

**FOOD AND FEEDING HABITS OF ASIAN ELEPHANTS
(*Elephas maximus* Linn.) - A CASE STUDY OF
IDUKKI WILDLIFE SANCTUARY**

By
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THESIS

Submitted in partial fulfilment of the
requirement for the degree of

Master of Science in Forestry

Faculty of Agriculture
KERALA AGRICULTURAL UNIVERSITY

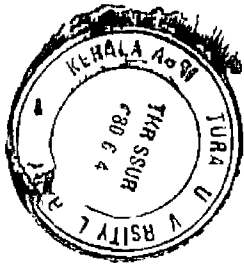
Department of Wildlife Science
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VELLANIKKARA, THRISSUR

1994

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VTR/EO



***Dedicated to elephants
the mammoth with a gentle heart***

DECLARATION

I hereby declare that the thesis entitled **Food and Feeding Habits of Asian Elephants (*Elephas maximus* Linn.) - A Case Study of Idukki Wildlife Sanctuary**" is a bonafide record of research work done by me during the course of research and that the 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

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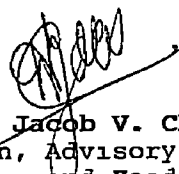


CERTIFICATE

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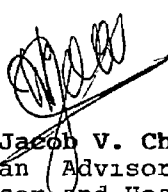
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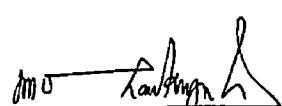


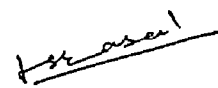
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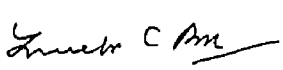
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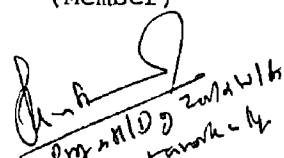
We the undersigned members of the Advisory Committee of Sri Vinod, T R. a candidate for the degree of Master of Science in Forestry agree that the thesis entitled Food and Feeding Habits of Asian Elephants (*Elephas maximus* Linn.) - A Case Study of Idukki Wildlife Sanctuary" may be submitted by Sri Vinod T R in partial fulfilment of the requirement for the degree


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ACKNOWLEDGEMENTS

This study was successfully carried out and completed with the help and co-operation of a number of persons and organizations. I take this opportunity to place on record my deep sense of gratitude and indebtedness to each and every one of them.

Dr Jacob V Cheeran Professor and Head (1/c) Department of Wildlife Science, College of Forestry, my major advisor had been helpful and encouraging throughout the research programme. His valuable guidance, indispensable inspiration and propitious support made my study a success.

Dr U Mohamed Kunju Director PG studies, Kerala Agricultural University and former Special Officer (1/c) College of Forestry encouraged me a lot.

Dr P S Easa Scientist 1/c, Wildlife Division, Kerala Forest Research Institute, made several critical and useful suggestions and extended valuable help in the field.

Dr Luckins C Babu, Associate Professor and Head (1/c) Department of Tree Physiology and Breeding, College of Forestry was always there with constant encouragement and support.

Chief Conservator of Forests (Wildlife) Government of Kerala, permitted me to carry out the research work in Idukki Wildlife Sanctuary. The Kerala Agricultural University funded the study. Dr C C Abraham and Mr H Nagesh Prabhu IFS former Special Officers College of Forestry were helpful in several respects. Dr Chand Basha IFS, Director Kerala Forest Research Institute permitted me to use the facilities of the Institute.

The Wildlife Warden Idukki provided moral and physical support during the field work. Mr Gopalakrishnan Assistant Wildlife Warden made my field visits and stay at Idukki comfortable. The field staff of Idukki Wildlife Sanctuary assisted in trekking different parts of the Sanctuary. The assistance of the local tribal trackers and fire watchers of Idukki Wildlife Sanctuary were of considerable help in the completion of the field work.

Dr S Chinnamani Special Officer, College of Forestry identified the grasses. Dr N Sasidharan Kerala Forest Research Institute identified the trees and shrubs. Dr S Sankar KFRI extended moral support. Dr U M Chandrasekhara, KFRI, also made some valuable suggestions. Dr K Sudhakara College of Forestry helped in the seed studies.

Mr Santhosh Kumar A V Mr Kannan C S and Miss Reena P C helped me in statistical and computer analysis Mr Pradeep Kumar of KFRI drew the figures Mr Raveendran K K Research Assistant KFRI assisted me in field visits My friends Mr Jayamadhavan A Mr Gopakumar S Mr Kunhamu T K Mr Nameer, P O Mr Ashok B Divatar in Jamaludheen V Mr Animon M M Mr Nagaraj N Miss Tanie Thomas were helpful in several respects Mr Ravindran O K Peagles Mannuthy neatly typed the manuscript

My parents and brothers accepted the numerous financial liabilities I imposed upon them and encouraged me a lot during the study



VINOD, T R

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Introduction

CHAPTER - I
INTRODUCTION

The Asian elephant (Elephas maximus L) and the African elephant (Loxodonta africana) are the only two living representatives of the Proboscidea. The pressure of the rapidly expanding human population and the conversion of forest lands for agriculture, settlements and developmental activities have already reduced the Asian elephants range to a small fraction of their past area (Fig 1). Habitat destruction is continuing to fragment and isolate elephant populations throughout its present geographic range. The consequences of habitat fragmentation and destruction have affected the wildlife in general and the elephant in particular due to its large home range. Urgent conservation and management measures must be carried out in order to save the species from extinction.

1.1 Distribution of Asian elephant

The surviving population of Asian elephant in the wild is estimated to be about 34 000 (Santiapillai 1987) which lives in 13 countries in the Indian sub-continent and South-east Asia namely India, Nepal, Bhutan, Bangladesh, China

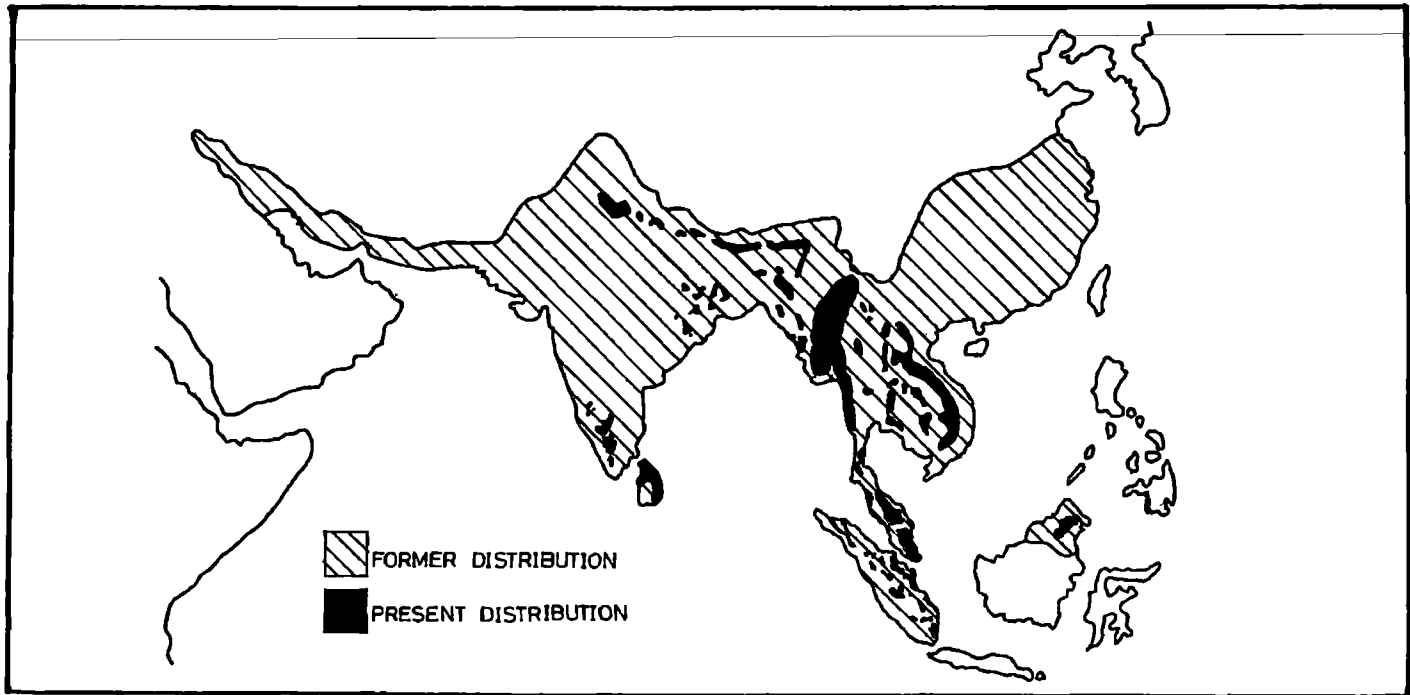


FIG1 FORMER AND PRESENT DISTRIBUTION OF THE ASIAN ELEPHANT

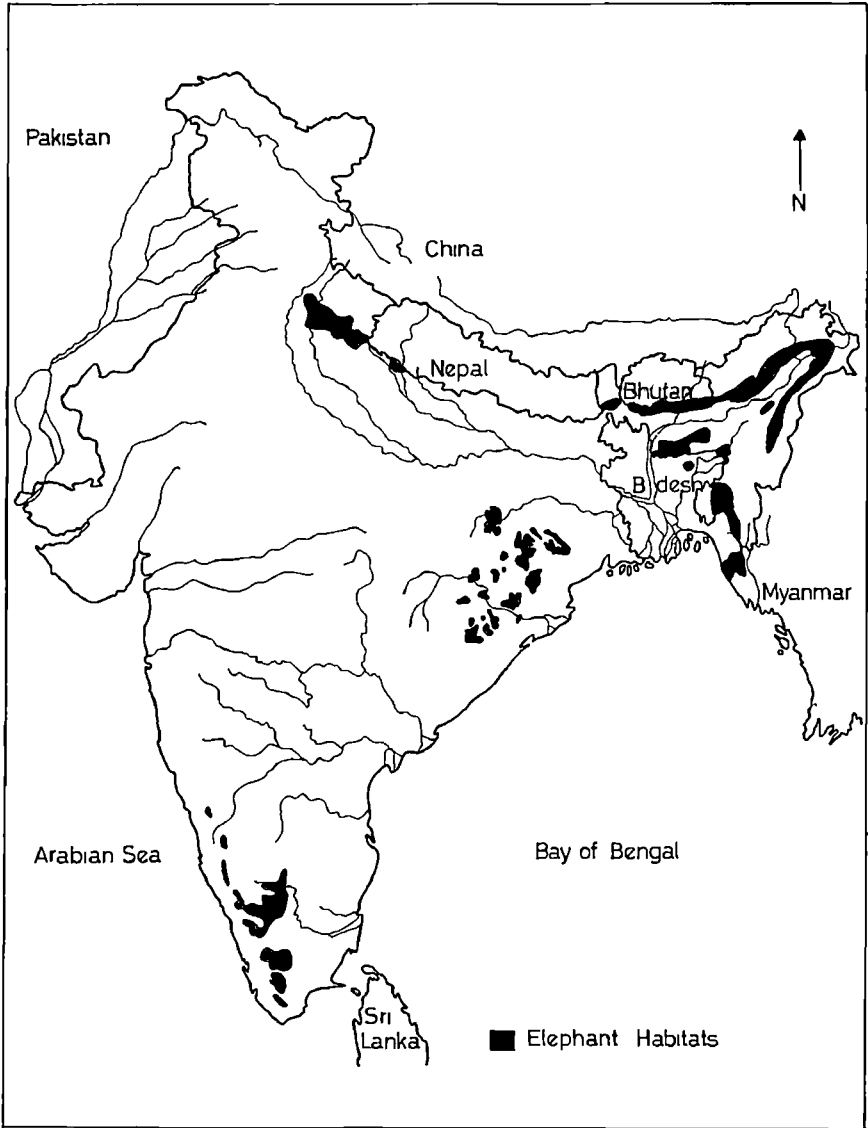
SOURCE SANTIAPILLAI & JACKSON (1990)

Burma Thailand Kampuchea, Laos Vietnam Malaysia Sri Lanka and Indonesia

India has the largest remaining population of the Asian elephant. The estimated wild population in India is between 17 000 and 22,000 which is confined to forested hilly tracts of North North east Central and South India (Sukumar, 1986). Distribution of elephants in India is given in Fig 2. In South India, the elephant is distributed over the Western Ghats and adjacent Eastern Ghats in the states of Kerala, Karnataka and Tamil Nadu (Fig 2b). As per the population figures estimated by Kerala Forest Department in 1993 about 4200 elephants were recorded from different forest divisions in Kerala. Elephants in Kerala exist as seven populations (Fig 3) six of which are in ecological continuity with adjacent elephant habitats of either Tamil Nadu or Karnataka (Easa 1989).

