THE ECOLOGY OF THE DE BRAZZA'S MONKEY *Cercopithecus neglectus* SCHLEGEL IN KISERE FOREST, KENYA.

BY

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DECLARATION

This thesis is my original work and it has neither been presented nor is it being presented for a degree in any other university.

July 31, 1991

JOSEPH W. MURIUKI

This thesis has been submitted for examination with our approval as the university supervisors.

DR. H. M. TSINGALIA — DATE

PROFESSOR THELMA E. ROWELL — 6 August '91 — DATE

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DEDICATION

Dedicated to my dear parents, Elizabeth Wandia and Wahome Muriuki for everything that they have done for me, and to Thelma Rowell.

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ABSTRACT

The ecology of the endangered de Brazza's monkey *Cercopithecus neglectus* was investigated in the Kisere Forest Reserve between December 1987 and March 1989. The total number of contact hours was 528. A total of 43 monkeys were counted which comprised of three troops and three solitary adult males. Troops numbered 11, 13 and 16 monkeys. All troops had a single resident adult male, at least three adult females and juveniles, thus they had a polygynous social organization. The sex ratio deviated from unity and five births occurred betwen January 1988 and March 1989.

Home ranges varied between 4.1 to 6 ha, densities were high and flooded areas of the forest were heavily used. This species was only found near rivers, spent more than 50% of the time below 5 meters and preferred sheltered areas for sleeping sites. The daily path length ranged from 330-1001 meters. Feeding peaks occurred around midday. The de Brazza's were mainly frugivorous but leaves and invertebrates formed a substantial part of the diet. Slow moving invertebrates were preferred . Feeding on various food items had a diurnal pattern. All behaviour categories reported for all other congenerics were observed. Polyspecific associations were absent.

INTRODUCTION AND LITERATURE REVIEW

Over time, species of animals have been lost to extinction. The circumstances preceding this is demographic contraction which in most cases is nonrandom, precipitated by activities like overkill or relentless loss of habitat. Under such conditions, random events can drive specific or populational extinction. Whereas the role of human demographics is significant, a lot of species would be saved if data on various aspects of their live histories was available. It is of vital importance therefore, that the conservation of a species should start with gathering information about its biotic and abiotic environment. In the book edited by Soule in 1986, various contributors have emphasised on the importance of proper research not only for decision making but also for creating awareness among scientist and nonscientists alike. There has been a general tendency to sympathise with the plight of highly conspicuous species while others go extinct in oblivion. The de Brazza's monkey could easily fall in the latter category as observed by Gautier-Hion & Gautier (1978). It is noteworthy that other primate species would probably have faced the same fate as the golden lion tamarin *Leontopithecus rosalia* were it not for timely studies.

Primates, while being ubiquitously distributed in habitats are often found in impossibly dense and inhospitable rain forest of Africa, Southeast Asia and the neotropics. It is no great wonder that the study of primates under natural conditions only started about 50 years ago. Pioneer work on primate behaviour and ecology was started by Carpenter on howler monkeys, spider monkeys and gibbons (Struhsaker 1975). Japanese Macaques also received early attention (Imanishi & Itani 1950) in Sruhsasker (1975). After a hiatus of about a decade, renewed work was continued by Washburn and deVore (1961), Altmann (1962), Rowell (1966)

and also by Schaller (1965), Struhsaker (1969), Kummer (1970) and Gartlan (1966).

Due to difficulty of studying primates in forests, there was an obvious bias in the early studies towards open habitat primates. Theories developed from these studies were incorrectly generalised to cover allprimates. Since the largest number of primates live in forests, it became important to study these primates in order to develop a more accurate view of primate biology (Struhsaker 1975)

Studies of rainforest guenons have been conducted especially in Africa, including work done by Gautier-Hion & Gautier (1976,1978, 1980,1985, 1988), Rowell (1982,1984,1988), Waser (1977), Cords (1984,1986, 1987, 1988), Struhsaker (1975,1977,1979, 1981). In central and South America, pioneer work was done by Hladik and Hladik (1969, 1979) and was continued by Chivers (1977). The information available now is more representative of primate biology and ecology.

The genus *Cercopithecus* is a member of the old world primates. It is comprised of more species than any other genus of the African primates, totalling at least 23 species (Wolfheim 1983).

With the exception of *C. aethiops* and *Miopithecus talapoins* most of the species do not live in groups with more than one adult male. Most are small (2-8Kg), have brightly coloured fur and have distinct facial markings (Kingdon 1980). They are all noticeably sexually dimorphic and *C. neglectus* is the most strikingly so (Rowell 1988).

Not withstanding the large number of species, the genus has not been very well studied in the longterm, relative to other primate genera. This is most likely because of the nature of their habitat which is dense forest which makes observation difficult (Aldrich-Blake 1979). It appears that

human predation in some areas compounds the problem. Only about half of the species has been studied (Cords 1986). For most species, even where presence has been confirmed, the population densities are unknown. In the absence of data on basic demography and community relationships in different geographic areas is is therefore difficult to assess the importance of specific ecological variables that determine the distribution and abundance of guenons.

Most *Cercopithecus* monkeys inhabit forests of West and Central Africa (Hill 1966) and there is some variation in habitat preference (Wolfheim 1983). Most of the forest species are primarily aboreal and are quick and agile in trees. Occasionally they may feed on or near then ground (Wahome, Cords & Rowell 1988). Only *C. neglectus*, *C. ehoesti* and *C. mona* are often at the ground level and the first and the third are closely related (Ruvolo 1988).

The feeding ecology of the guenons is quite varied. Differences in the study methods make it difficult to compare interpopulational differences. Only data from studies on *Cercopithecus mitis* and *C. ascanius* are comparable. The guenons are generally frugivorous. Larger species are generally more folivorous and less insectivorous than small ones (Cords 1984, 1986, 1987) and there is a high degree of overlap in diet. (Struhsaker 1979; Gautier-Hion & Gautier 1978,1980; Cords 1984,1986).

Fifteen of the species live in social groups where the females are permanent members. Males live their natal groups at puberty and may be solitary (Tsingalia & Rowell 1984; Cords *et al* 1986; Cords 1988; Cords and Rowell 1987). With the exception of *M. talapoins* females of all species have no sexual swellings and hence do not show any external signs of oestrus (Rowell 1982). There is little information on most reproductive

parameters from natural populations since longterm studies of known individuals are lacking (Cords and Rowell 1987). Data from captive animals give an estimate of these parameters in the field see Gautier-Hion & Gautier (1976, 1978); Rowell & and Richards (1979) for habituated study groups. Some members of the genus like *C. neglectus* are very elusive and have hence escaped attention.

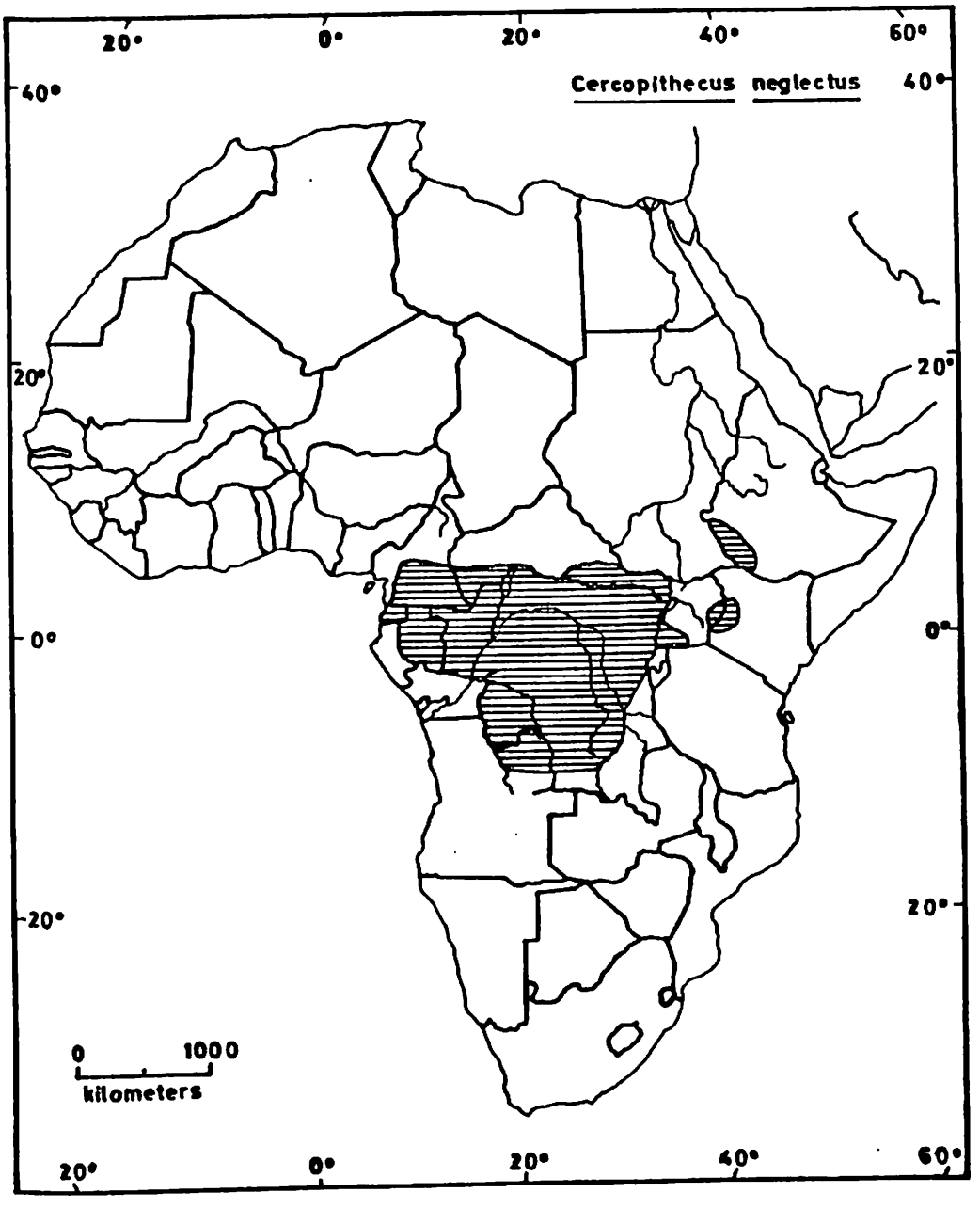
There are two sub-groups in the genus. The de Brazza belongs to the 'diana ' sub-group which also includes *C. diana, C wolfi, C. pogonias, C. mona and C. campabelli.* The 'mitis' sub-group comprises of the other members of this genus (Ruvolo 1988). Among the guenons the de Brazza's monkey *C. neglectus* is the least studied.

The general distribution of the de Brazza's monkey has been described. It occupies a wide belt in central Africa from Cameroon to the southern Ethiopia through Zaire and northern Angola. In the west it occurs as far North as 4°40'N and as far south as 10°S. West as far as equatorial Guinea. In the east it has been reported as far North as 7°26'N and 35°02'E and as far as 5°11'N and 36°12'E in Ethiopia (Wolfheim 1983). Most of the areas where the species is found have been opened up for human occupation thus changing the distribution of this species. Malbrant and MacLatchy (1966) reported that the de Brazza's monkey does not seem to occur in coastal areas (Fig.1)

In Kenya, the monkey is found in riverine forests of densely populated areas in the western region. Small isolated populations are found at Kitale, Saiwa Swamp, Mt. Elgon, slopes of the Cherangani Hills, Mt, Kenya and near maralal (Booth 1962; Hill 1966; Kingdon 1971; Wolfheim 1983; Brennan 1984, 1985) and the Kakamega forest (Muriuki & Tsingalia 1990, see Fig. 2)

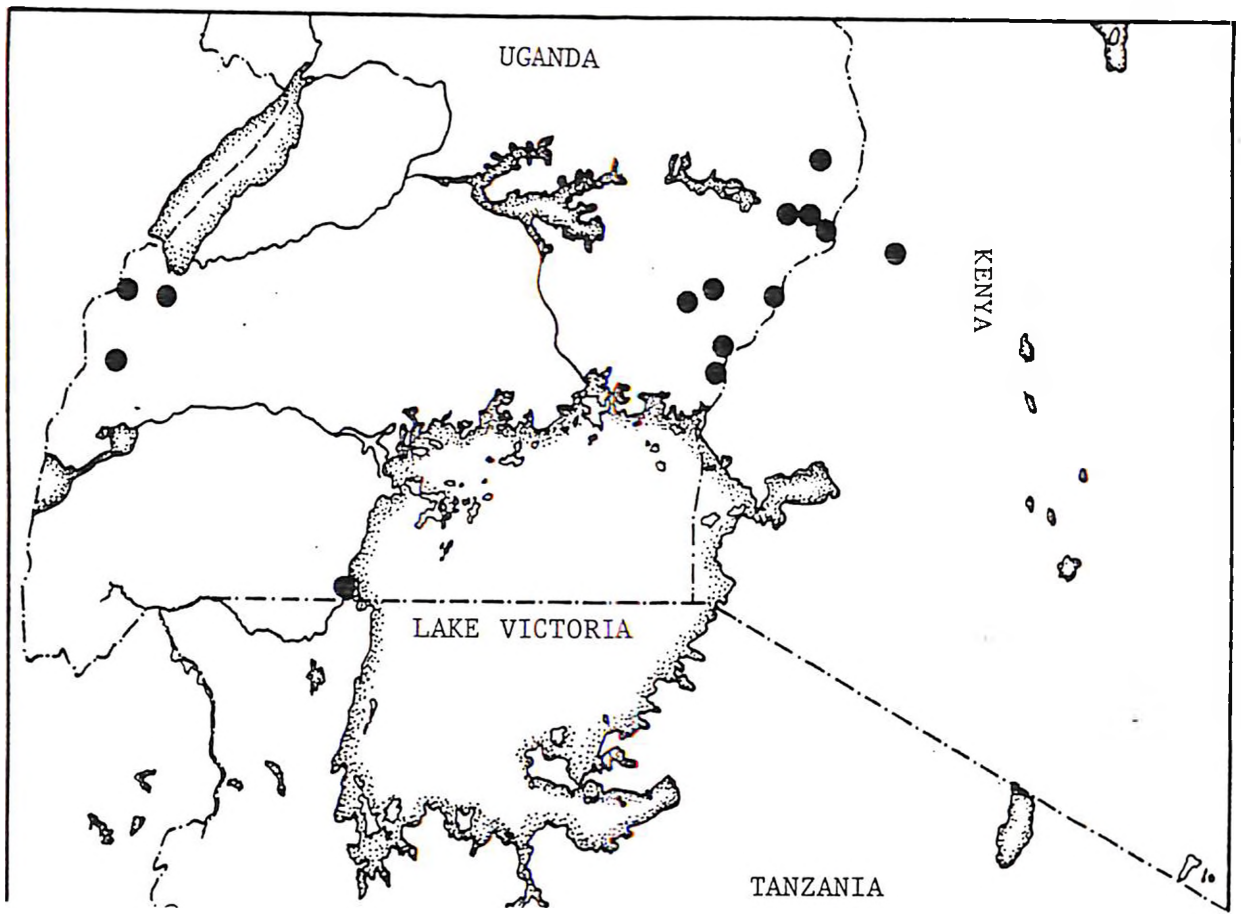
Fig. 1. The distribution of the de Brazza's monkey

(Most of the areas have since been cleared and the distribution of the de Brazza's monkey has changed)



Source: Wolheim (1983)

Fig. 2. The distribution of the de Brazza's monkey in East Africa


UGANDA
KENYA
LAKE VICTORIA
TANZANIA

Estimates of densities of the de Brazza's monkey are rare but consistent. For instance, Quris (1976) found 0.28 individual per hectare in North eastern Gabon. Gautier- Hion & Gautier (1978) calculated a density of 0.3-0.5 individuals per hectare in the Makokou forest in Gabon and Brennan (1984,1985) found a density of 0.35 individual per hectare in western Kenya. Many researchers have reported small groups consisiting of one to 35 individuals (Brown & Urban 1970; Kingdon 1971; Gautier-Hion & Gautier 1978; Brennan 1984).

The de brazza's monkey though typically a humid forest, riverine species typical of swamp forest and seaesonally flooded forest (Kingdon 1971; Gautier-Hion & Gautier 1978; Scott 1980; Brennan and Else 1984; Brennan 1984, 1984), occurrs in a variety of forest habitats. Brown and Urban (1970) reported this species to occur up to one kilometer away from the river. Kingdon (1971) reported it to occur along streams in dry montane forests up to an altitude of 2100meters. The same author reported that this species can use secondary forests and palm trees.

The nature of the de Brazza's habitat makes a direct competitor of man for land, and it is therefore a small wonder that it has lost most of its habitat to human settlement (Kingdon 1971; Wolfheim 1983; Brennan 1984 ,1985).

The de Brazza's monkey is easily distinquished from the other Cercopithecines by the white beard and muzzle, chestnut coloured hair on the forehead and greeny-grey body.

It has a characteristically obliquely curved white stripes on the upper thigh and white areas below the callosities are continuous with the thigh (Hill 1966; Kingdon 1971; Chiarelli 1972; Lozen 1974). Among the guenons, it is stocky in build and highly sexually dimorphic. Males weigh from nine to eleven Kilograms and females weigh around four kilograms (Kingdon

1971; Gautier-Hion & Gautier 1976,1988; Rowell & Richards 1979). With exception of distictive sex organs, both sexes have the same pelage except for a red perineum in females. The newly born *C. neglectus* have a soft brown coat with an indistinct white chin.

