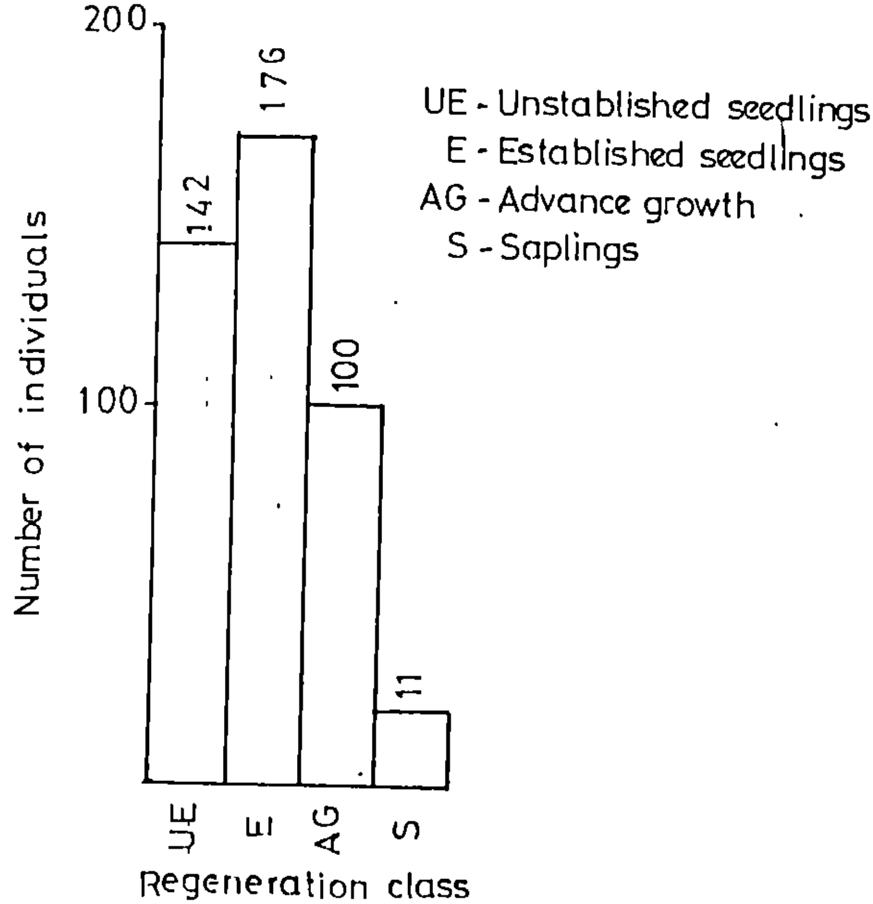


Fig. 19. REGENERATION STATUS OF VATERIA INDICA

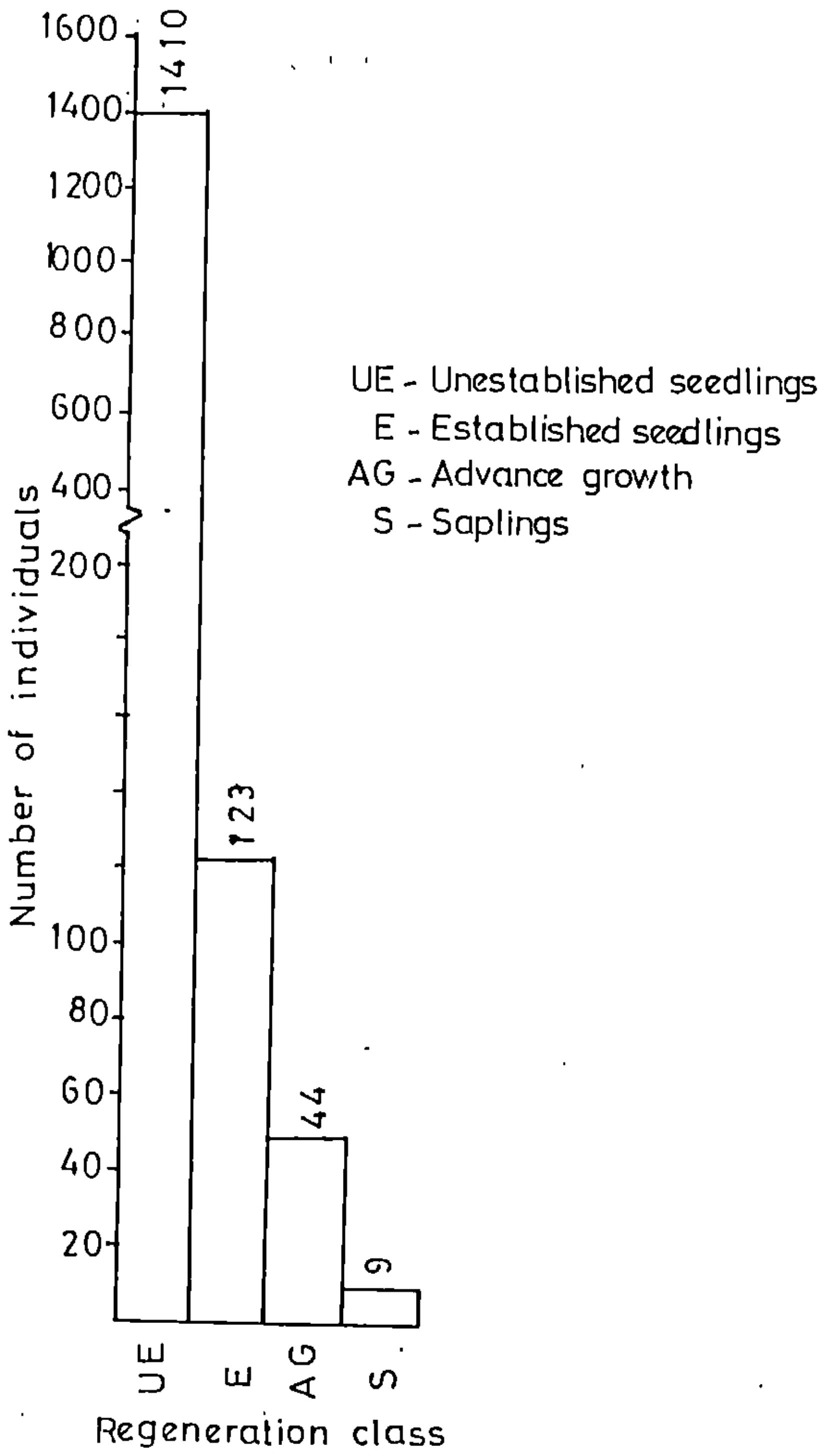


Fig 20 REGENERATION STATUS OF POLYALTHIA FRAGRANS

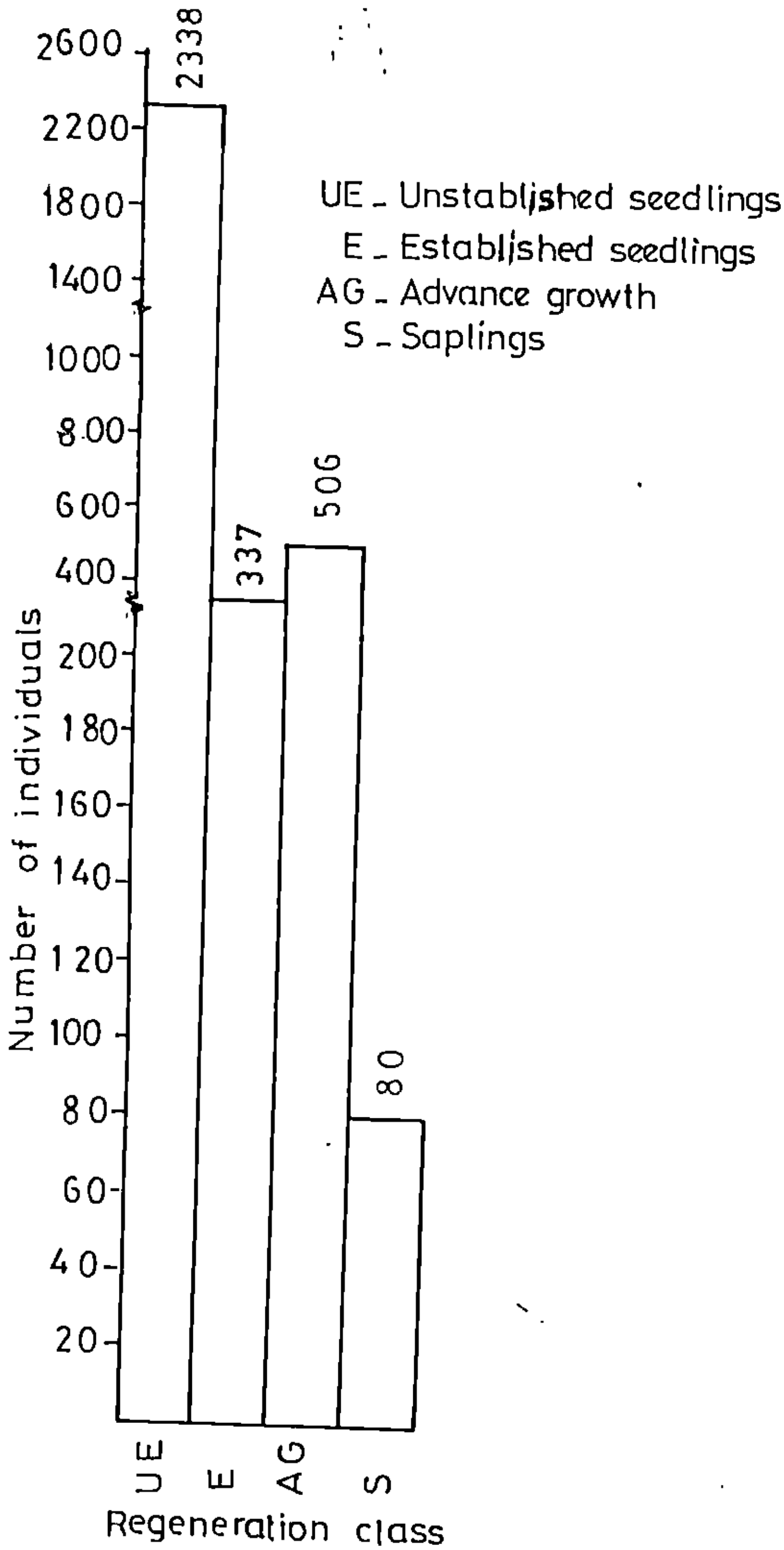


Fig.21 REGENERATION STATUS OF HOPEA PONGA

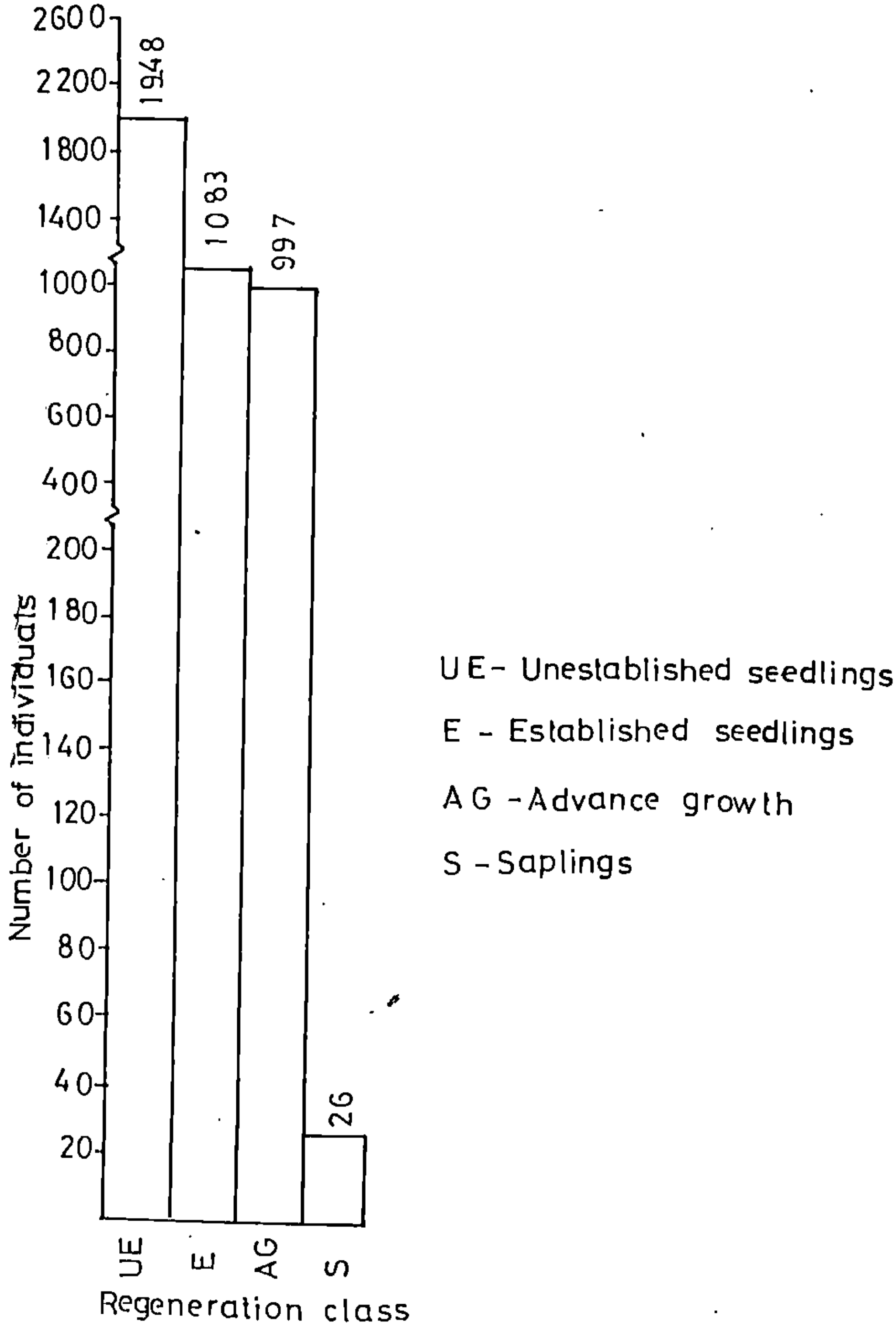


Fig. 22. REGENERATION STATUS OF ARTOCARPUS HIRSUTUS

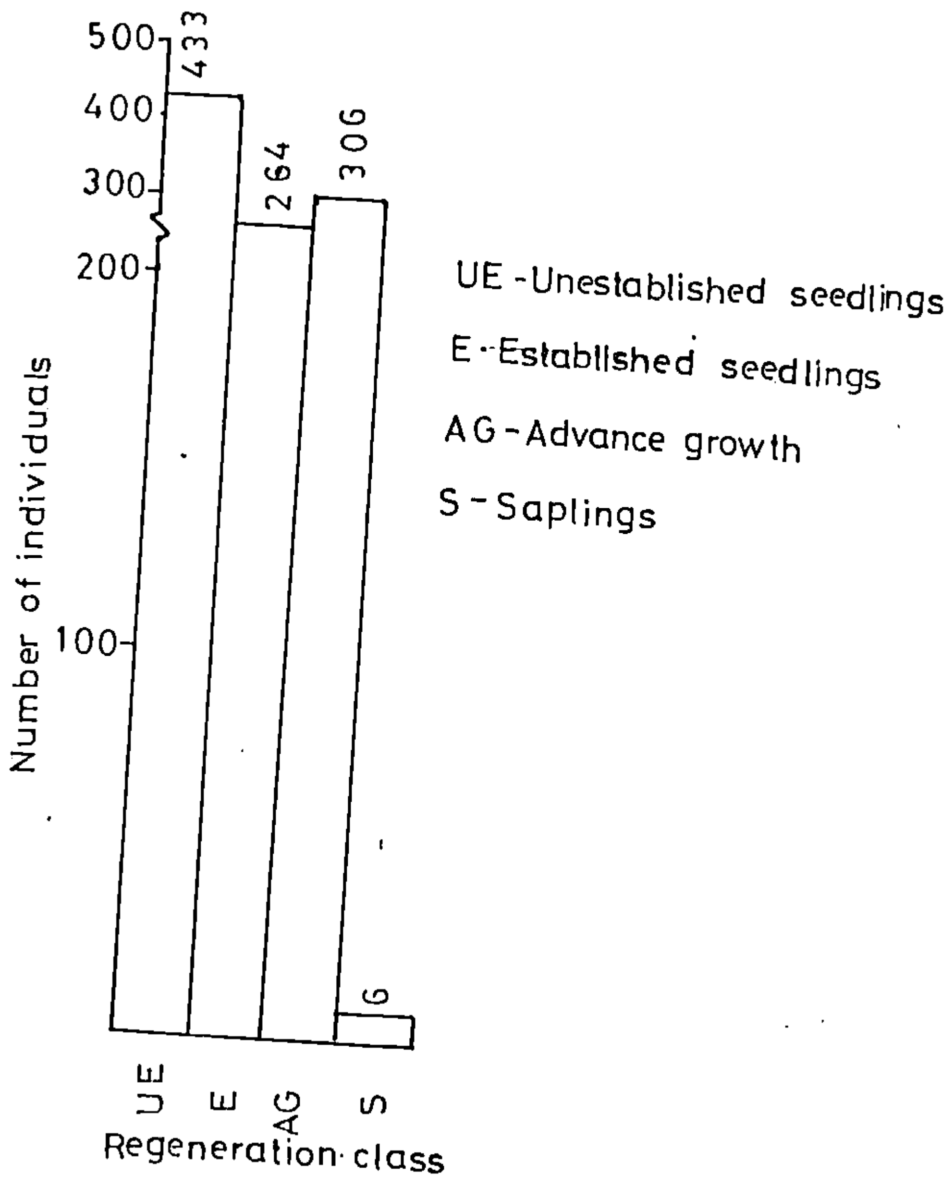


Fig.23. REGENERATION STATUS OF HOLIGARNA ARNOTTIANA

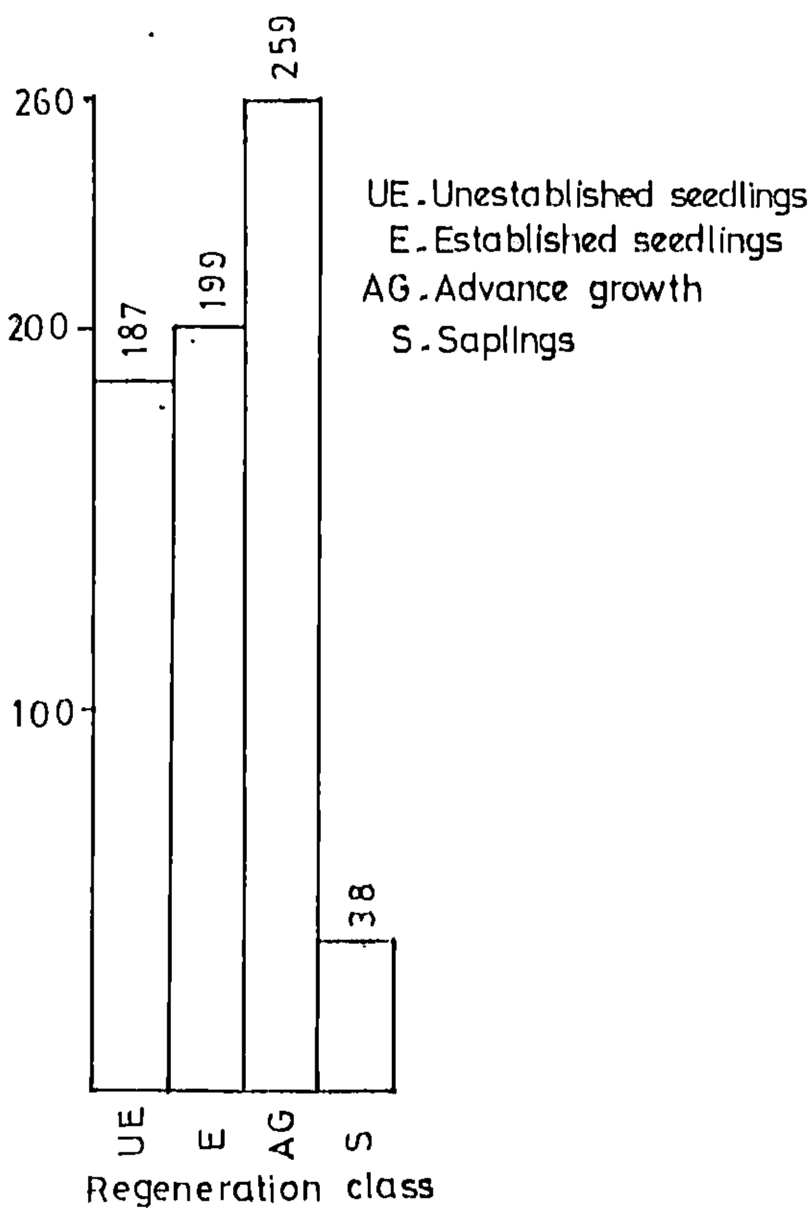


Fig 24 REGENERATION STATUS OF STROMBOSIA CEYLANICA

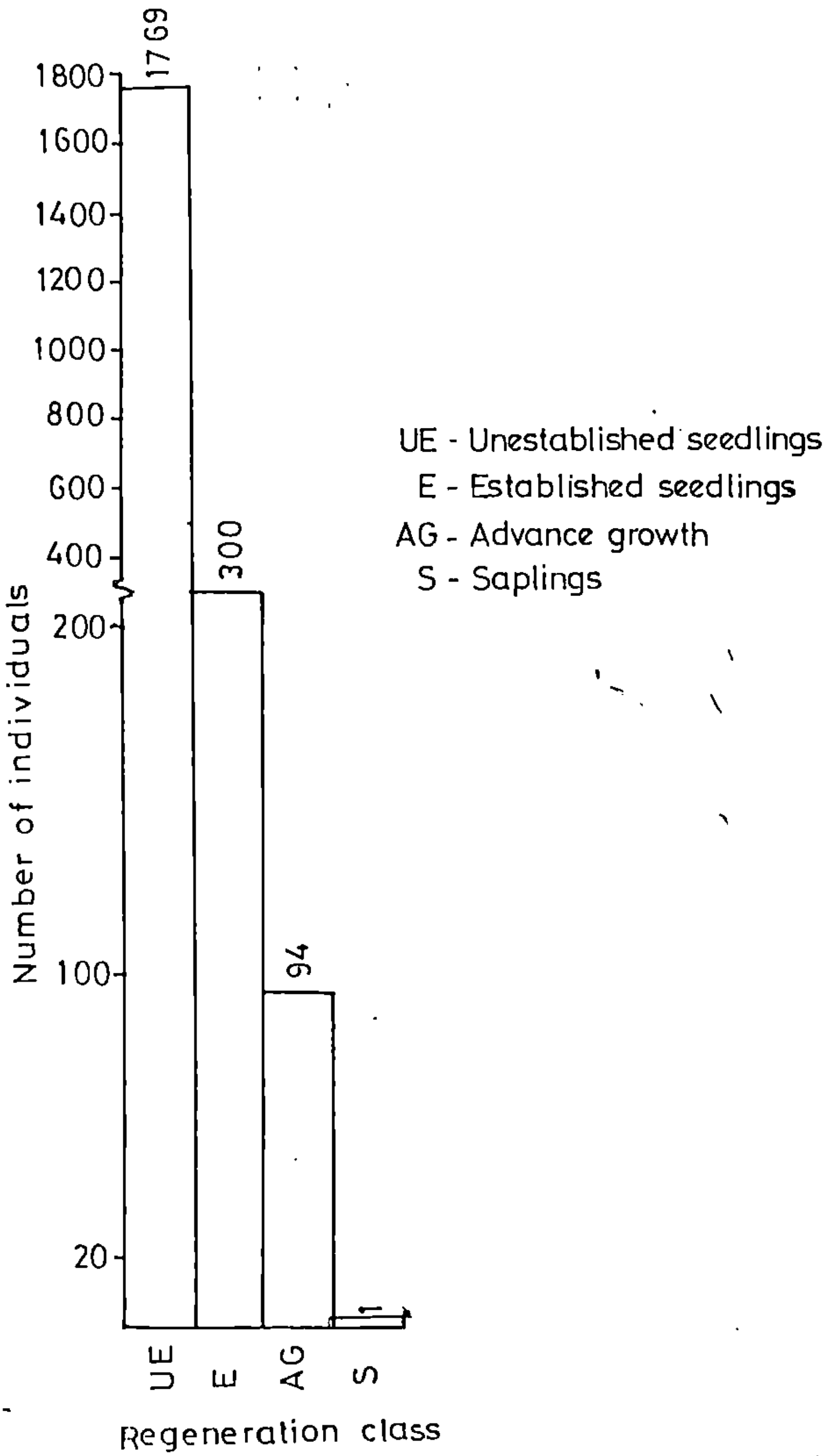


Fig. 25. REGENERATION STATUS OF HOPEA PARVIFLORA

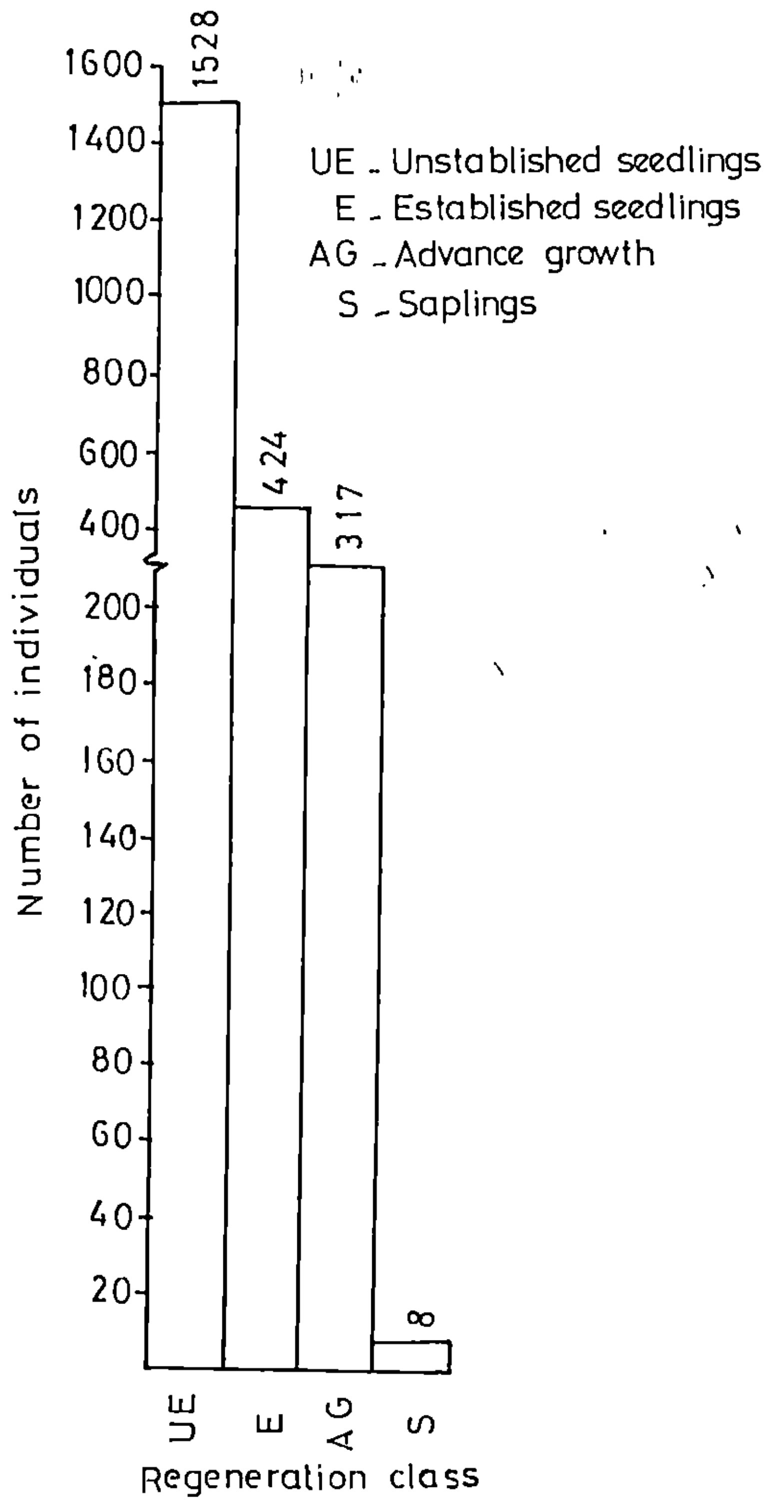


Fig 26 REGENERATION STATUS OF MESUA NAGASSARIUM

Plate 16. Regeneration of Artocarpus hirsutus.

Plate 17. Regeneration of Mesua nagassarium.

Plate 18. Regeneration of Strombosia ceylanica.

Plate 19. Regeneration of Holigarna arnottiana.

