KFRI Research Report No. 212

ELEPHANT POPULATION IN PERIYAR AND ADJACENT AREAS - A DEMOGRAPHIC STUDY

(Final Report of Research Project KFRI 267/97)

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CONTENTS

ABSTRACT

A study was carried out in Periyar Tiger Reserve and adjacent areas including Ranni, Konni and Achenkovil Forest Divisions during 1997 to collect information on the group composition, sex ratio, density and population of elephants, especially tuskers. This area forms the portion of Elephant Reserve No. 10. The area mainly comprises tropical wet evergreen forests and grasslands, followed by deciduous forests.

Information on group size, composition and structure of elephants was collected through direct observations. The individuals were classified into different age-sex categories. Transects were laid to collect information on dung density.

A total of 379 elephants were sighted in 63 herds. Herd size of elephant was found to range from 1 to 19. About 14 percent were loners. Total number of adult males was found to be 28, of which 14 were makhnas and remaining tuskers in a proportion of 1:1. Adult females formed a major portion of the population (58.6%) followed by subadult females. Adult males constituted 7.4% of the population. The overall male to female sex ratio was 1:87 and adult male to female 1: 7.9. The overall sex ratio of Periyar Tiger Reserve alone was found to be 1:11.5. The overall elephant density is 0.5/km^2 in the study area and the density was higher in grasslands (0.9/Km^2) compared to other habitats.

ABSTRACT OF PROJECT PROPOSAL

Code	**: KFRI 267/97**
Title	**: Elephant population in Periyar and adjacent areas – A demographic study**
Objectives	**: To estimate group size composition and sex ratio of elephants.** **: To estimate the density of elephants in different habitats**
Date of Commencement	**: May 1997**
Scheduled date of completion	**: August 1997**
Funding Agency	**: Asian Elephant Conservation Centre, Bangalore**
Project Team	
Principal Investigator	**: P. S. Easa**
Research Fellow	**: S. A. Sabu Jahas**

ACKNOWLEDGEMENTS

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INTRODUCTION

Information on the population of a species in the wild is an important attribute for judging its future for conservation and management. This is especially true for a species like elephant, which is larger in size contributing higher proportion of biomass among the wild animals. It is also essential to study the structure, dynamics and level of organisation of a species, since the population is linked with the environmental conditions. Social organisation of a population such as herd size, composition and structure would generate essential information on population characteristics and trend (McCullough, 1993 & 1994).

Earlier studies in different elephant ranges have reported the population estimates of Asian elephants in the Indian sub-continent (Nair and Gadgil, 1978; Singh, 1978; Joseph, 1980; Lahiri-Choudhury, 1980; Sukumar, 1985; Daniel *et al.*, 1987; Easa, 1989a; Easa and Balakrishnan, 1995)). However, most of these were not based on accurate field surveys (Daniel, 1980). The number, herd size, composition and structure of elephant populations in some of the wildlife sanctuaries in Kerala were also documented (Vijayan *et al.*, 1979; Nair *et al.*, 1985; Nair and Balasubramanyan, 1985; Balakrishnan and Easa, 1986; Easa, 1989a).

Population structure and group composition of elephants in Periyar have been reported in earlier studies (Kurup, 1971; Vijayan, *et al.*, 1979; Vijayan, 1980; Nair, *et al.*, 1985; Mohanachandran, 1990; Joseph, 1990). Most of these had reported a highly skewed sex ratio in elephants in the area. A recent study by Ramakrishnan *et al.* (1998) reported that sex ratio of elephants in Periyar progressively skewed since 1969 reaching a peak of 1:122 in 1989. They have also discussed various consequences of such a skewed sex ratio on the population. However, considering the contiguity of Periyar with the adjacent forested areas of Ranni, Konni and Achenkoil, an intensive search of all the areas was suggested during the discussion in a workshop held at Trivandrum in 1998.

Thus the objective of the study was to estimate the population of elephants in Periyar Tiger Reserve and adjacent areas along with details on the structure, size, composition and the population density in various habitats.