The social organization of the de Brazza's monkey is not well studied. In Gabon they are reported to live in small monogamous groups comprising of an adult male, an adult female and one or two offsprings (Gautier-Hion and Gautier 1978). In Kenya, group sizes suggesting more than one adult female per troop have been reported (Brennan, 1984,1985). In Kakamega forest, Kenya groups with more than one adult female have been observed. These observations suggest the possibility of a social organization that exhibits interpopulational differences (Leutenegger & Lubach 1987).

Nothing is known of annual reproductive patterns of the de Brazza in the wild. Based on studies of captive animals, the first pregnancy has been reported to occur at three and half years of age. This is early for *Cercopithecus* as most of the species have been reported to start menstruating at the age of four years. The gestation period has been estimated at170 days with births in captivity occurring in most months of the year (Gautier-Hion & Gautier 1976; Rowell and Richard 1979).

Based largely on stomach contents analysis and captive studies, the de Brazza's monkey like other *Cercopithecus* is an omnivore with frugivorous tendencies (Hill 1966; Kingdon 1971; Gautier-Hion & Gautier 1978, 1980). Unlike other *Cercopithecus* and may other primates in general, the de Brazza has not been reported to participate in polyspecific associations (Gautier-Hion & Gautier 1978,1988).

In East Africa, no detailed ecological study has been carried out on this species. In her census in 1984, Brennan reported less than 150 animals

in Kenya. Most of them occurred in privately owned land which awaits conversion into agricultural land. It is generally agreed that habitat destruction and human predation are the major factors that account for the reduced de Brazza's monkeys population and are threatening its survival at least in Kenya (Wolfheim 1983; Brennan & Else 1984; Brennan 1984,1985).

The status of the monkey throughout the rest of its range is largely due to its elusive nature but the IUCN's Red Data Book describes it as not endangered or threatened (Phyllis Lee *et al* 1988).

It is clear therefore, that the socio-ecology of the de Brazza's monkey is of considerable theoretical interest. There is, however, little data available owing to its shy and elusive nature, and the general inaccessibility to its habitat.

In 1983, Tsingalia reported a group of de Brazza's monkeys in Kisere forest, an isolated patch of the Kakamega Forest. This population was hitherto unknown, but easily observable. Kisere Forest is a nature reserve and the only other habitat after Saiwa Swamp National Park where the de Brazza is offered formal protection.

This research project was carried out to study this newly reported population with aim of looking into the ecology of the population. The Objectives of the study were:

1. Carry out population census of the de Brazza's monkey in the Kisere forest.
2. Determine troop size and composition of de Brazza's monkey in Kisere Forest.
3. Study habitat use and social behaviour of the de Brazza's monkey in Kisere forest.
4. Make recommendations for the conservation of the de Brazza' s monkey.

2. STUDY AREA AND SUDY SITE

2.1 The Kakamega forest reserve

The Kakamega forest is located in western Kenya, directly south of the Nandi escarpment. It is situated between latitudes 0°10'N and 0°21'N and longitudes 34°47'E and 34°58'E about 40 Km northeast of Lake victoria. Altitude above sea level varies between 1520m and 1680m. The gazzetted Forest Reserve is approximately 238km^2 in area although only 48% of this land is under natural forest. The forest is presently an island in a highly agricultural area with a human population density of 175 persons per Km^2 (Cords 1987; Tsingalia 1988).

The Kakamega forest is the only remnant of the Guineo-Congolean forest type in kenya and it has characteristics resembling those of the lowland Congo basin further west Lucas (1968) in Cords 1987.

Lind and Morrison (1974) classified the Kakamega forest as semi-montane or semi decidous while Zimmerman (1972) and Hamilton (1974) classified it as "drier type Guineo-congolean lowland forest". Based on rainfall and temperature data available at the Kakamega forest station, the forest eceives an average annual precipitation of 2215 +/-26mm. The rain falls seasonally with the long rains starting in March or April through July or August and the short rains falling in October and November (Fig. 3). Mean monthly temperature range from a minimum of 11-21°C and a maximum of 18-29°C (Fig. 4). Two major rivers pass through the forest, each with several tributaries. In the northern section is the Isiukhu river which originates from the Nandi hills and the Nandi escarpment. The southern section is dissected by the Yala river and many tributaries with sources mainly in Tinderet and south Nandi forest (Kokwaro 1988).

Fig. 3. Mean Monthly rainfall (mm) at Kakamega forest.
(Data is from 1859 to1985)

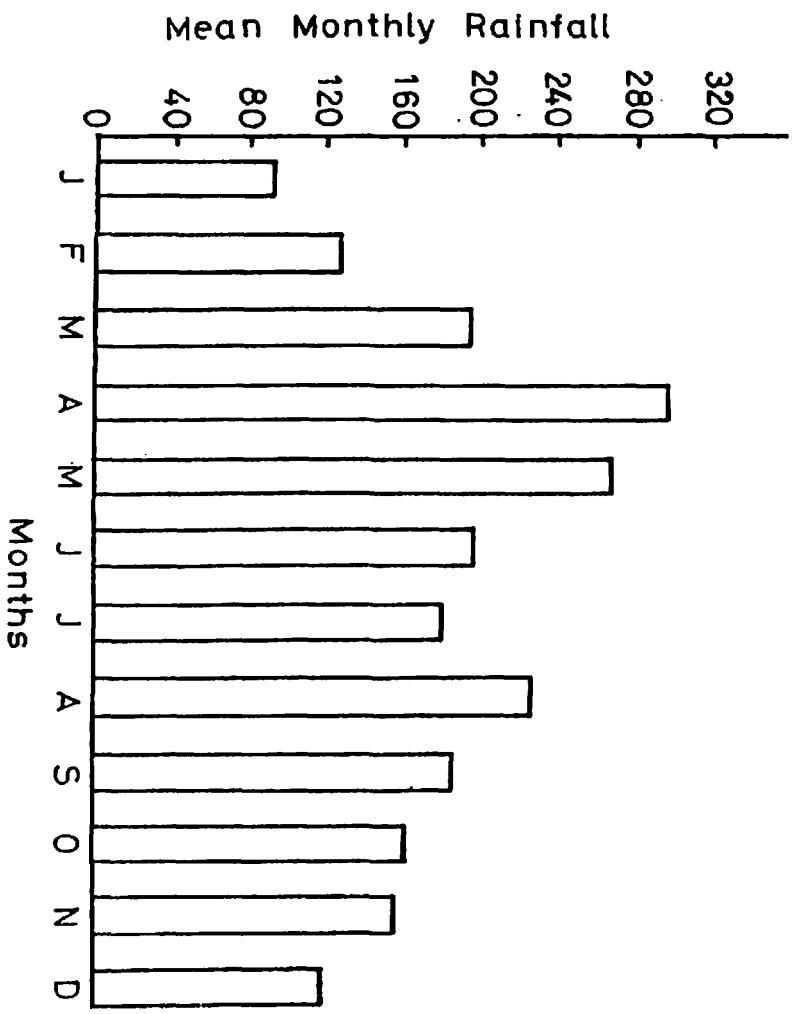
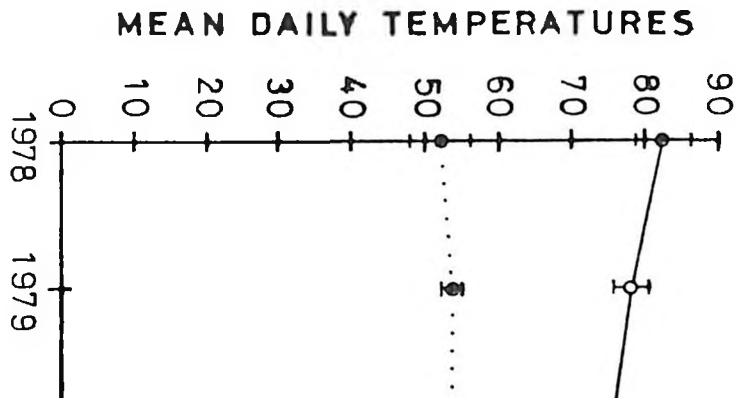
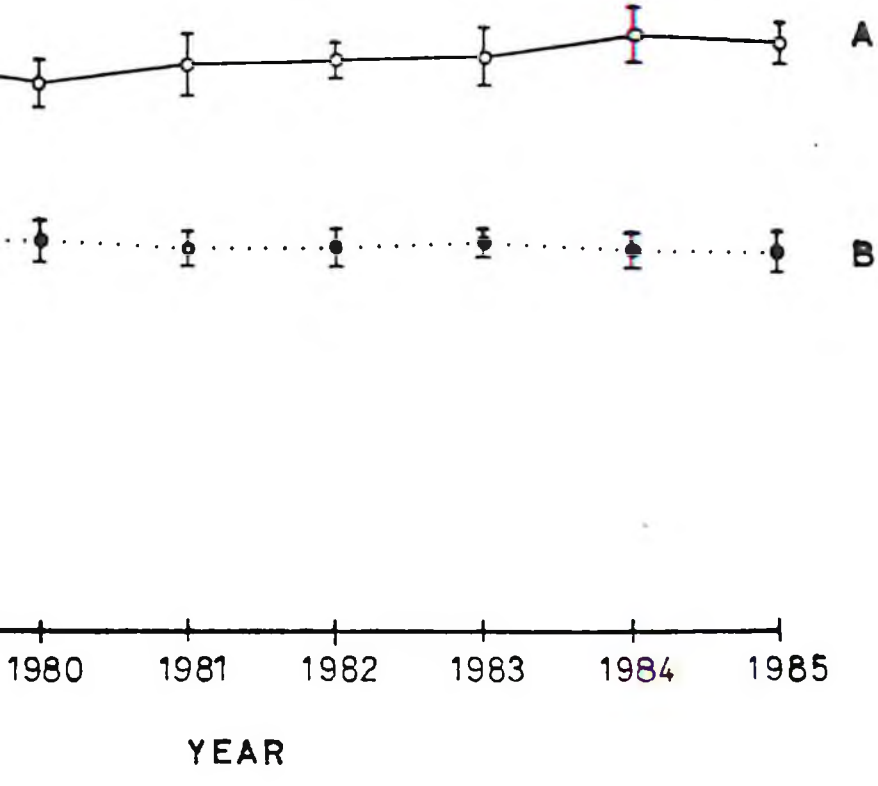

Mean Monthly Rainfall
0
40
80
120
160
200
240
280
320
Months
J
F
M
A
M
J
J
A
S
O
N
D

Fig. 4. Variation in mean daily temperature (°F) at Kakamega forest


MEAN DAILY TEMPERATURES
0
10
20
30
40
50
60
70
80
90
1978
1979



Source: Tsingalia (1988)

Delsol *et.al* (1987) (in Tsingalia 1988) reported that 56% of the soils of the Kakamega forest are granitic in origin. They are well drained, deep and of variable natural fertility. Granitic soils are fairly fertile and support a large number of forest plant species (Tsingalia 1988). Other soils mainly from basic rocks like basalt and phonolites or from biotite and gneiss can be found interspersed with granitic soils.

The flora of the Kakamega forest show marked similarities to those of the Central african forests (for a plant species list see Cords 1984). The fauna has been documented by Zimmerman (1972) for birds, Kingdon (1971) for mammals and Spawls (1978) for snakes in(Cords (1987)).

2.2 The study site: Kisere Forest Reserve

The Kisere Forest Reserve is a part of the Kakamega forest reserve and is located 2Km from the northern boundary of the main Kakamega Forests (Fig. 5). It is biologically and geographically related to the main Kakamega forest and makes up 1.8% of the total area (Table 1).

Kisere forest was established as a forest reserve in 1933. Together with Buyangu forest they form The Kakamega National Reserve which was established in 1984. Since there is no meteorological station in or near the reserve, data from the Kakamega forest station is used to describe climate at kisere. The distance between the two forest is short and no significant difference is expected in climate. The rivers Isiukhu and Nandamaywa almost surround Kisere Forest Reserve.

Although written records only start in the 1940s reports suggest that riverine forest existed along the Isiukhu and the Nandamaywa rivers joining the Kakamega forest to the Kisere forest allowing considerable biological exchange between the two forests (Tsingalia 1988). Unlike the

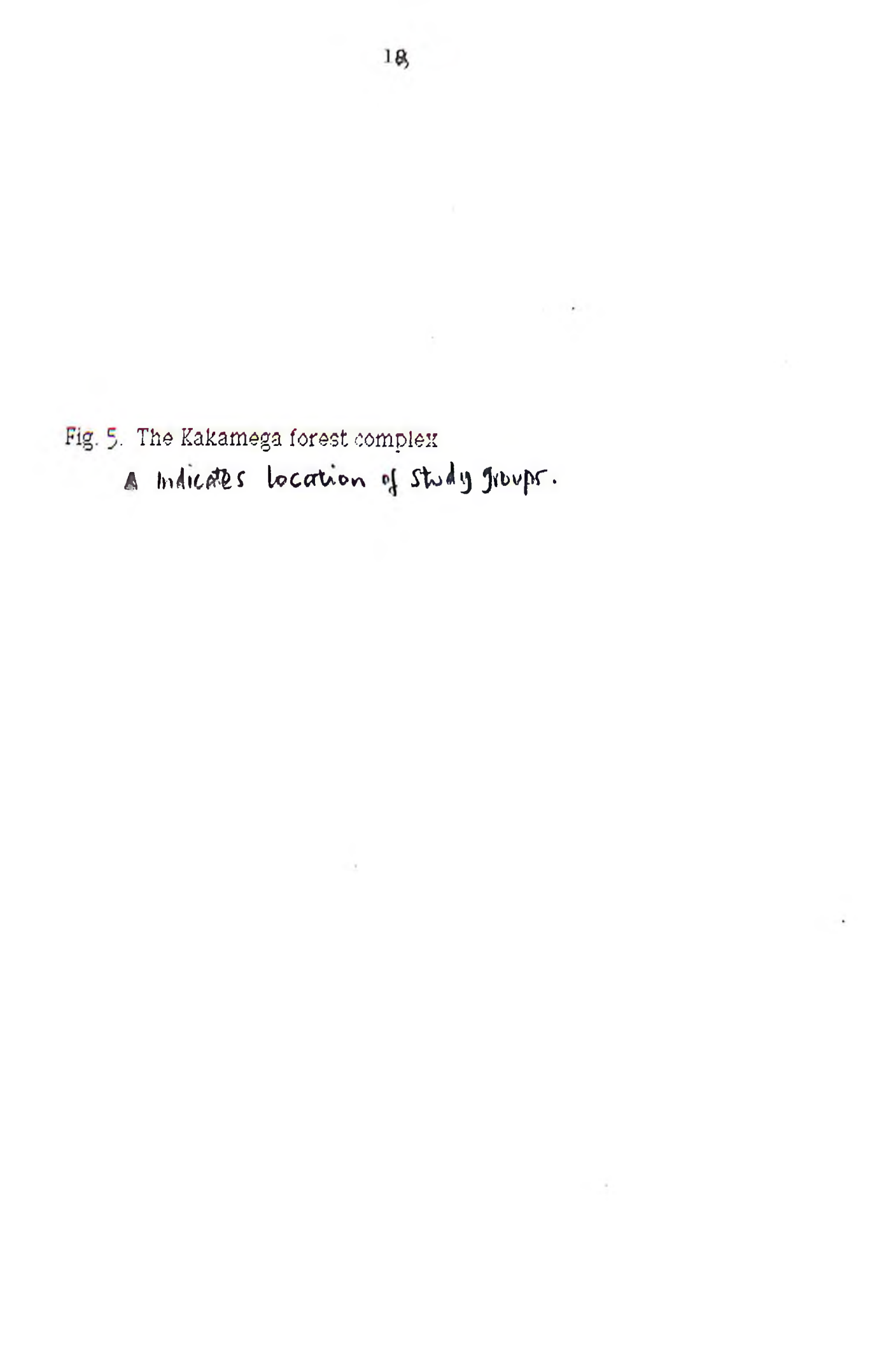
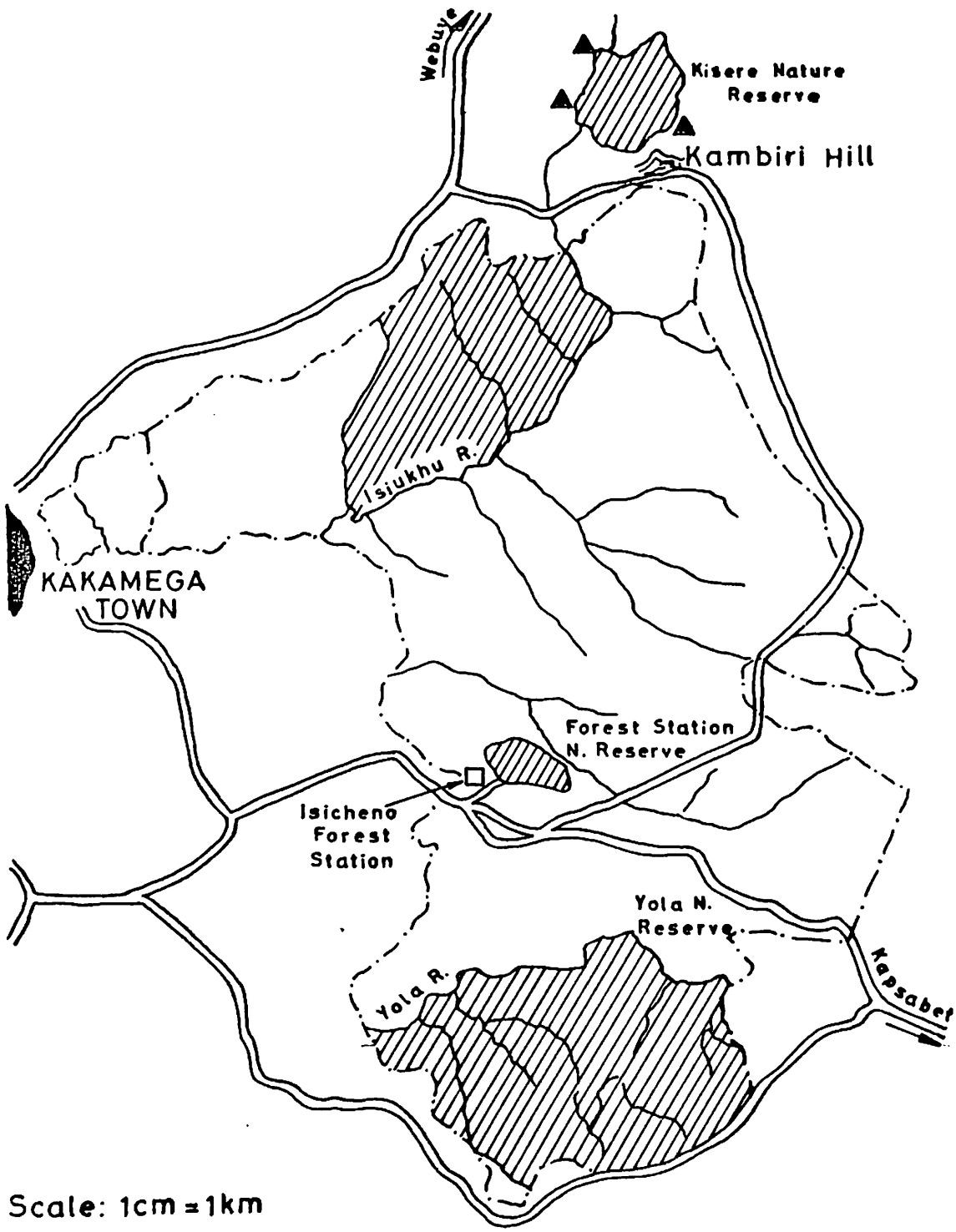