water, organic carbon, Exchangeable bases and Exchange acidity following the method of Jackson (1972).

The results of the soil analysis are presented in Table 8.

Table 8

Soil properties

Depth cms.	pH 1:2 water	O.C. in percentage	E.A.	E.B meq/ 100 g.
Forest				
0-20	4.7	0.66	4.1	4.7
20-40	4.8	0.41	4.1	6.0
40-60	4.8	0.34	3.9	3.5
Ecotone				
0-20	4.9	0.59	4.1	4.5
20-40	4.8	0.36	4.1	4.0
40-60	5.0	0.42	3.6	5.0
Cultivated area				
0-20	5.5	0.44	1.7	7.5
20-40	5.7	0.24	1.2	8.5
40-60	5.7	0.42	1.2	9.0

DISCUSSION

As mentioned earlier the forest of the study area belongs to Champion and Seth's "Southern Tropical West Coast Evergreen" (low level) type. Almost the entire low land forests in Kerala have disappeared along with associated mangroves due to land reclamation. Few patches of untampered forests, scattered here and there, but invariably associated with the temples are still preserved.

In utter contrast to the barron, simplistic transformations of the forest at the hands of man, the tropical forest is a miracle of biological ingenuity. The incredible diversity of the climax rainforest, with its hundreds of thousands of species of plant and more than a million species of animal is not simply the response of greater solar radiation and rainfall compared with more temperate zones, it is the end product of many millions of years of evolution during which the fauna and flora have gradually moulded the environment, to suit their own requirements. The humidty of the forest, the relative coolnes of the forest floor, the extraordinary rapidity with which the nutrients are absorbed back into the living system, so that virtually none leaches away, the mechanisms by which the vegetation ensures it's survival and propagation are the result of intricately linked factors, all of which disappear when the forest is gone (Bunyard, P. 1985)