STUDY AREA

The vast stretch of forests extending from north of Aryankavu pass to Periyar Tiger Reserve forms the Elephant Reserve No. 10 of the Project Elephant Scheme (Easa, 1994) (Fig. 1). This includes the Reserve forests of Achenkoil, Konni, Ranni,

Goodrickal, Kumaramperur, Mount Plateau and Periyar Lake. The area falls under the administrative control of Achenkoil, Konni and Ranni Forest Divisions and Periyar Tiger Reserve, and Erumeli Range of Kottayam Forest Division (Between 8° 56' and 90° 34' N. lat. and between 76° 52' and 77° 25' E. long). The total extent of the Reserve is about 2400 km^2 and is contiguous with Varashunad Hill of Tamil Nadu. About one third of the area constitutes Periyar Tiger Reserve. The major vegetation types include tropical wet evergreen forest followed by deciduous forest. About 170 km^2 have been planted with teak, eucalypts, etc.

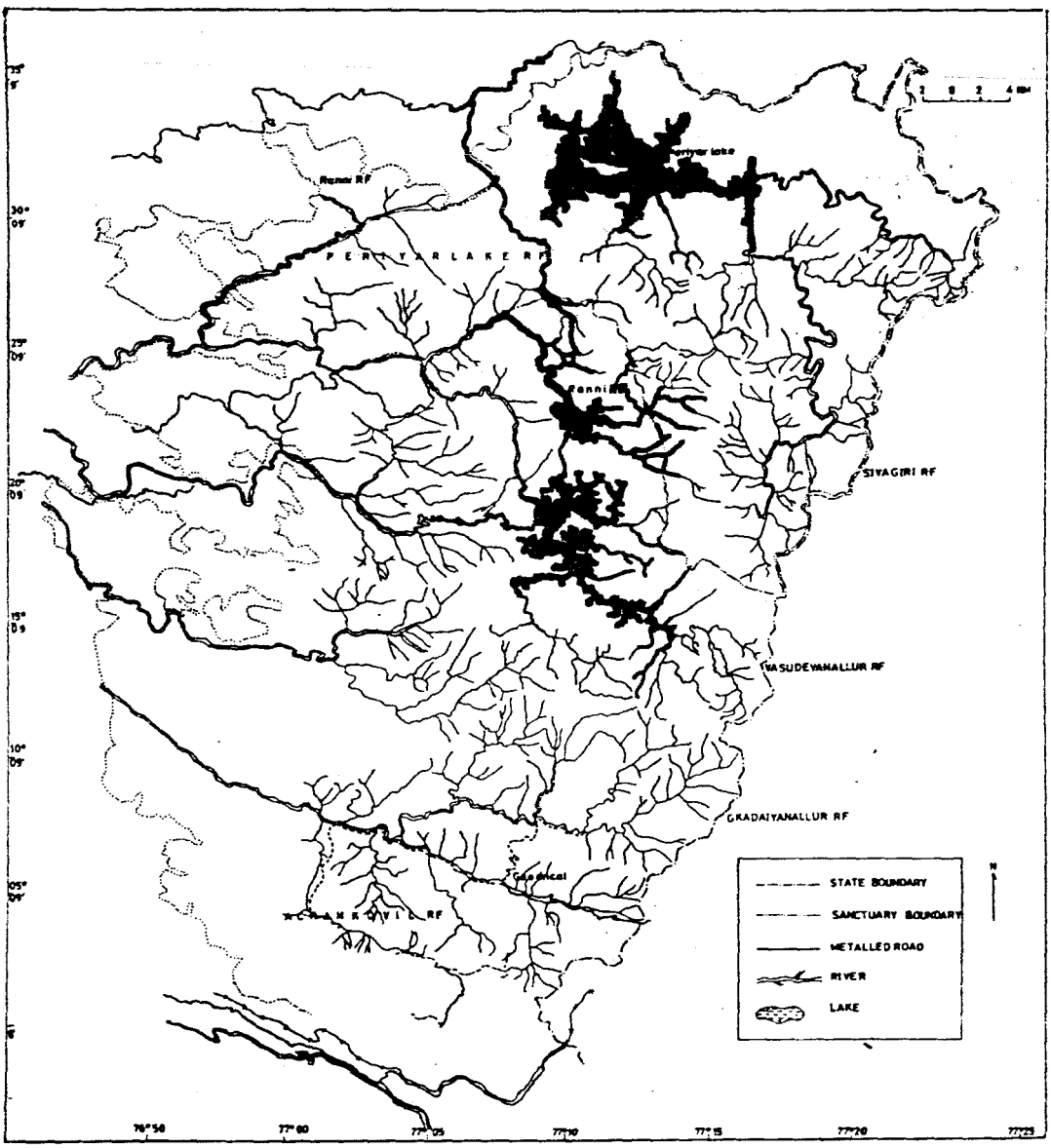


Figure 1. Periyar and adjacent areas

Average annual rainfall in the Reserve ranges from 3000 to 5000 mm and temperature varies from 13° to 29° C. The terrain is highly undulating with valleys and hills. The tributaries of Pamba and Periyar drain the area. In spite of large scale planting of most of the moist deciduous forest and encroachments in the lower regions, the Reserve has a vast expanse of tropical wet evergreen forest. Most of the evergreen forests are confined to Periyar Tiger Reserve and Goodrickal Range of Ranni Forest Division. Patches of evergreen forests are found in Kallar, Vadasserikkara and Achenkoil Ranges. Extensive reed areas are located in Goodrickal, Kallar and Vadasserikkara Ranges. These have been regularly exploited for industrial purpose. However, the eastern part of this Reserve bordering Tamil Nadu is still intact. The deciduous forests are met with in Achenkoil, Konni, Ranni and Erumeli Ranges. A large portion of these has been converted into plantation. The Elephant Reserve has Periyar and Kakki reservoirs. A part of the area is highly degraded due to human activities and fire. Major portions of the evergreen forests are infested with the weed, *Mikania*. A part of the habitat is highly degraded in Achenkoil Range due to plantation activities and frequent fire. Sabarimala areas of Vallakkadavu Range are degraded due to pressure from the pilgrims.