Fig. 5. The Kakamega forest complex
▲ indicates location of study groups.



Source: Tsingalia (1988)

Table 1. Forests that constitute the Kakamega Forest complex (area and percent of total given)

FOREST	AREA (ha)	PERCENT OF TOTAL
Kakamega	23777	89.7
Kisere	484	1.8
Malaba	719	2.7
Bunyala	785	3.0
Maragoli	750	2.8

(Unpublished forest records)

main Kakamega forests where trees were felled in the 1940s (Cords 1987) the Kisere forests has never been felled. It has been suggested that lack of a bridge across the isiukhu and Nandamaywa rivers may have made access difficult. Social factors also played part in preserving the forest reserve. Local residents held revered beliefs that there were sacred snakes in the forest and hence nobody would venture very deep inside the forest (pers. comm. with the local people)

The trees in Kisere are on the average taller than those remaining in the main Kakamega Forest. Kisere has a well defined canopy at 30meters with canopy cover of 80-90%. This canopy is absent in the main Kakamega Forest because of logging. The understorey is also different in the two forests with *brillantasia nitens* more common in the Kakamega forest and the more shade tolerant *Dracaana afromontana* being the dominant understorey in parts of the Kisere forest. Hardwoods like *Olea welwitschi* and *Manilkara butugi* dominate the Kisere forest while softwoods like *Croton megalocarpus* dominate in the main Kakamega forest (Tsingalia 1988). The fauna of the kisere forest like that of the Kakamega forest show similarities to that of the Central African forests. The species diversity ahs been reduced because it is an island. It is rich in the species of birds but poor in mamals. Monkeys are by far the most conspicuous mammals (table 2) . Other mammals that are found in the reserve are listed in table 3.

In the rivers Isiukhu and Nandamaywa, Cape clawless otters have been seen fishing and at Buyangu, forest hogs appear to be increasing in numbers because of reduced hunting pressure (Tsingalia 1988; Jackson pers. com. pers obs.).

About 20 years ago, cape buffalo *Cynocerus caffer* and African elephant *Loxodonta africana* were resident in the forest. Today , however

they have all disappeared (Mungahu pers. comm.). At present Kisere is a habitat island in a sea of human settlements. It is, however, unique because of its relatively undisturbed state and perhaps it is the most representative of the Guineo-congolean forest in Kenya.

2.3. Study duration

A preliminary survey was carried out in December 1987, March 1988 and August 1988. Data were collected intensively in april 1988 and continuously from September 1988 to March 1989. Three troops were followed sytematically for 93 days of contact with a total of 528 hours. The mean number of hours of contact per day was 5.7 hours with a range of 3.3-1.8 hours. Mean number of days of observation per month was 11.6 with a range of 9-16 days. There were days when it was hard to locate a troop and if a three hour search proved fruitless, the time was devoted to sampling vegetation or to analysing data.

The focal group observer technique was used in the study but the exact protocol in described for each parameter under investigation.

Table 2. Types of primates resident in the Kisere Reserve

Common name	Scientific name
Blue monkey	*Cercopithecus mitis stuhlmanii*
Redtail monkey	*Cercopithecus ascanius schmidt*
De Brazza's monkey	*Cercopithecus neglectus*
Black and white colobus monkey	*Colobus guereza*
Olive baboon	*Papio anubis*

Table 3. Other mammals that have been seen in the Kakamega Forest.

Common name	Scientific name
Potto	*Perodictus potto*
The African genet	*Nadinia binotata*
Genet	*Genetta tigrans*
Flying squirrel	*Anomalus fraseri*
Giant squirrel	*Protoxerus stangerii*
Sun squirrel	*Heliosciurius rufobrachium*
Bushbuck	*Tragelaphus scriptus*
Blue duicker	*Cephalophus monticola*
Red duicker	*Cephalophus callipygus*
Suni	*Neotragus moschatus*
Tree pangolin	*Manis tricuspis*
Jackal	*Canis adustus*
Spotted hyena	*Crocuta crocuta*
Leopard	*Panthera pardus*

Plate 1. A de Brazza's monkey mother and juvenile

Plate 2. A part of the Kakamega Forest Reserve from the Top of Buyangu hill.

Plate 3a. A scene along the Nandamaywa river showing grazing next to the forest edge

Plate 3b. A scene along the Nandamaywa river shopwing a sugar cane farm right next to the forest edge

Plate 4. A scene along the Isiuku river during the rainy season

Plate 5. A swampy section of the river Isiukhu

Plate 6. Troop A de Brazza's monkey on *Ficus thoningii* tree

3. POPULATION CENSUS AND GROUP COMPOSITION

3.1 Introduction

The age and sex composition descibes the structure of a population, provides insight into its history and is useful in predicting reproductive potential of the population (Turner 1978). Population studies of the de Brazza's monkey *C. neglectus* are few and the status of the monkey is unknown in most of its range (Kingdon 1971).

Reports on troop sizes vary. Small troops made up of three to four individuals were reported in the Makokou forest of Gabon (Gautier-Hion & Gautier 1978). Similar troop sizes were reported by Malbrant and MaClatchy (1969). Quris (1976) reported an average of three monkeys with a range of 2-6 animals in northeastern Gabon. In western Kenya troops are said to vary from 1-6 individuals (Brennan 1984, 1985), While in Ethiopia, Brown and Urban (1970) reported large troops of 6-10 individuals. Kingdon (1971) reported seeing large troops of 15-35 individuals in "East Africa".

There is disparity in the reports on group composition. In Gabon, Gautier-Hion & Gautier (1978) reported a monogamous social organization, comprising of an adult male, adult female and one or two juveniles. These family units were cohesive. Occassionally, however, these family units merged and formed larger groups in a non-confrontational way and later seperated. In East africa (including Ethiopia) larger groups than would form stable monogamous units have been reported. There has been speculation that the Kenyan and Ethiopian de Brazza's may be polyynous (Leutenegger & Lubach 1987)

3.2 Methods

3.2.1 Census

A troop of de Brazza's monkeys was first sighted in Kisere forest by Tsingalia in 1984 along the Nandamaywa river (Muriuki & Tsingalia, 1990). It was thought that these monkeys would occur in the entire forest. To determine if this was true, residents living along the the forest edge were interviewed with the aid of colour pictures of all the primates that had been reported to live in the forest. Details of the location of the monkeys, date and time of sighting were noted. Where possible information on the activity of the monkeys at the time was also collected. This method of survey was shown to be effective by Brennan in 1984. The entire Kisere forest was searched and all species of mammals that were encountered was noted. de Brazza's were not seen far away from the water confirming distribution reported by other workers. (Hill 1966; Kingdon 1971; Gautier-Hion & Gautier 1978; Wolfheim 1983; Brennan 1984,1985). The survey was then concentrated along the rivers Isiukhu and Nandamaywa as the study progressed. The method of using landmarks along a transect has been used by other workers e.g. whitesides *et al* (1988). Surveys were carried out from 6.00hours to 19.00 hours; weather permitting. Stops were made every 50 or 100 meters depending on the visibility and both sides of the river were scanned using a pair of 7x42 binoculars for 15 minutes or longer if de Brazza's were suspected to be in an area.

On sighting of a primate group, its location, size and distance from the river and the activity at the time of sighting was noted. When possible the distance of the group from a previously sighted group was recorded. Both sides of the river were visited sytematically every other week to ascertain that no de Brazza's had been missed. Revisits were made to all sites where de Brazza's had been sighted during the surveys.

3.2.2 Group composition

The approximate age of individuals encountered in a troop was estimated by comparison with captive de Brazza's monkeys of known age observed by the author at the Institute of Primate Research at Karen Kenya. Size and colour was assumed to show à corresponding relationship to age. Adults of each sex were distinquished using external genitalia. The adult female is easy to identify because of the obvious brownish perineal region and in most cases well-defined nipples. The adult male on the other hand is conspicously larger than the rest of the troop and it has a blue scrotum. Members of the troop were categorised in to adult male, adult female, subadult male or female, large juvenile, small juvenile and infant. If an adult de Brazza's monkey was at least 200m away, it was described as solitary. Struhsaker used 100meters in a study of red colobus monkeys in 1975. Where an adult or subadult was seen fleetingly, it was classified as "big" (Table 4).

As the study progressed, and the troops were followed more frequently, individual members of each troop were recognized by natural markings e.g. shape of the tail or beard, lost ears or digits shape of nipples and general appearance. At the end of the study all adult and sub-adults of two troops, some adult members of a third troop and a number of juveniles were individually known. This also helped in troop identification. Individual identification is the best method of elucidating the age- sex classes and has been used extensively (Struhsaker 1975; Eisenberger *et al* 1981; Tsingalia and Rowell 1984; Cords 1984).

de Brazza's are hard to follow due to their elusive and inexpressive nature. Taking advantage of of the cultivated fields along the river I

Table 4. Age-sex class categorization criteria for the de Brazza's monkeys in Kisere Forest Reserve

	Male	Female
Adult	stocky in build, blue scrotum, white beard brown diadem,white trousers, grey lack body white rump. Hums, copulates with adult females	Smaller than the adult male. Brown perineum; vulva and nipples usually obvious, white beard shorter than the male's. White trouser brown diadem.
Sub-adult	Larger than adult female but smaller than adult male. Blue scrotum visible Same pelage as adults not heard to hum,not seen to copulate.	Smaller than the adult male, equal toor smaller than the adult female in size. Red perineum a and vulva obvious. Nipples may not be visible. Same pelage as adults
large juvenile	May be the same size as the adult female but lean and lanky Scrotum whitish, testis not obvious. Brownish body, red rump, brown diadem. Blackish limbs white beard and trousers	Smaller than adult female, red rump or perineum, no nipples visible. May have the same pelage as adults or large juvenile amale

	developing. Not heard to hum.	
Medium juvenile	Smaller than large juvenile, scrotum visible White trouser not distinct Short white beard. Limbs brownish like the rest of the body	Same characteristics as medium juvenile male save for the scrotum
Small juvenile	Scrotum not visible small in size, very short white beard, no diadem No white trouser, brown body and very red rump	Same as small juvenile male
Infant	Very tiny, blond all over very small white beard No diadem, trouser. Very red rump, big eyes. Usually carried by mother.	Same as male infant
UID or "Big"	Either adult male or female stature but the defining characteristics not well observed	

initially used crops of sugar cane *Saccharum officinale* and maize *Zea mays* for cover. However, since the monkeys had been seeing people from across the river for many years they were not disturbed by human presence, unless the person approached to within ten meters. As the study progressed I was able to to sit five meters away from the troop without disturbing them. The adult male and females simply ignored me but the juveniles remained nervous. A visit was made to the Saiwa Swamp National Park in October 1988 to look at the group composition of that population for comparison with that of the Kisere population.

3.3 RESULTS

3.3.1 Census

A total of three troops of de brazza's monkeys were studied in the Kisere forest and they had a total of 43 individuals. The largest troop (C troop) occupied the banks of river Nandamaywa and was comprised of 16 individuals. The other two troops occupied the Isiukhu river. The smaller troop (Troop A) had a total of eleven individuals and foraged along the southern end of the river. Troop B, located north of troop A had thirteen individuals.

Two solitary adult males were seen along the river isiukhu and one along the Nandamaywa river. I observed the resident adult males chasing suspected solitary adult males but because of the thick forage it was not possible to observe the male under pursuit. Ocassional de Brazza's hums were also heard far away from any troop. Thomas Shamalla, a local resident reported seeing a de Brazza crossing from the Kisere forest to the Kakamega

Forest, a distance of about 2Km and he also reported seeing de Brazza's monkeys along rivers in the main Kakamega forest. I was not able to confirm this in my study.

3.3.2 group composition

Each of the three troops studied in Kisere forest Reserve had a single adult male, several adult females sub-adult females, juveniles and infants. (Table 5).

The adult sex ratio (including sub-adult females) deviated from unity (X^2 =9.800,df=1, p< 0.05) indicating a multifemale group composition and the juvenile to adult ratio (including sub-adult females) was 1:2 indicating a growing population.

At Saiwa Swamp National Park, two troops were found to have a similar composition but troop E had a large proportion of sub-adult females because I could not characterise them properly and I classified them as "big". In the Kisere forest reserve, however, there were no sub-adult males resident in any of the troops. It was not posssible to confirm the presence or absence of sub-adult males in the troops seen in the Saiwa Swamp National Park. Large Juveniles males were present in all the Kisere troops. One large juvenile male who was close to become a sub- adult was resident in troop A in April 1988 but in September of the same year he was not in the troop. I assumed that he had emigrated.

3.3.3 Population dynamics

No deaths were recorded in the course of the study. Only one large juvenile/ sub-adult male left Troop A and three infants were born in Troop C. The first infant was born in January 1989 and in February of the same

Table 5. Age-sex composition of troops of de Brazza's monkeys in Kisere forest Reserve at the end of the study and at Saiwa Swamp national Park.

KISERE FOREST RESERVE

	ADULT MALE	SUB-ADULT MALE	ADULT FEMALE	SUB-ADULT FEMALE	LARGE JUVENILE	MEDIUM JUVENILE	SMALL JUVENILE	INFANT	TOTAL
A	1	0	3	2	1	2	2	0	11
B	1	0	3	3	1	3	2	0	13
C	1	0	4	2	2	2	2	3	16
		SAIWA SWAMP NATIONAL PARK							
D	1	0	3	2	1	1	-	1	9
E	1	0	-	5	-	2	-	-	8

year two more were born. The mothers of the three infants looked pregnant in October 1988. The actual day of birth was no known because the female tended to keep to keep to themselves during the last days of pregnancy. In March 1988 two infants were seen in Troop A constantly carried by their mothers. They had not been observed in the troop in December 1987. One female looked pregnant in April 1988 and in September of the same year, she hads no infant and I assumed that she gave birth and the infant died in the interim period.

3.4. DISCUSSION

The presence of the de Brazza's monkeys in the Kisere forest extends its known range in Kenya about 120Km south from the Cherangani Hills. This population was not reported by Brennan in her census of western Kenya in 1984 where most of the populations were on private land.

As predicted by Brennan (1984) these pieces of once expansive forests will give way to agricultural onslaught thereby destroying the de Brazza's habitat. This is likely to further decimate numbers of this species in Kenya. Kisere forest reserve and the Saiwa Swamp National Park are thus the only refuges for the small numbers of the de Brazza's monkeys in Kenya which have received official protection and must continue to be protected.

