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Territorial and intergroup behaviour of the Lesser Bushbaby, Galago senegalensis moholi (A. Smith), in semi-natural conditions in the field

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Fig.4. The proportion of sleeping places occupied by different sized groups.

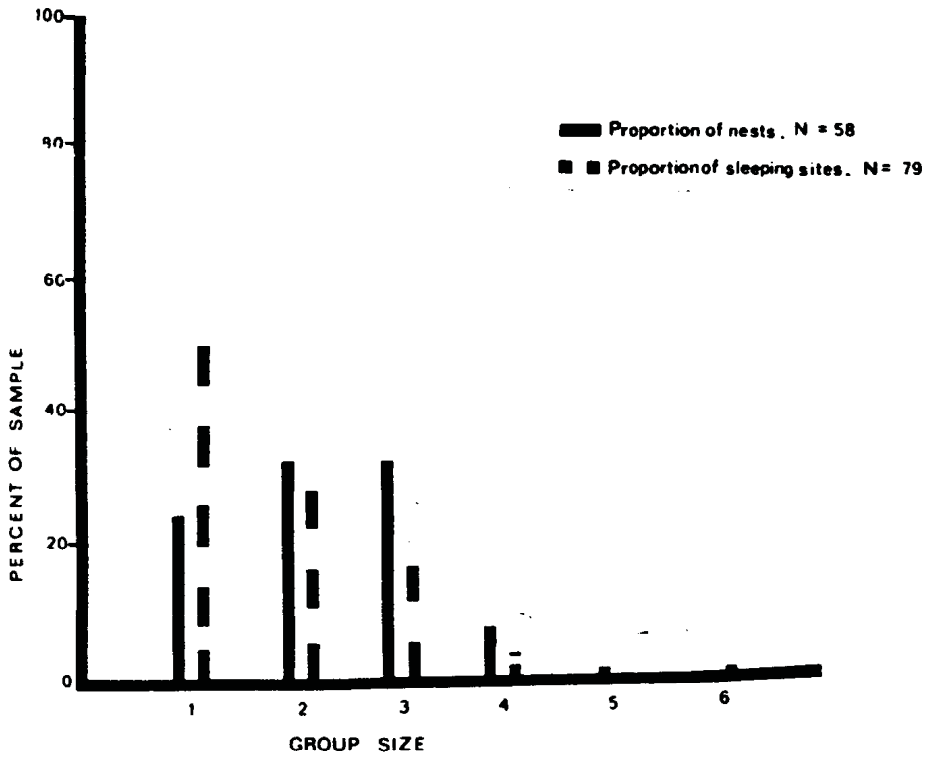
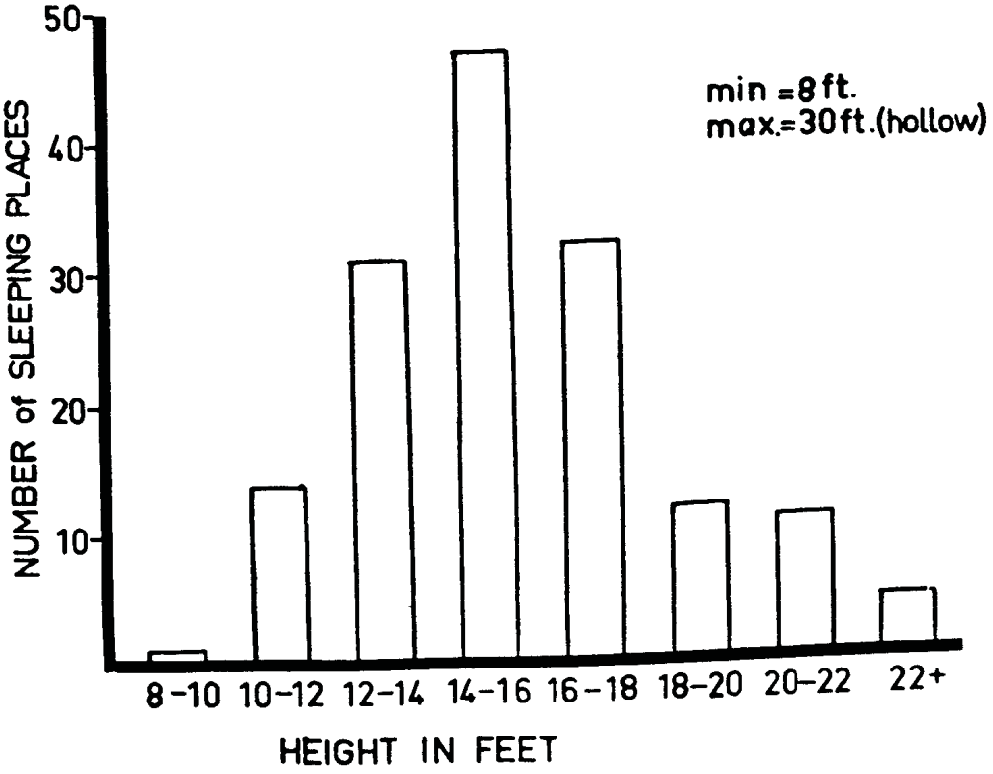


Fig.5. Height of sleeping places in study area.



formed by an old bird's nest, or bird's nests are used as such without modification. Bushbabies were seen sleeping on such nests made of grass or twigs and on one occasion two adults and a young infant shared a hanging weaver bird's nest (plate 2c).

The nests are sometimes used repeatedly for several months or are renewed in the same tree or an adjacent tree. Vincent (1968) notes that the dwarf galagos (g. demidovii), build a number of nests close to one another in a similar way.

The nests found differ from those of G.s.bradfieldii in South West Africa, which are covered on top (Sauer & Sauer 1963). Haddow & Ellice (1964), note that G. senegalensis in East Africa lives by day in tree holes, often only 4 - 5 feet above ground.

Bushbabies without nests are extremely difficult to see, even when the presence of an animal in a particular tree is known for a fact. In the laboratory, they tend to find dark and confined corners during the daylight hours and the wild ones likewise remain well hidden. This habit together with their dull grey colour and light undersides, provides excellent camouflage (Plate 3a & b).

Each individual or family may have two or three favourite sleeping places which are used at certain times of the year. Once these spots are known to the observer it is

possible to find the animals by investigating each one. There is occasionally an alternation in the use of sleeping places from one day to the next with neither place being favoured, or the animal may favour one and make only infrequent use of the other.

During the year, with changes of temperature and leaf cover, particular types of trees become more or less suitable for sleeping purposes, so that there is a gradual change in the use of sleeping places throughout the year.

In the winter when night temperatures can drop to as low as 20^{o}F it is not uncommon to find bushbabies exposed to the direct rays of the sun at the ends of branches, with little protection or camouflage, (plate 1). During the summer, bushbabies are rarely exposed to the sun except in the early mornings. Sleeping trees are chosen having dense foliage and shade. Groups may frequently be found sleeping on branches beneath the nest or towards the centre of the tree.