1.2 The Idukki population

The Idukki population is the most disturbed elephant population in Kerala. The area, once contiguous with the Periyar and Malayattur forests is presently isolated due to the construction of three dams namely Idukki Arch dam Cheruthoni dam and Kulamavu dam as a part of Idukki hydroelectric project and large scale encroachments. This



SOURCE SANTIAPILLAI & JACKSON (990)

Fig 2 Distribution of elephants in India

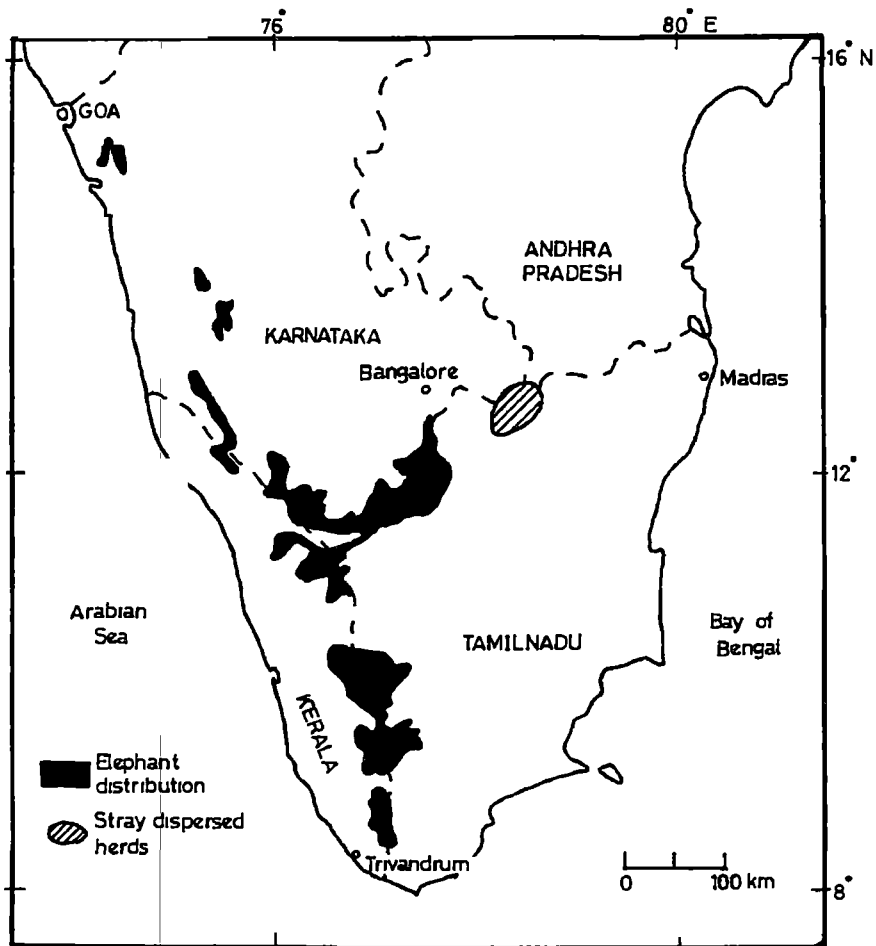


Fig 2 b MAP OF ELEPHANT DISTRIBUTION IN SOUTHERN INDIA

source: Sukumar 1989

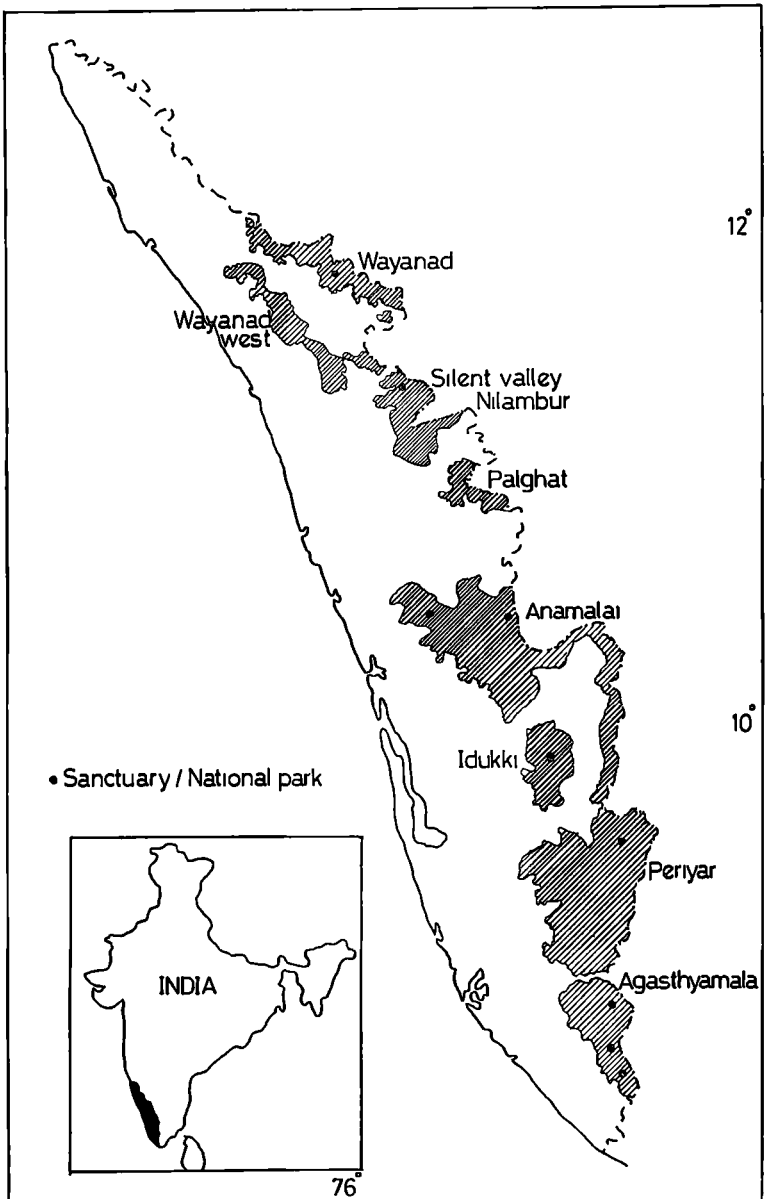


Fig 3 Distribution of elephants in Kerala

SOURCE EASA (1989)

resulted in the destruction of the habitat of elephant to a large extent. Plantations, human settlements and roads and other development programmes restricted the movement of elephants to a smaller area. Studies on the impact of the river valley projects on wildlife of Idukki Wildlife Sanctuary were made by Nair and Balasubramanyan (1985) and they reported a population of about 75 elephants in the area.

1.3 Ecological studies on Asian elephants

Detailed ecological studies on Asian elephants were comparatively less and were carried out mainly in Sri Lanka, Malaysia and India. Studies on ecology of Asian elephant in Sri Lanka were carried out by McKay (1973), Kurt (1974), Vancuylenberg (1977), Olivier (1978a), Eisenberg (1980), Ishwaran (1984) and Santiapillai et al (1984). In India, most of the studies were conducted in South India. Krishnan (1972), Vijayan et al (1979), Nair et al (1980), Nair et al (1985), Sukumar (1985, 1989), Sivaganesan and Desai (1985), Daniel et al (1988), Sivaganesan (1989) and Easa (1989) reported certain aspects of ecology and behaviour of elephants in India. Khan (1967), Olivier (1978a), Seidensticker (1984) and Khan (1987) studied the ecological and ethological aspects of Asian elephants in Malaysia. Santiapillai and Suprahman (1986) reported ecological studies on Asian elephant in Sumatra.

1.4 Scope of the study

The Wildlife Sanctuaries and National parks provide protection to the animal. Some of these areas are degraded and requires scientific management for improvement (Eg Idukki Wildlife Sanctuary). Habitat improvement programmes necessitate information on food and feeding habits of animals in its natural condition. Another basic information required is the distribution and abundance of the population. Population studies will provide information on the trend of the population i.e. increase or decrease. This will in turn help to evaluate the existing management plan.

1.5 Objectives of the study

Since the studies on ecology of Asian elephants in their natural habitats are meagre the present investigation was carried out in Idukki Wildlife Sanctuary Kerala with the following specific objectives

- 1 To identify the food plants of elephants
- 2 To study the feeding habits of the animal in its natural condition
- 3 To find out how elephants act as a seed dispersal agent
- 4 To estimate the elephant population in the study area

Review of Literature

CHAPTER II
REVIEW OF LITERATURE

2 1 Literature on African elephant

African elephants have been the subject of detailed investigation for a long time. All the aspects of African elephants were well studied.

2 1.1 Food and feeding habits

Elephant is known to be a generalist feeder. Sikes (1971) considered it as a forest dwelling browser incorporating grass into its diet in grassland habitats. Buss (1961) regarded elephant as primarily a grazer. The studies on feeding habits of African elephants have shown that selection of food depends on the vegetation of the area and they alter their feeding habits in relation to season (Field and Ross 1976). Barnes (1982) reported the feeding behaviour of elephants in Ruaha National Park, Tanzania.

Kalemera (1989) described the feeding preferences of elephants in the Acacia tortilis woodland of Lake Manyara National Park, Tanzania. Habitat selection and preferred food plants of a desert-dwelling elephant population in the northern Namibia Desert were reported by Viljoen (1989).

Kabigumila (1993a) reported the feeding habits of elephants in Ngorongoro crater, Tanzania. Feeding behaviour and diet of the forest elephant in the Santchou Reserve, Cameroon were studied by Tchamba and Prosper (1993). The diet of forest elephants in Gabon was studied by White et al (1993). Kabigumila (1993b) reported the duration of feeding while describing the diurnal activity of elephants in Tanzania. Effects of elephant browsing on the vegetation in Kalamalou National Park in Cameroon were studied by Tchamba and Mohamat (1992).

The number of plant species consumed by the elephant vary from place to place. Douglas-Hamilton (1972) identified 134 plant species fed by elephant in Lake Manyara. In Kidepo valley, 59 food plants were recorded (Field and Ross, 1976). Guy (1976a) identified 133 food plants in Sengwa, while in Bia National Park, 138 plant species were identified as food species of elephants (Short 1981).

Barnes (1980), Eltringham (1980), Jachmann and Bell (1985), Weyerhaeuser (1985), Okula and Sise (1986) and Swanepod and Swanepod (1986) reported the effects of elephant browsing on trees. Mwalyosi (1987) showed the contribution of elephants to Acacia tortilis mortality and the resultant opening up of the acacia woodland in Lake Manyara National Park, Tanzania.

Field and Ross (1976) reported that regeneration of certain tree species was suppressed by elephants and fire. The impact of elephant, giraffe and fire upon the Acacia tortilis woodlands of Sarengeti were studied by Pellew (1983). Bell and Jachmann (1984) suggested burning to manipulate elephant distributions and impact on woodland. Elephant-fire relationship in Combretum/Terminalia woodland in south-west Niger was shown by McShane (1987).

Seasonal differences in the proportion of time spent in grazing, browsing and debarking have been reported in African elephants by Buss (1961), Laws et al (1975), Guy (1976b), Eltringham (1980) and Barnes (1982). Barnes (1980) showed that there was a significant difference between bulls and cows in the time spent on feeding on individual trees and he attributed this to the difference in the social groups formed by bulls and cows.