Although the IUCN red data book does not place the de Brazza among the endangered species, their decreasing numbers in Kenya have led scientist and naturalists to suggest local extinction may occur (Leakey 1969; Kingdon 1971; Brennan and Else 1984). The Kisere forest population is breeding successfully. The addation of at least 43 monkeys to the nationwide estimate of 150 monkeys (Brennan 1985) is vital. The Kisere forests groups are largest so far reported (Brown & Urban 1970;

Gautier-Hion and Gautier 1978; Brennnan 1985) and the possibilty of more troops in the main Kakamega forest is high especially with presence of maany rivers and tributaries. Kakamega and Kisere forests have had biological exchanges in the past along the Nandamaywa and Isiukhu rivers (Tsingalia 1988). De Brazza's have been seen crossing dry land to reach the main Kakamega forest. This should allow for a build up a de Brazza's population in the main Kakamega forest. There have been reports of de Brazza's walking for kilometers overland to reach new habitats (Kingdon 1971). Kisere forest may therefore act as a reservoir from which the population will expand into the surrounding forests.

All troops seen in the Kisere Forest Reseve and the Saiwa swamp National Park had a resident male, more than two adult females and several offspring ranging from infants to sub-adults all living together in a cohesive group. This is a clear indication of a polygynous social organization (Krebs and Davies 1986). This contrasts the finding by Gautier-Hion & Gautier in Gabon (1978) who reported small family units comprising of an adult male, adult female and one or two offspring living in cohesive monogamous groups.

They also reported mixing and merging of these unit which was non-confrontational although thay always later broke up to reestablish original families. Intertroop encounters in other guenons are usually aggressive (Cords 1984; Tsingalia and Rowell 1984).

In southeast Ethiopia (Brown and Urban 1970) and "East Africa" (Kingdon 1970; Brennan 1985), the troops are larger. Brown and Urban did not clarify composition of the troops which the observed but they comprised of six to ten members. Brennan (1985) categorised animals according to size and she found it difficult to differentiate adult females from sub-adult

females. In some cases nipples may be hard to observe in nulliparous adult females (pers. obs.). The troops in Ethiopia and those in East Africa appear to be too large for stable monogamy. Luetenegger and Lubach (1987) speculated the de Brazza's may exhibit intrapopulational variation in social organization ranging from monogamy to facultative polgyny and this study confirms it.

Various characteristics that are generally correlated with monogamy do not appear to apply to the de Brazza's monkey. It is remarkably sexually dimorphic in an array of features. The de Brazza's do not show any territoriality. Adult females have been reported not to be aggressive to conspecifics of the same sex and the male does not show high paternal investment (Gautier-Hion & Gautier 1976,1978, 1985). In woodland park zoo in Seatle Washington, Oswald and Lockhard (1980) reported that more than one adult female had been enclosed in a cage with one adult male. The relationship between the females was non-confrontational. This was also observed in Tigoni by Rowell and Richards (1979). Solitary males further supports a polygynous social organization since it is common in other cercopithecines for SA males to leave their natal groups at maturity (Cords 1987; Tsingalia & Rowell 1984; Rowell 1988). Solitary males are also a feature of other polygynous societies (Krebs & davies 1986).

Interpopulational differences in social organization is not restricted to de Brazza's monkeys among primates. It has also been reported in Mongoose lemurs, Mentawai Langurs and humans (Jolly 1985).

Among other taxa, Social organization depends on the ecological conditions prevalent in environment in which an animal lives. In a habitat where the distribution of food is sparse but uniform, the likelihood of monogamy increases, whereas in scenario where food is clumped, various

forms of polygyny will evolve (Krebs and Davies 1986). Distribution of the population and the operational sex ratio also plays a role in the evolution of social organization. Where the population is low and/or the sex ratio approaches unity, monogamy is favoured. On the other hand large populations with a sex bias will promote aggregation of members of one sex (usually females,), making them easier to defend and this promotes the development of polygamy (Clutton-Brock, Guiness & Albon 1982). However, the borderline between mating systems, social systems and societies is not clear (Rowell 1991). Strum and Latour (1987) stress that even though various ecological variables should not be ignored while expaining social systems, it cannot be assumed that aninals just fit into a destined social structure, they play a big role in shaping it. In general birds are more monogamous than mammals while in fish whole range of social organizations have evolved under different environmental conditions, and the same species may display interpopulational differences in social organization (Barlow 1988). In primates, monogamy is not widespread being restricted to small sized species some of which are nocturnal. Most of the others are polygamous with one or several males in the same social group (Jolly 1985). De Brazza's monkeys do not fall into any of these categories and a more plausible explanation of its social structure needs to be offered.

The number of births recorded in the course of the study give an indication of seasonality. It is in agreement with the data from Gabon where most breeding occured between November and April (Gautier-Hion & Gautier 1978). In captivity Rowell and Richards (1979) described the de Brazza as a year breeder. Most of the births occured between January and February and between June and July. They had records of a total of eleven females for a period of ten years. Data on breeding of de Brazza's monkeys

are not available but in captive animals, sexual maturity in males may occur at the age of eight years (Gautier-Hion & Gautier 1985). Age at first birth for females is four and half years (Gautier-Hion & Gautier 1976) with a gestation period of of approximately 170 days (Rowell and Richards 1979).

There is scarce data on the interbirth intervals in guenons (Cords & Rowell 1987) but Kirkevold and Crokett (1987) reported a mean of 13.1 months with a range of 11.4 to 15.6 months. Rowell and Richards (1979) reported an interbirth interval of 20 months, but it may be longer in the wild as has been noted in vervets and blue monkeys (Cords and Rowell 1987).

4 HABITAT USE

4.1 Introduction

Home range implies a definite area of the habitat where animals spend majority of their time. This does not necessarily imply exclusivity but means an area in which the animal is encountered (Rudnai 1970). Burt (1943) (in Mwangi 1988) describes the home range as the area occupied by an animal during "normal" activities but Struhsaker (1975) argues that the home range should include the total area used by a population including lacunae where animals just survey and pass through in the course of foraging The home range provides the animal with all the necessary resources required for survival and reproduction (Mwangi 1988) and is correlated with to both the individual and group weight and type of diet (Clutton-Brock and Harvey 1977). Most of the studies on home range use of mammals are based on mark-recapture data. In contrast, estimates and measures of primate home ranges are based on direct observation over relatively long periods of time which permits a more accurate measure of the area used by the species under study (Struhsaker 1975; Gautier-Hion and Gautier 1978,1980; Cords 1984,1986,1987; Rowell 1977,1982,1988; Chism and Rowell 1988). The most complete information on the home range use by the de Brazza's monkey was presented by Gautier-Hion and Gautier (1978) for a population in Gabon.

4.2 Methods.

Home range use was determined using the focal group technique. Each of the three troops of de Brazza's monkeys was followed for six days a month for eight months. Troop B was followed for six months. Position and

movement of the troops was recorded on a field map of the study area, following methods used by Altmann and Altmannm(1970), Cords (1984,1987) and Chism and Rowell (1988). To determine the distance from the river and daily distance travelled (daily path length) the area where most monkeys were concentated also called the position of the estimated center of mass (ECM) of the group (Altmann and Altmann 1970; Cords1984,1987) was recorded hourly from7.00 hours to 18.00 hours when possible. Cords (1984) argues that this method is subjective because of the spread of the group. In order to avoid this problem, I moved back and forth along the river keeping track of as many individuals as possible. Distance was estimated to the nearest meter by pacing and direction was determined using a compass as was done by Chism and Rowell (1988). Paces were measured using a fibreglass tape. Hourly measures of path length were summed up to give the daily path length. Only days when the monkeys were followed for more than ten hours were used in the analysis Home range was determined using the minimum poplygon method as done by Cords (1984).

To determine the intensity of habitat use the study area was divided into three categories.

(i) "Swampy" areas which flooded during the rainy season and contained small streams.

(ii) "Flat" areas which flooded periodically but did not contain streams but they had thick undergrowth.

(iii) "High" areas which were well above the flood level, contained sparse vegetation and were mainly dominated by tall trees.

Presence of the troops in each of these habitats was recorded and scores were summed up to give the proportion of time spent in each habitat.

Spread of the group, the distance between the most outlying individuals was noted hourly.

Height above the ground was also measured by hourly records of the etimated center of mass (ECM) where at least 60% of the troop was included (Cords 1984). If 50% of the troop was at different heights, both heights were scored and the average calculated. For analysis these heights were classified as:

(i) Low (0-5 Meters)

(ii) Medium (6-10 Meters)

(iii) High (>10 Meters)

Low represents undergrowth and herbaceous climbers, medium represents short trees and shrubs and high represents tall trees.

Activity pattern was determined by scan sampling on an hourly basis. In each scan, the first activity by the first seven monkeys (fewer if less than seven were sighted) was recorded. The activities were divided into these categories.

(i) Feeding, the manipulation of food, ingestion of food or the inspection of microhabitats for invetebrate prey,

(ii) Rest-inactivity whether sitting awake or asleep,

(iii) Movement - any directional movement like walking, running or junping where these activities were not related to feeding,

(iv) Others - Including activities not directly related to the above three like grooming, playing, aggression etc.

This method has been used for other primates (Struhsaker 1975; Fossey and Harcourt 1977; Waser 1977; Cords 1984, 1987), Lions Rudnai 1974; Saba 1974) and Bustards (Mwangi 1988). The number and the definition of categories vary. The relative visibility and the frequency of

activities limits the use of scanning as a measure of time budgets(Altmann 1974). It is, however, a good method to evaluate differences and determine the diurnal activity patterns (Cords 1987).

Sleeping places were characterised by recording the distance from the river, height above the ground and the nature of the vegetation. The location of the sleeping place in the home range was also noted. This was only done for those days when the troops were followed until they went to sleep (after 18.00 hours) or when the troop was found before members dispersed for the day e.g. 6.00hours. A similar description of sleeping sites was done by Gautier-Hion and Gautier (1978) fo the Brazza's monkeys and for Talapoins in Cameroon By Gautier-Hion (1973).

4.3 RESULTS

4.3.1 Home ranges

Troops A and B foraged along the river Isiukhu and troop C along the river Nandamaywa. The crude density of the de Brazza's monkeys in the Kisere forest was 0.88 individuals per hectare. The monkeys were only found long rivers Isiukhu and Nandamaywa and were absent in the rest of the forest. The three troops only used a total of 15.1 hectares or 3.12% of the total area of the Kisere Forest Reserve. Isiukhu runs for 1.2 Km along the edge of the reserve, while Nandamaywa runs for 1.5Km. Along the rivers Isiukhu and Nandmawywa there were at least 22 individuals/Km and 11 individuals/ Km respectively. Troop A had a home range of at least five hectares, Troop B 4.1 ha and Troop C 6 ha. Corresponding densities were 2.2, 3.2 and 2.6 individual per hectare.

Time spent in various habitats is given in Table 6. The swampy area was preffered to high areas (Tukey's test q= 3.586 df= P< 0.05). Troops A and B shared an area of overlap representing 5% of the home range of troop A and 14% of Troop B's home range. They were never seen to use this area at the same time. When either of them was in the area the other would be in the opposite end of its home range (n=22 days). Troop B was recorded six times on the bank of opposite the forest, about 200meters away from the forest reserve feeding on riparian vegetation flanked on either side by *shambas*. Troop A was observed on the bank opposite the Forest Reserve feeding on guava fruits and herbaceous climbers like *Neobutonia wightii* (n=8 times)

4.3.2 Distance from the river.

Table 6 Proportion of(%) time spent by de Brazza's monkeys in various habitat types at Kisere forest in percentages. The number of days ofobservation are given in parenthesis.

Troop	A	B	
HABITAT CATEGORY	(n=36)	(n=14)	(n=30)
"SWAMPY"	60	58	74
"FLAT"	36	29	20
"HIGH"	4	13	6

Tukeys test q= 3.586, df=∞.P< 0.05.

All the three troops of de Brazza's were found very near the river. The mean distance from the river was 17.9+/- 10.4 m (n=8 months), with a mode of 20m and a range of 0.5 to 220m. There was no significant difference between mean distance from the river in the dry and wet months (t= 0.865, df=6, two tailed test P>0.05 see Table 7). They, were however far away from the river during the very dry months of February and early March; probably because there were few fruiting trees near the river.

Monkeys were found near the river in the early morning, (0700 hours-0.8 hours) close to the sleeping sites. Between 0900 hrs and 1000 hrs they moved further away from the river to feed on fruiting trees. At midday they came near the river to feed on seasonal herbaceous climbers and herbs and probably to hide from the heat in the thicker foliage. After 1500 hrs they fed far away from rivers possibly because it was cooler by then and returned to river's edge after 1700hrs to rest for the night (Fig. 6)

4.3.3 Daily path length

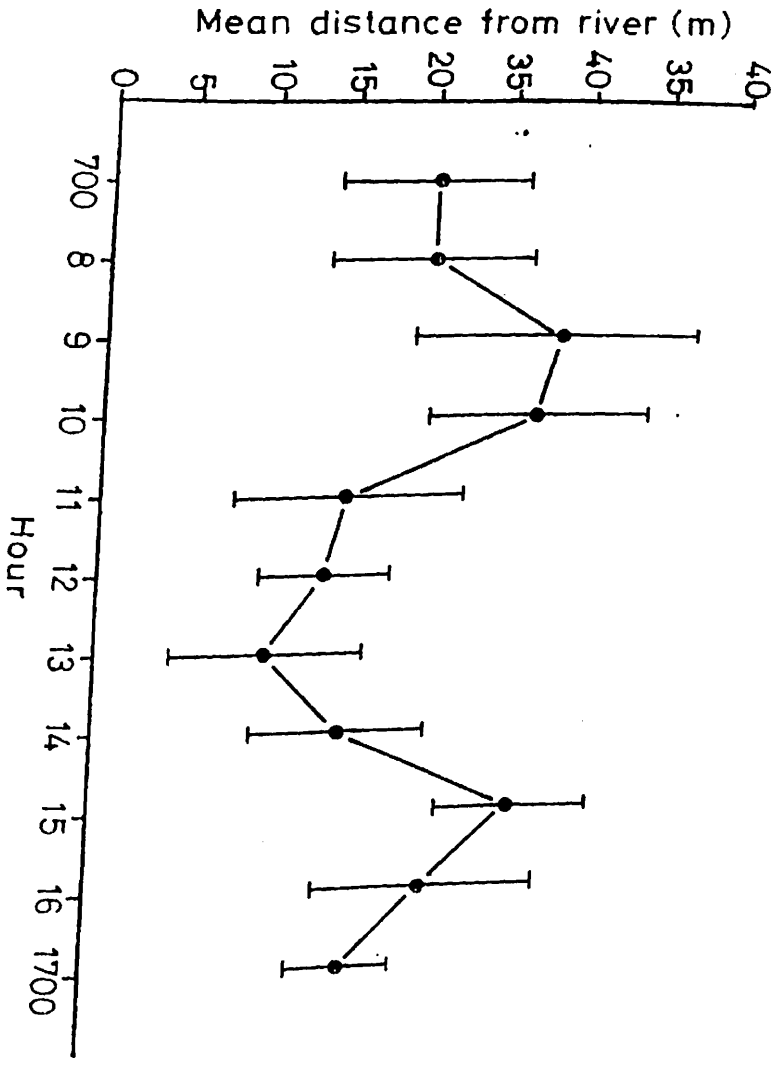
The mean daily path length was 310.2 +/- 171.3m (n= 69 days) with a median of 400m, mode of 520m and a range of 58-1001m. The difference in the daily distance moved in the wet and dry months was significant. (t=5.578. df=6, two tailed test P<0.05 see Table 8). The mean hourly path length was 34.7+/- 9.53m (n=251 hours). The monkeys moved longer distances in the morning, slackened at midday and moved longer distances again in the late afternoon. As dusk approached monkeys moved faster as they returned to their sleeping sites (Fig. 7).

The mean group spread was 17.8+/- 6.14m (n= 187 records) with a range of 12 to100m. The group was more compact when feeding from a fruiting tree than when feeding on leaves from various trees.

Table 7. Monthly distance (in meters) from the river for Kisere de Brazza's monkeys. (n=8 months)

WET MONTHS Month	Mean	S.D.	Range
April	23	15.84	2-100
Sept	9	5.20	2-20
Oct	18	4.93	0.5-150
Nov	14	5.36	0.5-60
DRY MONTHS Dec	16.2	4.92	2-80
Jan	12	4.89	3-50
Feb	31	5.40	6-220
March	35	8.67	2-150

Fig. 6. Diurnal variation in distance from the river in meters


Mean distance from river (m)
0
5
10
15
20
35
40
35
40
Hour
700
8
9
10
11
12
13
14
15
16
1700

4.3.4 Height above the ground

The de Brazza's monkeys were found at a mean hegnt 7.4+/- 2.67m (n=329 records) with mode of 8m and a range of 0.5 to 25m above the ground. The diffrence between time spent at various heights was significant (Kolmogorov-Smirnov D_{max}=40.667 (3,329) P<0.05). They spent significantly more time between 0 and 10m above the ground than at heigh higher than this (G=115.604, df=1, P<0.05), this making up 79% of the total scores recorded, while 43.8% of the time was spent between 0 and 5 meters. The latter stratum is the undergrowth and shrub layer commonly refered to as "lower stratum" (Table 9a). In the more open areas and areas where fruiting trees ocurred, monkeys tended to move higher up. In the "swampy" areas where the undergrowth was thick, the adult male, adult females and sub-adult females were usually below two meters. Juveniles were, however, not seen near the ground and they were usually 3m above the ground. Early in the morning monkeys were usually more than eight meters above the ground. It is during this time that they left their sleeping places and fed on fruits in tall trees.