Laboratory data shows that nests are built by females, just before and for some time after the arrival of infants. (Doyle et al. 1967). The nest is probably used as a platform on which to give birth, while providing support and camouflage for the offspring.

Females with young infants may build more than one

nest within a short period. New nests are built as the old ones deteriorate depending on the availability of nesting material. New nests are only seen between November and the following May.

The nest is of a size to suit the number of animals in the family group, so that large and small nests are found occupied by large or small groups. There are indications that males do not build nests of more than one or two leaves, but they occupy proper nests together with the female and offspring.

Nests may also be built after they are no longer essential for the support of the young. They may merely provide a comfortable platform in a suitable place where the whole family can sleep together without being exposed from below.

During March and April 1969, five nests and one sleeping site were found in the same trees as had been used for sleeping during May 1968. The nests were all new, the old ones having completely disappeared and only one of the trees had been used for sleeping purposes during the preceding two months. It may be quite normal for particular animals to use the same trees, year after year, during the season when they provide suitable cover.

2.6. GROUP MOVEMENTS

2.6.1. Locomotion

The bushbaby has three fundamental methods of locomotion, jumping from branch to branch, hopping along the ground between trees and climbing within a tree.

The jump of Galago senegalensis has been analysed by Hall-Craggs (1965). Normal standing jumps are performed from a crouched position (plate 5), the legs are flexed and then brought forwards to take the force of landing. During the jump the hands are usually held against the chest and they grip the substrate on landing. Extremely long jumps of approximately 15 feet are achieved by a variation of this method which has not been seen in the laboratory and is not recorded by Hall-Craggs. On taking off, the arms are brought sharply forwards and held straight above the head (figure 6). This action presumably provides extra momentum for the jump.

When moving within the often exceedingly thorny trees (plate 10), the bushbaby creeps stealthily along the smaller branches where they are too dense to allow a jump. The long legs enable the body to be arched over thorns or projections, or the thorns themselves may be used as a ladder.

Bushbabies were seen to fall from a tree on only six occasions. Two were infants. Three animals fell due to a branch breaking on landing while one fell through

what appeared to have been a misjudgement. One individual dropped 16 feet and landed on the ground with a dull thud, but it immediately jumped back into the tree.

2.6.2. Movement to and from the Sleeping Place

Individuals and groups were observed leaving the sleeping place at dusk on 64 occasions and observed returning to it on 50 occasions. The intervening hours of wakefulness, calculated for each month of the study period, are shown in table 4.

The time at which bushbabies begin their activity varies within 15 minutes on either side of sunset. They usually return to the sleeping place some time before sunrise, particularly during the winter months when the nights are longer.

The behaviour shown on leaving the sleeping place is described by Sauer & Sauer (1963). After a period of grooming, stretching and scent-marking, the individuals move rapidly away from the nest one after another. They usually leave along a particular path or set route, but these habitual movements are not invariable. A pair has been observed to leave the nest by a similar route during 5 months, after which they left in a completely different direction.

In each case, members of the group soon split, each one going off alone in order to forage. During the night the group does not function as a unit.

Table 4. Hours of Activity during the year

Month	Sunset *	Mean time to leave sleeping place.	Sunrise *	Mean time to return to sleeping place	Hours of activity
JUNE 1968	17.22	17.05	6.52	6.25	13.1/3
JULY	17.30	17.20	6.55	6.00	12.2/3
AUGUST	17.46	18.07	6.41	5.35	11.1/2
SEPTEMBER	17.59	18.16	6.11	5.20	11
OCTOBER	18.12	18.15	5.39	5.12	10.7/8
NOVEMBER	18.32	18.35	5.13	5.00	10.3/8
DECEMBER	18.53	18.40	5.08	5.15	10.1/2
JANUARY 1969	19.05	-	5.25	-	No observations
FEBRUARY	18.55	19.00	5.49	5.32	10.1/2
MARCH	18.29	18.36	6.06	5.45	11.1/8
APRIL	17.56	18.00	6.21	6.05	12
MAY	17.31	17.45	6.37	6.20	12.1/2

* Standard times for sunrise and sunset on the 11th day of each month in Johannesburg.

During the study period, single bushbabies were observed for a total of 268 hours. Two or more were observed together for 114 hours. This sample indicates that the busbbaby spends approximately 70% of the time alone. Movement of more than two animals together for any length of time is rare.

At dawn or some hours before, members of the group come together again. They may move about together and as the light increases they begin to move purposefully towards the sleeping place. Alternatively, each animal may arrive at the sleeping place from a different direction at approximately the same time or one may meet up with the others on the way there. Once in the sleeping tree they groom and settle down well before sunrise.

2.6.3. Movement of Individuals

Most activity occurs between ground level and a height of 20 feet which is the approximate height of the tree canopy. In larger trees bushbabies will sometimes ascend to 35 or 40 feet. Only a small proportion of time is spent in small trees and saplings of less than 6 feet in height.

The most active periods of the night, judging by the number of trees traversed during each hour, occur immediately after leaving the nest and just before returning to it in the morning.

Jumps of up to 15 feet may be performed from one thorn-covered branch to another, sometimes rapidly without hesitation. More often, when making long jumps, the animal appears to assess the situation. In a typical example, the bushbaby goes to the end of a branch and stares in the direction of travel (plate 10a). The head and body may be moved from side to side or the animal stands upright several times by flexing the hind legs. This process may be repeated several times from a higher or lower branch, after which the bushbaby may still not jump. If disturbed it will sit quietly, high in the tree, before returning to attempt the jump. Finally a particular jump may be abandoned altogether and the same distance is covered across the ground or the animal moves away in another direction.

In moving across large open spaces, any small trees, stumps, fallen branches or fence posts may be used as vantage points (plate 6). Individuals were often seen to use particular stretches of barbed wire fencing in order to progress from one tree to another without going on to the ground. In doing this they either jump from one post to the next, spaced 10 feet apart, or they walk along the top of the wire. One animal walked 70 yards along a wire, the accompanying tail movements appeared to subserve maintaining balance.

All wild bushbabies are extremely wary before covering long distances on the ground. It is normal for the

animal to go to the end of a branch where it checks the environment in all directions for a period of up to 20 minutes. It then comesdown the tree to a low branch where it looks around again and eventually drops onto the ground. When on the ground it sits in an upright position facing the tree which it has just left, while checking once again. Providing there is no disturbance it turns round and takes long rapid jumps to the next tree, sometimes pausing to look around before jumping into it.

Occasionally, movement along the ground is performed in a broken series of short hops, the animal pauses after each jump until it reaches the point of no return. Thereafter it moves rapidly to the next tree.

Individual movements show an infinite variety depending on the spacing of trees within the area. Distances of up to 60 yards are known to be covered along the ground. Two examples to show the sequence of movement between trees and on the ground are given below.