Different methods have been previously used to identify the feeding habits of elephant. For African elephant the stomach contents have been weighed to estimate total intake and separated into broad categories such as browse, leaves, grass, bark, fruits etc to determine proportional contribution (Wing and Buss 1970). Laws et al (1975). Direct observational methods based on the proportion

of time spent in feeding on different species have been used by Field (1971) Field and Ross (1976) Guy (1976a) and Barnes (1982) An assessment of long term food habits of Tsavo elephants based on stable carbon and nitrogen isotope ratios of bone collagen was done by Tieszen et al (1989)

Laws et al (1975) estimated on the basis of the stomach contents that wild elephants consume 1.5 per cent (dry weight fodder) of their body weight every day The total time spent in feeding may be between 12 and 19 hours per day (Guy 1975) An elephant may drink over 100 litres of water at one time and upto 225 litres in a day (Sikes 1971)

2.1.2 Seed dispersal studies

Many tropical animals depend partly or entirely on fruit for food at least part of the year and many tropical trees and shrubs bear fruits adapted for animal consumption (Howe, 1984) All studies of tropical seed dispersal by animals report seasonality Howe (1977) explained that food may be far more limiting in some seasons than in other, and consequently trees bearing fruits during lean times will play a greater role in maintaining entire communities of fruit eating animals than those bearing fruit during peak production of the entire forest Cox et al (1993) reported the biological and physical factors influencing Acacia constricta

and Prosopis velutina establishment in Sonoran desert Elephant feed upon fruit and disperse seeds (Buss, 1961 Laws et al , 1975 Short, 1981) Lieberman et al (1987) reported the quantities of seeds characteristics of fruits and seeds of the species encountered and the results of germination trials comprising fresh seeds (from ripe fruits) and ingested seeds (from dung) from Bia National Park Ghana Germination rates of fresh seeds, separated from the pulp and ingested seeds were assessed at Bia National Park Ghana by Lieberman et al (1979) and Lieberman and Lieberman (1986)

Fruiting pattern seed germination and distribution of Sclerocarpa caffra in an elephant inhabited woodland of Zambia were reported by Lewis (1987)

2.1 3 Population studies

2 1 3 1 Direct methods

Aerial counts have been widely used in censusing African elephant, Loxodonta africana (Laws et al 1975 Eltringham 1980) This method has been exclusively used in open habitats in Africa and has less application and reliability in forested habitats Prinzivalli (1992) explained the use of infrared detectors to count elephants in a forest environment Registration counts were successfully

used in African elephants (Douglas-Hamilton and Douglas-Hamilton 1975)

Although line transect methods of censusing have been in vogue for several decades (Skellam 1958 Eberhardt, 1968), they have been more recently given a firm theoretical and practical background by Burnham et al (1980) A sample size of 40 population units (elephant groups) is stipulated by Burnham et al (1980) as being the minimum required to satisfy statistical procedures

2 1 3 2 Indirect methods

Jachmann and Bell (1979 1984) estimated the elephant numbers and occupance by means of dropping count in the Kasungu National Park, Malawi The decline in elephant numbers of Rwenzori and Kabalega Falls National Parks Uganda was reported by Eltringham and Malpas (1980) Edroma (1981) estimated the number and distribution of elephants in Kidepo Valley National Park Uganda Ottichilo (1986) reported the number and distribution patterns of elephants in the Tsavo ecosystem, Kenya

Merz (1986) estimated the elephant numbers in Tai National Park Ivory Coast Jachman (1986) described the population dynamics of Kasungu elephants Elephant population trends in Kenya were given by Ottichilo et al (1987) while

the status and trends of elephants in the Serengeti Mara ecosystem were given by Douglas-Hamilton (1987) Dropping counts were used to assess elephant abundance in the remote forests of north-eastern Gabon (Barnes et al , 1991)

2 2 Literature on Asian elephants

Detailed studies on Asian elephants were comparatively less and were conducted mainly in Sri Lanka Malaya and India

2 2.1 Food and feeding habits

Fisenberg and Lockhart (1972) McKay (1973) Vancuylenberg (1977) and Ishwaran (1979) have reported the food and feeding habits of Asian elephants in Sri Lanka Olivier (1978a) made a comparative study on feeding pattern of elephants in the primary and secondary forests of Malaya and Sri Lanka respectively

Krishnan (1972) and Sukumar (1985) have reported certain aspects of food and feeding behaviour of elephants in India A feeding pattern established for one area cannot be the same for another area Sivaganesan and Desai (1985) indicated that grass forms the bulk of the diet of elephants Studies on feeding behaviour of Asian elephants by McKay (1973) Sukumar (1984 1985 1989) Sivaganesan and Bhushan (1986) Sukumar et al (1987) and Easa (1989) have shown that

proportion of various plant categories in the diet varies widely with season

Sukumar (1990) and Easa (1989) have reported certain aspects of food and feeding behaviour of Asian elephants in South India. Sukumar and Gadgil (1988) reported the differences in foraging of crops by male and female Asian elephants.

Sukumar (1985), Santiapillai and Suprahman (1986) and Easa (1989) reported the seasonal differences in the proportion of grazing and browsing in Asian elephants. Olivier (1978a) suggested that the body size and dental arrangement of elephants were specialised for grazing. Eisenberg and Lockhart (1972), Ishwaran (1984), Santiapillai and Suprahman (1986) and Easa (1989) reported bark feeding behaviour of Asian elephants.

The number of plant species eaten by elephant varies from place to place. McKay (1973) recorded 89 plant species consumed by elephants in Gal Oya in Sri Lanka. Olivier (1978a) identified 390 species of plants consumed by elephants in Malaya. Sukumar (1985) has recorded 112 plant species eaten by elephants at Chamarajanagovi, Kollegal and Satyamangalam Forest Divisions in South India. He identified the most commonly eaten plants which were from five botanical

taxa namely the order Malvales (families Malvaceae Sterculiaceae and Tiliaceae) and families Leguminosae, Palmae Cyperaceae and Gramineae

Santiapillai and Suprahman (1986) identified 83 elephant food plant species in Way Kambas Game Reserve, Sumatra Easa (1989) recorded 93 food plant species of elephant in Parambikulam Wildlife Sanctuary, Kerala He commented that more than 50 per cent of the food plants were of the families Poaceae and Cyperaceae of which bamboos formed a major food item in the area

2.2.2 Population studies

2 2 2 1 Census methods

The IUCN/SSC Asian Elephant Specialist Group (AESG) recognised the need to standardise census methods and in 1984 set up a sub committee to consider and formulate methods suitable for widespread use in varied habitats over the entire range (Daniel et al , 1985) Sukumar et al (1991) have reviewed the methods used in counting Asian elephants and discussed the limitations and applicability of these methods in various habitat types

2 2 2 1 1 Direct methods

Elephant populations in many parts of India have since the late 70s been censused by total counts (Krishnamurthy 1980 Choudhury 1980) Total count method is well applicable in areas having less than 50 sq km and having only a small elephant population (Santiapillai 1992) Registration counts were successfully used in Asian elephants by Eisenberg and Lockhart (1972) Good visibility is an essential prerequisite for individual recognition (Olivier 1978b) Sukumar (1985) estimated the number of individuals of Biligerirangan elephant population while Desai (1987) estimated the Mudumalai elephant population by this method Sukumar (1985) stated that this method was a biased indication of the sex ratios

Water-hole count has been used to get an estimate of about 60 elephants in Dalma Sanctuary in Bihar (Sukumar et al 1991) Density estimates through sample counts can be made through sampling definite plots quadrats or belt transects or through plotless methods such as line transects (Sukumar et al 1991) Sukumar (1985 1989) estimated elephant densities by an area time model

2 2 2 1 2 Indirect methods

The concept of sampling elephant dung to estimate actual densities is relatively new and was used to estimate the elephant densities in Myanmar and Thailand by Blower (1985) and Dobias (1985). The method described by Barnes and Jensen (1987) was adapted and tested in a variety of habitats in India. In two of these sites the population estimate was known through long term research projects and the results obtained by this method were comparable (Sale et al , 1990). Based on these trials modifications were proposed (Dawson 1990) and the method was presented at the International Workshop on censusing elephants in forests held in January 1991 in Southern India (Dekker et al 1991).

Ramachandran et al (1986) have counted dung piles that had accumulated in 22 plots of one-hectare plots over a period of one month in Periyar Tiger Reserve. They used Vamaylenberg's (1977) defecation rate of 15 times a day to estimate the elephant numbers.

Population estimates of Asian elephants in different parts of Indian sub-continent have been reported by a number of investigators (Singh 1978, 1980, Daniel 1980a, 1980b, Shahi, 1980, Choudhary 1980, Choudhary et al 1985, Dobias 1987, Dawson and Blackburn 1991 and Dawson and Dekker 1992).

Estimates based on accurate field surveys are lacking with respect to many of these areas (Daniel, 1980b) Santhiapillai (1987) commented that the elephant populations of South India were better studied in comparison to the other areas of the country

Numerous studies were carried out on the status of elephants in South India (Krishnan 1972 Nair et al 1977 Nair and Gadgil, 1978 Nair et al 1980 Joseph 1980 Sukumar 1985 Easa 1989) Number herd composition and age structure of elephant populations in some of the Wildlife Sanctuaries of Kerala were listed by Vijayan et al (1979) Nair et al (1985) Nair and Balasubramanyan (1985) Balakrishnan and Easa (1986) and Easa (1989)

The Wildlife census conducted by Kerala Forest Department and organised by Kerala Forest Research Institute in 1993 made use of a combination of total count and line transect method (both direct and indirect) to estimate the elephant population in Kerala

Study Area and Methods

CHAPTER - III

STUDY AREA AND METHODS

3.1 Study area

The present study was carried out in Idukki Wildlife Sanctuary Kerala. The area lies between latitudes $9^{\circ}45'$ to $9^{\circ}55'$ N and longitudes $76^{\circ}50'$ and $77^{\circ}05'$ E (Fig 4). The sanctuary covers an area of 77 km^2 , including 33 km^2 of water spread and is in contiguity with adjacent forested areas of Ayyappan Koil and Nagaram Para Forest Ranges (Ramesan undated). The area falls in Nagarampara Reserve forest and forms the catchment area of Idukki Hydel Project. The tract is situated in the Western Ghats in Thodupuzha and Udumpanchola taluks. The headquarters of the Sanctuary is at Painavu.

3.1.1 Climate

The climate in the area can be described as almost cool and humid. The temperature ranges between 13°C to 29°C . The temperature is maximum in March-April and minimum in December (Ramesan undated). The average annual precipitation is 4100 mm. The area gets both the South-west and North-east monsoons (Fig 5). Table 1 shows the normal and average monthly rainfall of Idukki district.