Ambient temperature are usually low and they appeared to go to tall trees to "bask" in the morning sun. At around midday monkeys descended to below a height of five meters and fed on herbs and herbaceous climbers and possibly took shelter from the heat. During this time they also searched for invertebrates located in the thick foliage and along the river banks. By 1700 hrs when it was cool the monkeys climbed to tall trees to feed for the last time on fruits and leaves and appeared to "bask" again. At around 1800 hours they descended to a lower level to "roost" for the night (Fig 8). The difference between heights occupied in the morning and the afternoon was

Fig 7 Diurnal varaition in distance travelled (path length) in meters by the de Brazza's monkeys

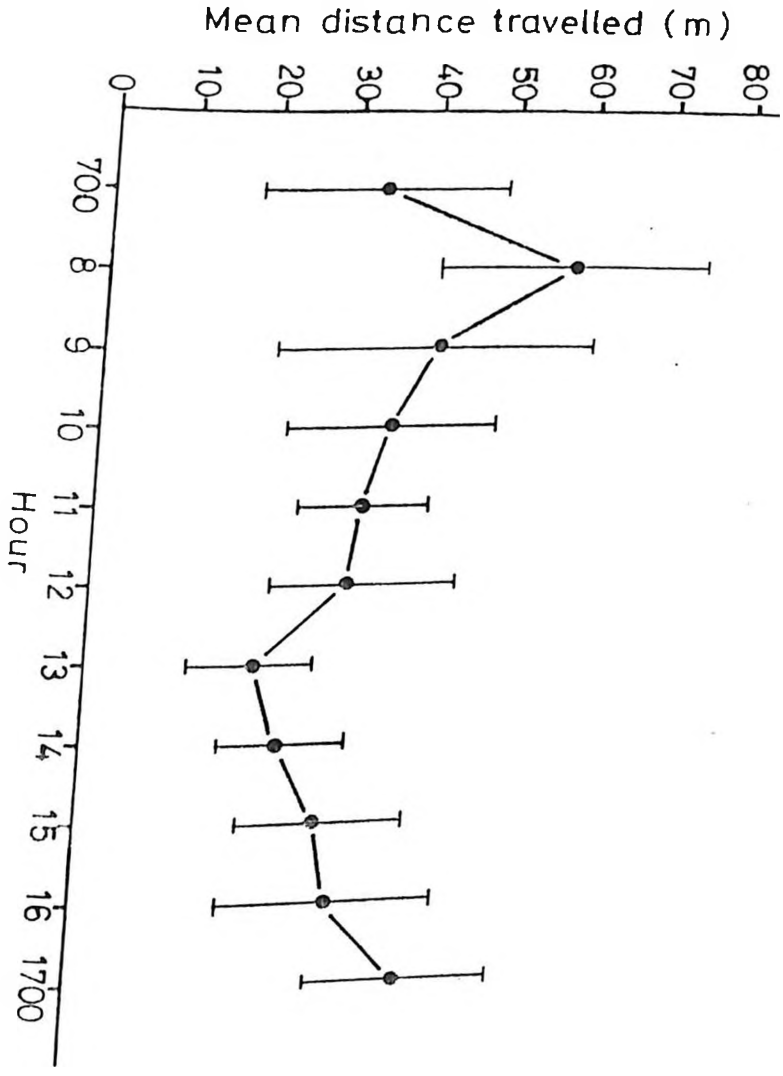

Mean distance travelled (m)
0
10
20
30
40
50
60
70
80
Hour
700
8
9
10
11
12
13
14
15
16
1700

Table 8. Monthly daily path length in meters for Kisere de Brazza's monkeys.

Month	Mean	S.D.	Range	n (Days)
WET MONTHS				
April	433	62.93	295-501	10
Sept	416	110.5	200-505	7
Oct.	395	88.33	255-551	12
Nov.	592	207.85	400-1001	8
DRY MONTHS				
Dec.	145	68.77	58-252	8
Jan	100	31.38	66-162	7
Feb.	180	55.86	140-219	2
Mar.	231	42.02	130-302	15

Table 9. Frequency of occupation of different height classes by Kisere de Brazza's monkeys.

Height class	Frequency	Percent
Low (0-5m)	144	43.8
Medium (6-10m)	116	35.3
High (>10m)	69	21.0
Total	329	100

Kolmogorov-Smirnov D_{max} = 40.667 (3,329) P< 0.05

Table 10. Time allocation by the de Brazza's monkeys at Kisere forest. (n=288 scores)

Activity	Feeding	Resting	Moving	Resting	Others
Time interval					
0600-0900	43	6	5	5	59
0900-1200	69	25	11	3	108
1200-1500	5	67	0	1	73
1500-1800	23	19	6	0	48
Total	140	117	22	9	288

not significant (t= 1.45, df = 10, two tailed test, P>0.05).

4. 3. 5 Activity pattern

De Brazza's monkeys allocated more time to feeding (Tukey's test q=3.570, P<0.1) and to resting (q=3.5 i, P< 0.1) relative to other activities (Table 9b). Feeding was more frequent in the early morning and evening. Resting was more prevalent at around midday when it was hot. There was more movement in the morning as the monkeys left their sleeping sites, in the late afternoon as they started to forage more and late in the evening as they went back to the their sleeping places. Hardly any activity ocurred at midday Most of the " other" activities which were mostly social gestures occurred early in the morning (Fig.9).

4.3.4 sleeping places

I was able to follow the monkeys late enough or find them early enough on 16 days to survey the sleeping sites. They slept about 20 meters away from the river at a height of 7 to 10 meters above the ground. The sleeping sites were usually overgrown with thick leaved understorey trees like *Chaetacme aristata* or broad laeved trees like *Craibia brownii* with lots of vines. These trees were not flooded during the rainy season and occurred on beds in the river, presumably acting as shelter from the wind. Troops A and C had two sleeping sites each. The former had one in the middle and the other at then edge of its home range. The latter had the two sleeping sites at the edge of its home range. The choice of the sleeping sites appeared to depend on the place the troop was dusk approached.

Fig. 8. Diurnal variation in height above the ground in meters for the de Brazza's monkeys

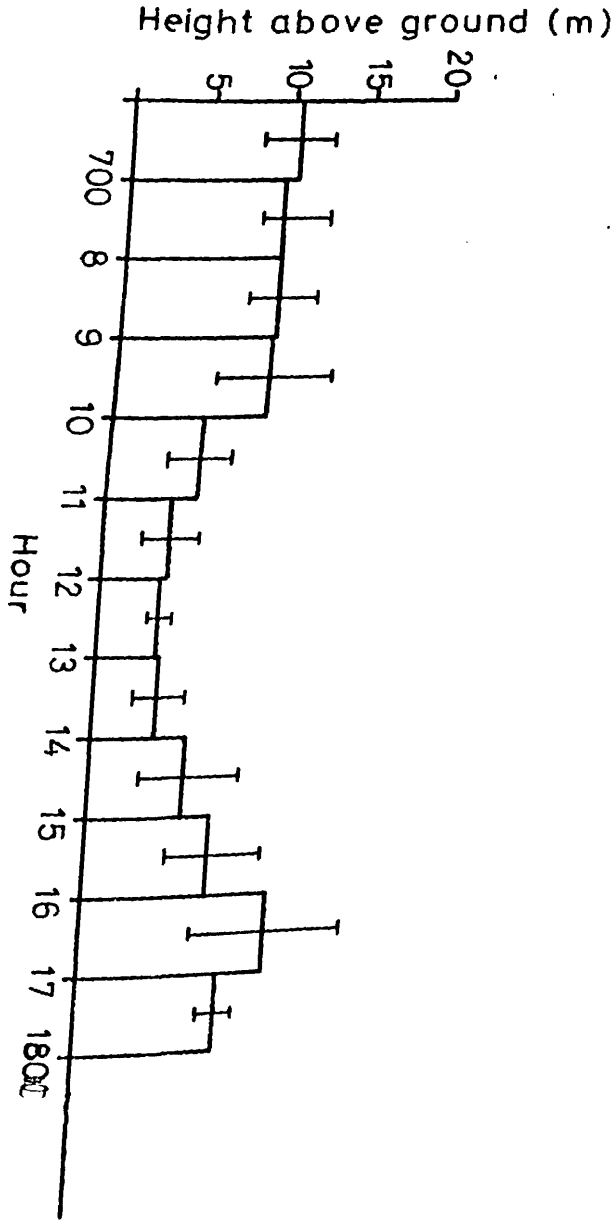
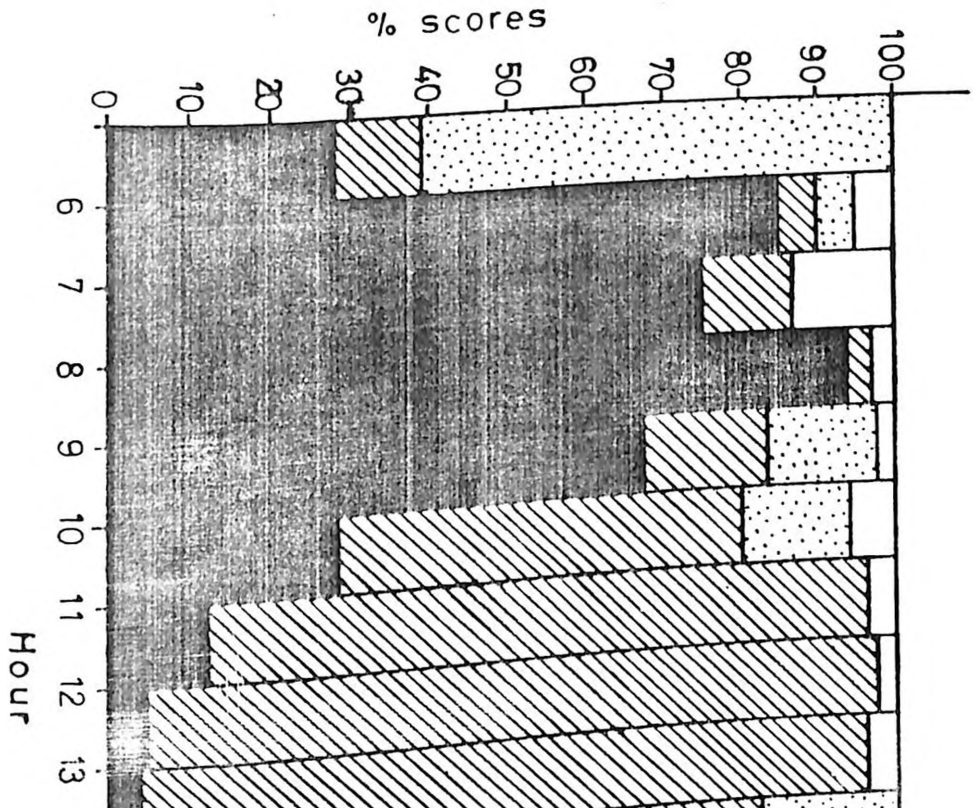
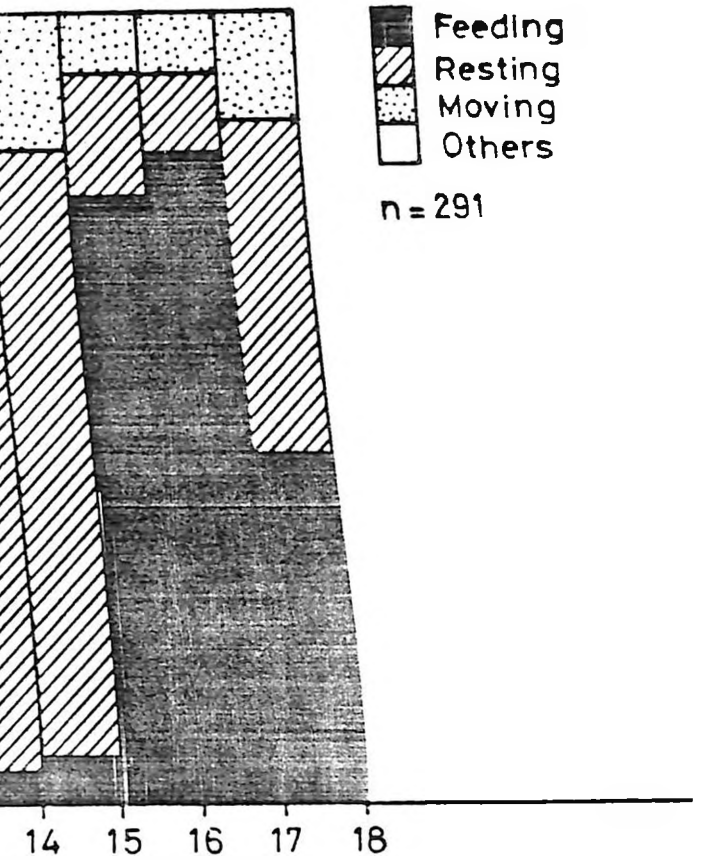

Height above ground (m)
5
10
15
20
Hour
700
8
9
10
11
12
13
14
15
16
17
1800

Fig. 9. The activity pattern of the de Brazza's monkey in the Kisere forest


% scores
0
10
20
30
40
50
60
70
80
90
100
Hour
6
7
8
9
10
11
12
13


Feeding
Resting
Moving
Others
n = 291
14
15
16
17
18

4.4 DISCUSSION

de Brazza's monkeys have a small home range (4-10 Ha) as reported by Gautier-Hion & Gautier (1978). The densities reported for Gabon and Trans Nzoia are low; 0.3-0.4 and 0.35 individuals per hectare respectively. The density of the Kisere population was about seven times higher (2.2 to 3.2 individuals per hectare). The majority of the monkeys at Kisere were juveniles (51%) and hence the population may have a corresponding lower biomass. The home range is a dictate of the individual and group weight and type of diet (Struhsaker 1975). Diet cannot be easily assessed since it is an arbitrary concept and so it is hard to say whether the densities were indeed higher at Kisere than in other places where de Brazza's monkeys have been studied.

Deviations from this simple relationship of home range and group or individual weight have also been reported in two other *Cercopithecus* species studied at the Kakamega forest. A blue monkey troop comprising of 45 individuals had a home range of 37.8 ha while a smaller redtail troop (25 members) had a larger home range of 59.8 ha. In comparison, an individaul blue monkey is nearly twice as heavy as a redtail of the same age. (Cords 1987). Black and white colobus troops (n=6) ranging in size from 7 to 12 individuals had home ranges varying 5.8 to 11.3 ha (Rowell unpublished data). The colobus are, however, heavier than any of the guenons in the forest. It is hence possible that the home range size may also be determinen by the intensity with which it is used. De Brazza's monkeys are reported to use their home range very intensively (Kingdon 1971; Gautier-Hion & Gautier 1978). At Kisere the river appears to be very important since the monkeys are found close to it and therefore it may be more appropriate to use the length of the river (especially the "swampy" parts), than home

range *per se*.

The de Brazza's monkey is riverine and it has been dubbed the "swamp monkey" (Scott 1980). All other workers report finding the de Brazza very near water (Booth 1962; Hill 1966; Kingdon 1971; Gautier-Hion & Gautier 1978, Wolfheim 1983; Brennan 1985, 1985). Nobody has ever explored the reason why the de Brazza's are riverine. Other riverine *Cercopithecus* include talapoin *M. talapoins* (Rowell 1982) and the diana monkey *C. diana* (Kingdon, 1971).

The daily path length of the Kisere population closely agrees with that reported by Gautier-Hion and Gautier (1978) for the Gabon population. Mean distance was 550m with a mode of 500 to 550m and a range of 250-1010m (n=24 days). The mean path length was, however, shorter compared to that reported for other *Cercopithecus sp* in the Kakamega forest where blue monkeys and redtail monkeys had a daily path length of 600-1750m and 920-2385m respectively (Cords 1987). Other studies show that on average monkeys move shorter distances during the dry season (Struhsaker 1975; Cords 1984, 1987; Chism & Rowell 1988). The daily path length increases with increase in feeding group weight or size although the relationship is not linear (Waser 1977) and is positively correlated with amount of rainfall (Struhsaker 1975). The exact relationship has however not been determined

In Gabon Gautier-Hion and Gautier (1978) reported that de Brazza's spent 50% of the time below 10m in areas with thick undergrowth. In the more open areas, they spent only 8% of the time near the ground. The adult male was more likely to be near the ground than females. The structure of the habitat apppeared to influence the height at which the de Brazza's foraged The riparian vegetation at Kisere is more dense than one in the

interior and the monkeys spent more of the time below 10m here. Feeding time and type of food also appear to have influenced the height at which the species foraged. Blue monkeys at Kakamega forests have been reported to descend to the ground around midday (Wahome *et al* 1988) and the same pattern was observed in the red colobus (Struhsaker 1975; Clutton-Brock 1977), siamangs (Chivers 1969,1979) and blue and reedtail monkeys (Cords 1984,1987).

The Kisere de Brazza's population shows a diurnal rythm in the activity pattern unlike that reported for the Gabon population which exhibited an arythmic acivity pattern (Gautier-Hion & Gautier 1978). Since the Gautiers (1978) only followed males who were tagged with radio collars, it is possible that the differences are due to the methods used in studying the two populations.