DISTANCE IN YARDS TRAVELLED THROUGH TREES = (T)
DISTANCE IN YARDS TRAVELLED ALONG GROUND = (G)

Individual A: 40(T); 23(G); 157(T); 16(G); 137(T)
16(G); 24(T); 19(G); 19(T).

Individual B: 237(T); 17(G); 10(T); 26(G); 80(T);
22(G); 20(T); 21(G); 62(T).

The movements of a female in between visits to her young infants are shown in figure 7.

2.6.4 Movements During the Daytime

Movement away from the sleeping place during the day is rare but it has been observed in the winter months. Movements within the sleeping tree, or trees immediately adjacent, are more common and appear to be related to temperature regulation.

The animals move into the sun in the early morning or during the winter months but into the shade as the sun gets higher, particularly in the summer. Frequently a nest may be used for part of the day, while at other times members of the group sleep in forks or on branches of the nest tree.

In mid-winter, a particular family group was found to be active between 9.00 a.m. and 11.20 a.m. on 3 consecutive days. They moved across the home range from a shaded nest site to more exposed positions, in the forks of trees, some 80 yards away (plate 1b & c). While moving, they behaved normally as at night, grooming themselves, licking gum and even jumping along the ground to get from tree to tree. In the late afternoons they moved back to the nest and started the night's activity an hour before dark.

Fig.6. Long jump with arms extended.

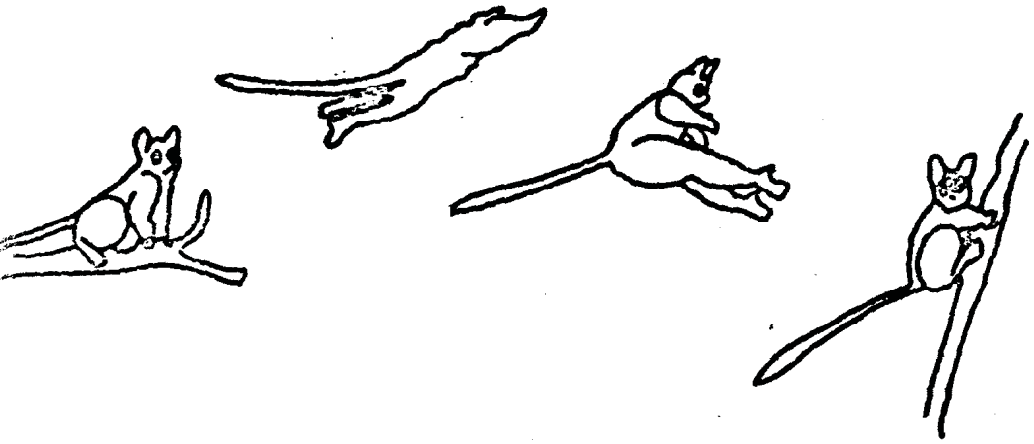
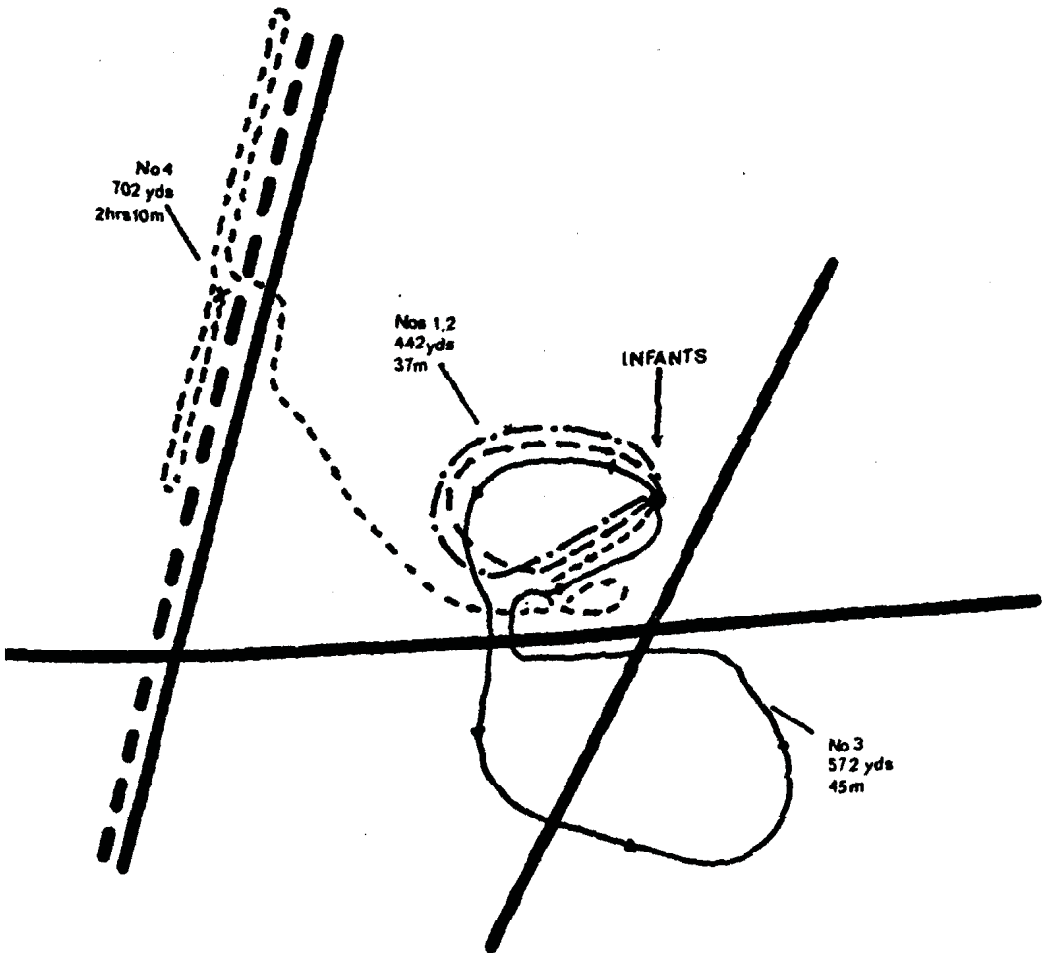


Fig.7. Movements of a female between visits to young infants.



2.7 GROUP RANGE

The movements of individual bushbabies and family groups may be illustrated through the concept of home range. Range is defined as the area traversed by a group in the course of normal feeding and maintenance activities (Burt, 1943). The home range is a composite measure which may be expressed as the area encompassed by multiple nightly ranges (De Vore & Hall, 1965).

2.7.1 Night Range

The present study indicates that the average path length of bushbabies during a night is 1.25 miles. This distance is calculated from a direct pacing out of the movements of bushbabies during each hour of observation. It represents movement through a mean number of 500 trees each night.