The forests are more or less contiguous with a few enclosures, settlements and estates in Vallakkadavu, Mannarappara, Naduvathumuzhi, Vadasserikkara and Goodrickal Ranges (Easa, 1994). The fewer number of enclosures and settlements in the Reserve make it an ideal habitat for elephants. About 208 ha of private estate at Pachakanam and the 0.6 ha of land occupied by 13 families at Kochu Pamba are the major settlements in the northern part. There have been changes in the cultivated crops from cardamom to a mixed type. A number of smaller settlements are found towards south.

METHODS AND ANALYSIS

Density estimate: Fifty-four transects of 2 km length were laid at random in the study area covering all the habitat types in Periyar Tiger Reserve and the adjacent areas of Ranni (Ranni, Goodrickal, Vadasserikara forest ranges), Konni (Konni, Naduvathumuzhy, Mannarappara forest ranges) and Achenkoil Forest division (Kanayar, Kallar and Achenkoil ranges) and Erumely Range of Kottayam Divisions. The method suggested by Barnes and Jensen (1987) was used for collecting information on indirect evidences (dung piles) of the elephants. The stages of dung decay were also recorded.

The data from different transects were pooled to estimate the density using the computer program DISTANCE (Laake *et al.*, 1994). The decay rate of 0.0146 (Dawson and Dekker, 1992) was used for the density at evergreen forest. However, the decay rate of 0.0187, obtained from the study in Wayanad (Easa, 1999) was used for grassland, moist deciduous forest and plantations while estimating elephant density in different habitats. The defecation rate of 16.33/day, obtained from the study at Mudumalai by Watve (1992) was used in the present analysis since this could not be collected from the study area.

STRUCTURE, HERD SIZE, HERD COMPOSITION AND SEX RATIO

The study area was covered on foot taking care to spend time in each type of habitat in proportion to their extent. However, most parts within the study area were visited recording the size, composition and structure of the elephant herds sighted. The methods suggested by Sukumar (1985) was followed for classifying the individuals into different age-sex categories. Only the completely classified herds had been taken for the analyses of herd size and structure. Herd size, composition and proportion of different age and sex classes in the population were derived on the basis of all sightings during the study time.

