CHAPTER I - GENERAL INTRODUCTION AND STUDY AREA

1. INTRODUCTION

Movements of an individual or a group of animals are generally restricted to an area named as home range or territory. The concept of home range had originally been suggested by Seton (1909). Burt (1943) defined it as that area traversed by the individual in its normal activities of food gathering, mating and caring for young. This excludes the area of uncharacteristic and erratic wanderings outside the normal range.

Animals primarily move in search of resources which are essential for living and reproducing successfully. These resources include food, water, shelter and mates. Food and water are among the basic requirements of all living forms. As a resource, food is generally not evenly distributed in the environment (habitats). Mostly, habitats are heterogenous with respect to resources, especially food and water, which vary spatially and also temporally.

With regard to herbivores in heterogenous habitats, food distribution and abundance can vary spatially to a great extent, depending on many abiotic factors such as climate (rainfall), topography (altitude) and soil type. Animals in such heterogenous environments move between habitats in a manner that maximize their fitness. Decisions on which space to occupy are fundamentally important because easy access to resources is an important factor favouring reproduction and for long-term survival of the species.
Animals that use the same area or home range year after year are likely to have better knowledge about resource distribution and abundance, thereby may use it optimally. In contrast, animals that keep shifting their range to new areas, would encounter a good resource patch by chance alone, the knowledge gained in the past will be of less or no use in the new area. Therefore, animals that use the same area or home range would optimally use resources that vary both in time and space than the animals that keep shifting its range. This could be one of the reasons why animals show strong fidelity to their home ranges.

In elephants, the home range seems to be immutable and knowledge of it appears to be maintained by ‘tradition’ within each tightly knit family group or even between individual bulls (Wyatt and Eltringham, 1974; Leuthold, 1977; Viljoen, 1989a). Most of the earlier studies on ranging behaviour of elephants in Asia (Olivier, 1978a; Sukumar, 1985, 1989a, 1989b; Easa, 1988; McKay, 1990; Desai, 1991; Daniel et al., 1995; Joshua and Johnsingh, 1995; Baskaran et al., 1995) and Africa (Leuthold and Sale, 1973; Douglas-Hamilton and Douglas-Hamilton, 1975; Leuthold, 1977; Thouless, 1995) have estimated the home range size, but have not examined the use and nature of such ranging behaviour i.e., How do different clans and bulls use their home range?; How far do clans and bulls overlap in space and time? and What is the extent of fidelity shown by clans and bulls to their ranges?. Some earlier studies did indicate that clans and bulls exhibited strong fidelity to their home ranges in Africa (Viljoen, 1989a) and in Asia (Daniel et al., 1995; Baskaran and Desai, 1996).
The spatial locations of the home ranges reported in earlier studies in Asia (Olivier, 1978a; Sukumar, 1985, 1989a, 1989b; Desai, 1991; Baskaran et al., 1995) and in Africa (Leuthold, 1977; Thouless, 1996) indicate that home ranges of clans and bulls are not distributed uniformly over all the habitat types (i.e., home ranges of some animals fall within a single vegetation type, while that of some others fall over many vegetation types). Thus, it appears that all clans and bulls do not have access to all the resources that are available in a population's range. Earlier studies on seasonal movements, habitat use and feeding behaviour of elephants in Asia (McKay, 1973; Vancuylenberg, 1977; Olivier, 1978a; Sukumar, 1985, 1989a, 1989b, 1990; Easa 1987; Sivaganesan, 1991; Daniel et al., 1995) and Africa (Buss, 1961; Wing and Buss, 1970; Field, 1971; Leuthold and Sale, 1973; Caughley and Goddard, 1975; Western, 1975; Williamson, 1975; Eltringham, 1977; Leuthold, 1977; Barnes, 1983; Short, 1983; Jachmann, 1988; Viljoen, 1989b; Kabigumila, 1993; Tchamba and Seme, 1993; White et al., 1993) were chiefly on population or sub-population levels and related the habitat use and feeding behaviour of elephants to the optimal foraging theory. They did not look into how the individual clans and bulls in a population use the available habitats and food resources. The present study mainly designed with a view to collect information on ranging and resource use strategies of individual clans and bulls in a population.
2. REVIEW OF LITERATURE