The pattern of movement of each bushbaby is in accordance with the observations of I.E. Brown (1966), on small mammals:

> "Movements are purposeful and include many exploratory activities as well as feeding. The animal often returns to the home site by the route it used for its outward journey. A night's or even a week's activity may be centred on one particular sector of the range. Certain areas in the range are favoured and visited frequently."

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When moving within the home range, bushbabies habitually

use the same generalised pathways. While these pathways are not strictly rigid, it is not uncommon to see individuals repeatedly making the same jumps from one particular tree to another, or crossing the same open spaces by going onto the ground. In general all movements are directional from one part of the home range to another, but the route taken is highly variable. It is possible for a bushbaby to traverse the home range within two hours, although this is rarely done. The animal may make a circular excursion of half a mile or more, starting from a certain point and returning to that point from the opposite direction some hours later.

The flexibility of movement in a directional way along recognisable pathways and the variability of these pathways, strongly indicates that the animals have a thorough knowledge of the area in which they live.

1.7.2 Home Range

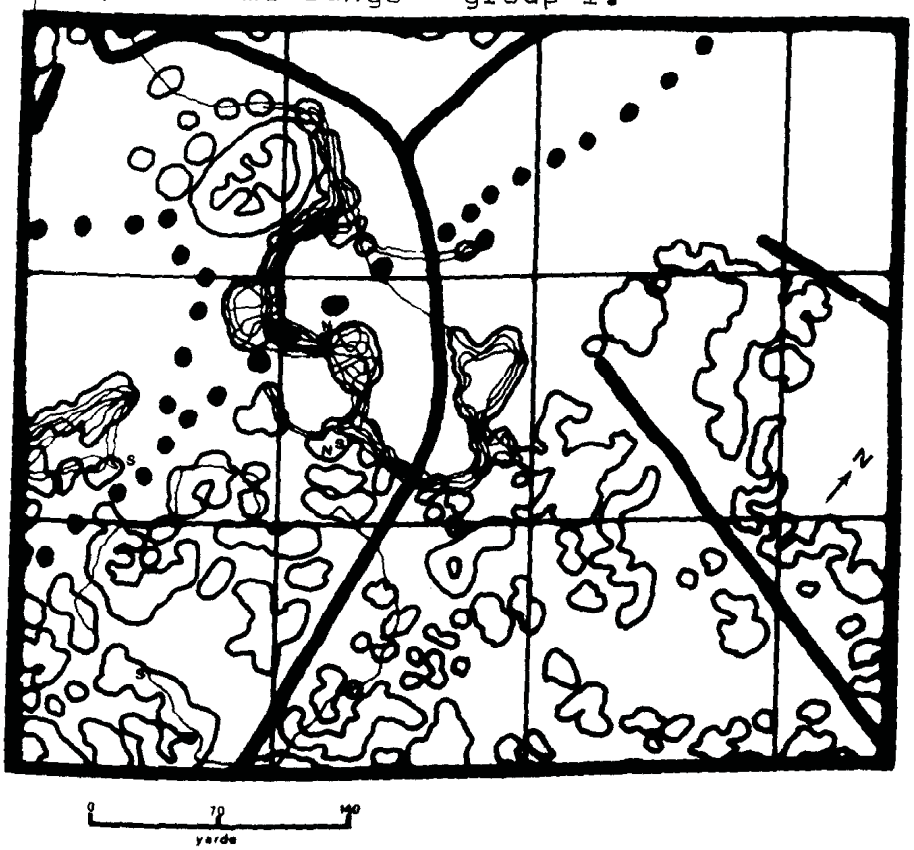
All movements observed during the year for each individual of 15 family groups were plotted onto accurate maps of the study area. Each of the maps 1 to 4 shows the range of a group during a two month period, based on between 25 and 75 hours of observation. When the peripheral points of movement are joined, the area enclosed represents the home range of that group.

Since the group does not move as a unit, it is not known whether the composite area covered by the group is

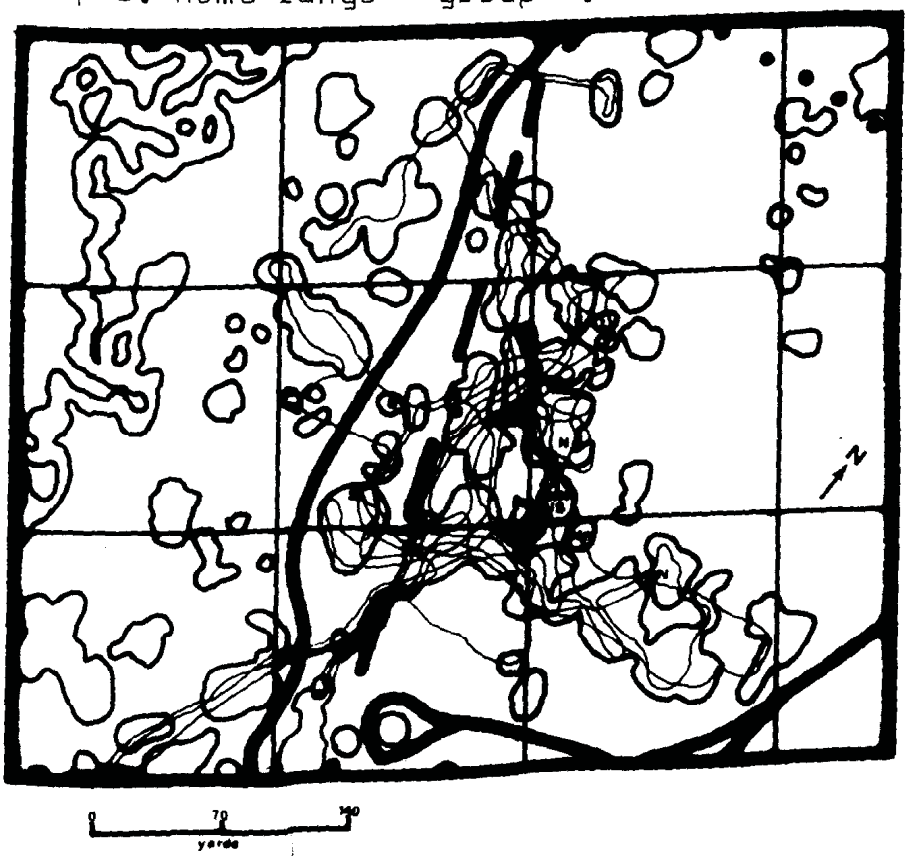
KEY TO MAPS. NUMBERS 1-6.

▬▬▬	Home Range Boundary.
▬ ▬ ▬	Area included in Study.
———	Roads and Fire Breaks.
B.	Farm Buildings.
··········	Furrows and Dams.
— — — — —	Fencing.
N,n.	Nests.
S,s.	Sleeping Sites.
	Individual Trees or Tree Groups.