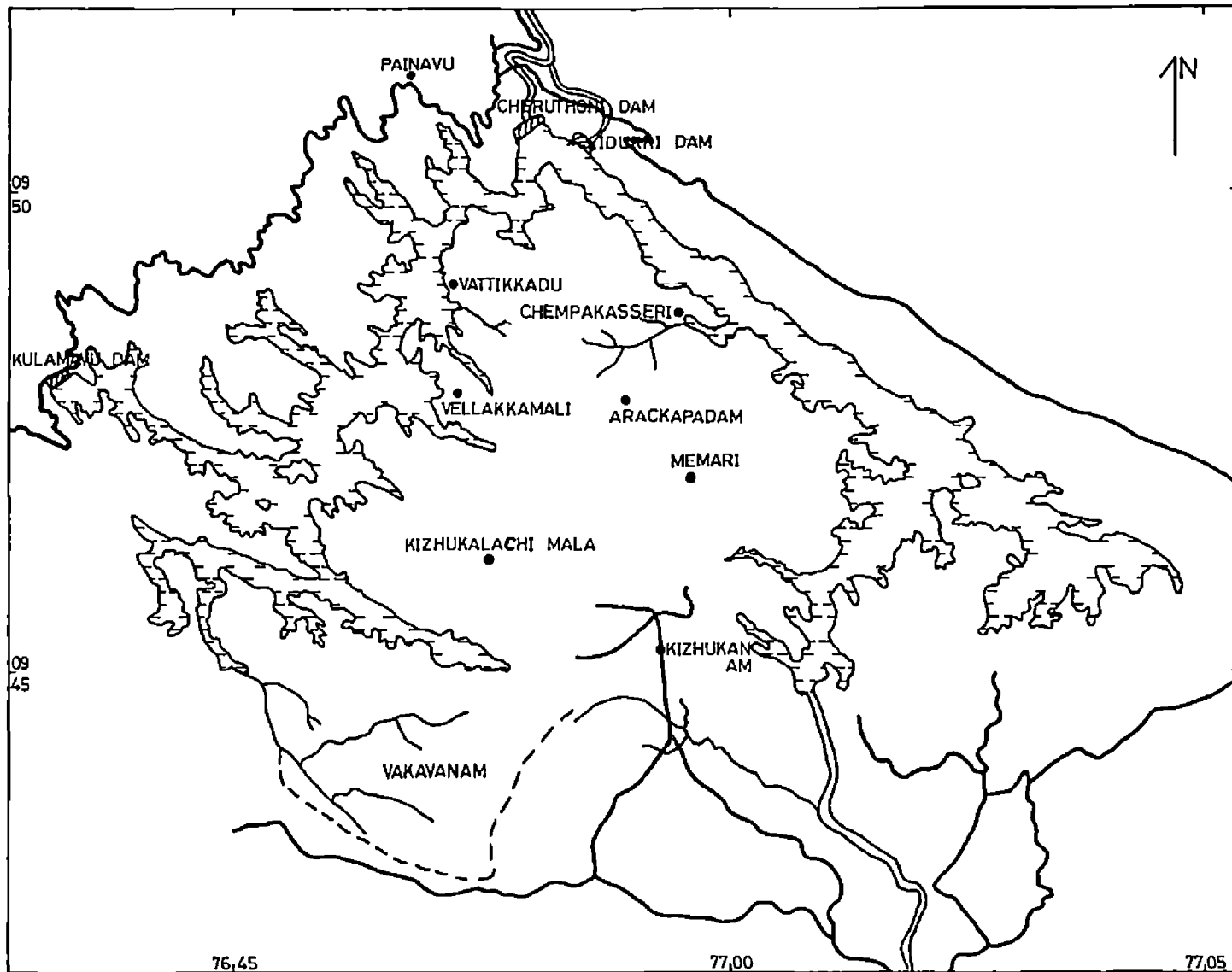


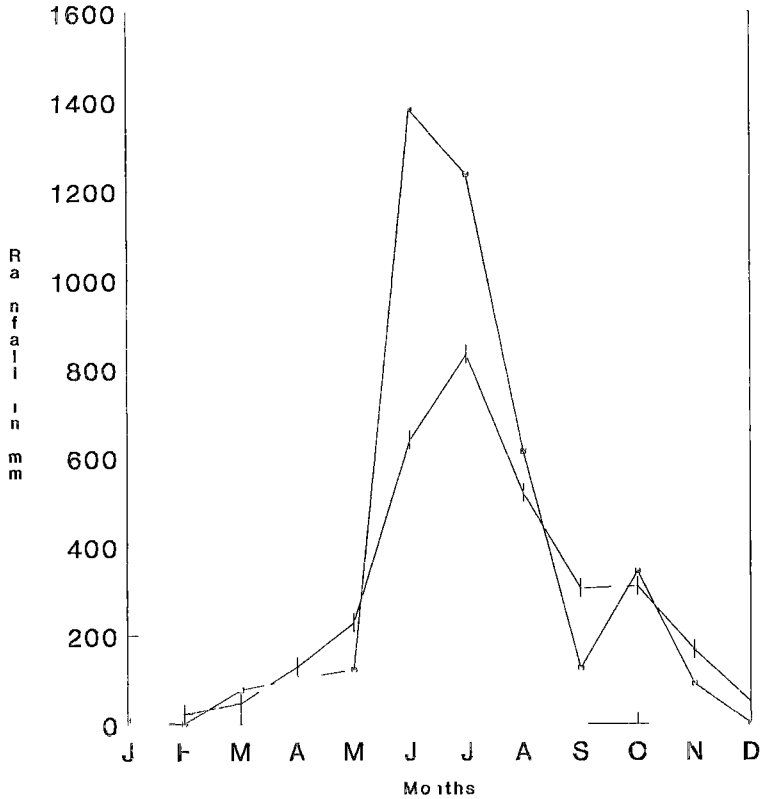
Fig 4 Study area

Table 1 Normal and average monthly rainfall in Idukki district 1991-92 (in mm)

Month	Average	Normal
January	10	19
February	1	23
March	77	47
April	102	129
May	123	228
June	1380	638
July	1235	831
August	613	518
September	126	305
October	344	310
November	91	167
December	2	50
Total	4104	3265

Source Farm Guide 1993 Farm Information Bureau Government of Kerala

Fig 5 Normal and average monthly rainfall of Idukki district



Average | Normal

During 1991-1992

3 1.2 Physiography

Physiographically the area is a hilly terrain with elevation ranging from 800 to 1000 m. The terrain is undulating in many areas, rugged with lofty peaks and precipitous slopes in other areas. The highest peak in the sanctuary is Kizhukalachimala 1272 m (Fig 4)

3 1 3 Water sources

The whole area is drained by Periyar and its tributaries. The Idukki Reservoir, extending to about 33 km², forms the three sides of the sanctuary. In addition to this a number of water holes are also there in the Sanctuary. Three dams namely Idukki Arch dam, Cheruthoni dam and Kulamavu dam which are situated in the sanctuary help to keep the water level intact during summer.

3.1.4 Vegetation

The area consists of evergreen, semi-evergreen moist deciduous and savannah types of forests. Most of the area is under grasslands. Hill tops are mostly covered by grassland and the foothills and stream banks have the moist deciduous forests. The Evergreen forests are confined to nullahs and valleys. The forests are classified on the basis of Champion and Seth (1968) into the following four types

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- 1 West coast tropical evergreen forest
- 2 West coast tropical semi-evergreen forest
- 3 South Indian moist deciduous forest
- 4 South Indian sub-tropical hill savanna

3 1 4 1 West coast tropical evergreen forest

This type of forest occupies a very restricted portion of the Sanctuary. Such forests are seen in Vakavanam and Kizhukalachimala areas. Small patches of evergreen forests also occur at Vattikkadu Vellakkamali, Chempakasserry and other areas. Physiognomically it is featured by its luxuriance of vegetation, diversity of life forms and formation of typical stratification. Epiphytes are numerous and are represented by orchids, ferns, mosses and aroids. The tract is hilly. The area is relatively free from biotic interference. Common species constituting the top canopy and second storey are Artocarpus heterophyllus, Vateria indica, Dipterocarpus indicus, Palaeum ellipticum, Cullenia exarillata, Persea macrantha, Calophyllum apetalum, Canarium strictum, Mesua ferrea, Hopea parviflora, Machilus macrantha, Dysoxylum malabaricum, Elaeocarpus tuberculatus, Holigarna arnottiana, Myristica dactyloides, Aporosa lindleyana, Cinnamomum and Polyalthia fragrans. Undergrowth consists of Strobilanthus, Calamus, Pandanus, Curcuma spp., Clerodendrum infortunatum, Glycosmis pentaphylla etc.

Plate 1a. Evergreen forests with grasslands at the
back drop in Kizhakkalachimala



Lianas like Entade sp and various species of Dioscorea are common

3 1 4 2 West coast tropical semi-evergreen forests

These forest types are seen in the transitional zones of evergreen and deciduous forests and are having a mixture of evergreen and moist deciduous characters

3 1 4 3 South Indian moist deciduous forest

About sixty per cent of the forested area is dominated by this type Extensive areas within the arms of the reservoir and along its margins are covered by this type of forest Grazing, repeated annual fires and other biotic interferences have prevented this forest towards further progress in physiognomy Most of these forests are in a retrogressive stage from a highr type such as evergreen forest and semi evergreen forest and this type of forest is more or less stable They are composed of tall trees with height ranging from 30 to 36 m or more, forming close canopies and as a rule mixed and have semi-deciduous species in the upper canopy with evergreens in the lower storey On account of fire the ground flora species are few with few grass species The top canopy is comprised of various species of Terminalia, Tectona grandis Dalbergia latifolia Lagerstroemia macrocarpa Pterocarpus marsupium Grewia tiliaefolia

Plate 2a. Moist deciduous-grassland ecosystem.
Note the elephant on the back ground

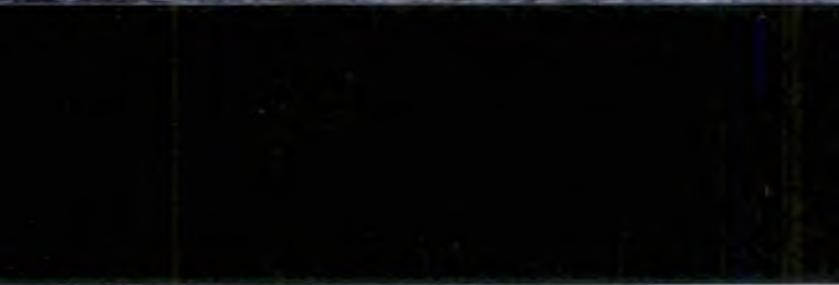
Plate 2b. An e
decidu



Plate 3a. Grasslands

Execution
Bond

Plate 3b. Grassland with fire hardy species



Anogeissus latifolia Vitex altissima Xylia xylocarpa,
Albizia sp etc The middle storey comprises of Careya
arborea, Dillenia pentagyna Embllica officinalis, Haldina
cordifolia Mitragyna parviflora Schleicheria oleosa and
Randia brandisii Undergrowth consists of Lantana camara
Eupatorium odoratum Zizyphus sp etc Bamboos and reeds are
rare Lianas are featured by various species of Acacia Butea
parviflora Spatholobus roxburghii Calycopteria floribunda
and Bauhenia sp

3 1 4 4 South Indian sub-tropical hill savanna

Hill tops are mostly covered with grassland
Repeated annual fires are the main cause for the formation of
the grassland Pyroresistant grasses like Themeda Cymbopogon
etc with some fire hardy species like Careya arborea Butea
monosperma Wondlandia notoniana etc are seen in this type of
forest

3 1.5 Fauna

There is a wide range of animals in the Sanctuary
Herbivores include elephant (Elephas maximus) Sambar (Cervus
unicolor) Barking deer (Muntiacus muntjak) Mouse deer
(Tragulus meminna) Nilgiri Langur (Presbytis johni) and
Bonnet Macaque (Macaca radiata) Gaur (Bos gaurus)

previously reported to be present in the sanctuary is not seen during the study. Carnivores reported to be found in the area are tiger (Panthera tigris), leopard (Panthera pardus), jungle cat (Felis chaus) and wild dog (Cuon alpinus). Wild boar (Sus scrofa) is the common omnivore. Other animals found in the sanctuary are Porcupine (Hystrix indica), Malabar Giant squirrel (Ratufa indica), Toddy cat (Paradoxurus hermaphroditus), Common Mongoose (Herpestes edwardsi) etc. Reptiles include Monitor lizard (Varanus bengalensis), Python (Python molurus), Rat snake (Ptyas mucosus), Cobra (Naja naja), tortoise (Testudo elegans) etc. The Sanctuary has a rich variety of avifauna. The common birds in the area are Great Indian hornbill (Buceros bicornis), Indian oriole (Oriolus oriolus), Jungle fowl (Gallus sonnerati), Forest eagle owl (Bubo nipalensis), Little grey heron (Butorides struitus), Jungle crow (Corvus macrorhynchos), Yel (Eudynamis scolopacea), Black capped kingfisher (Halcyon pileata). A number of indigenous and introduced fishes namely Barbus kandrea, Discogranthia lantia, Barilius bakeri, Barbus sarana, Barbus carnaticus, Cutla catla, Tilapia mossambica etc. are available in the reservoir and rivers.

3 2 Methods

3.2.1 Studies on food plants

The study area was divided into four major habitat categories namely tropical evergreen forests semi-evergreen forests moist deciduous forests and grass lands Direct observations on elephant feeding behaviour were made in selected zones representing each of the four major habitat categories The observation hours were distributed in proportion to the type of habitats available in the study area The plants picked up and consumed by elephants were noted and the feeding sites were visited soon after the animal moved away from the area The specimens of plants consumed were collected and identified Evidences of feeding on tree barks were also noted

3.2 2 Feeding habits

3 2 2 1 Total time spent in feeding and drinking

Direct observations were made on elephants from 06 00 h to 18 00 h on 2 seasons namely dry season (January to April) and wet season (May to December) The time spent in feeding and drinking was recorded Data collected during a period of one year were pooled together and analysed for finding per cent of time spent in feeding and drinking The student s

t-test was carried out to find out the influence of season on the total time spent in feeding and drinking. For convenience walking, resting, wallowing etc are put under other activities.

3.2.2.2 Proportion of time spent in browsing, grazing and debarking

Direct observations on the proportion of time spent in feeding on different species of plants were made in selected zones representing each of the four major habitat categories. The scan sampling method was employed, the plant species being eaten by each visible member in a herd were recorded at 5 minute intervals (Altmann 1974). Each record was scored as browsing or grazing or debarking and the species noted. Data collected during January to April were considered here for dry season and those during other months for wet season. The data collected during a period of one year were pooled together and analysed for finding out the proportion of time spent in browsing, grazing and debarking. Further, the student's t-test was performed to assess the influence of season on the proportion of time spent in the three categories of feeding.

3.2.3 Seed studies

Searches for fresh elephant dung were made from February to May 1994 prior to the start of major wet seasons.

in selected zones of the four habitat categories. Each pile of dung encountered was examined in situ for seeds. Undamaged seeds with proper seed coat were collected and brought to the laboratory for counting, identification and germination trials. Any seeds germinating at the time of collection were noted.

The trees were identified by direct field observations. Raw seeds were also collected and brought to the laboratory for identification and germination trials. Germination trials and tetrazolium test were carried out for both ingested and raw seeds.