In Asia, extensive studies have been carried out on the status of the Asian elephant (*Elephas maximus*) and its distribution (Anon. 1934; Singh, 1969, 1978, 1980; Krishnan, 1972; Olivier, 1978b; Nair and Gadgil, 1978; Daniel, 1980; Joseph, 1980; Nair et al., 1980; Lahiri-Choudhury, 1980, 1983, 1985; Mishra, 1980; Vijayan, 1980; Krishnamurthy, 1980; Gupta, 1985; Shahi and Choudhury, 1985; Sukumar, 1985, 1986, 1989b, 1992, 1995; Nair et al., 1986; Sivaganesan and Bhushnan, 1986; Santiapillai, 1989; Choudhury, 1991; Smith and Mishra, 1992; Barua and Bist, 1995; Datye and Bhagwat, 1995; Easa and Asari, 1995; Sivaganesan and Kumar, 1995; Singh, 1995; Venevongphet, 1995), ecology (McKay, 1973, 1990; Olivier, 1978a; Ishwaran, 1984, 1993; Santiapillai et al., 1984; Sukumar, 1985, 1989a, 1989b, 1990; Daniel et al., 1987, 1995; Easa, 1987; Sivaganesan; 1991; Datye, 1993; Desai and Johnsingh, 1995; Sivaganesan and Johnsingh, 1995; Sivaganesan and Sathyaranayana, 1995; Sukumar and Ramesh, 1995; Rameshkumar, 1995a, 1995b) and behaviour (Mishra, 1971; McKay, 1973, 1990; Vancuylenberg, 1977; Easa, 1987, 1988; Daniel et al., 1987, 1995; Sukumar and Gadgil, 1988; Balasubramanian et al., 1995; Baskaran et al., 1995; Joshua and Johnsingh, 1995; Rameshkumar and Sathyaranarayana, 1995; Datye and Bhagwat, 1995; Baskaran and Desai, 1996; Desai and Baskaran, 1996), in many parts of its distribution range. However, the influence of ranging on habitat utilization and feeding behaviour of elephants have not so far been documented in Asia. To fill up this lacuna in our knowledge, the present study was undertaken on ranging
and resource utilization of the Asian elephant in Nilgiri Biosphere Reserve, South India.

The Nilgiri Biosphere Reserve has diverse climatic conditions (two distinct wet seasons and a dry season) and habitat types ranging from tropical semi-evergreen to tropical thorn forest. In Asia, this Reserve has the single largest population of Asian elephant living in high density, ranging over a vast contiguous habitat, with relatively little disturbance. This area was therefore selected to study the behaviour of the elephants. This study relates to three major aspects i.e., home ranges, habitat use and feeding behaviour. The findings are discussed in detail in the following three Chapters, respectively.
3. STUDY AREA

3.1 LOCATION

The study area is located in Nilgiri Biosphere Reserve (NBR) which lies between 76° 0'E and 77° 15' E longitude and 12° 15' N and 10° 45' N latitude. It covers an area of 5520 km² and is situated at the junction of three Southern States - Tamil Nadu, Karnataka and Kerala (Figure 1). The entire area can be divided into three sub-areas, namely, the area north to the Nilgiris (NBR north), the area south to the Nilgiris (NBR south) and the eastern Ghats area. Within the NBR the actual study area was centered in the Mudumalai Wildlife Sanctuary (MWS), adjoining Sigur and Singara Reserve Forest in Tamil Nadu, Bandipur Tiger Reserve (BTR) in Karnataka and Wynad Wildlife Sanctuary (WWS) in Kerala. One study clan operated mostly outside this main area, and it ranged through the Reserve Forests of Nilgiri North, Sathyamangalam and Coimbatore Divisions. These areas were also covered in the present study in the course of monitoring the clan.

3.2 PHYSIOGRAPHIC FEATURES

The main study area (Mudumalai Wildlife Sanctuary, Bandipur Tiger Reserve, Wynad Wildlife Sanctuary and Sigur and Singara Reserve Forests) has an undulating terrain with an average elevation of 1000 meters above MSL. This area is drained by the rivers viz., Nugu and Moyar and their tributaries, which are perennial, excepting few tributaries.
Figure 1. Map of Nilgiri Biosphere Reserve (NBR) showing the study area - Mudumalai Wildlife Sanctuary (MWS), Bandipur Tiger Reserve (BTR), Wynad Wildlife Sanctuary (WWS), Nilgiri North Division, Sathyamangalam Division and Coimbatore Division.
3.3 CLIMATE

The study area has a diverse climate due to its varied reliefs and topography. The minimum and maximum temperature ranges from 7°C in December to 37°C in April. The temperature towards the eastern part of the study area is usually higher than the western part due to variations in the altitude, rainfall and vegetation. The study area receives rain both from southwest (May to August) and northeast (September to December) monsoons. The mean annual rainfall varies from 600 mm to 2000 mm. Based on monsoon and the climate of the study area, the year was classified into following three seasons.

3.3.1 Dry season (January - April)

The early dry season (January and February) receives negligible amount of rain but the temperature is lower than the late dry season. The late summer (March and April) receives a low rainfall (Figure 2) from the pre-monsoon showers; however, this part of the season experiences the highest temperature (37°C) and drought like conditions.