Ecological studies on the low land evergreens of Kerala is practically nil and this investigation is of a pioneering nature.

(1) Regarding the floral wealth, this area comprises of 180 species of which 50 are of arborescent nature. Among the arborescent ones the family Dipterocarpaceae is highly represented (62.6%). Five species *Hopea parviflora*, *H. ponga*, *H. racophloea*, *Vateria indica* and *Vatica chinensis* are represented by this family at Iringole and all of them belong to the first stratum. The heavy preponderance of Dipterocarpaceae at Iringole is similar to that of the low land Dipterocarp forests of Malaysia although in number of species the two cannot be

compared. It is also worth mentioning that out of the five species represented four are endemic to the southwestern part of the Peninsular India.

(2) This area also contain eleven wild relatives of the cultivars. Among them Araceae, Dioscoreaceae and Piperaceae account for two species each.

(3) From the point of view of medicinal plants this area is a treasure house. Roughly one third of the species encountered are of some medicinal use.

(4) Analysis of the vegetation points to many interesting features. Trees of different species belonging to various girth classes are encountered. Trees with a girth of over 420 cm. at breast height and above 45 m. in height are noteworthy. As is generally the case, the species belonging to lowest girth class viz. less than 30 gbh are very highly represented (59.4%), followed by 30-60 cm. class (17.4%), 60-90 cm. class (8.7%) etc. in descending order. Species like <u>Polyalthia fragrans</u>, <u>Hopea</u>

ponga and Holigarna arnottiana (Figs. 6, 7 and 9) follow the conventional pattern, the graph being 'L' shaped. In Mesua nagassarium 60 to 90 cm. girth class is very well represented (Fig.12). In the case of Vateria indica (Fig. 5) although the graph shows the conventional type, species belonging to higher girth classes (over 240 cm.) are very mell marked. In Strombasia ceylanica (Fig. 10) and Artocarpus hirsutus (Fig. 8) not a single tree above 120 cm. are seen. There is a heavy concentration of the girth class of less than 30 cm. (nearly 98%). It remains a puzzle as to where the mother trees are. In the case of Artocarpus hirsutus atleast an explanation can be offered that the fruits are eaten and the seeds might have been dispersed by birds or animals and the seedlings are in the process of vigorous growth. Figure 11, pertaining to Hopea parviflora does not follow any convention. Species of lower girth classes are comparatively less and mother trees are quite high. But if regeneration is considered there is more regeneration of Hopea ponga than Hopea parviflora. Perhaps, most of the trees of Hopea parviflora are either overmature or senile.