Differential apportioning of time to different activities relative to the time of the day has been reported for baboons (Atmann & Altmann 1970), red colobus (Struhsaker 1975), Black and white colobus (Waser 1977) and blue and redtail monkeys(Cords 1984, 1985). Lions also have a similar pattern (Rudnai 1970; Saba, 1974) and bustards (Mwangi 1988). Optimization theories postulate that the duration and timing of an activity is ddetermined by the profitability of the activity (Mwangi 1988). Morning and evening feeding peaks may represent the demand for energy supply and midday resting may represent an adaptation to high temperature (Chivers 1969, 1974 in Clutton-Brock (1977).

Sleeping sites described for the Kisere population are similar to those described for the Gabon population. The site was probably chosen because it provided refuge from the ravages of weather like rain and wind and it made it dificult for predators to pounce on the monkeys unawares. Talapoin

monkeys sleep on trees with a lot of climbers overhanging the river (Gautier-Hion 1973). Some of the habitat use strategies for the Kisere de Brazza's monkeys are similar to that of the Gabon population but most of them are remarkably different from those reported for congeners and other primates in general.

5. FEEDING

5.1 Introduction

Feeding, a major activity of many primates, is a dominant aspect of their biology. The type of food eaten is a fundamental aspect of an animal's niche and therefore the distribution of an animal's food can be a major determinant of the distribution of a species or a single group within a habitat (Thorington 1970). Feeding can also have a direct effect on group size (Waser 1977), since the availability of food resources ditcates the biomass that can be supported by a particular habitat.

The feeding ecology of the de Brazza's monkey forms an integral part of its ecology. Food and feeding habits of the de Brazza's monkey has been described by booth (1962), Hill (1966), Brown and Urban (1970), Kingdon (1971) and Gautier-Hion and Gautier (1978).

5.2 Methods

Measurement of diet composition in wild primates has usually been approched in one of the five ways..

(i) Analysis of stomach contents

(ii) Analysis of dung samples

(iii) Visual measurements of different foods eaten

(iv) Measurement of proportion of feeding time spent on diffferent foods.

(v) Measurement of frequency with which different foods are eaten (Clutton-Brock 1977).

The fifth method was chosen in this study becuase of ease with which ift could be used in the field with animals like de Brazza's monkeys whose

timid nature would have made it very difficult to assess feeding parameters using the other four methods. Even with this method it was sometimes difficult to get feeding scores because some of the animals could be hidden in the thick foliage when feeding. The important thing however, was to get the proportion of food items in the diet.

A feeding score was recorded when an individual fed on one type of food item (e.g. leaf, fruit etc.) from a particualr plant species. If the same combination of animal-item-species persisted for more than 30 minutes, then a new score was entered. If any of the three parameters changed, a new score was recorded. The order of arriving at or leaving from a fruiting of individuals tree was also noted. This was done continuously throughout the study period. The method is biased towards foods that are eaten frequently but in relatively small amounts and towards plant species that act as clumped food sources (e.g. fruiting trees). It has, however, been used successfully to study the food habits of the red colobus (Struhsaker 1975) and for blue and redtail monkeys (Cords 1984,1987). Feeding on invertebrates was scored similarly except that the substrate and the nature of the motor pattern used to capture prey were also recorded as in Cords (1984). Prey items could rarely be identified. The prey had to be swallowed in order for the score to be entered. The data for all the troops were combined according to the plant species and types of foods consumed.

5.3 RESULTS

A total of 1988 feeding scores were recorded during eight months of the study. At least 47 plant species were used. This number does not include specimens that were not identified.

Table 11. Plant species used as food by the de Brazza's monkeys at Kisere forest.

Plant species	Item	% Of Total
Ficus thoningii	fruit, leaves, gum	17.7
Celtis durandii	fruits, leaves	12.2
Mansikera butugi	fruit	11.0
Cheetacme aristata	fruits, leaves	6.6
Neoboutonia wightii	leaves	5.4
Isoglossa laxa	leaves	4.2
Prunus africana	fruit, leaves	3.7
Celtis africana	leaves	3.1
Ipomoea wightii	leaves	3.1
Blighia unijugata	leaves, buds	2.5
Tecles nobilis	leaves, blossoms	2.0
Parinari excelsa	leaves fruits	1.8
Cassipourea ruwensorensis	leaves, fruits,blossoms	1.7
Lecaena cerore	fruits blossoms	1.7
Fernonia urens	leaves	1.4
Strychnos usambarensis	leaves,buds,fruits	1.4
Trichilia emetica	leaves	1.4
Ficus ternicostata	fruit	1.3
Albizia grandibracteata	fruit	1.1
Acacia spp	blossoms ,pods	1.1
Olea welwitschii	leaves,seeds	1.1
Markamia platycalyx	leaves,blossoms,pods	1.0
Neoboutonia macrocalyx	blossoms	0.9
'Chirese'	leaves,blossoms	0.8
Funtumia latifolia	leaves,gum	0.8
Cucumis hirsutus	fruit	0.7
Ficus capensis	fruit leaves	0.6
B odoratissimum	leaves,buds	0.5
Afrocarpus gracilior	leaves,fruits	0.5
Diospyros abyssinica	leaves ,buds	0.5
Albertisioides	blossoms	0.4
Cassipourea gerrardii	blossoms,pods	0.4
Sebium ellipticum	leaves	0.4
Antiaris toxicaria	leaves	0.4
Orchid	leaves	0.4
Trema guineensis	fruit	0.3
Rinorea brachypetala	leaves, buds	0.3
Ficus mallotocarpa	fruit	0.2
Ficus asperifolia	fruit	0.2
Dombeya spp	blossoms	0.2
Hibiscus spp	blossoms	0.2
Psidium guajava	fruit	0.2
Ritchiea albertsii	leaves,fruits	0.1
Myrsine africana	fruit,leaves	0.1
Faggaropsis angolensis	leaves	0.1
Acanthus pubescens	leaves	0.1
Antiaris toxicaria	leaves	0.1
Croton megalocarpus	leaves,blossoms	0.1
Uncertified		2.2

Table 12 The top ten most important plant species used by the de Brazza's monkeys in Kisere forest. The rest of the species which are used by the de Brazza's are not included in the analysis

Plant species	Percent use
Ficus thoningii	25.4
Celtis durandii	17.6
Manilkara butugi	15.9
Cheetacme aristata	9.5
Neobutonia wightii	7.8
Isoglossa laxa	6.1
Prunus africana	5.3
Celtis africana	4.4
Ipamoea wightii	4.4
Blighia unijugata	3.6

5.3.1 Plant species

The ten most commonly used plant species comprised 69% of the total number of scores recorded (Table 10). The first three species made up 58.8% and were large trees whose fruits were heavily used by de Brazza's. Leaves of *Celtis durandii* and *Ficus thoningii* were also fed on. *Chaetacme aristata*, the fourth most frequently used plant is an understorey shrub-like tree whose leaves were eaten by de Brazza's. *Neobutonia wightii, Isoglossa laxa* and *Ipomoea wightii*, all herbaceous climbers were heavily used by the monkeys who fed on them throughout the year, especially in those areas which flooded during the rainy months (Table 11). All the individual plants that were exploited by the de Brazza's were found not more than 220m from the river's edge. Fruiting trees especially. *Ficus thoningii, Celtis durandii* and *Manilkara butugi* were heavily exploited when in season. The de Brazza's preffered fruiting trees that were close to the river but in the absence of such trees they travelled deeper into the forest in search opf fruit. The de brazza's would feed on a fruiting tree until all the fruits were exploited, after which they would visit another tree. Troop C spent two weeks on *Manilkara butugi* trees five meters apart which had fruited simlutaneously. They spent one week near a fruiting *Ficus thoningii* which was 500m from the first two trees. Troop A spent three weeks oscillating between a fruiting *Celtis durandii* and a fruiting *Ficus thonongii* 30m away.

5.3.2 Mode of exploitation

The de Brazza's spent early morning feeding on a fruiting tree, then descended to feed on herbaceous plants or leaves of climbers. They then went back to the same tree in the late afternoon to feed on fruits. They fed quietly and appeared to choose each item carefully. Fruits were usually

selected and were either removed from the branch by hand or else the branch was held with one or both hands and the fruits fed on directly. Generally few fruits were wasted in the process except for the fruit that fell from the disturbance of the tree. Leaves were also fed on by either of the two modes used to feed on fruits. The de Brazza's did not approach or leave fruiting tree in a definite order with regard to age or sex.

5.3.3 Food items.

Fruits which formed a large part of of the diet of the de Brazza's monkey accounted for 44.7% of the total feding scores. Leaves formed 32% of the total diet. Fruits and leaves formed 77 % of the total number of feeding scores and were a major food source for the de Brazza's monkey. Young leaves, however, were preferred to old leaves. Young leaves fromed 19.5% while old leaves formed 12.6% of the feeding scores. Invertebrates formed 10.2% of the total feeding scores. Blossoms, Buds, mushrooms, gum and latex, seeds and other items which could not be identified formed other items in the diet (Fig. 10). The difference between use of different food items was not significant ($G = 566.598$, $df = 9$ $P > 0.05$). There was significantly more fruit in the diet than leaves ($G = 36.048$, $df = 1$ $P < 0.05$)

5.3.4 Invertebrate prey

Throughout the study period at least 202 invertebrates were ingested by the de Brazza's monkeys. *Prunus africana*, *Craibia brownii*, *Funtumia latifolia* and *Ficus sp.* were the plants on which most of these invertebrates were captured. They were generally removed from trees with horny cracked barks and wide cracks or from branches covered with moss, vines and broad leaved tree species. Use of these substrates was found to differ

Table 13. Substrate on which invertebrate prey was captured by the de Brazza's monkeys.

Substrate	Bark	Leaf	Dead branch	Moss covered surface	Total
Score	66	84	29	23	202
Percent	32.7	41.6	14.4	11.4	100

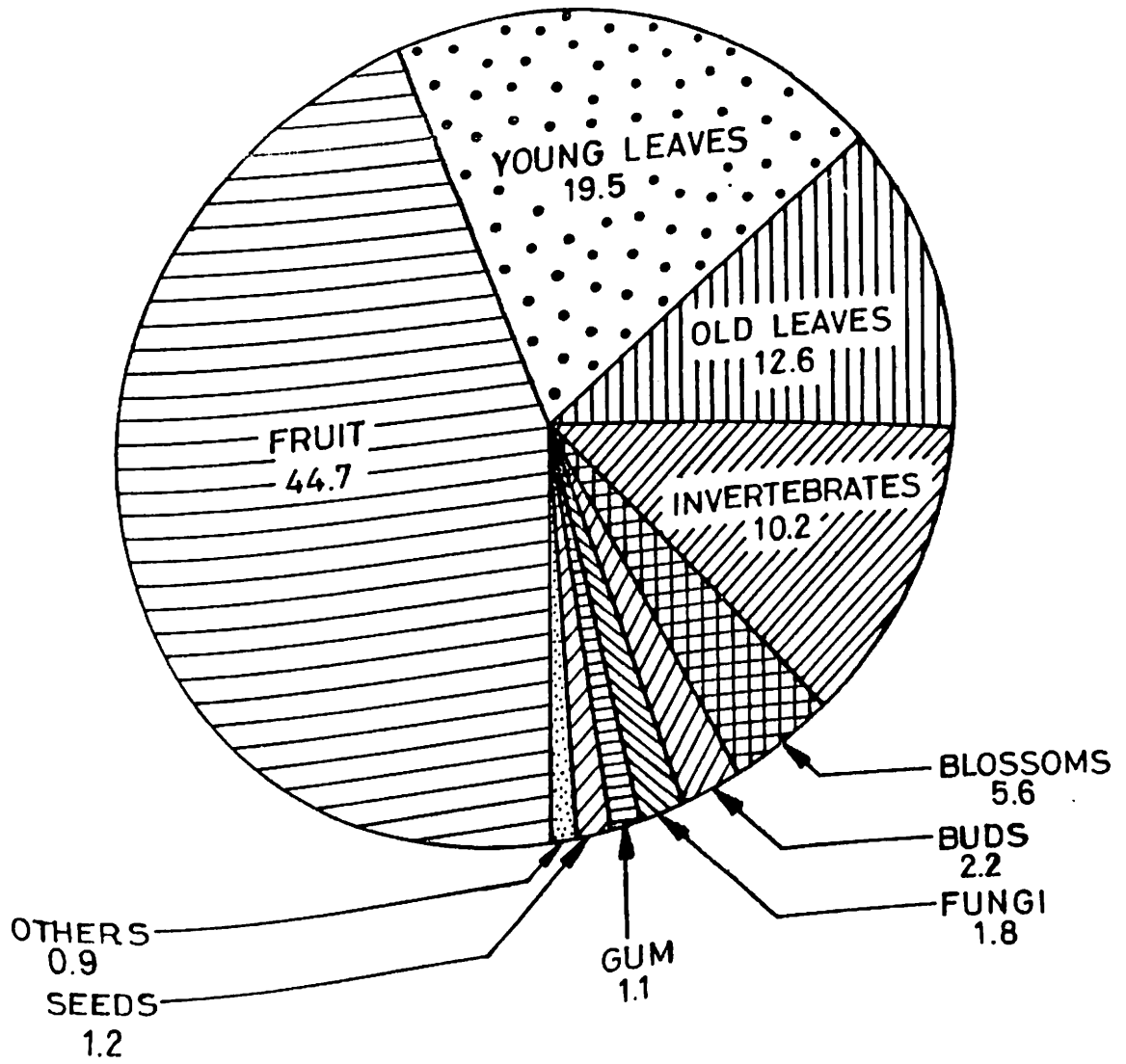
G= 52.469, df= 3 P< 0.05

Table 14. Motor action used by the de Brazza's monkeys to capture invertebrate prey.

Motor pattern	swatt	Pounce	Pick	bite off	total
Score	26	20	87	69	202
Percent	12.8	9.9	43.1	34.2	100

G= 64.762, df=3, P< 0.05

Fig. 19 The diet composition of the de Brazza's monkeys in the Kisere forest


YOUNG LEAVES
19.5
OLD LEAVES
12.6
INVERTEBRATES
10.2
FRUIT
44.7
BLOSSOMS
5.6
BUDS
2.2
FUNGI
1.8
GUM
1.1
OTHERS
0.9
SEEDS
1.2

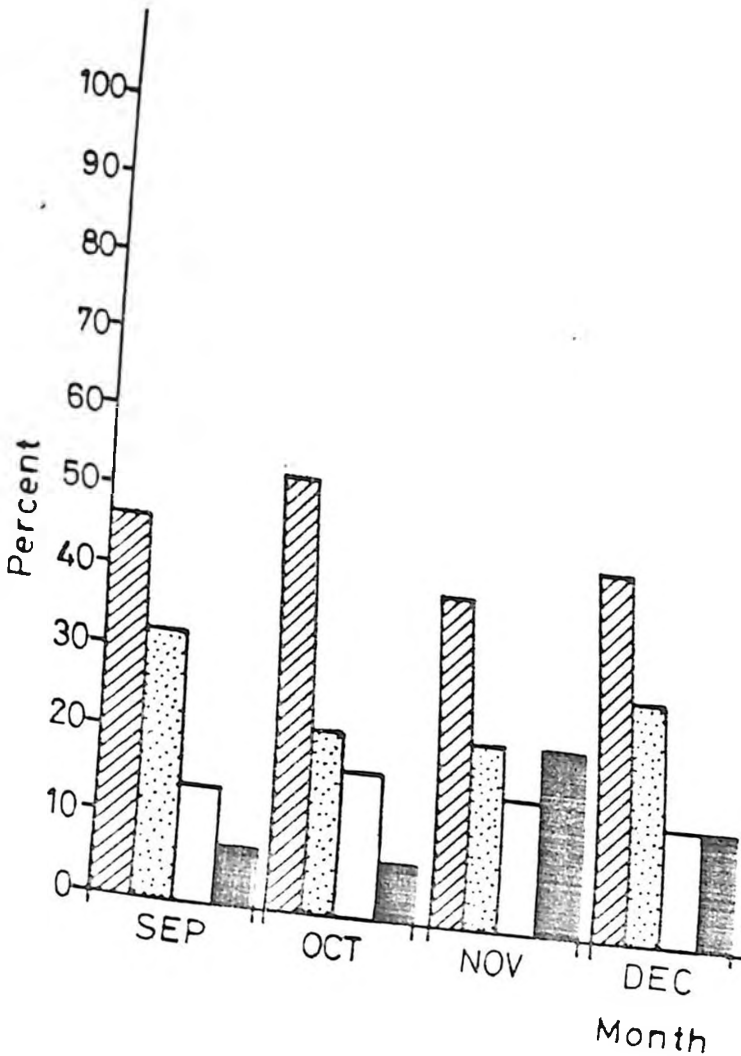
significantly (G= 52. 469, df=3 P <0.05 see Table 12a). Motor pattern for the invertebrate prey capture was also signigficantly different ((G=64.726, df=3, P< 0.05). Monkeys were more likely to use slow than fast motor patterns (G=61.920, df=1 P< 0.05 see Table 12b). They were seen to uncurl leaves carefully and bite off invertebrates or pick them up with their hands and ingest them. The faster methods of swatting and pouncing were rarely used. The de Brazza's hence preffered less mobile prey, cocoons and caterpillar were most ideal. These invertebrates were more likely to be found in cracks, moss covered surfaces and dead parts of a plant. They were seen capturing ants and they also scratched at barks to get termites from their nests. I saw them capture moths. Adult females were seen walking along the river bank presumably trying to get invertebrates. A sub-adult female from Troop A was seen feeding on a lizard in November 1988, the only invertebrate prey recorded in this study.