3.3.2 Southwest monsoon or First wet season (May - August)

The southwest monsoon which starts by late May reaches its peak in June (Figure 2). By August, the rain gradually declines. The Western part of the study area receives the highest rainfall during this monsoon. Except the extreme eastern part of the study area, all other areas receive major rainfall
Figure 2. Mean monthly rainfall in different habitats during the study period (1991-1995)

- Moist deciduous forest
- Dry deciduous forest
- Thorn forest
from this monsoon. The water availability is high in the Western part during this period.

3.3.3 Northeast monsoon or Second wet season (September - December)

The northeast monsoon starts by mid September and reaches a peak by October (Figure 2). It gradually declines from November and almost stops by December. December is colder than other months in this season. The extreme eastern part of the Reserve receives its highest rainfall in this monsoon. Water is available in all the major streams and ponds during this period.

3.4 VEGETATION

The study area has three major forest types namely Tropical Moist Deciduous, Tropical Dry Deciduous and Southern Tropical Thorn forest (Champion and Seth, 1968). Corresponding to the gradient in rainfall, the vegetation varies from southern tropical thorn forest in the east to southern tropical moist deciduous forest in the west. In between these two lies the dry deciduous forest. Apart from these three major forest types, small extent of mixed deciduous forest occur, between dry deciduous and thorn forest.

3.4.1 Tropical moist deciduous forest (MDF)

This forest type occurs only in the northern part of the Reserve (covering the western part of Mudumalai Wildlife Sanctuary, most of Wynad
Wildlife Sanctuary and northwestern part of Bandipur Tiger Reserve). The dominant tree species are *Tectona grandis, Lagerstroemia lanceolata, Kydia calycina, Pterocarpus marsupium* and *Syzygium cumini*. The tree canopy is mostly closed. The ground cover mainly composed of *Helicteres isora, Desmodium* spp. and *Curcuma* spp. (Plate 1A). Weed species such as *Lantana camara* and *Eupatorium odoratum* are common. The dominant grass species are *Cyrtococcum patens, C. oxiphillum, Themeda cymbaria, Apluda mutica,* and *Imperata cylindrica*. Bamboo (*Bambusa arundinacea*) is very common along the perennial water sources and is a characteristic feature of this forest type. Swamps (*Vayals*) are common in this type of vegetation due to poor drainage. Swamp vegetation mainly consists of *Pennisetum hockanackeri* a tall grass and bamboo along the periphery and along the streams. Annual fire in this vegetation type is less intense compared to other vegetation types because of low grass cover and high soil moisture.

### 3.4.2 Tropical dry deciduous forest (DDF)

This forest type forms the major vegetation type in the study area. It is distributed in the central part of the Bandipur Tiger Reserve and Mudumalai Wildlife Sanctuary. The tree species composition is mainly of *Anogeissus latifolia, T. grandis* and *Terminalia* spp. Profuse regeneration of *Shorea talura* is common on hill tops of the northwestern part of the Mudumalai Wildlife Sanctuary (Doddakati block) and the southern part of the Bandipur Tiger Reserve (Chemanallah block). The tree canopy is mostly semi-open. The understorey is dominated by grass species *Themeda cymbaria, Cymbopogon flexuosus* and *Themeda triandra* (Plate 1B). The weed *Lantana*
Plate 1: Major vegetation types in the study area

A. Tropical moist deciduous forest
B. Tropical dry deciduous forest
C. Southern tropical thorn forest
cameara is common along drainage especially towards the eastern side. Fire intensity is severe due to accumulation of deciduous leaf litter and the presence of vast stretches of tall grass.

3.4.3 Southern tropical thorn forest (TF)

This forest type is confined to the eastern side of Mudumalai Wildlife Sanctuary, Bandipur Tiger Reserve and the southern part of Coimbatore Forest Division. The dominant tree species includes Ziziphus mauritiana, Acacia spp., Anogeissus latifolia, Albizzia amara and Erythroxylum monogynum. Acacia intsia (an important elephant browse) and Lantana spp. are the common woody shrubs abundant along the nullahs (dry streams) and perennial water sources. The tree canopy is mostly open. The understorey consists of Acacia intsia, Gymnosporeoa emarginatus and Opuntia spp.. These shrubs are distributed in isolated patches separated from one another by intervening strips of grass cover (Plate 1C). Heteropogon contartus, Bothriochloa sp., Digitaria sp. and Aristida adscencionis are the dominant grass species. The grass growth is very poor because of low rainfall (800mm), and poor soil nutrients coupled with severe cattle grazing in many areas. Fire hazard is not severe as many areas are overgrazed by cattle.