(5) The structural data of the vegetation are also interesting. The IVI shows that the association is of Hopea ponga - Vateria indica. Hopea parviflora closely follows the two because of its larger basal area. Relative density and Relative frequency wise Polyalthia fragrans stands above Hopea parviflora but its basal area is negligible. The situation is more or less the same with regard to Mesua nagassarium also. Other species follow the normal pattern. Species like Holigarna arnottiana, Myristica malabarica, Artocarpus hirsutus and Strombosia ceylanica exhibit low basal areas.

(6) Physiognomically, three strata can be recognised in the forest at Iringole. The dominant stratum of over 35 m. in height is represented by 10% of the individuals; the middle stratum by 26.1% and the lowest stratum by 64.1%. Hopea ponga, H. parviflora and Vateria indica are well represented in the first strata, while the reverse is true in the case of Strombosia ceylanica and Artocarpus hirsutus. However, in the case of H. parviflora trees belonging to the second and third strata are

negligible. Mesua nagassarium, Polyalthia fragrans and Holigarna arnottiana are fairly distributed in the middle story. Most of the individuals of Myristica malabarica belong to the middle stratum. Hopea ponga and Vateria indica are fairly well represented in all the strata. Isolated trees of Vitex altissima and Elaeocarpus serratus are seen in all the stages.

(7) Generally, in the tropics the dominant life forms are the phanerophytes. Depending upon the location, whether the forests are in high rainfall zone or in low rainfall area the phanerophytc nature undergoes transition from the Mega phanerophytes to Nanophanerophytes. In the case of Iringole too the climate is favourable towards Phanerophytism although Mega phanerophytes are not encountered. The meso, micro and nano phanerophytes are more or less evenly distributed. Unlike the normal spectrum lianas are very high. Therefore, it is appropriate to designate the life form of Iringole as Phanerophytic - Liana complex.

(8) Regarding species richness case studies from many areas are available. Murca Peres (1953) on a five hectare forest in Amazonia recorded 224 species representing 136 genera and 52 families among 2607 trees of over 30 cm. gbh. The poorest wet evergreen forests of Puerto Rico contains only 51 species in a total of 10 acres, while the richest in Regnum Johor Reserve contains 227 species per hectare. In Silent Valley a quarter hectare area easily contains 33 species out of 370 individuals of over 10 cm. gbh, while at Muthikkulam and Nelliampathy for the same extent of area 336 and 294 inviduals were recorded (Chand Basha, 1987). Iringole can be considered numerically richer in the number of individuals (viz. 2310 individuals of over 10 cm. gbh in one and a half hectare) area than Silent Valley, Muthikkulam or Nelliampathy all situated at an elevatgion of about 900 m. However, in termes of species diversity the area is poor. Only 20 species could be recorded in one and half hectare area as against 33 species at Silent Valley, Muthikkulam and Nelliampathy. This is reflected in the values of Simpson's Index also. It is 0.74 at Iringole, as compared to 0.94 for Silent Valley and Muthikkulam and 0.87 for Nelliampathy. Dominance of

vegetation by a single species is a very rare phenomenon and if at all encountered will invariably be due to specific edaphic conditions.

(9) Environmental factors are of utmost importance in controlling the direction of regeneration. Regeneration is also affected by biotic interferences. Due to heavy fruit production followed by plentyful seed sources the evergreen forest floor is featured by a dense mat of seedlings. The regeneration status is also governed by various other factors like, the, prevalence of seed trees in various species, the efficiency of their distribution mechanism, the frequency and regularity of their seed production, seasonality of the year and so on.

In the study area, regeneration of certian species does not appear to be a problem at all. In the case of *Polyalthia fragrans*, *Artocarpus hirsutus* and *Hopea ponga* all the four stages are fairly well represented (Figs 20 to 22). Saplings are very negligible for *Cinnamom malabathrum* and *Hopea parviflora* (Fig. 25). The same is true in the case of *Holigarna arnottiana* also. *Vateria indica* shows more of established seedlings and seedlings of advance growth than the unestablished ones (Fig. 19). Other than the sapling stage the regeneration of <u>Strombosia ceylanica</u> follows the reverse (Fig. 24). There is profuse regeneration of <u>Mesua nagassarium</u> but it is retarded beyond the stage of advance growth.

(10) The soil in the forest is strongly acidic. Towards the ecotone there is a slight rise in the pH, while in cultivated area it is medium acid in reaction (5.5 to 5.7). As a rule, the evergreen forest ecosystem have lower pH than the agricultural ecosystems of Kerala.

The organic carbon content in all the three areas are low with the one in the forested ecosystem having the highest value. There is a declining trend in the organic carbon content with the change in the vegetational characteristics.

Exchange acidity values are the highest in the soils from forested ecosystem while being the lowest in the cultivated areas. On the other hand exchangeable bases are the lowest (4.7) in the forest ecosystem. As expected, higher values are available in the agricultural system.

Although the vegetation represents an evergreen type the soils do not have the typical qualities of the evergreens of Kerala. The typical soils have higher values of organic carbon and bases in the surface layers. The low values at Iringole may be due to the disturbances around the temple.

SUMMARY

Principal cause of the current devastation of tropical forests lies in the complexity of social and economic development. Crucial factors like commercial demand for timber and other products and subsistance needs for food, both aggrevated to a significant extent by population growth and inequitable pattern of land ownership. Human processes have made it extremely difficult to conserve wild plant and animal genetic resources. But Sacred Groves serve as vehicles for ecological and genetic conservation wherein inherent diversity of flora and fauna are preserved for the present and future human use. They give the last opportunity to conserve large samples of relatively undisturbed biomes and ecosystems. They have a vital role to play in the social, economic, cultural and spiritual progress of humanity.