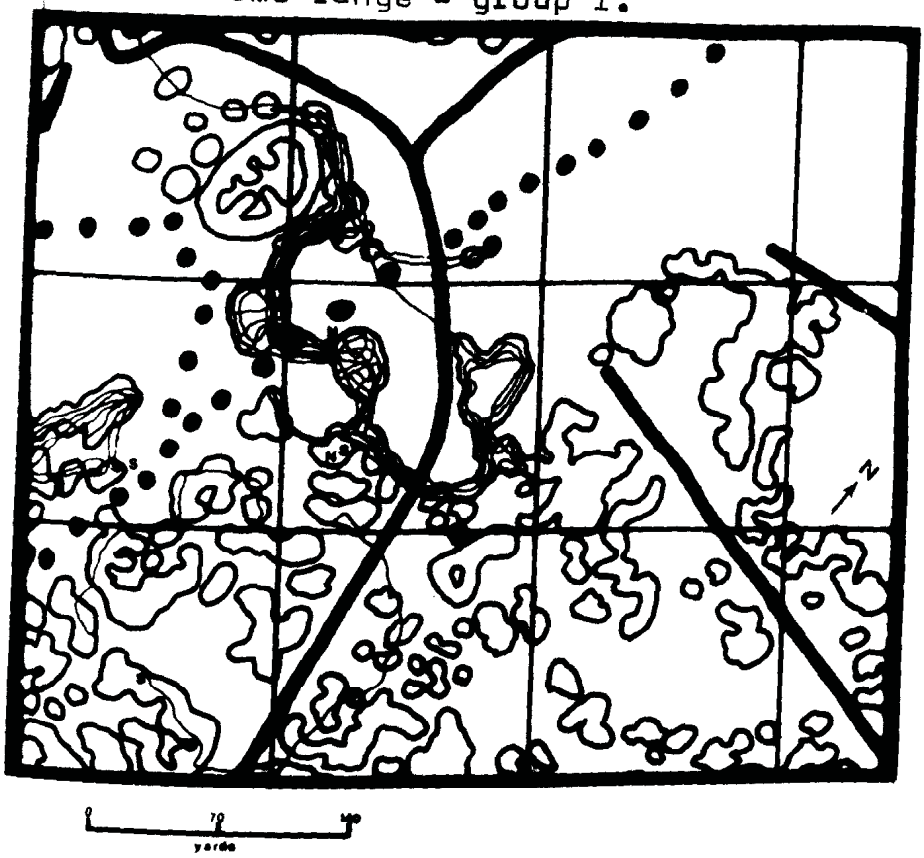
Map 1. Home range - group 1.



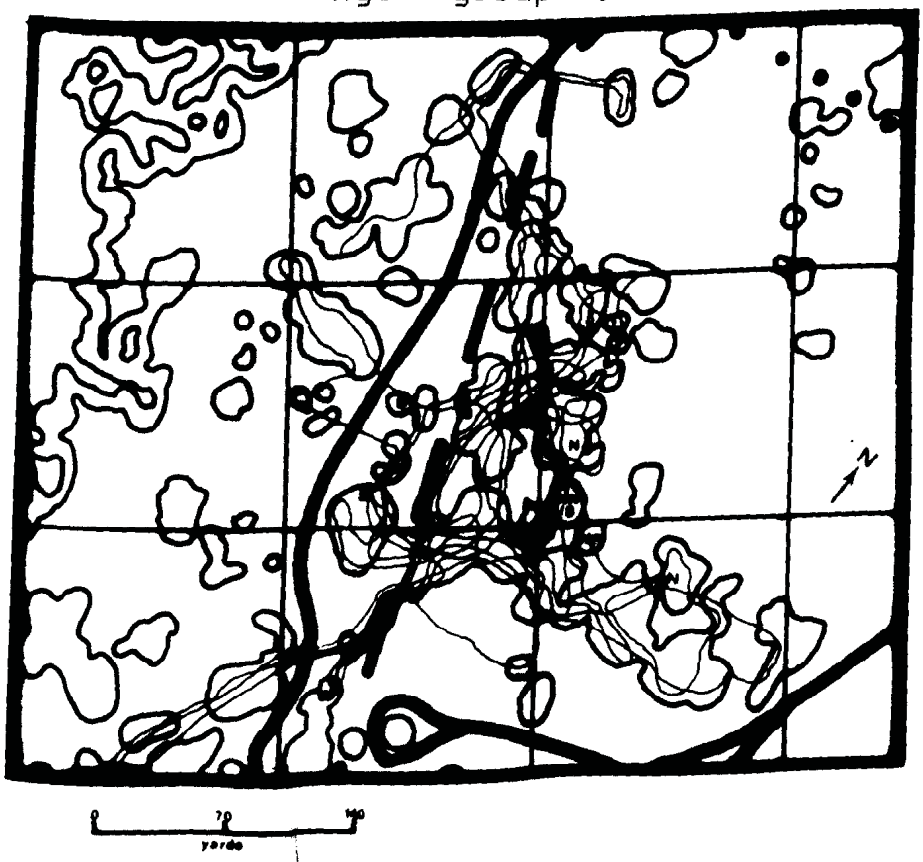
Map 2. Home range - group 2.