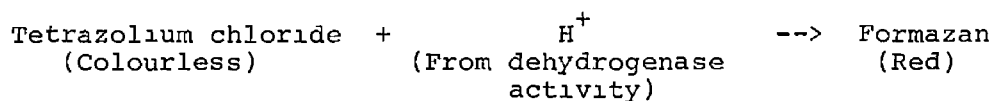
3.2.3.1 Germination rates

Germination rates of fresh seeds collected from plant and ingested seeds were assessed. Small seeds were set to germinate on moist absorbent paper in covered petri dishes. Medium sized and large seeds were sown in plastic trays filled up with sand. Comparable sizes of fresh seeds and ingested seeds (from elephant dung) were prepared as far as possible. Sample sizes in some of the germination trials were very small due to the scarcity of seeds in elephant dung. Petri dishes and plastic trays were moistened as needed and exposed to partial artificial shade, natural day length (around 12 h day light, 12 h darkness) and normal room temperature (20°-30°C).

Germination was recorded at frequent intervals for 28 weeks after planting

3 2 3 2 Tetrazolium test

Seeds (both fresh and ingested) were soaked in water overnight at room temperature to soften them for cutting and to hydrate the tissues. Excess water removed and the seeds were placed on wet paper towel to keep them moist. Proper cuts were made to hasten staining without damaging the embryo. Cut seeds were placed into suitable containers provided with enough 1 per cent Tetrazolium solution (pH 6.5-7.0) prepared from 2,3,5 triphenyl tetrazolium chloride in tap water to cover seeds. The chemical basis for the tetrazolium method is the reaction



Seeds were incubated at 38°C in the dark for 2 to 8 hours. When staining was completed immediately removed the TZ solution and rinsed seeds with water two to three times to remove any unbound formazan. Seeds were cut into half to excise the embryos and expose the remaining endosperm. Seeds were evaluated depending on staining for their germination.

3 2.4 Population studies

3 2 4 1 Number and density

A direct simultaneous count of elephants in the study area was carried out in May 1994 with the help of trained volunteers tribals and staff of Kerala Forest Department. The study area was divided into 6 blocks and all blocks were simultaneously covered in a day on foot. The next day the counting was repeated. The time of sightings size and composition of herds sighted and locations of sightings were noted. The elephants were classified as adult-males adult-females juveniles and calves for easy identification. From this count the total number and density of elephants in the study area could be estimated.

3 2 4 2 Herd size and its seasonal variation

Herds encountered were observed and the number and composition recorded of elephants were computed by considering the total number of herds observed during the one year study period. A solitary elephant was considered as a herd for calculating the herd size frequency. The data on herd size were pooled to find out the seasonal averages for dry (January-May) and wet (June-December) seasons. The variance in herd size in each season was compared by the F-test. The

student s t test was carried out for computing the difference between average herd size for the two seasons

3 2 4 3 Distribution of elephants

Information collected through the indirect dung count method was used to know the distribution of animals. The line transect sampling model described by Burnham et al (1980) was used to estimate dung density. Transects of 2 km length were laid at 5 localities namely Vakavanam (Evergreen and semi evergreen forests), Meenmutti (Moist deciduous forests), Arakkappadam (Grassland), Chempakasserı (Grassland and evergreen forests) and Anjilithandu (Grassland and evergreen forests). These localities were selected so as to represent all the habitat types and are well distributed in the study area (Fig 6)

Each transect was traversed along a straight line during the months of June and October 1993 and January 1994 and every dung pile seen from this line (on either side) at any distance was taken into account and the perpendicular distance from the transect to the centre of the dung pile was measured. The density of droppings was calculated by using the Fourier Series analysis developed by Burnham et al 1980

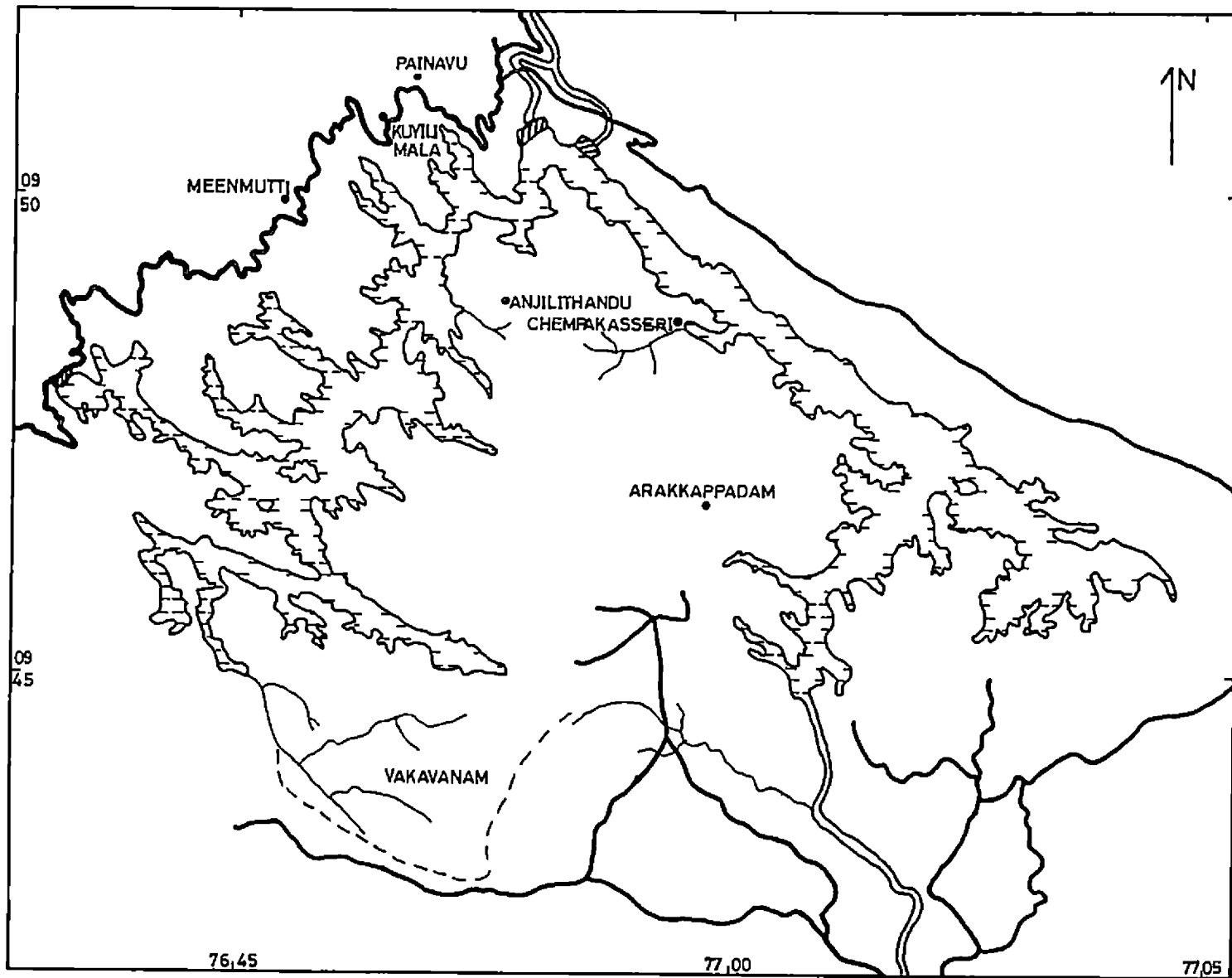


Fig 6 Localities of line transect

Results and Discussion

CHAPTER - IV

RESULTS AND DISCUSSION

4 1 Food plants

Table 2 gives a list of the species of plants consumed by elephants in the study area. They were found to feed on 61 species of plants. About 38 per cent of the food plants were of the family Poaceae.

Leaves, twigs, rhizomes and shoots of bamboos were eaten by elephants. The parts of grasses consumed varied according to season. In areas with short grasses the entire plants were uprooted, sometimes scraping the ground with the forefoot and consumed after removing the soil by dusting against the fore-leg. In the case of tall grasses like Themeda triandra and Cymbopogon flexuosus grass blades were removed without uprooting and placed in the mouth after the usual dusting against the fore-foot. Only very few species of herbs were fed by elephants in the study area.

Elephants in the study area were found feeding on the barks of 24 species of trees (Table 3). Feeding on tree barks was observed throughout the year. Tectona grandis, Careya arborea, Terminalia paniculata, Macaranga indica, Grewia tilifolia, Dillenia pentagyna and Garuga pinnata were the common species debarked for feeding by elephants.

Table 2 List of plants fed by elephants in Idukki Wildlife Sanctuary

Sl No	Family	Species
1	Poaceae	<u>Andropogon lividus</u>
2		<u>Arundinella mesophylla</u>
3		<u>Arundinella leptochloa</u>
4		<u>Bambusa arundinacea</u>
5		<u>Chrysopogon zeylanicus</u>
6		<u>Coix lacryma-bobi</u>
7		<u>Coelachne meeboldii</u>
8		<u>Cymbopogon caesius</u>
9		<u>Cymbopogon flexuosus</u>
10		<u>Dendrocalamus strictus</u>
11		<u>Digitaria marginata</u>
12		<u>Imperata cylindrica</u>
13		<u>Ischaemum rugosum</u>
14		<u>Leersia hexandra</u>
15		<u>Ochlandra travancorica</u>
16		<u>Oxytenanthera bourdillonii</u>
17		<u>Panicum sp</u>
18		<u>Pennisetum purpureum</u>
19		<u>Seturus mucronatus</u>

Contd

Table 2 (Contd)

Sl No	Family	Species
20		<u>Sorghum halepense</u>
21		<u>Themeda triandra</u>
22		<u>Themeda cymbaria</u>
23		<u>Urochloa reptans</u>
24	Cyperaceae	<u>Cyperus aristatus</u>
25	Anacardiaceae	<u>Buchanania axillaris</u>
26		<u>Lannea coromandelica</u>
27		<u>Mangifera indica</u>
28		<u>Spondias pinnata</u>
29	Bombacaceae	<u>Bombax ceiba</u>
30	Burseraceae	<u>Garuga pinnata</u>
31	Caesalpinaceae	<u>Bauhinia recemosa</u>
32	Combretaceae	<u>Terminalia arjuna</u>
33		<u>T bellarica</u>
34		<u>T paniculata</u>
35		<u>T tomentosa</u>
36	Dilleniaceae	<u>Dillenia pentagyna</u>
37	Euphorbiaceae	<u>Bridelia crenulata</u>
38		<u>Macaranga indica</u>
39		<u>Fleocarpus tectorius</u>
40	Fabaceae	<u>Dalbergia latifolia</u>

Contd

Table 2 (Contd)

Sl No	Family	Species
41		<u>Dalbergia</u> <u>sissoides</u>
42		<u>Pongamia</u> <u>pinnata</u>
43	Lecythidaceae	<u>Careya</u> <u>arborea</u>
44	Lythraceae	<u>Lagerstroemia</u> <u>microcarpa</u>
45	Marantaceae	<u>Schumannianthus</u> <u>virgatus</u>
46	Mimosaceae	<u>Albizia</u> <u>lebbeck</u>
47		<u>Xylia</u> <u>xylocarpa</u>
48		<u>A</u> <u>procera</u>
49	Moraceae	<u>Artocarpus</u> <u>heterophyllus</u>
50		<u>A</u> <u>hirsutus</u>
51		<u>Ficus</u> <u>bengalensis</u>
52		<u>F</u> <u>racemosa</u>
53	Myrtaceae	<u>Syzygium</u> <u>cumini</u>
54	Papilionaceae	<u>Desmodium</u> <u>sp</u>
55	Rubiaceae	<u>Haldina</u> <u>cordifolia</u>
56		<u>Mytragyna</u> <u>parviflora</u>
57	Sapotaceae	<u>Chrysophyllum</u> <u>roxburghii</u>
58	Sterculiaceae	<u>Helecteres</u> <u>isora</u>
59	Tiliaceae	<u>Grewia</u> <u>tilifolia</u>
60	Verbenaceae	<u>Tectona</u> <u>grandis</u>
61	Zingiberaceae	<u>Curcuma</u> <u>sp</u>

Fruits of Careya arborea and Dillenia pentagyna were commonly consumed by the elephants in the study area

Elephants require a large quantity of food. This leads to the minimum selectivity of food species in natural habitat for their consumption. Advantages of polyphagy among wild animals have been elaborated by Crawley (1983). Polyphagous herbivores are not affected by the fluctuation in the abundance of any one or a few plant species. Further, the broad diet assumes a year-round availability of nutrients to them (Westoby 1974). Elephants were found to be well adapted to exploit all types of vegetation by their prehensile trunk.

The number of plant species recorded in the diet of elephants in different areas clearly indicates the polyphagous nature of both African and Asian elephants (Table 4). It ranges from 59 species in Kidepo valley to 390 species in Malaya. Thus elephants in Idukki Wildlife Sanctuary also show the polyphagous nature.