RESULTS

Herd size: A total of 379 elephants were sighted in 63 herds. Of these, 289 were from Periyar Tiger Reserve, 45 from Achenkoil and 45 from Ranni. Percentage frequency distribution of herd size in the study area is given in Figure 2.

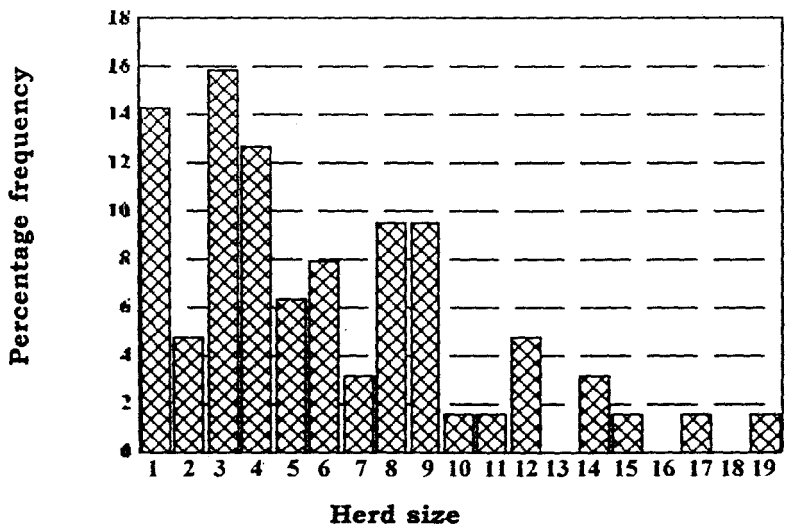
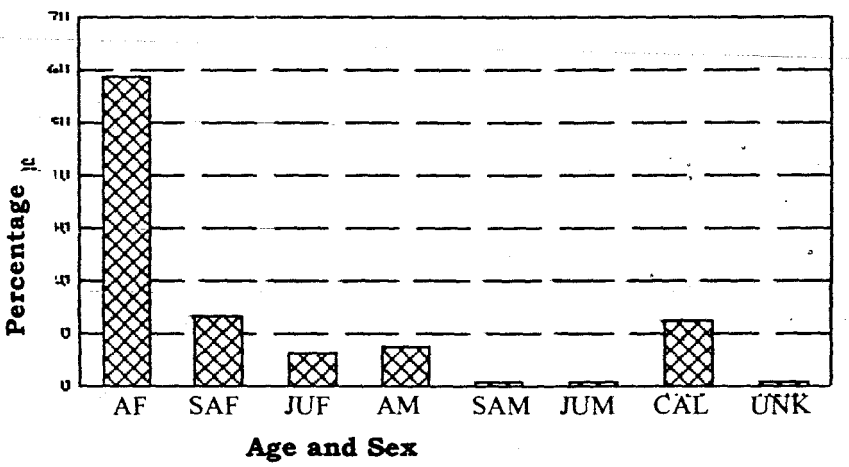


Figure 2. Percentage frequency distribution of herd size of elephants

The herd size was found to range from 1 to 19. About 14 percent were loners (most of them were makhnas and tuskers). Twenty eight adult males were sighted, of which 14 were makhnas and remaining tuskers, in a proportion of 1:1.

Herd composition and age structure: A schematic presentation of percentage frequency distribution of various age-sex classes of elephants in the population is given in Figure 3. Adult females formed a major portion of the population (58.6%) followed by sub adult females (13.2%) and juvenile females (6.%). Adult males constituted only 7.4 percent and sub adult males and juvenile males formed 0.79 percent each. About 12 percentof the population were calves, which could not be sexed.