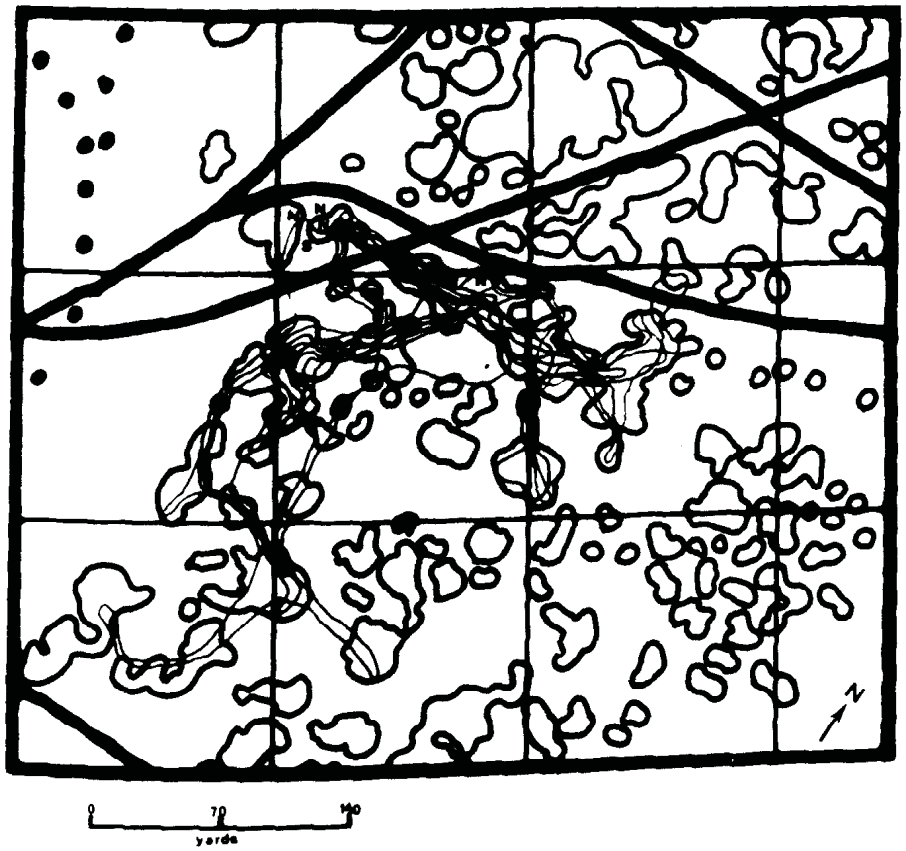
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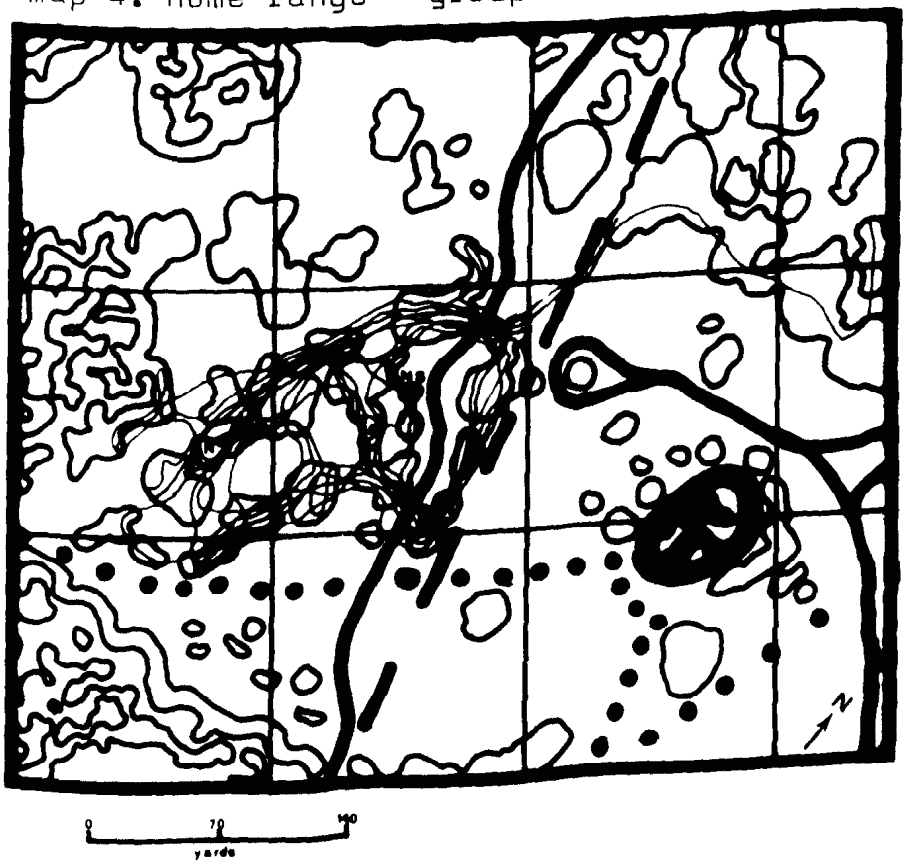
Map 2. Home range - group 2.



Map 3. Home range - group 3.



Map 4. Home range - group 4.



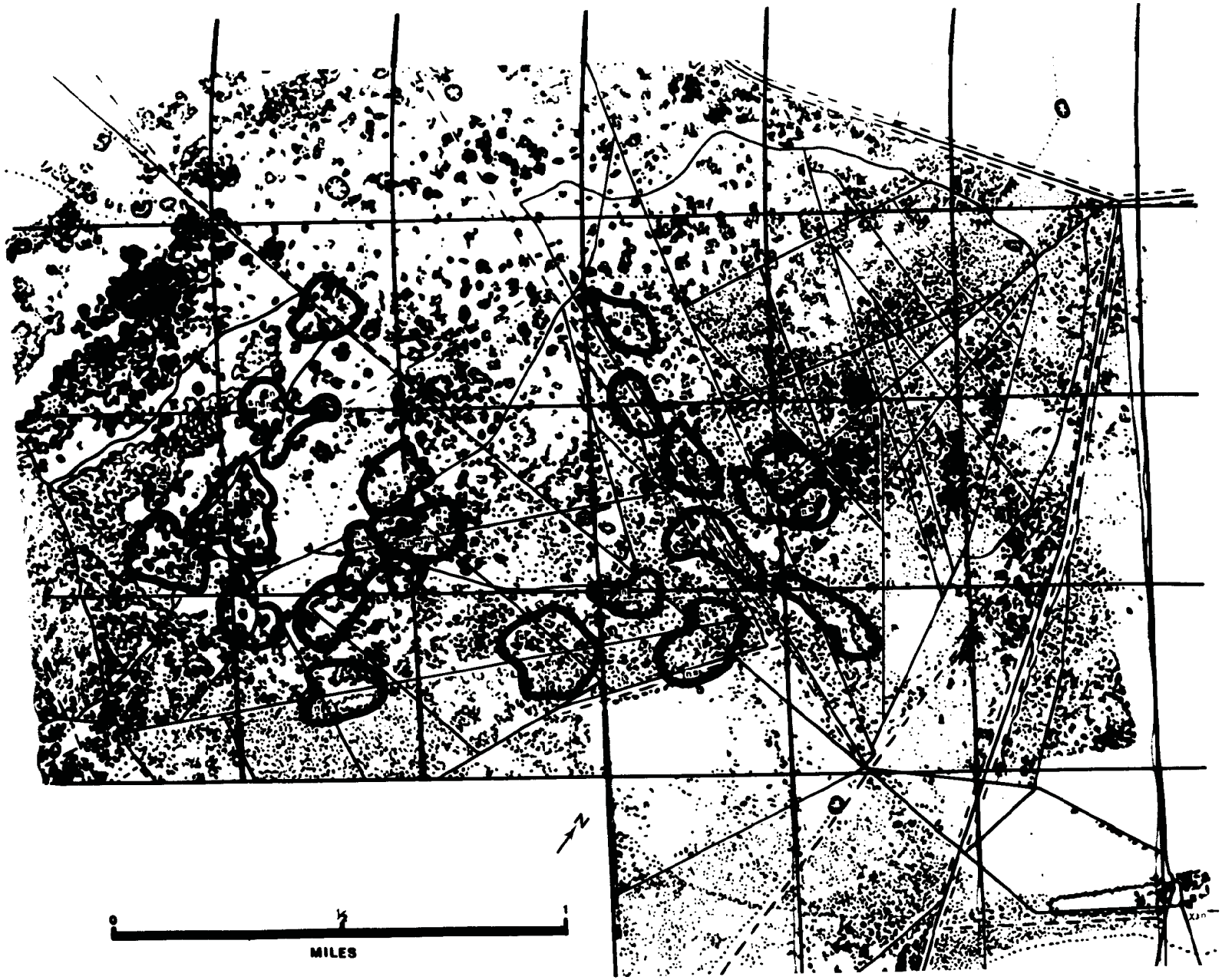
representative of the range of each animal. It seems likely that each bushbaby moves over a particular area within the home range of the group.