The factor that influences the selection of a plant is the palatability. Selection of tall grasses by elephants is related to their phenophase and palatability. During the wet season, the new flush of grass is preferred by elephants. Fresh grass may be palatable for its higher soluble

Table 3 The plant parts eaten by elephant

Sl No	Plant species	Parts eaten by elephant
1	<u>Albizia lebeck</u>	Leaves & branches
2	<u>A procera</u>	leaves & branches
3	<u>Andropogon lividus</u>	all parts
4	<u>Artocarpus heterophyllus</u>	leaves & fruits
5	<u>A hirsutus</u>	leaves
6	<u>Arundinella mesophylla</u>	all parts
7	<u>A leptochlox</u>	all parts
8	<u>Bambusa arundinacea</u>	Leaves, twigs rhizomes & shoots
9	<u>Bauhinia racemosa</u>	Bark leaves & branches
10	<u>Bombax ceiba</u>	Bark
11	<u>Bridelia crenulata</u>	Bark
12	<u>Buchanania axillaris</u>	Bark
13	<u>Careya arborea</u>	Bark leaves & fruits
14	<u>Chrysophyllum roxburghii</u>	Fruits
15	<u>Chrysopogon zeylanicus</u>	all parts
16	<u>Coelachne meeboldii</u>	all parts
17	<u>Coix lacryma-jobi</u>	all parts
18	<u>Cymopogon caesius</u>	all parts
19	<u>C flexuosus</u>	all parts

Contd

Table 3 (Contd)

Sl No	Plant species	Parts eaten by elephant
20	<u>Cyperus aristatus</u>	all parts
21	<u>Curcuma sp</u>	Leaves
22	<u>Dalbergia latifolia</u>	Bark and leaves
23	<u>D_ sissoides</u>	Bark & leaves
24	<u>Dendrocalamus strictus</u>	Leaves twigs rhizomes & shoots
25	<u>Desmodium sp</u>	Basal portions
26	<u>Digitaria marginata</u>	all parts
27	<u>Dillenia pentagyna</u>	Bark & fruits
28	<u>Eleocarpus tectorius</u>	Fruit
29	<u>Ficus bengalensis</u>	leaves & branches
30	<u>F racemosa</u>	leaves & branches
31	<u>Garuga pinnata</u>	Bark and leaves
32	<u>Grewia tilifolia</u>	Bark leaves & branches
33	<u>Haldina cordifolia</u>	Bark
34	<u>Helecteres isora</u>	Bark and leaves
35	<u>Imperata cylindrica</u>	all parts
36	<u>Ischaemum rugosum</u>	all parts
37	<u>Lagerstroemia microcarpa</u>	Bark
38	<u>Lanea coromandelica</u>	Bark
39	<u>Leersia hexandra</u>	all parts

Contd

Table 3 (Contd)

Sl No	Plant species	Parts eaten by elephant
40	<u>Macaranga indica</u>	Bark
41	<u>Mangifera indica</u>	Bark leaves & fruits
42	<u>Mytragyna parviflora</u>	Bark
43	<u>Ochlandra travancorica</u>	all parts
44	<u>Oxytenanthera bourdillonii</u>	all parts
45	<u>Panicum sp</u>	all parts
46	<u>Peniclitum purpurium</u>	Branches
47	<u>Pongamia pinnata</u>	all parts
48	<u>Schumannianthus virgatus</u>	all parts
49	<u>Seirpus mucronatus</u>	all parts
50	<u>Sorghum halepense</u>	all parts
51	<u>Spondias pinnata</u>	all parts
52	<u>Syzygium cumini</u>	Bark
53	<u>Tectona grandis</u>	Bark & branches
54	<u>Terminalia arjuna</u>	Bark
55	<u>T bellirica</u>	Bark
56	<u>T paniculata</u>	Bark
57	<u>T tomentosa</u>	Bark
58	<u>Themeda cymbaria</u>	all parts
59	<u>T triandra</u>	all parts
60	<u>Urochloa reptans</u>	all parts
61	<u>Xylia xylocarpa</u>	Bark

carbohydrate content (Field 1976) When the grasses mature elephants switch over to the basal portion of the grass tussock which is succulent They also increasingly feed on short grasses which are relatively tender

4 2 Feeding habits

4 2.1 Total time spent in feeding and drinking

Observations were made for a total of 107 hours 55 hours in dry season and 52 hours in wet season The percentage of time spent in feeding and drinking in dry and wet seasons is given in Table 4 Feeding accounted for 65 45 per cent of activity in dry season (Fig 7) whereas it was 80 77 per cent in wet season (Fig 8) There is significant difference between seasons in the time spent for feeding (Table 5) The time spent in drinking varies from 2 73 per cent in dry season to 1 92 per cent in wet season The seasonal difference in time spent in drinking is found to be non-significant (Table 6)

4.2 2 Proportion of time spent in browsing, grazing and debarking

The proportion of time spent in the three categories of feeding by elephants in dry and wet season is given in Table 7 Grazing was predominant in both dry (63 89 per cent)

Table 4 Diversity of plant species consumed by elephants

Geographical area/ place	No of plant species recorded	Reference
Africa		
Tsavo Royal National Park (East)	104	Bax and Sheldrick, 1963
Lake Manyara	134	Douglas-Hamilton, 1972
Wankie National Park	61	Williamson, 1975
Kidepo Valley	59	Field and Ross 1976
Sengwa	133	Guy 1976 b
Bia National Park	138	Short, 1981
Asia		
Gal Oya	89	McKay, 1973
Malaya	390	Olivier 1978 a
Chamaraja Nagar - Satyamangalam S India	112	Sukumar 1985
Way Kambas Game Reserve	83	Santiapillai & Suprahman, 1986
Parambikulam WLS	93	Easa 1989
Idukki WLS	61	Present study

Fig 7 Activity time budget of elephants
in dry season

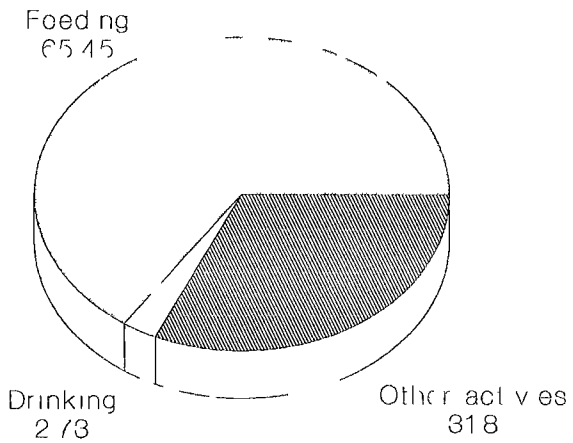


Fig 8 Activity time budget of elephants
in wet season

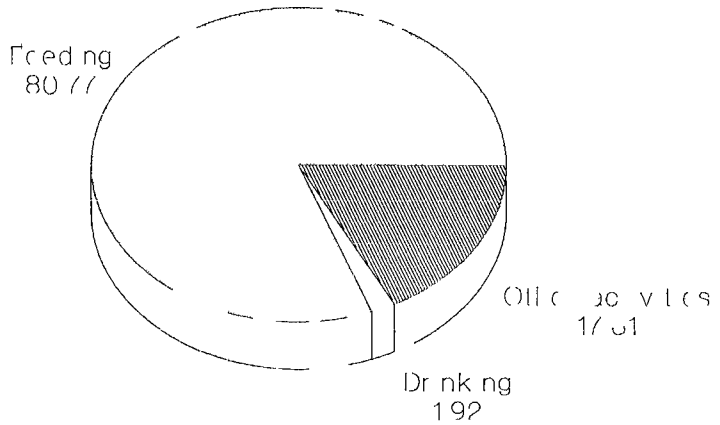


Table 5 Percentage of time spent in feeding and drinking in dry and wet seasons

Seasons	Percentage of time spent in feeding	Percentage of time spent in drinking
Dry	65 45	2 73
Wet	80 77	1 92
Annual	72 61	2 33

Table 6 Table of mean and t statistic of feeding and drinking variables for dry and wet seasons

Seasons	Feeding		Drinking	
	Mean	S D	Mean	S D
Dry	67 10	11 89	2 71	2 48
Wet	80 89	7 08	1 96	2 85
t value	-3 15*		0 67(NS)	

* Significant

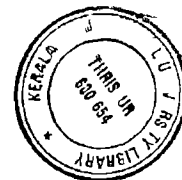


Table 7 Percentage of time spent in feeding categories by elephants of Idukki Wildlife Sanctuary in dry and wet seasons

Seasons	Feeding category		
	Grazing	Browsing	Debarking
Dry	63 89	22 22	13 89
Wet	71 43	21 43	7 14

and wet (71.43%) seasons (Fig 9 and 10) There is no significant difference between the proportion of time spent in grazing browsing and debarking by elephants in the study area according to season (Table 8)

The present observation in Idukki Wildlife Sanctuary indicate that elephant spend much of their time (72.61 per cent) for feeding. A comparison of the data of Wyatt and Eltringham (1974) on African elephants and McKay (1973) and Easa (1989) on Asian elephants are given in Table 9. Several authors have reported that African elephants feed for 16 to 18 hours a day (Laws 1970 Douglas-Hamilton 1972) Guy (1976a) estimated 12 to 14 hours feeding per day in Sengwa area Vancuylenberg (1977) recorded 17 to 19 hours of feeding time for Asian elephants in Sri Lanka.

The present observation agrees with those of the earlier investigations that a higher percentage of time is spent for feeding by elephants. The result is more or less similar to those of Wyatt and Eltringham (1974) and Vancuylenberg (1977). However the percentage of time spent in feeding by elephants in Idukki was higher compared to those of Easa (1989) for Parambikulam. This may be due to the fact that the present investigation was carried out in a grassland dominated area compared to a mosaic type of vegetation.

Fig 9 Percentage of time spent in feeding categories in dry season

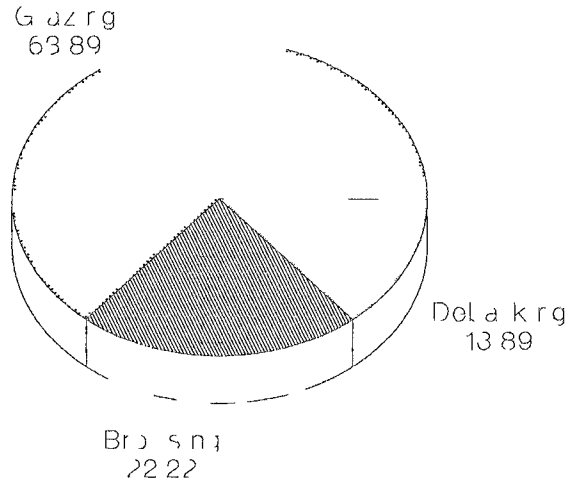


Fig 10 Percentage of time spent in feeding categories in wet season

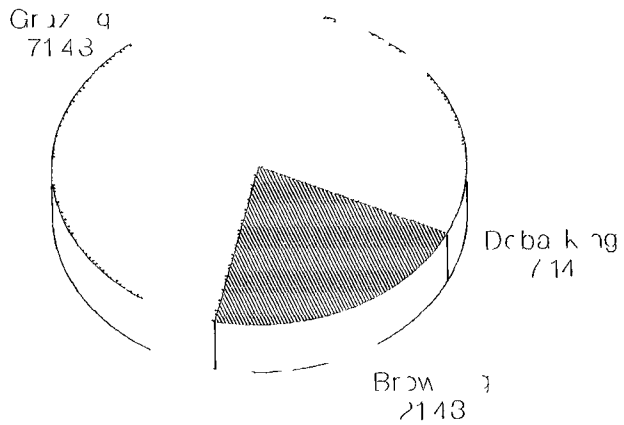


Table 8 t-values for the proportion of time spent in the three categories of feeding by elephants in Idukki Wildlife Sanctuary

Seasons	Feeding category					
	Grazing		Browsing		Debarking	
	Mean	S D	Mean	S D	Mean	S D
Dry	61 92	14 13	23 00	7 34	15 07	13 14
Wet	71 78	8 89	21 29	9 37	6 94	6 42
t-value	-1 88 (NS)		3 76 (NS)		1 76 (NS)	

Table 9 A comparison of reported time spent in feeding and drinking of African and Asian elephants with the present study

Source	Duration of activities in percentage		Total hours of observation	Forest type
	Feeding	Drinking		
African elephant				
Wyatt and Eltringham, 1974	74 2		458	Savanna
Asian elephant				
McKay, 1973	91 1	0 1	185	Grass land
Easa, 1989	64 8	1 4	1525	Evergreen & moist deciduous
Present study	72 61	2 33	107	Grassland dominated

comprising all habitat types in Parambikulam. Further, the observation hours were considerably less as compared to those of Easa (1989).