AF-Adult female; **SAF**- Sub adult female; **JUF**-Juvenile female; **AM**- Adult male; **SAM**- Sub adult male; **JUM**- Juvenile male; **CAL**- Calves; **UNK**- Unknown

Figure 3. Percentage frequency of age and sex classes of elephants in the population

Sex ratio: Sex ratio of the elephant population in the area is summarized in Table 1. The overall male to female sex ratio was 1: 8.7. A male to female ratio of 1:16.7 was observed in the sub adult category and 1: 7.7 among the juveniles. However, the ratio of adult male to adult female was 1: 7.9.

Table 1. Sex ratio of elephants in Periyar Tiger Reserve and adjacent areas

Age class	Male : Female
Adult	1 : 7.93
Sub adult	1 : 16.67
Juvenile	1 : 7.67
Overall	1 : 8.68

A comparison of age-sex class proportion in different forest divisions in the study area is given in Table 2. The overall sex ratio of elephants in Periyar Tiger Reserve (PTR) alone was 1:11.5. The adult male to adult female ratio was 1:10.1. The overall sex ratio was 1:4.7 in Ranni and 1:4.6 in Achenkoil.

Table 2. Male: female ratio of elephants in different forest divisions

Age class	PTR	Ranni	Achenkoil
	Male : Female		
Adult	1 : 10.12	1 : 3.43	1 : 6.50
Sub adult	1 : 38	**	1 : 3
Juvenile	1 : 10	**	**
Over all	1 : 11.50	1 : 4.71	1 : 4.57

** = No male sightings in sub adult and juvenile classes

POPULATION DENSITY

Density of elephants in the study area was estimated to be 0.505/km^2. Density estimate for Periyar Tiger Reserve was 0.61/km^2, Ranni Forest division 0.53/km^2, Achenkoil 0.30/km^2 and Konni Forest Division 0.38/km^2 (Table 3 and Fig 4). The density in Erumely Range was only 0.22/km^2.

Table 3. Elephant density in different forest divisions

Divisions	No. of Transects	Dung density/km^2	CV %	Df	CI		Elephant density/km^2
					Lower	Upper	
PTR	25	682.87	5.48	480	613.43	760.16	0.61
Ranni	14	602.15	7.94	189	515.50	703.36	0.53
Achenkoil	3	427.49	22.21	27	272.52	670.57	0.30
Konni	10	337.72	11.02	97	271.58	419.97	0.38
Erumely	2	253.62	26.73	14	144.38	445.53	0.22
Overall	54	565.61	4.13	813	521.68	613.24	0.50