Fig 11 shows the use of the most important foods items throughout the study period. In most months, the relative proportions of young leaves, old leaves and invertebrates fluctuated. The proportion of the four most important food items varied diurnally. Consumption of fruit peaked in thee early morning and late afternoon. The proportion of the foliage in the diet (young and old) was low in the morning, peaked at around midday and fell off in the late afternoon. The proportion of invertebrate prey in the diet generally peaked at midday and late afternoon but was slower in the morning and late afternoon (Fig.12)

5.3.5 Drinking

Two adult females were seen twice drinking from the river in October 1988. Two adult females and two juveniles were also seen scooping water

Fig. 11. Monthly proportions of the four most important food items for de Brazza's in Kisere Forest Reserve


100
90
80
70
60
50
40
30
20
10
0
Percent
SEP
OCT
NOV
DEC
Month

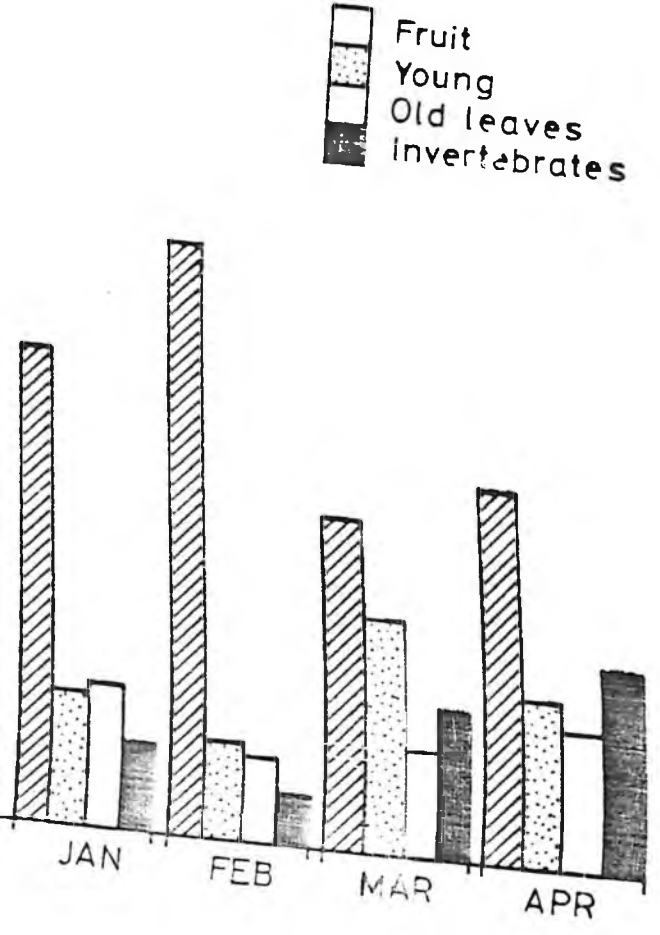
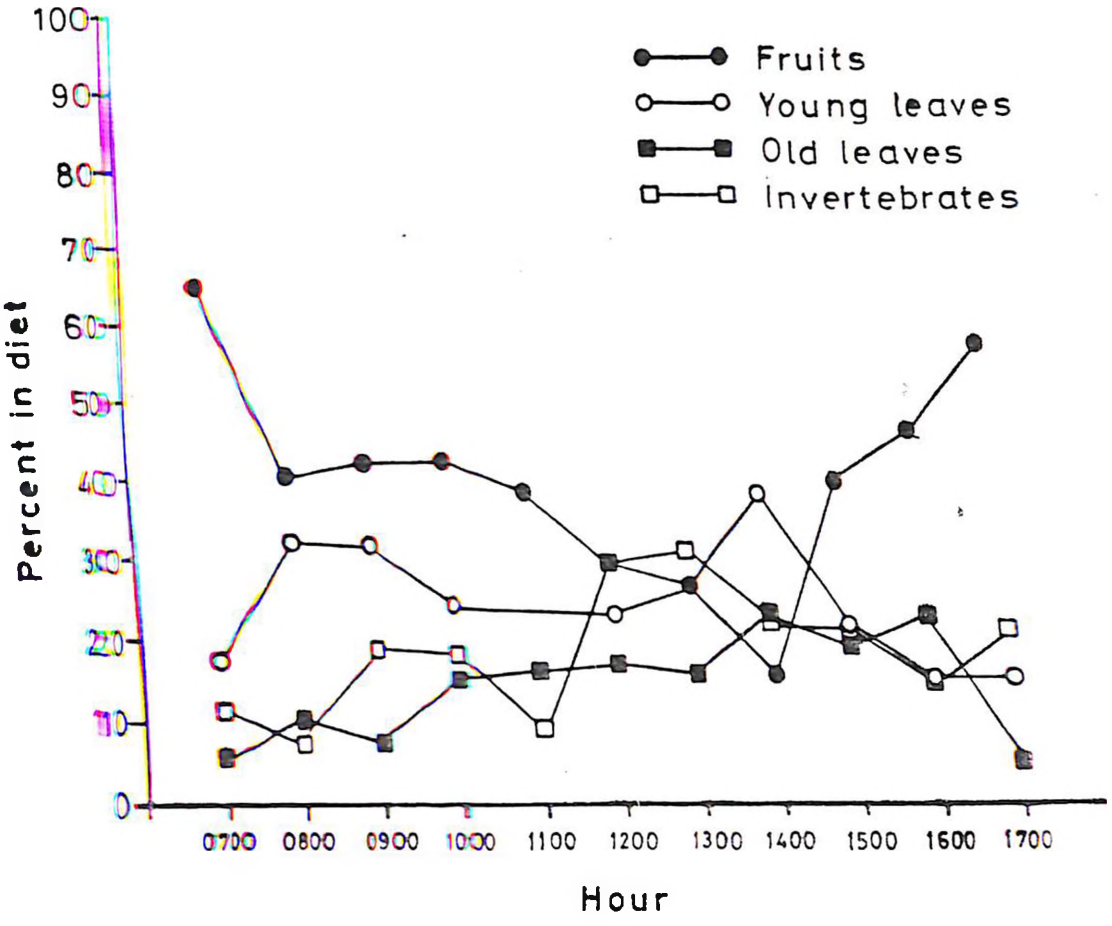

Fruit
Young
Old leaves
Invertebrates
JAN
FEB
MAR
APR

Fig. 12. Diurnal variation in use of the four most important food items in the diet of the de Brazza's monkeys in Kisere Forest Reserve


Fruits
Young leaves
Old leaves
Invertebrates
Percent in diet
100
90
80
70
60
50
40
30
20
10
0
0700
0800
0900
1000
1100
1200
1300
1400
1500
1600
1700
Hour

from a hollow trunk of an Acacia tree in April 1988 but drinking was rare

5.4 DISCUSSION

The de Brazza's at Kisere forest Reserve were predominatly frugivorous. This is in general agreement with the diet of the de Brazza's in Gabon. In a study of stomach contents, Gautier-Hion and Gautier (1978) reported a diet of 74% fruit and seeds, 9% leaves, 5% insect and animal matter and 12% flowers, mushrooms and earth. The data were based on dry weight of food items found in the monkeys' stomachs and it is not possible to compare directly with the data from the Kisere population.

Most *Cercopithecus* are predominantly frugivorous (Gautier-Hion 1980; Cords 1984,1986, 1987), although the proportion of fruit differs. Food choice suggests a balanced diet. Fruits and flowers provide digestible carbohydrates while leaves especially young ones provide the proteinaceous ingredient of the diet (Clutton-Brock 1977). Young leaves are preferred because they have a higher concentration of proteins and a lower concentration of cellulose and liginin and possibly of secondary plant substances which may act as antifeedants. Gum and seeds are eaten to suplement minerals and vitamins which may be lacking in other food items (Fenny in Smith (1977))

The pattern of diurnal exploitation of the different components of the diet may reflect an adapation on energy requirement. When the monkeys woke up in the morning, they were normally hungry and in need of energy. fruit were easy to gather and they were clumped in distribution. These foods also had a higher concentration of energy- providing carbohydrates. Monkeys that spent the night near a fruiting tree had an advantage. As the day progressed they ate more leaves and invertebrates, a diet rich in

proteins Leaves especially the young ones were harder to gather than fruits and they demanded more time and energy per unit effort to eat and digest than fruits. The activity of the invertebrates also increased as the day progressed which is determined by temperature. Mobile prey were more conspicuous and may have caused more active feeding by the de Brazza's monkeys at around midday. It also required more time and energy to find and harvest invertebrates (Chism & Rowell 1988) and hence, the monkeys were probably constrained to synchronise predatory behaviour with the prey's activity rythm. Invertebrate prey may be restricted to the later part of the day because thay are harder to digest and would be inappropriate for the monkeys when they wake up in the morning in demand of energy (Clutton-Brock 1977).

The de Brazza's monkeys were not likely to use very fast movements (Gautier-Hion and Gautier 1978) and they were apt to dslow orey alike caterpillar and some ants. The same kind of prey items reported in this study werealso reported fro thge Gabon population by Gautier-Hion and Gautier (1978).

Weight of the monkey is important. De Brazza's are relatively heavy and since most vegetation support is fragile, they might select sedentary prey which may require less movement to capture. This has also been reported for the relatively heavy *Cercopithecus nictitans* (Gautier-Hion 1980). Vertebrate prey consumption is usually rare in guenons but it has been reported in blue monkeys (Wahome *et.al* 1988). Other primates have also been seen to drink water from holes in hollows of trees (Struhsaker 1975; Cords 1984). However there is no other report of guenons drinking directly from the river. It is odd that this happened when rains were heavy and food was more succulent. Giving allowances for interspecific variation,

the diet of the de Brazza's monkeys at Kisere does not stand out as an exception from that of other guenons or primates in general.

6. SOCIAL BEHAVIOUR

6.1 Introduction

Behaviour consists of patterns of movement in time. It deals with sequences some of which may be invisible. Behaviour always has a cause and may be an interaction of an external stimuli and internal drive mechanisms like the central nervous system and hormones (Eilbl-Eibesfeldt 1970). Social behaviour and organization may be influenced by different ecological pressures especially diet and predation (Krebs & Davies 1986). Forest monkeys are group living, social animals, and the structure of the social groups reflects and influences individual behaviour. In the social group, the animal learns to use its biology efficiently and adapt to its environment. The characteristics of forest monkey social groups differ according to many variables which reflect responses to and exploitation of the environment and improves an individuals fitness as in securing food, getting a mate escaping from predators and exchanging information and experiences. The cohesiveness and coordination of animal societies are often their most striking feature and in forest monkeys each individual is constantly responsive to the movement, gestures and calls of others (Manning 1980). Certain interactions have evolved which besides having utilitarian functions also serve to strengthen the bond between members of a group. Mutual groomings or greetings are individual activities although they are performed simultaneously. The also serve to synchronise mood in a group or strengthen group cohesion (Rudnai 1970).

It is difficult to study the social behaviour of forest monkeys because conditions of observations are poor and the oppportunity of controlled experiments limited. The information may also be be small because studies

take a short relative to a primates long life span (Chalmers 1979, Cords and Rowell 1987). Studies on the genus *Cercopithecus* have however been carrried out by Rowell (1975, 1984, 1987, 1988) Berman (1984), Cords (1984, 1987, 1988) and Gautier-Hion and Gautier (1980, 1988).

The social organization of the de Brazza's monkey is little documented. Studies on captive monkeys have been carried out by Morike (1976), Kirkevold and Crokett (1987) and Gautier-Hion and Gautier (1976,1988). They reported lack of grooming while the frequency of other social activities was low. They also reported de Brazza's mokeys to actively avoid polyspecific associations.

6.2 Methods

Three troops were studied using the focal animal sample technique (Rowell 1966, Altman 1970; Cords 1984, 1987), in which all observed occurences of of a particular behaviour (Altmann 1974) were recorded over a given period of time. The type of behaviour, the conditions under which it was exhibited and the response of the recipient was noted. Behaviour categories were:

i. Grooming- the concentrated and prolonged (at least 30 seconds) inspection of and individuals fur or skin (only allogrooms were recorded)

ii. vocalization- all sounds produced by a member of any age-sex class;

iii. aggressive behaviour- (antagonism towards conspecifics)

iv. reaction to predators

v. Interspecific intreactions

vi. any other noteworthy occurence.

The age -sex class of the individual who was infront of the group when they were involved in any directional movement was also recorded

(Gautier-Hion and Gautier 1978)

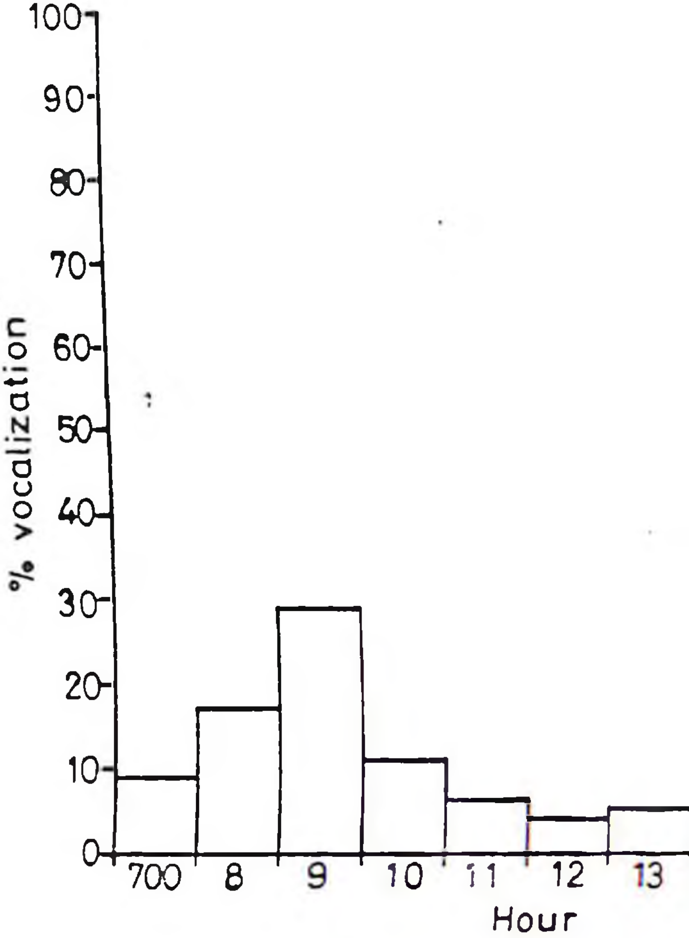
6.3. RESULTS:

6.3.1 Vocalizations

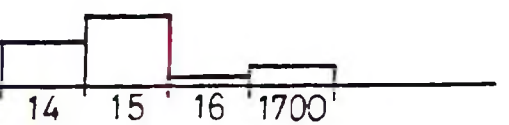
All the vocalizations that described by Kingdon (1971) and Gautier-Hion and Gautier (1978) were produced by the de Brazza's monkeys at Kisere Forest Reserve. The adult male produced the 'hum' or ' awoo' more frequently than any other sound. This occured when the troop was widely dispersed or when they changed direction of movement. The troop responded by looking around and then resuming feeding or by moving slowly in the general direction of the adult male. The male was seen to hum and then dash off from the troop and then return later. Most of the hums ocurred when then monkeys were busy feeding in the early morning and the late afternoon (Fig.13). The difference between hums produced in the morning and afternoon was not significant (Mann-Whitney U=24.5, df=5,6, two tailed test P> 0.05), although there were peaks in the early morning and late afternoon.

The male also produced a sharp barking call in December 1987 when a crowned hawk eagle *Stephanoetus coronatus* swooped down on Troop A and in October 1988 when the adult male chased a solitary male. Adult females sub-adult females and large juveniles produced contacts croaks in the course of feeding or resting. This was the commonest vocalization. They also produced alarm growls when they spotted strangers. Adult females geckered at other individuals when competing for feeding space or when aggressive. Young juveniles and infants produced shrill squeals when in distress as was the case in december 1988 when a sub-adult female tried to

Fig. 13. The percent daily production of hums by de Brazza's monkeys male in the Kibere forest Reserve (n=52)



100
90
80
70
60
50
40
30
20
10
0
% vocalization
700
8
9
10
11
12
13
Hour


14
15
16
1700

groom an unwilling small juvenile.

6.3.2 Grooming

All age-class members exchanged grooms. All members participated equally in grooming (G_{adj} =7.988, df=7 P› 0.05, n=82). Fifty four percent of the groomings occured among adult females. The adult male was only seen to groom adult females. Participation in grooming was correlated with age (r_s=0.652, df=7, P› 0.20 see Table 13a). Among adult females some adults appeared to share grooms more frequently than with other members of the troop. All members were seen to solicit grooms and some of the attempts were unsuccessful. There was no definite pattern in grooming and any part of the body could be offered for grooming. Adult females were seen to supplant one another from fruiting trees and then the supplanter would follow the supplanted individual and groom her. This was especially seen inin those dyads that shared grooms frequently.