The time spent on feeding by elephants in dry season was comparatively low. Disturbances due to fire, tourism, poaching, forestry operations and plantation activities in the study area are in its peak during this period. This resulted in a low availability of grasses and sedges in dry season and the elephants used to spend most of its time in evergreen patches.

A comparatively high intake of water in dry season indicates a higher requirement to cope with the hot climate. Thus, the activity time budget of elephants showed seasonal differences in Idukki Wildlife Sanctuary.

Seasonal difference in the proportion of grazing, browsing and debarking have been reported in African elephants (Buss 1961, Field 1971, Wyatt and Eltringham 1974, Laws et al 1975, Guy 1976b, Barnes 1982). Santiapillai and Suprahman (1986) and Sukumar (1985) have reported similar observations in Asian elephants. These investigations have indicated a preference for browsing in dry season and grazing in wet season by elephants. Easa (1989) showed that elephants

in Parambikulam spent more time in grazing in dry season and browsing in wet season

But in the study area grazing was predominant in both dry and wet seasons. This may be due to the fact that the area is dominated by grasslands. Feeding on bark is observed throughout the year in the study area. Easa (1989) also reported bark feeding behaviour of elephants in Parambikulam Sanctuary. Laws et al (1975) suggested that supplementation of the diet with fibrous bark was to maintain an optimum fibre protein ratio.

4.3 Seed studies

Altogether 40 piles of elephant dung were examined during the period of February to May 1994. A total of 682 seeds representing 4 species were collected. Every pile of dung examined during the months of April and May contained seeds. The density of seeds per pile ranged from 3 to 148 and the number of species ranged from 1 to 3.

The most frequent (found in 65 per cent of dung piles examined) and the most abundant (51 per cent of total seeds collected from the dung) species was Dillenia pentagyna. Carex arborea was the second frequent (found in 60 per cent of dung piles) and abundant species (43 per cent of total seeds collected from the dung) in the area.

The germination success of fresh and ingested seeds are shown in Table 10. The germination rate was slightly higher in ingested seeds. In the case of Chrysophyllum roxburghii germination of ingested seeds started earlier than those of fresh seeds. Tetrazolium test was carried out for both ingested and fresh seeds. The results are shown in Table 11. Ingested seeds of Careya arborea shows a 100 per cent germination in both germination trials and tetrazolium test. Chrysophyllum roxburghii shows 88 to 90 per cent germination rate. In case of Eleocarpus teotorcus no seeds were germinated during field trials but 60 per cent of the seeds were found to be germinable in tetrazolium test. Tetrazolium test showed a higher germination rate compared to field trials.

Eventhough there is not much significant difference in the viability of seeds elephant in the study area have an important role in the seed dispersal of Careya arborea and Dilleima pentagyna. The experimental environment used here differs from the natural milieu of these seeds. The ingested seeds are normally embedded in elephant dung at the time of germination. This may further enhance the germination rate.

The significance of elephant as a seed dispersal agent was shown by Short (1981), Keon (1983), Lieberman et al (1979) and Lieberman and Lieberman (1986), Alexandre (1978).

Table 10 Abundance and germination success of seed species recovered from elephant dung

Species	Abundance in dung		Germination rate (%)	
	No of dung piles in which seeds found	Total No of seeds	Fresh	Ingested
<u>Chrysophyllum roxburghii</u>	4	24	70	86
<u>Careya arborea</u>	24	293	95	100
<u>Dillenia pentagyna</u>	26	348	63	65
<u>Eleocarpus tectorius</u>	2	17	0	0

Table 11 Germinability and viability of ingested and raw seeds

Species	Germinable seeds (%)	
	Fresh	Ingested
<u>Chrysophyllum roxburghii</u>	80	90
<u>Careya arborea</u>	93	100
<u>Dillenia pentagyna</u>	60	73
<u>Eleocarpus tectorius</u>	60	60

found that seeds from elephant dung germinated more rapidly than those from fresh fruits although final percentage were similar and seedling growing in dung appeared to be more vigorous. He also stated that the absence of regeneration in several primary forest species has been attributed to the disappearance of elephants from the sites of the Ivory Coast.

Thus the elephants in Idukki Wildlife sanctuary acts as a seed dispersal agent and promotes the germination of seeds.

4.4 Population studies

4.4.1 Number and density

A total of 72 elephants were recorded in Idukki Wildlife Sanctuary. Among them 4 (6%) were adult males, 61 (85%) were adult females, 4 (6%) were juveniles and 3 (4%) were calves (Fig 11). The ecological density of elephants in the study area was estimated to be 1.6 animal/km² and crude density was about 0.9 animal/km². Out of the 4 adult males seen, 3 are tuskers.

4.4.2 Herd size and its seasonal variation

A total of 53 herds were observed during the one year period. Herd size was found to vary from 1 to 19 in wet season (Fig 12) and 1 to 10 in dry season (Fig 13). The

Fig 11 Percentage of age and sex classes of elephants in the population

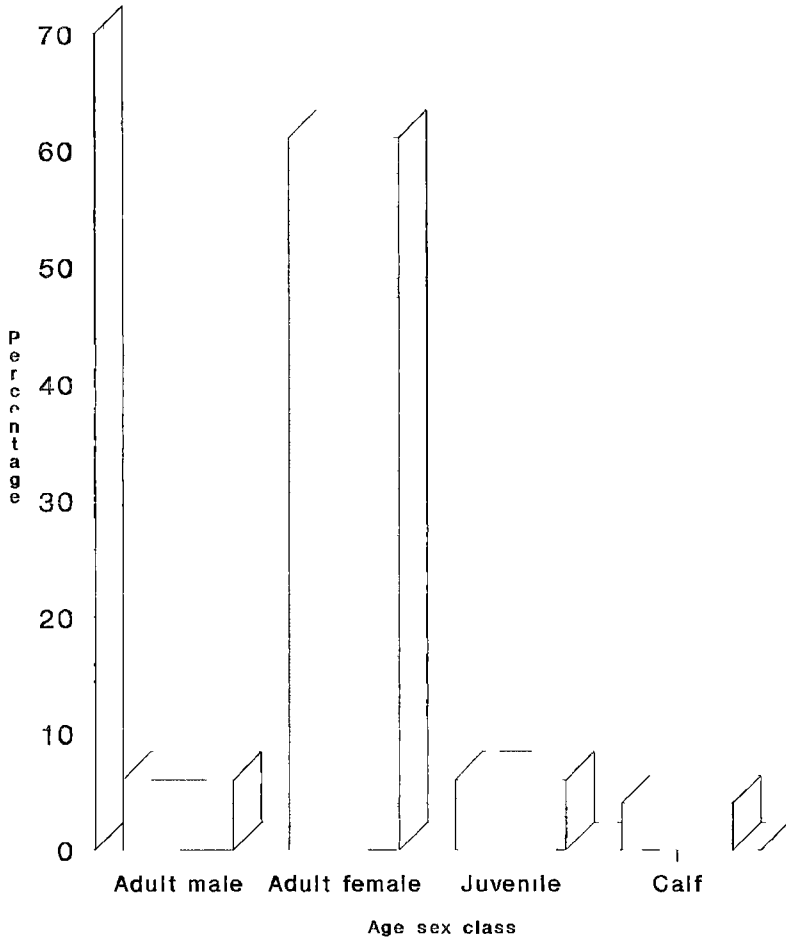


Fig 12 Herd size distribution in dry season

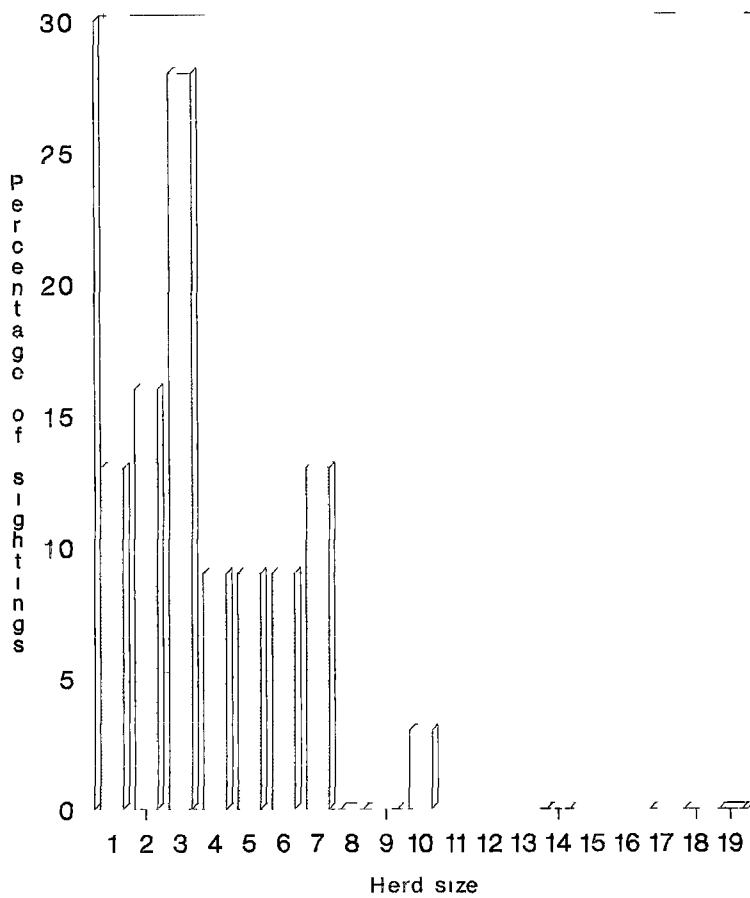
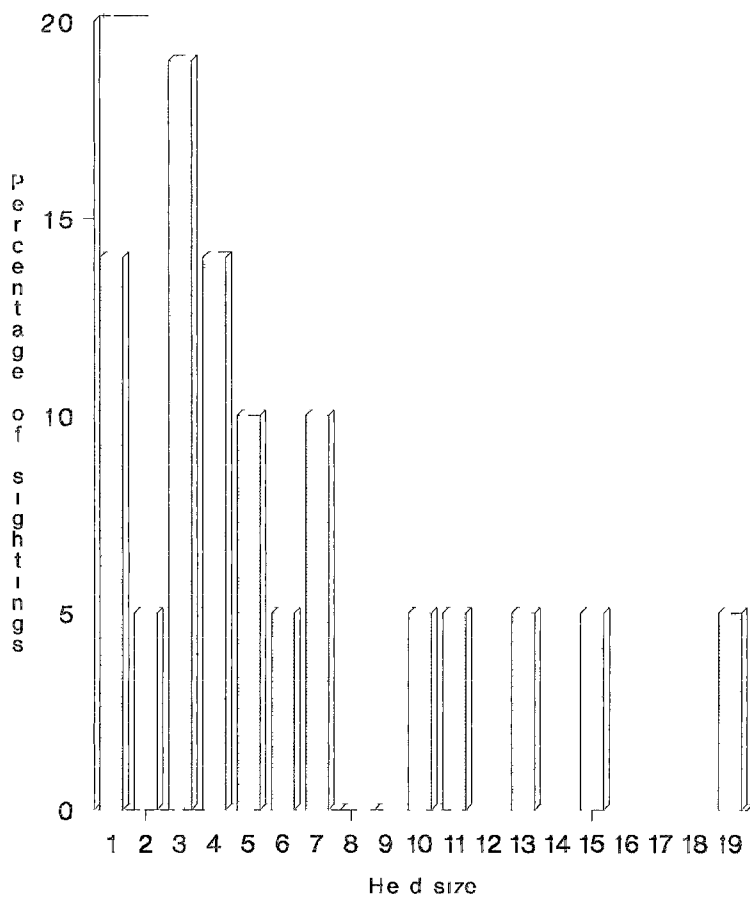


Fig 13 Herd size distribution in wet season



percentage of sightings under each category of herd size is given in Table 12. The most commonly observed herds were of 1, 2, 3, 4 and 7, each constituting 13, 11, 25, 11 and 13 per cent respectively of the total sightings.

The variances in herd size in two seasons compared by F test were found to be equal.

	Dry season -- -----	Wet season -----
N	32	21
\bar{X}	5.263	5.368
S^2	7.830	5.679

$F = 1.9015$ (ns) at 5 per cent level

The student's t-test carried out for computing the difference between average herd size turned out to be non significant.