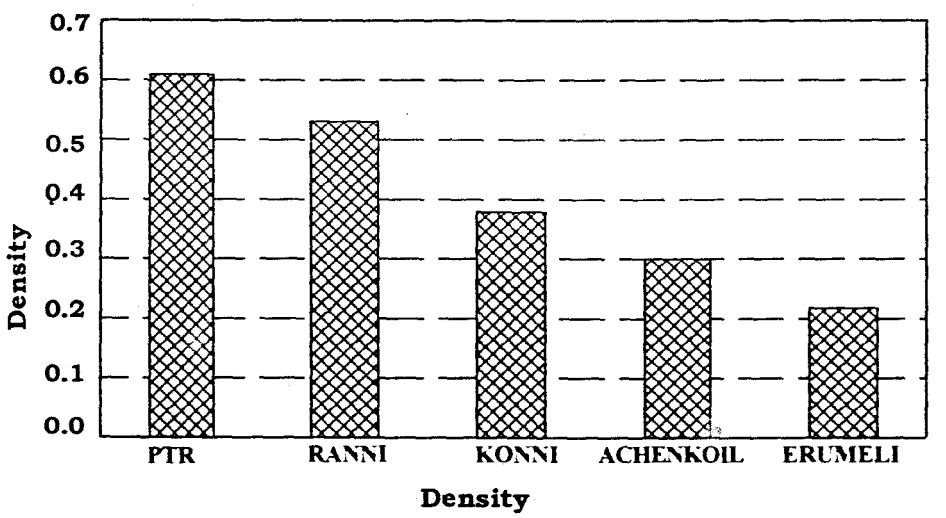


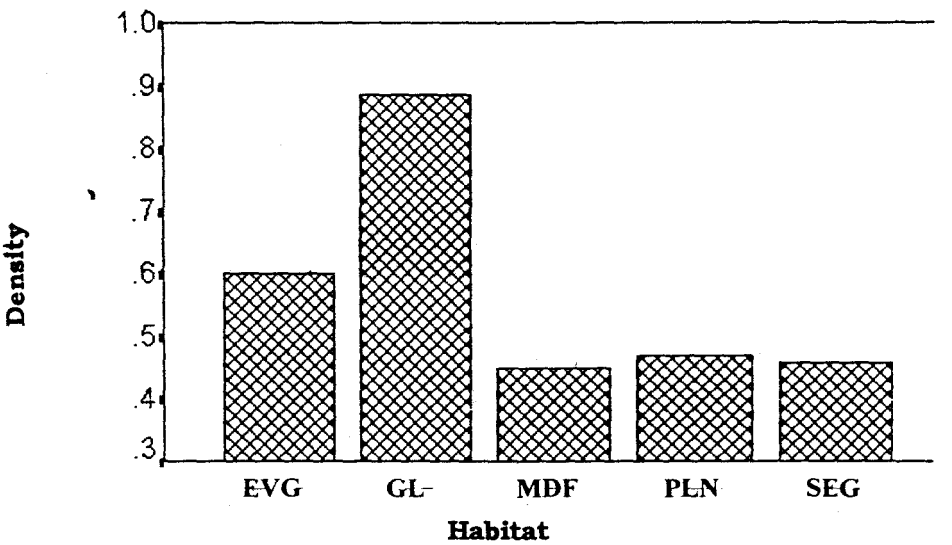
Figure 4. Elephant density in different forest divisions

The dung density and the elephant density estimates in different vegetation types during the study period are summarised in Table 4 and Figure 5. Grasslands had a higher density followed by evergreen forest and plantation.

Table 4. Elephant density in different habitats

*Habitat transects	No. of density/km²	Dung	CV %	df	CI		Decay rate	Elephant density/km²
					Lower	Upper		
EVG	20	675.16	6.82	318	590.80	771.56	0.0146	0.60
GL	7	781.40	11.01	146	630.17	968.91	0.0187	0.89
MDF	4	394.55	15.90	46	287.05	542.32	0.0187	0.45
PLN	14	412.43	8.49	163	349.32	486.93	0.0187	0.47
SEG	9	519.62	10.17	132	425.95	633.90	0.0146	0.46

*EVG= Evergreen, GL= Grassland, MDF= Moist deciduous, PLN= Plantation, SEG= Semi evergreen



EVG=Evergreen,GL=Grassland,MDF=Moist deciduous,PLN=Plantation,SEG=Semi evergreen

Figure 5. Elephant density in different habitats

POPULATION TREND

In a polygyamous society where one male mates with several females, there is surplus of males in spite of the low number of adult males due to various reasons. The mating of all the available females is otherwise ensured, provided the breeding male number is high. If the mortality of breeding class males increases further, it will lower the fertility. Even if the population does not lose its fitness through inbreeding, it could lose its evolutionary potential in the long run. It is estimated that to keep the effects of inbreeding deppression at a minimum level, a minimum of 50 breeding individuals are required in a population. The effective breeding population (Ne), calculated using the formula , Ne= 4x Nm x Nf / Nm + Nf gives an estimate of 111.31 for the population indicating a higher number of breeding elephants.

DISCUSSION

Eisenberg and Seindensticker (1976) mentioned the possibility of elephant density ranging from 0.12 to 1/km^2 in suitable south east Asian habitats. Studies in Africa (Buechner *et al.*, 1963; Leuthold, 1976b; Lewis, 1987) and Asia (Eisenberg and Lockhart 1972; Sukumar, 1985; Easa, 1989b; Sivaganesan, 1991; Desai and Baskaran, 1996) have shown the influences of food and water availability on density distribution of elephants.