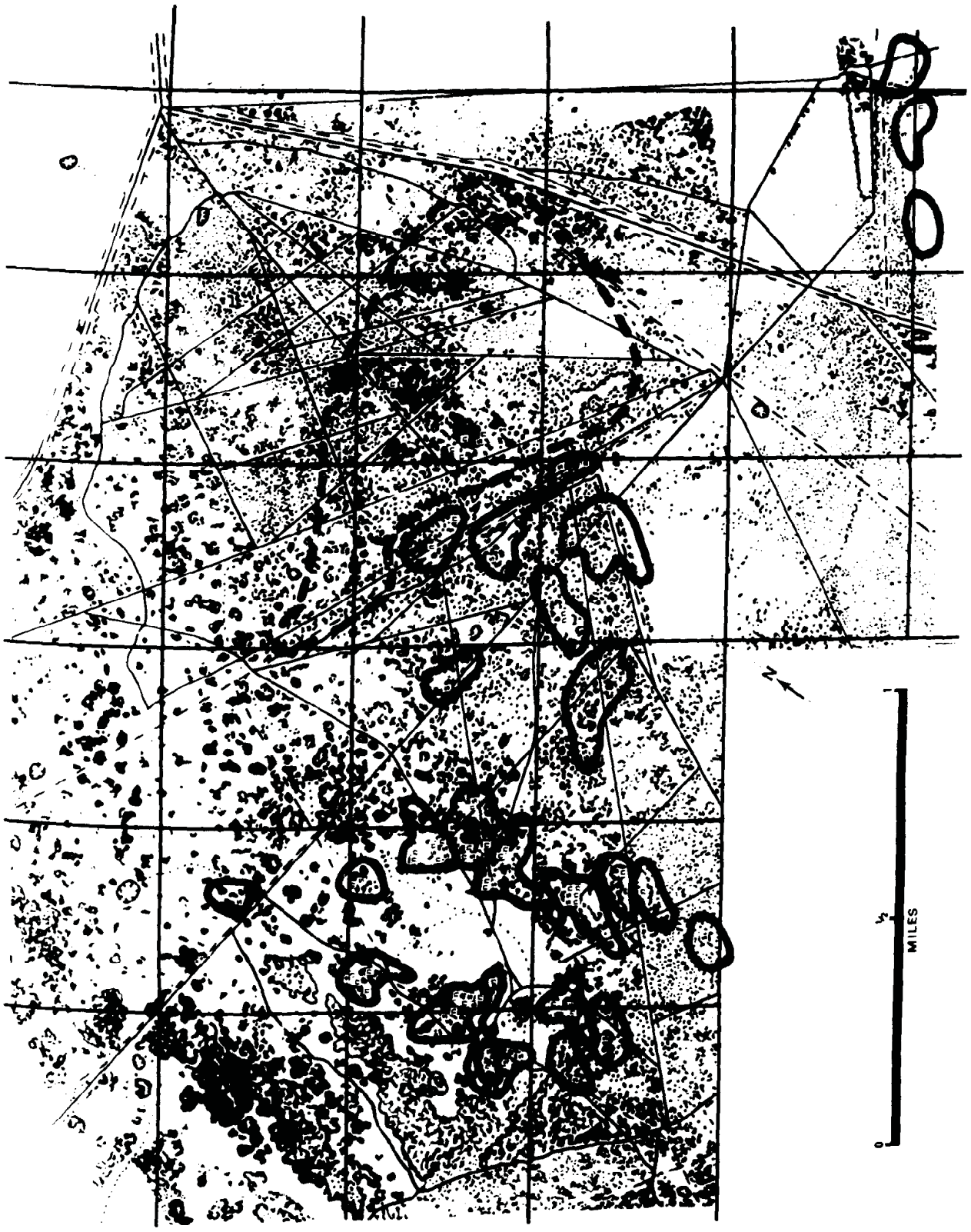
The 15 groups studied have an average home range size of 7 acres with a variation between 3 acres and 9.6 acres. (The smaller figure is thought to be inaccurate due to insufficient observations). The size of the home range is considerably larger than that described for Callicebus monkeys by Mason (1968), but smaller than for the majority of primates so far studied. However, for a small animal it is somewhat surprising to find such a large home range. This may be partly accounted for by the great activity and nightly path length of the bushbaby and the nature of the vegetation. The open bush of the study area is presumably less productive than more dense regions. The use of space within the home range has not been accurately assessed and requires further study using a grid system. It appears to be similar to that described for the territories of the arborial Howler monkeys by Carpenter (1964), which;

> "like those of many other animals have arborial pathways, food trees which change during the season, resting and sleeping trees. Vocalisations are important but fighting is rare."

The approximate home range boundaries for each of 20 groups were plotted during June and July 1968 (map 5)

Map 5. Home range boundaries and sleeping places (Jun. - Jul. 1968).





Map 6. Home range boundaries and sleeping places (Feb. - Mar. 1969).

and again during February and March 1969 (map 6). The boundaries are not strictly rigid, there is an overall shifting of the home ranges during the year as shown by a comparison of the two maps. At any one time the home ranges are evenly distributed where there is uniform bush cover. Natural boundaries are formed by roads, breaks or large open spaces, otherwise there is a slight overlap of the ranges. Occasionally an individual may make a long narrow inroad into the home range of another group and by this means the members of different groups may be brought together.

2.8 FOOD HABITS

Bushbabies in the study area feed on insects and Acacia gum both of which are available throughout the year to a varying extent. It would appear that this diet provides for all water requirements since bushbabies have not been seen to drink in the wild, or even to lick condensation from the surface of leaves.

During the winter months the animals subsist on gum, supplemented by occasional insects. Gum is licked or eaten in lumps for periods of up to 15 minutes at a time. Records made in mid-winter show that an average time of 12 minutes is spent feeding during each hour of the night. Periods of up to 15 minutes may be spent on the ground looking for insects, worms and grubs.

In spring and summer when insects are plentiful, there is a marked decrease in the amount of time spent feeding, with very little searching on the ground. Gum is frequently licked but only for short periods. Eating occurs on an average of 6 times each hour. This represents a total of approximately 60 insects eaten in a night, together with a little gum. There is an obvious difference in the physical condition of bushbabies between winter and summer.