S^2	-	4.9243
S	-	2.2191
t	-	-0.0474 (ns)

4.4.3 Distribution of elephants

The distribution of elephants assessed from the dung density in various zones showed a significant difference.

Table 12 Percentage of occurrence of herd size in dry and wet seasons

Herd size	Percentage of sightings	
	Dry	Wet
1	13	14
2	16	5
3	28	19
4	9	14
5	9	10
6	9	5
7	13	10
8		-
9	-	-
10	3	5
11		5
12	-	
13	-	5
14	-	-
15	-	5
16	-	-
17	-	-
18	-	-
19	-	5

Plate 4. A herd of elephants feeding on the grasses



between seasons. The graphic representation of the dung density distribution is given in Fig 14. During June 1993 highest dung density distribution was observed at Meenmutty and Arakkappadam areas (Table 13) whereas in October 1993 it was highest in Vakavanam and Anjilithandu areas (Table 14). During January 1994 a higher distribution was observed at Meenmutty and Vakavanam areas (Table 15).

Continuous monitoring over years is required to assess the trend in the population of elephants. But the total count conducted in the study area and observations brought out useful information on the elephant population in the area. Elephant population in the study area was estimated to be 72. Nair and Balasubramanyam (1985) reported a population of about 75 elephants in the area. The difference may be due to the seasonal movements of elephants to the adjoining areas.

Density of elephants in the area was higher than those reported for Asian elephants in Sri Lanka, Malaya and some parts of India. It ranged from 0.1 to 0.46 elephants/Km² (McKay 1973, Ishwaran 1984, Santiapillai et al 1984). Crude density varied from 0.12 to 0.27 animals/Km² in the forest of Malaya and ecological density was as high as 0.65 animal/Km² (Olivier 1978a). Sukumar (1985) reported a crude density of 0.53 elephants/Km² in Chamaraja Nagar and Satyamangalam Forest divisions in South India. Easa (1989)

Fig 14 Dung density distribution

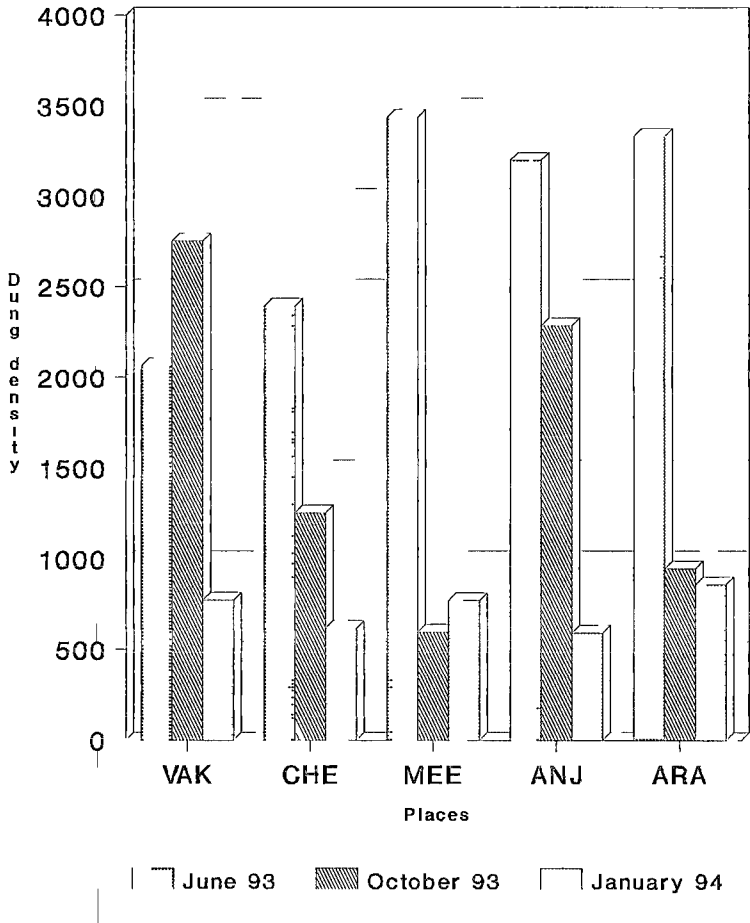


Table 13 Dung density distribution of various zones in June 1993

Area	Density ₂ (Dung/Km ²)	S E	Percentage of Co-efficient variation
Vakavanam	2064	785 2	38 0
Chempakasserı	2393	964 9	40 3
Meenmutty	3437	1222 0	35 5
Anjilithandu	3200	1113 0	34 8
Arakkappadam	3333	962 3	28 9

Table 14 Dung density distribution of various zones in
October 1993

Area	Density ₂ (Dung/Km ²)	S E	Percentage of Co-efficient variation
Vakavanam	2754	954 1	34 6
Chempakasseri	1250	416 7	33 3
Meenmutty	595 2	266 2	44 7
Anjilithandu	2285	1706 0	74 7
Arakkappadam	945 9	357 5	37 8

Table 15 Dung density distribution of various zones in January 1994

Area	Density ₂ (Dung/Km ²)	S E	Percentage of Co-efficient variation
Vakavanam	770 6	309 5	40 2
Chempakasseru	615 3	230 7	37 5
Meenmutty	769 2	222 1	28 9
Anjilithandu	590 9	163 9	27 7
Arakkappadam	859 8	260 8	30 0

estimated a crude density of about 0.4 animals/Km² and an ecological density of about 0.5 animals/Km² in Parambikulam Sanctuary. However, Nair et al (1985) estimated an overall density of 1 elephant/Km² and an ecological density of 3 elephants/Km² in Periyar Tiger Reserve which is higher than the present estimate.

The largest herd seen in the study area was 19 in June. The herd sizes in dry and wet seasons showed no significant difference suggesting a non-correlation between herd size and season. The most commonly observed herds were of 1, 2, 3, 4 and 7 elephants. This pattern of smaller herds is a characteristic of highly disturbed population. Eisenberg and Lockhart (1972) reported a pattern similar to that of Idukki in elephant populations of Sri Lanka.

The sex ratio of elephants of Idukki also show several peculiarities. The male-female ratio of adults in the study area was 1.15:3. The corresponding figures for Asian elephants in Periyar and Bandipur were 1.25:3 and 1.8:8 respectively (Nair et al 1986). Sukumar (1985) reported an adult sex ratio of 1.5:1 in his study area in Tamil Nadu. Easa (1989) estimated an adult sex ratio of 1.6:8 in Parambikulam Sanctuary. The young ones in the population appears to be very low. These facts show that the elephant population at Idukki Sanctuary is in a state of decline.

Distribution of dung density in various zones show a significant difference. During June 93 the movement of elephants are more or less confined within the sanctuary. But in October 1993 the elephant distribution is more in the evergreen forests of Vakavanam and Anjilithandu. There is also a movement of elephants from the sanctuary to the adjoining areas. This may be due to the disturbances caused by the plantations and other forestry operations inside the sanctuary. In the month of January 1994 there is a clear movement of elephants from the sanctuary to the adjoining areas. The plantation activities carried out by the social forestry department and the occurrence of fire may disturb the population and this may be the possible reason for the outward movement. Thus in order to protect the elephants in the Sanctuary all the operations inside the sanctuary must be stopped and the area should be kept intact for some period (10 or 20 years).

Summary

SUMMARY

Asian elephants have been adversely affected by the conversion of forest lands for agriculture settlements and other developmental activities. Poaching for tusk lead to a highly desperate sex ratio in many populations of elephant. Habitat fragmentation has highly affected the elephant population due to its large home range. Elephants in Kerala numbering about 4200, exist as seven populations, six of which are in ecological continuity with adjacent elephant habitats of either Tamil Nadu or Karnataka.

The present investigation was carried out in Idukki Wildlife Sanctuary Kerala during 1993-94. The sanctuary with an area of 77 km² is situated at an altitude of about 800 to 1000 m. The area consists of evergreen, semi-evergreen moist deciduous and savannah types of forests.

The Idukki Reservoir extending about 33 km² forms the three sides of the sanctuary. A wide range of large and medium sized mammals were observed in the area. The sanctuary has a rich variety of avifauna and reptiles. A number of indigenous and introduced fishes are available in the reservoir and rivers.

Information on food plants of elephants in the study area was obtained by direct observations. Elephants in Idukki

Wildlife Sanctuary were found to feed on 61 species of plants. About 38 per cent of the food plants belong to the family Poaceae. Barks of 24 species of trees were fed. Fruits of Careya arborea and Dillenia pentagyna were also commonly fed by elephants.

Activity time budget was studied by direct observation. The proportion of time spent in grazing, browsing and debarking were computed by observing the elephants in different habitats and noting the time spent on each category of feeding. Feeding accounted for 65.45 per cent of elephant activity in dry season whereas it was 80.77 per cent in wet season. The time spent in drinking varies from 2.73 per cent in dry season to 1.96 per cent in wet season. There is a significant difference between seasons in the time spent for feeding. The seasonal difference in time spent in drinking is found to be non-significant. Grazing was predominant in both dry (63.89 per cent) and wet (71.43 per cent) seasons.

Search for fresh elephants dung were made and undamaged seeds were collected. Trees were located and raw seeds were also collected. Germination trials and tetrazolium test were carried out for both ingested and raw seeds.

A total of 682 seeds representing 4 species were collected from the elephant dung in the area. Seeds of

Dillenia pentagyna and Careya arborea were the most frequent and abundant in the dung examined. The germination rate was slightly higher in the ingested seeds as compared to the fresh seeds collected from the trees.

Population of elephants in the area was estimated by direct simultaneous count. Herd size composition and age structure of population were calculated on the basis of all sightings. Distribution of elephants were assessed by dung count. A total of 72 elephants were observed in the area. The ecological density was estimated to be 1.6 animal/Km² and crude density was about 0.9 animal/Km².

Herd size was found to vary from 1 to 19 in wet season and 1 to 10 in dry season. The most commonly observed herds were of the size 1, 2, 3, 4 and 7. Only 4 adult males were found in the area. The male female ratio of adults in the study area was 1:15.3.

Distribution of dung density in various zones show a significant difference. There is a clear movement of elephants from the sanctuary to the adjoining areas due to fire and disturbances caused by the plantations and other forestry operations inside the sanctuary.

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**FOOD AND FEEDING HABITS OF ASIAN ELEPHANTS
(*Elephas maximus* Linn.) - A CASE STUDY OF
IDUKKI WILDLIFE SANCTUARY**

By
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ABSTRACT OF A THESIS

Submitted in partial fulfilment of
requirement for the degree of

Master of Science in Forestry

Faculty of Agriculture
KERALA AGRICULTURAL UNIVERSITY

Department of Wildlife Science
College of Forestry
VELLANIKKARA, THRISSUR

1994

ABSTRACT

The present investigation was carried out in Idukki Wildlife Sanctuary, Kerala during 1992-94 with the objective of identifying the food plants of elephants and to study the feeding habits of the animal in its natural condition. The study also aimed at finding out how elephants acts as a seed dispersal agent and to estimate the elephant population in the study area.

Information on food plants of elephants in the study area was obtained by direct observation. Activity time budget was also studied by direct observation. The proportion of time spent in grazing, browsing and debarking, were computed by observing the elephants in different habitats and noting the time spent on each category of feeding. Elephants in Idukki Wildlife Sanctuary were found to feed on 61 species of plants. About 38 per cent of the food plants belong to the family Poaceae. Barks of 24 species of trees were eaten. Fruits of Careya arborea and Dillenia pentagyna were also commonly consumed by elephants. Feeding accounted for 65.45 per cent of elephant activity in dry season whereas it was 80.77 per cent in wet season. Time spent in drinking varied from 2.73 per cent in dry season to 1.96 per cent in wet season. The seasonal difference in time spent in feeding is found to be significant whereas that of drinking is found to

be non-significant. Grazing was predominant in both dry (63.89 per cent) and wet (71.43 per cent) seasons.

Search for fresh elephant dung were made and undamaged seeds were collected. Trees were located and raw seeds were also collected and the germination rate was compared with raw seeds. Elephant in the area was found to act as a seed dispersal agent. A total of 682 seeds representing 4 species were collected from the elephant dung. Seeds of Dillenia pentagyna and Careya arborea were found to be most frequent and abundant in the dung examined. The germination rate was slightly higher in the ingested seeds as compared to the fresh seeds collected from the trees.

A direct simultaneous count was made in the area. A total of 72 elephants were observed. The ecological density was estimated to be 1.6 animal/Km² and crude density was about 0.9 animal/Km². Herd size varied from 1 to 19 in wet season to 1 to 10 in dry season. The male-female ratio of adults was found to be 1:15.3. Dung density distribution showed a clear movement of elephants from the sanctuary to the adjoining areas.