HERD SIZE, COMPOSITION AND STRUCTURE

Herd size is a measure of the ecological health and larger herd size reflects stressful condition (Laws, 1974). Eltringham (1977) reported the possibilities of larger herd size due to poaching pressure. The smaller herds frequented more in the study area could be the reflection of the forested habitats (Peek *et al.*, 1974; Leuthold, 1976b). The least frequented large sized herds could be aggregations of different family units forming extended family (Laws *et al.*, 1975) and have no long-term cohesion (Ishwaran, 1984).

The fewer occurrences of all male herds in the population could probably be an indication of the low proportion of males in the study area. The overwhelming proportion of solitary bulls could also be pointing to the low male proportion in the population.

A herd of two adult males with a makhna and a tusker was observed once. Most of the observations show that the tusker was largely solitary whereas the makhnas were more often with herds. The overall mean herd size of elephant in the study area is 5.9.

SEX RATIO

Adult male to adult female sex ratio in the study area is 1:7.9 and the overall sex ratio was 1:8.7. The sex ratio of elephants in Periyar Tiger Reserve alone was 1:10.1 with an overall sex ratio of 1:11.5.

Downing (1980) considered sex ratio as a measure of reproductive performance of the population. Sukumar (1989) discussed in detail the possible influence of disparate sex ratio on the fertility of the elephant population. Most mammalian populations are reported to have an adult sex ratio biased towards females. This has been attributed to the higher natural mortality of males. He suggested that the operational adult sex ratio need not be as disparate as disparate observed sex

ratio in the population. Further, considering the non-seasonality of breeding in elephants, a disparate sex ratio can still ensure mating of almost all-mature females. Cowan (1950) and Clutton-Brock *et al.* (1982) have mentioned a female biased adult sex-ratios in population of certain mammals, close to carrying capacity.

The proportion of different age-sex classes in the elephant population in Periyar Tiger Reserve indicates a shift towards the older age classes with adult and sub-adult females contributing highly. The calves form 12.40 percent of the population indicating a good proportion of breeding females. A comparison with earlier reports from Periyar (Ramachandran *et al,* 1986) indicates a stable age distribution, which in turn points to a steady environment regardless of the fluctuations in the population. A comparison with another population will be futile since each has its own particular distribution for a given set of environmental conditions (Wilson, 1977). The percentage of calves could be normally taken as the trend in the population growth rate. Sukumar (1989) mentioned of the unreliability of such interpretation of sex ratio due to several reasons including the established annual fluctuations in the recruitment to the population.

Ramakrishnan *et al.* (1998) attributed the skewed sex ratio and low number of calves and juveniles to increased poaching pressure. However, one of the factors never considered in previous interpretations of the data on sex ratio of elephants in Periyar is the number of animals officially captured and thus removed from the Periyar population since 1810 (Kesavapillai, 1970) and lasted till the late 1970s. Though complete official records were not readily available, enquiry and interviews with the experienced mahouts, who had participated in elephant capture in Konni elephant camp made available the details of about 64 elephants captured from the area and brought to camp. About 67percent of these were males. This would suggest that removal of males through capture would also have contributed to the skewed sex ratio in the area. The age structure of elephants captured in the Mysore Kheddah of 1968 (as given in Sukumar, 1989) also indicates a comparatively higher percentage of males in the catch. The sex ratio at stable age distribution depends on the magnitude of difference in mortality rate of male and female elephants (Sukumar, 1989). The males captured are not available to the population.

Wilson (1977) has discussed the pros and cons of inbreeding in animals. The smaller sized, more stable and closed groups have greater degree of inbreeding. Inbreeding accompanying the small group size favour social evolution but leads to a decline in competence and loss of heterozygosity reducing the ability to cope with the

fluctuations in the environment. Social groups avoid incest through behavioural mechanism such as dispersion as in lions (Schaller, 1972) and some of the old world monkeys and apes (Itani, 1972)

One of the major differences the present observations have with earlier reports is the almost equal percentage of makhnas (tuskless males) among the males in the population. An indication on such a possibility is of course given in Ramakrishnan *et. al.* (1998) where three out of five males recorded were makhnas. Long term monitoring of the elephant population in Periyar and adjacent areas would yield a wealth of information on the problems of inbreeding, sex ratio, natality, mortality and other interesting aspects.

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