3.5 FAUNA

The Reserve is remarkable for its faunal diversity. The Reserve constitutes only 0.15% of India’s land area, but has 20% mammals, 28% of birds, 28% reptiles, 24% of amphibians and 13.5% of fishes (together 23%) of
India’s vertebrate assemblage (Daniels, 1993). The Reserve is also remarkable for its endemic species (25 species of vertebrates).

The Reserve is well known for the Asian elephant, with an estimated population of 3900 to 4800 individuals (Santiapillai and Jackson, 1990). Large areas (41.3%) of the Reserve is protected as Sanctuaries and National Parks. This Reserve, with its large contiguous area and elephant population is the best area for long term conservation of Asian elephant (Daniel et al., 1987).

Other important mammalian species of this area are the Indian Gaur (Bos gaurus) the only bovid; three species of cervids, Sambar deer (Cervus unicolor), Spotted deer (Axis axis), Barking deer (Muntiacus muntjak) and Mouse deer (Tragulus meminna); two species of antelopes, the four horned antelope (Tetracerus quadricornis) and Blackbuck (Antelope cervicapra); one species of endemic mountain goat, the Nilgiri Tahr (Hemitragus hylocrius); four species of primates, the Nilgiri langur (Trachypithecus johnii), Common langur (Semenopithecus entellus), Bonnet macaque (Macaca radiata) and Slender loris (Loris tardigradus). Tiger (Panthera tigris), Panther (Panthera pardus), the Indian wild dog (Cuon alpinus) and Striped hyaena (Hyaena hyaena) are the large carnivores found in the area. In addition, Sloth bear (Melursus ursinus), Wild boar (Sus scrofa), Porcupine (Hystrix indica), Civets, Mongoose and Blacknaped hare are also found in the area.

3.6 LAND USE PATTERN

From the second century BC, the Nilgiri area has been peopled. It was mainly pastoral country harbouring hunters, gatherers and shifting cultivators.
Agriculture expanded in this area around the fifteenth century (Prabakar, 1994). By 19th century the British intensified the commercial exploitation of these areas. The montane climate was favourable for commercial crops like Tea and Coffee which had international markets and thus the area was intensively farmed with Tea and Coffee. A large part of the forest cover was lost during this period. After 1950, what remained of forest was exploited by timber industries and the construction of major dams during 1960 also contributed through changes in land use pattern. By 1972, parts of these areas were declared as National Park and Sanctuaries through Indian Wildlife Act, in order to conserve the endangered flora and fauna in their natural habitats. By 1989 a major part of the area was declared as the Nilgiri Biosphere Reserve.

3.7 BIOTIC PRESSURE

Overgrazing by domestic cattle and fire wood collection are serious habitat threats in the thorn forest areas of the study site. Silori and Mishra (1995) estimated 1800 cubic meter of fire wood and 451 cubic meter of cattle dung was being collected annually from the forest by eight villages around eastern part of the Mudumalai Wildlife Sanctuary. In moist deciduous forest of this Sanctuary, the biotic pressure is severe because of human settlements. However, due to very high rainfall and fertile soil, degradation is not as bad as in the thorn forest area. In Wynad Wildlife Sanctuary, a total of 69 hamlets in an area of 546.74 acres situated inside (Gopinathan, 1995) cause severe pressure on the adjoining areas. In recent years, grazing pressure and fire wood collection seems to be increasing in the fringes of Bandipur Tiger Reserve area. It has been estimated that about 1,16,000 domestic cattle graze in the areas bordering Bandipur Tiger Reserve (Raju, 1995).
b. **Adult males**: Males leave their natal clan after they reach puberty and lead solitary life not having any strong social bonds with clans and other males (Douglas-Hamilton and Douglas-Hamilton, 1975; Moss, 1988; Desai and Johnsingh, 1995).

c. **Protected areas (PAs)**: Forest areas that have been designated as National Park or Wildlife Sanctuaries.

d. **National Park (NP)**: An area designated for wildlife conservation. This area comes under the management of Wildlife Wing (a part of Forest Department).

e. **Wildlife Sanctuary (WS)**: An area designated for wildlife conservation but it enjoys a lower legal status than the NP. This area is also managed by the Wildlife Wing of Forest Department.

f. **Reserve Forest (RF)**: These forest areas are managed by the Territorial Wing of the Forest Department. Wildlife wing has no control over this area. These forests are open to normal forestry operations and not legally designated as wildlife conservation area.

g. **Revenue Land (REVF)**: These include forested and non-forested (agriculture and settlements) lands. A part of the land is privately owned and the rest is the public land under the Revenue Department (mostly forested land).