Due to the impossibility of seeing colours under the red light it is difficult to be specific about the types of insects eaten. Orders of insects which are known to be eaten are given below:

COLEOPTERA	-	Ground beetles
ISOPTERA	-	Winged termites
LEPIDOPTERA	-	Moths - adults, pupae, larvae
NEUROPTERA	-	Lacewings, antlion flies
ORTHOPTERA	-	Grasshoppers, locusts.

An analysis of the gut contents of 103 bushbabies in East Africa is given by Haddow & Ellice (1964).

No vegetable matter, apart from Acadia gum is eaten. Sauer & Sauer (1963), found that captive bushbabies showed interest in small birds and mice introduced into their enclosure. In the wild, no interest is shown towards these animals. Reports of bushbabies

raiding bird's nests for eggs probably derive from their habit of using old nests for sleeping purposes.

Individual bushbabies may go for periods of up to 3 hours without feeding. In general the maximum amount of feeding occurs in the first 4 hours after dark. Periods of foraging alternate with periods where the animal shows no interest in food but grooms, rests or moves rapidly from place to place. When looking for food within a tree the bushbaby flits from one branch to another, feeding briefly here and there and then moving to the next tree. Alternatively it feeds sporadically while moving to a particular tree which may be used repeatedly as a source of food.

Acacia gum is frequently found in forks, on the undersides of branches or near the base of tree trunks (plate 4c). Bushbabies often adopt a head down posture while licking gum (plate 7b), supported by the long legs. The feeding position may be changed repeatedly while licking at one spot. The bark is often chewed away to expose more gum. On one occasion an animal got a large piece of gum stuck to the roof of the mouth and spent 15 minutes licking it away.

Insects are always caught with the hands in a grabbing motion (plate 7a). Once caught they are often carried in the mouth to a comfortable fork or branch before

being eaten. When feeding on ground insects the bushbaby usually sits on a low branch staring at the ground. It jumps down intermittantly to grab a food item and immediately jumps back into the tree to eat it; insects which have been dropped onto the ground from a tree are sometimes retrieved. Bushbabies may spend periods of up to 15 minutes searching on the ground, they remain alert and quickly jump into a tree if danger threatents. Haddow & Ellice (1964), note that ground living insects were found in the gut-contents of two-thirds of the bushbabies which were examined and that they made up a considerable part of the total bulk of food.

Acacia karoo thickets prove the most densely populated bushbaby habitat. These trees abound with insects which are attracted by the gum and during the winter they provide the major source of food. Throughout the year, as different trees within each home range come into flower they become an attraction to bushbabies due to the numerous insects which feed on the flowers. Individuals may spend as long as 2.25 hours in a single tree, catching moths and other insects.

2.9 PREDATORS.

It is probable that these small agile primates have little to fear from any predator while they remain in the thorn trees, either during the day or at night, since they are able to jump rapidly from one tree

to the next. This does not apply to infants less than a month old which are completely vulnerable to any carnavour which might come across them. The chances of this happening, however, are minimal, due to the behaviour of the mother.

Possible predators of the bushbaby include civets, snakes, owls, genets, jackals, raptorial birds, cats and man. Of these the last mentioned causes by far the most serious depredation of populations, so that in many regions surrounding towns and villages the species is completely wiped out. Within the study area some families of bushbabies live in close association with man and his domestic animals. Serious depletion of numbers elsewhere is solely the result of these animals being caught and sold as pets. This practice, although illegal, still continues in South Africa and Botswana where Africans sell bushbabies by the roadside or railways.

Of the night-time predators only the cats, snakes and genets are able to climb trees but none are sufficiently agile to catch an alert bushbaby. Owls, raptorial birds and ground dwelling predators are no threat while the bushbaby remains in the cover of trees, but may well be in the open. Genets and jackals, which are recognisable by their characteristic reflective stares, are commonly seen moving around at night. A genet was once discovered due to a bout of alarm 'yaps' given by a bushbaby. It was found sitting on a bird's nest where it remained for

2.5 hours. The bushbaby remained interested in it for 20 minutes before ceasing to call and moving away.

It is obvious from the behaviour of bushbabies that they are extremely wary before descending to the ground nervous when in small trees. If they are deliberately disturbed they either move upwards or they retreat rapidly to a larger tree.

The state of awareness of an individual varies according to the circumstances. An undisturbed bushbaby moving quietly through the trees will go to the ground in order to feed or cross an open space with the minimum of visual and auditory checking of the environment. An agitated or aroused animal on the other hand, frequently shows nervous behaviour while making fear calls and will not descend to the ground without a much more elaborate ritual.

Various calls are given in situations involving possible predators. These are described by Andersson (1969) in the laboratory and discussed in relation to field data under communication. Bushbabies show a nervous reaction to the shadow of a flying owl cast on the ground by moonlight.

During the daytime bushbabies are either completely hidden from view from above by foliage or they are protected from aerial predators by the fact that they

nest and sleep in dense thorny trees. Even when sleeping without a nest they are extremely difficult to see from below. If, however, they are disturbed during the day, they soon become fully awake and will move rapidly away through the trees should the threat continue. This fact has been observed previously by Sauer & Sauer (1963).

It therefore seems unlikely that bushbabies are subject to much significant predation. They are plentiful in remote or protected areas, even close to human habitations, providing they are not caught as pets. Their success is undeniably a result of their secretive behaviour. Few people living in the area have ever seen a bushbaby apart from its eyes reflecting in car headlights.

2.10 RELATIONSHIPS WITH OTHER SPECIES

Bushbabies do not show any active interest towards other species apart from potential predators. There are very few other nocturnal arborial animals in the area of study. Apart from the genet, only the climbing mouse and the Acacia rat have been seen. If a bushbaby comes across one of these animals the two may stop briefly to regard one another, but no further interaction occurs. The movements of ground living animals such as hares, buck and domestic cattle at night may cause the bushbaby to look in their direction, but they do not induce any alarm. Roosting birds are sometimes disturbed inadvertantly

by the activity of bushbabies and they will occasionally fly away. During the day only birds and bush squirrels are known to share the same trees as bushbabies, but they ignore one another.

2.11 BIRTH PERIODICITY

The occurrance of births in the laboratory has been described by Lowther (1940); Sauer & Sauer (1963) and Doyle et al. (1967). The gestation period is established as being between 123 and 125 days. The females usually produce twins after the first birth. There is usually a post-partum oestrus so that each female is capable of giving birth twice during the year.

The incidence of births and matings in relation to the building of nests, temperature and rainfall data, from May 1968 to April 1969, is shown in figure 8.

The periods when the mothers are suckling coincide with the time of the year when there is high rainfall and high temperatures. Insects are abundant and nesting materials, coupled with suitable nest trees, can easily be found.

It appears that there are two separate birth and mating seasons during the year. The first infants were found in October and early November, while a much higher proportion of infants were born at the end of January