6.3.3 Antagonistic behaviour

This was common during feeding when most of the members of a troop would be aggregated together. Adult females supplanted each other from branches laden with ripe fruit and juveniles were also suplanted by other members of a troop. The resident male of Troop C was chased out of a *Celtis durandii* in November 1988 by an adult female after he pounced on a small juvenile.

6.3.4 Interspecific interactions

The de Brazza's were not seen to form any polspecific associations with

Table 15 Participation in grooming by different age sex classes of de Brazza's monkeys (n=80 scores).

Age-sex	AM	AF	SA	MJ	SJ	INFANT	UID
Percent	13.4	52.4	14.6	2.4	3.7	4.9	3.7

G_{adj}= 7.988, df=7 P> 0.05

congeners. Of 34 encounters between the Brazza's and red tail monkeys *C. ascanius* 56% were aggressive, 38% were neutral and 6% led to joint feeding. Fifty percent of 23 encounters between de Brazza's and blue monkeys (*C.mitis*) were aggressive, 25 were neutral and only 21.7% were pacific.

The de Brazza's tolerated colobus monkeys (*C. guereza*) as they fed together and often stayed in close proximity (Table 14). In all cases de Brazza' were the agressors in encounters with congeners. The adult male of Troop C chased and adult redtail from a fruiting tree on two ocassions. Adult females of the same troop were also chased redtails from a fruiting *Ficus thoningii*. Troop encounters between Troop A and blue monkeys were also observed twice. In Troop C , a small de Brazza's chased a blue monkey juvenile. Four colobus juveniles chased a de Brazza's juvenile from a fruiting *Celtis durandii*, but the mother came to the rescue. In most cases redtails would wait for the de Brazza's to leave a fruiting tree before coming in to feed. They also cleared out of as the de Brazza's approached a fruiting tree.

6.3.5 Predation

The crowned hawk eagle (*Stephanoetus coronatus*) was probably the only common predator of the de Brazza's monkeys in Kisere since other predators like the leopard *Panthera pardus* and the golden cat *Felis aurat*us were rare. The eagle was only seen twice during this study and in both cases it was not successful in catching a monkey. Some members of the d e Brazza's monkey either dropped into the undergrowth or froze when the attacks occurred. The adult male responded by running towards the direction of the eagle producing sharp barks while some adult females

Table 16 Interaction between de Brazza's monkeys and blue monkeys, redtailed monkeys and black and white colobus monkeys.

	Troops	de Brazza's	Troops	Others avoid
Redtail	*intermingle*	*aggressive*	*adjacent*	de Brazza's
n	2	19	13	2
Blue				
n	5	13	5	-
Colobus				
n	20	2	20	-

produced alarm growls.

people accompanied by dogs were seen in the forest but an incident of a monkey being killed was not witnessed. When the monkeys froze or remained hidden in vegetation, the white beard, brown diadem and white trousers were hidden because they remained curled and appeared like dark masses. They also hid on the opposite side of a tree trunk with the head facing down. If approached closer by a person they stealthily descended to the ground and moved away. In open areas members of a troop run away by jumping from tree to tree (Table 15a). Juveniles especially the small ones had a remarkable ability of concealing themselves during times of danger.

6.3.6 Other behaviour

Only a single copulation was seen in October 1988. Play behaviour was also seen in juveniles. It involved rolling around in vines, chasing eavh other and restling. Mounting among juveniles was observed ocassionally. Saliva marking reported by Gautier-Hion and Gautier (1978) was not observed.

6.3.7 Movement.

When the troop was involved in any directional movement, any member could be at the front of the troop. Although the male was at the front of the troop more, the difference in which age class was at the front as not significant (G_{adj}= 2.748, df=3, P> 0.05 see Table 15b). The adult male often went ahead of the group and waited for them or went back if they failed to follow him.

Table 18 Mode of predator avoidance by the de Brazzas monkey (n=32 Scores)*

Response	freeze	run away	threaten	descend	others
Percent	32.3	32.3	19.4	6.5	9.7

G=9.907, df=4, P> 0.05

*description of responses is given in the text.

Table 19 Number of times that an age sex class member was infront when the troop was moving

Age-sex	adult male	adult female	sub-adult	juvenile	total
score number	10	18	5	11	44
percent	22.7	40.9	11.4	25.0	100

G_{adj}= 2.748, df=3, P> 0.05

6.4 DISCUSSION

In Kisere Forest Reserve, the de Brazza's monkeys were involved in social activities that have been reported for other *Cercopithecus* These social gestures, however, ocurred in lower intensity in comparison with those of the members of the genus like *C. ascanius schimdt* and *C. mitis stuhlmanni* (Cords 1894). Indeed even in captive de Brazza's monkeys the level of most social activities was low (Gautier-Hion and Gautier 1985; Kirkevold and Crokett 1987). Unlike other congenerics where the calls become elaborate with increase in age of the adult male, there is a loss of some in the male de Brazza's monkey. The hum, the most frequent call appears to announce the decamping of a stranger or to calm the monkeys after a disturbance. It may also serves to rally members of a group together (Kingdon 1971; Gautier-Hion and Gautier 1978,1980). This was also observed in other congenerics (Tsingalia and Rowell 1984, Cords and Rowell 1987). Adult female *Cercopithecus* normally give quiter vocalizations (Marler 1973). This was observed in de Brazza's monkeys. Despite the low frequency of social activities in de Brazza's monkeys, Kirkevold and Crokett (1987) reported grooming and juvenile play in captive de Brazza's monkeys. This was also observed in monkeys in the Kisere forest although there are no such reports on de Brazza's monkeys in nature. Kingdon (1971) reported that de Brazza's avoid grooming the white beard and the blue scrotum of the males since this would evoke aggression. This is a feature of sign stimulus (Manning 1980). In this case the brown diadem and the red rump would be reconciliatory and would hence be more likely to be offerd for grooming. In Kisere no definite pattern was observed in grooming and the white beard, blue scrotum and the diadem were as likely to be groomed as any other part. Indeed the beard was observed to be offered to initiate

grooming.

Avian predators did not appear to be a major threat to the semi-terrestrial de Brazza's. The only avian predator observed in this study, the cowned hawk eagle *Stephanoetus coronatus* appeared infrequently. This may be attributed to its larger home range size (Cords 1984) in comparison the total area of Kisere Reserve. The population density of this predator may be low. Pythons which are reported By Gautier Hion and Gautier (1985) as possible predators of the semi-terestrial monkeys were also not seen in the study. The de Brazza's employed inexpressive antipredator strategies like 'freezing' and concealement when danger was detected. Only when surprised did they run away. In cases where danger was very eminent, the adult male attacked the predator accompanied by noise. These antipredatory tactics were also reported by Gautier-Hion and Gautier (1978). Predator mobbing by adult males have also been reported in blue and red tail monkeys (Cords 1984) and in black and white colobus (pers. obs.)

The lack of polspecific associations in the de Brazza's was surprising, since Gautier-Hion and Gautier (1978), Cords (1986) and Gautier (1988) reported that polspecific associations are widespread among primates, very common in Africa and particulary well developed in the genus *Cercopithecus*. It is not surprising, however, that the only other members of the genus who do not show polyspecific associations, *C. ehoesti*, possibly C. *hamlyni* and *C. salongo* are also inexpressive, elusive and also semi-terrestrial. Polyspecific associations ahas been suggested to accord benefits to the participants such as effecient foraging and escape from predators (Cord 1984,1987; Gautier-Hion 1988). The Gabon de Brazza's population avoided poyspecific association by keeping off, but In Kisere they

did so by agressively attacking congeners.

They, however, did not mind the presence of the less closely related black and white colobus monkeys who were generally more noisy and boisterous. Whether this form of association was by chance or not could not be tested in this study. Gautier-Hion and Gautier (1978,1985) and Guatier-Hion (1988) argue that with the type of antipredatory strategy used by the de Brazza's monkeys, small group size is ideal and formation of larger groups by polyspecific association would jeopardize it. The small family units found in Gabon would fit with this hypothesis. The groups seen in Kisere are about three times to five times the size of the Gabon groups and may therefore not fit this hypothesis. It may be too soon to make conclusions but theories may have different interpretations. The quiet nature of the de Brazza's monkey, the different observation methods used and the different environmental conditions prevalent in these two studies make direct comparisons very difficult.

GENERAL DISCUSION AND CONCLUSSIONS

This study looked at the natural history of the de Brazza's monkey in the Kisere I have attempted to fit the findings into what is known about de Brazza's in other studies and also what is known about other guenons, especially those that live in the Kakamega forest. Whereas this comparison is of fundamental importance in defining how the de Brazza's monkey fits in the habitat, it is also hampered by lack of enough material for comparison since there are few data on this guenon. I hope that as more information becomes available, a more exhaustive review will emerge. At present the conservation of the remaining groups should take first priority since it is only by doing so that it will be possible to fulfill this endavour.

The group compositions of the de Brazza's monkeys in Kisere indicate an obvious case of polygynous social organization. This confirms the speculations that de Brazza's may exhibit an interpopulational difference in social organization across the continent. The similarity in group composition between Saiwa Swamp National Park and Kisere Forest Reserve supports the fact that at least in these areas the harem social organization exists. The Gabon Population was reported to be monogamous. This may suggest that there are habitat differences in characteristics of the Makokou forest in Gabon and Kisere Forest Reserve in Kenya. If this was so it would explain the observed difference in social organization. The increasing reduction of the habitat of the de Brazza's monkey may be putting a squeeze on the monogamous units and they may have responded by merger of smaller family units. Competition between the adult males would then lead to some of becomong solitary. It does appear, however, that de Brazza's are polygynous like their congeners in Kenya.

The population density of the Kisere population is high. Three hypothesis can be advanced to explain this. First the de Brazza's monkeys may have immigrated to Kisere reserve from the Cherangani Hills or from the Saiwa Swamp National Park some time back. Second they are successfully breeding and the population densities are increasing because of restricted emigration since Kisere is a habitat island. The third alternative explanation is that the population used to have larger home ranges when the used to utilise both banks of the river. When the bank opposite the river was cleared for cultivation, the home range decresed. Riverine forest has also been cleared along the river bank which does not fall under the reserve. As such the de Brazza's were forced to seek refuge in the protected reserve and in the process the population density has increased.

The river is very important to the de Brazza's. The dense understorey which grows near the river relative to the more open interior of the forest offers excelllent conditions for anti-predatory strategy for the semi-terrestrial de Brazza's monkeys. It can remain inconspicuous for hours. The open nature of the canopy near the river allows herbaceous climbers and herbs to flourish. De Brazza' s consume these herbs in high proportions after fruit. It appears that these seasonal herbs are very nutritious. It is advantageous for the de Brazza's monkeys to maintain close proximity to the river. The de Brazza's have also been seen to drink water directly from the river as well as search for insects along the river.

In this study the de Brazza's exhibit behaviours which have not been reported for the West African population. These were social gestures which are exhibited by many primates inluding grooming, supplants and play. It would hence be surprising that there is a geographic variation in these behaviours. Some of these gestures have been reported in the captive

animals and it is likely that they were missed because of difficult observation conditions. The elusive nature of the dė Brazza's monkey makes it a difficult animal to study. It requires a lot of patience to gather data on its ecology and hence rare behaviours can be missed. The presence of a semi-habituated population at the Kisere Forest Reserve offers an excellent opportunity to overcome some of these problems. The study met the objectives which it set out to investigate and hence it has provided very vital information on the ecology of this endangered primate species in Kenya.

The presence of the de Brazza's population in Kisere, an area not included in its range is important. This may imply that there are other isolated populations in Kenya which have not yet been sighted. Indeed Gautier-Hion and Gautier (1978) in their study in Gabon observed that the elusive nature of the de Brazza's monkey could lead to populations remaining undetected even where populations of the more obvious primates will have been exterminated. The presence of the de Brazza also further strengthens the need to protect the reserve.

From the findings of this study the following recomendations are suggested.

(i) A survey should be carried out in the rest of the Kakamega forest to confirm the presence or the absence of the de Brazza's monkey, establish the actual size of the population and determine whether there is sufficient habitat for the small isolated populations which are stranded in privately owned land to be translocated into the protected Kakamega Nature Reserve

(ii) The de Brazza's monkey populations at Kisere are high. This may be because the monkeys only use one bank of the river since the bank opposite is privately owned and under cultivation. To ease congestion and allow expansion of the present population a narrow buffer zone should be

established on the bank opposite the reserve. This would lead to the enlargement of the de Brazza's monkeys home range and serve to reduce erosion on the bank which is now evident. A small strip should be set aside after the buffer zone for grazing. This would help to prevent monkeys from wondering into peoples crops.

(iii) A corridor of forest should be established between Kisere Forest Reserve and the main Kakamega forest Reserve. This corridor would enhance the biological exchange between the two once continuous reserves. The exchange would occur under conditions where the monkeys would not be exposed to human predation as happens now.

(iv) The population trends of the de Brazza's should be monitored continously. This should be done for all habitats where de Brazza's monkeys are found.

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APPENDIX

A list of plant species which were collected at Kisere forest Reserve in the course of the study.

Family	Species
Acanthaceae	*Acanthus aboreus*
	Acanthus sp
	Brillantaisia nyanzarum
	Isoglossa laxa
	Justicia sp
	Thunbergia alata
Agavaceae	*Dracaena afromontana*
Amaranthaceae	*Aroyranthus aspera*
	Alternathera sessilis
Annonaceae	*Uvaria sp*
Apocynaceae	*Funtumia latifolia*
Araceae	*Caloasia scandens*
Araliaceae	*Polyscias kikuyensis*
Bignoniaceae	*Kigelia moosa*
	Markhamia platycalyx
Boraginaceae	*Cordia abyssinica*
	Ehretia cymosa
Caesalpiniaceae	*Caesalpinia decapetala*
Capparidaceae	*Ritchea albertsii*
Celastraceace	*Hippocratea goetzei*
Combretaceae	*Combretum molle*
Compositae	*Conyza spp*

	Tithonia aethiopica
	Vernonia spp
Convulvulaceae	*Hewittia sublobata*
	Ipomoea wightii
Cucurbitaceae	*Cucumis hirsutus*
	Momordica foetida
	Momordica friesoonium
Dioscoreaceae	*Dioscorea odoratissima*
Ebenaceae	*Diospyros abyssinica*
Euphorbiaceae	*Acalypha neptunica*
	Bridelia micrantha
	Croton macrostachyus
	Croton sylvaticus
	Erythrococca bongensis
	Margharitaria discoidea
	Neoboutonia macrocalyx
	Ricinus communis
	Sapium ellipticum
Flacourtiaceae	*Dovyalis macrocalyx*
Graminae	*Brachiaria spp*
	Oplismenus hirtella
Hypericaceae	*Harungana madagascarensis*
Labiatae	*Ocimum kilimandischarica*
	Plectranthus barbatus
	Plectranthus caninus
Leguminosae	*Acacia spp*
	Albizia grandibracteata

	Albizia gummifera
	Cassia didymobotyra
Loganiaceae	*Strychnos usambarensis*
Malvaceae	*Hibiscus spp*
	Parvonia urens
Meliaceae	*Entadrophragma guineense*
	Trichilia emetica
	Turrea hostii
Melianthaceae	*Bersama abyssinica*
Moraceae	*Antiaris toxicaria*
	Bosquea phoberos
	Ficus dawei
	Ficus exasperata
	ficus mallatocarpa
	Ficus capensis
	Ficus thonongii
	Ficus varruocarpa
	Morus lactea
Myrsinaceae	*Myrsine africana*
Myrtaceae	*Psidium guajava*
	Syzgium giuneensee
Mimosaceae	*Neomotonia wightii*
Olalaceae	*Strombosia scheffleri*
Oleaceae	*Ole welwitschii*
Palmae	*Raphia monbuttorrum*
Papilionaceae	*Craibia brownii*
	Erythrina abyssinica

Passifloraceae	*Passiflora edulis*
Piperaceae	*piper capensis*
	Piper guineense
Polygonaceae	*Oxygonum sinuatum*
Rhizophoraceae	*Cassipourea ruwenzorensis*
Rosaaceae	*Prunus africana*
Rubiaceae	*Hallocalyx dervilliodes*
	Chasalia aristata
	Vangueria apiculata
Rutaceae	*Clausena anisata*
	Fagara macrophyla
	Fagara milldbraedii
	Teclewa nobilis
Samydaceae	*Caesaria battiscombei*
Sapidaceae	*Bligbia unijuagta*
Sapotaceae	*Afrosersalia cerasifera*
	Baguaertiodendron oblanceolatum
	Aningeria altissima
	Chrysophyllum albidum
	Manilkara butugi
Sterculiaceae	*Dombeya spp*
Ulmaceae	*Celtis africana*
	Celtis Durandii
	Celtis Mildebraedii
	Trema guineense
	Chaetacme aristata
Urticaceae	*Urera lobata*

Verbenaceae	*Lantana camara*
	Premna angolensis
Violaceae	*Rinorea brachypetala*
Zingiberaceae	*Afromomum zambesiacum.*