Iringole is one such area where culture has provided protection to the landscape to safeguard the low lying "Southern Tropical West-coast Evergreen Forest", with typical association of <u>Hopea ponga</u> and <u>Vateria indica</u>.

Floral wealth of the area was assessed through fortnightly visits. Physiognomic and structural aspects of the vegetation were computed from data obtained by 15% enumeration Regeneration survey (two percent) was conducted to ascertain the status of regeneration of various species.

For the first time for the Sacred Groves in India in general and for Iringole in particular the following results were obtained to serve as a bench mark.

In a ten hectare area 180 species of angiosperms belonging to fifty different families were recorded. As in most of the tropical low lying wet evergreen forests of Asia Dipterocarpaceae was found to be the most dominant family with a representation of five species.

Ten percent of the flora of Iringole was found to be endemic to the west coast and low lying areas of the Western Ghats of Peninsular India.

This area can be considered as a gold mine as far as the medicinal plants are concerned. Sixty six out of one hundred and eighty species are of medicinal value. Wild relatatives of cultivars are fairly represented.

Analysis of vegetation through profiles and girth-class shows that important species like Polyalthia fragrans, Holigarna arnottiana and Myristica malabarica constitute the middle story and are more or less evenly distributed throughout the area. There is heavy preponderance of Hopea ponga belonging to various girth classes, scattered throughout Iringole. Hopea parviflora is represented heavily in the first stratum and most of the trees are either over mature or senile. This species is not able to progress much beyond the stage of advance growth. Saplings are feebly represented. The young ones of Hopea parviflora appears too sensitive to thrive under the dense crown of H. ponga.

There appears to be no constraints for the regeneration of Artocarpus hirsutus, Polyalthia fragrans and Hopea ponga. Potential species for the future are Artocarpus hirsutus, Mesua magassarium and Strombosia ceylanica. Absence of mother trees of Artocarpus and Strombosia are puzzling.

As far as the basal area is considered difference between Hopea ponga and H. parviflora is negligible, since reduction in number is made up by H. parviflora by increased number in higher girth classes.

Although the life form of the tropics is Phanerophytic in nature because of the complexities in the structure of the evergreen forest at Iringole, it is seen to be of "Phanerophytic - Liana complex".

The area is luxurient in species richness. In one and a half hectare area 2310 individuals of over 10 cm. gbh could be recorded. Simpson's Index is just 0.74. and diversity-wise it is poor.

The soils of Iringole are poor in organic carbon, high in exchange acidity and low in exchangeable base. These soils do not conform to the typical evergreen soils of Kerala.

Despite the poor soil conditions this forest is able to thrive and flourish because of the protection it has been receiving from the local population. At a time when shrinkage of forests is a global phenomenon, here, in Iringole, it is found to be expanding (Plate XX). As per the village survey records before 1920, it was 20 Acres and 81 cents (8.3241 ha.) in Survey Number 87/1 of Perumbavoor Taluk. But as per the resurvey done

Plate 20. Forest showing expansion.

in 1973, it was 9.0634 ha. (Sy. No. 122/1 and 122/2 of Perumbavoor Taluk). The survey done for this study (1987) shows that it has an extent of 9.8402 ha. Hence given protection, the forest will expand.

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ECOLOGICAL STUDIES OF A SACRED GROVE

(IRINGOLE, NEAR PERUMBAVOOR)

By

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ABSTRACT OF A THESIS

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ABSTRACT

Sacred Groves serve as unique examples of *in situ* genetic resource conservation through involvement of local people in the most economic and efficient manner. Ecological studies in Sacred Groves are practically nil and the present investigation, in such a fascinating field has brought out many interesting data for the first time.

The forests of Iringole Sacred Grove, lying at $10^{o}10'$N Latitude and $76^{o}30'$ E longitude, whithin Perumbavoor Municipality can be considered as Southern Tropical West coast Evergreen Forest (Low lying). The area is hot and humid with an annual precipitation exceeding 3000 mm. The dry season lasts from january to March.

The vegetation belongs to the typical *Hopea ponga* and *Vateria indica* association commonly encountered in southern half of the west coast of India.

Fifteen percent sample enumeration was conducted to study the physiognomy of the forests and to derive the nature of

association within it. Two percent regeneration survey was conducted to ascertain the status of regeneration of various species.

180 species of flowering plants belonging to 50 families are encountered at Iringole. The dominant arborescent family is Dipterocarpaceae. Ten percent of the flora shows endemism to West coast and low lying areas of the Western Ghats and nearly one third of the species are of medicinal importance.

There is a heavy concenttraton of Holigarna arnottiana, Myristica malabarica and Polyalthia frograns in the middle stratum. Hopea ponga and Vateria indica belonging to various girth classes are uniformly distributed in all the strata. Hopea parviflora is represented by overmature and senile trees. Potential species for the future generation are Artocarpus hirsutus, Mesua nagassarium and Strombosia ceylanica.

There appears to be no constraints for the regeneration of Artocarpus hiresutus, Polyalthia fragrans and Hopea ponga. Hopea parviflora rarely attains the sapling stage.

The life form at Iringole belongs to Raunkiaer's

The area is luxurient in species richness (2310 individuals above 10 cm. gbh in one and a half hectare) but poor in species diveristy.

The soils are poor in organic carbon, high in exchange acidity and low in exchangeable bases, but the forest is able to sustain, expand and progress towards the climax because of adequate protection offered by local people.

Thus our traditional society deserves special respect for the wise stewardship of such areas which we now seek to protect.