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A study of bushbuck (*Tragelaphus scriptus*) in Mole National Park, Ghana.

By

Bernice Dankwa-Wiredu

A GRADUATE THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE MASTER OF SCIENCE IN FORESTRY DEGREE.

Faculty of Forestry and the Forest Environment
Lakehead University
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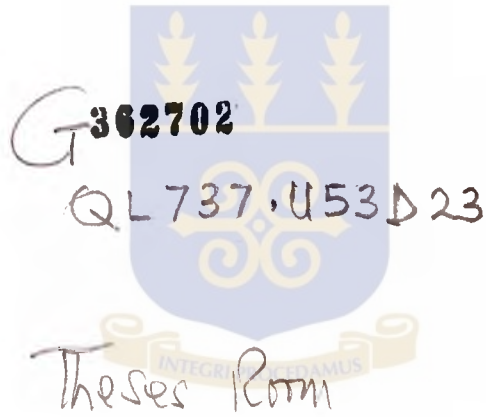

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ABSTRACT

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Keywords: Bushbuck *Tragelaphus scriptus*, Ghana, behavior, focal-animal, feeding sites, resting site, bedding sites, activity pattern, movement pattern.

The bushbuck (*Tragelaphus scriptus*), one of the ungulates occurring in Ghana, has not been the subject of extensive study. For the species and its habitat to be managed effectively to meet the needs of the people of Ghana and the tourist industry, a sound understanding of its habitat and behavior is required. This study examined the habitat and behavior of bushbucks in Mole National Park, Northern Ghana. The study also compared local knowledge to observational data.

The site selected for the study was in the Samole area and had Guinea savanna vegetation. Four bushbucks were used as focal animals for the study. One was fitted with a radio ear tag. These animals were followed, and data on their habitat, food and activities were recorded.

Bushbucks were found to have a low variability in their diet. Twenty-six food plants were found, with four being widely fed upon. All the food plants, except for two species, were dicotyledons. Bushbucks fed mainly on leaves from upright shoots. Each individual developed its own activity pattern and followed specific paths while foraging.

Bushbucks used the open savanna woodland and marshes that provided both food and cover to a greater extent than the riverine forest. A higher preference was shown for marshes. Resting and bedding sites were chosen irrespective of the tree species. Plant species with branches touching the ground, first branches between 27cm and 1m, and crown densities between 20-80% were readily chosen as resting and bedding sites.

Bushbucks were active at temperatures below 30°C. When temperature exceeded 31°C, bushbucks retreated to the bushes or thickets to rest and chew the cud. A temperature difference of between 2-5°C occurred in the shade and in the open areas within 1m of the resting and bedding sites.

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CONTENTS

Page

1. INTRODUCTION....1

1.1 PURPOSE OF THIS THESIS....1

1.2 THE BUSHBUCK (TRAGELAPHUS SCRIPTUS PALLAS)....2

1.2.1 General description of the bushbuck....2

1.2.2 Distribution of the bushbuck....3

1.2.3 Behavior and adaptations....4

1.2.4 Habitat and Food....5

1.3 BACKGROUND ECOLOGY....6

1.4 RESEARCH OBJECTIVES....7

2. MATERIALS AND METHODS....9

2.1 STUDY AREA....9

2.1.1 Study site....11

2.2 SURVEY PROCEDURES....12

2.2.1 Interviews....12

2.2.2 Direct observation....14

2.2.2.1 Preliminary survey....14

2.2.2.2 Capture, tagging, radio-tracking and identification....15

2.2.2.3 Vegetation sampling....17

2.3 ANALYTICAL METHODS....19

3. RESULTS....21

3.1 INTERVIEWS....21

3.2 DIRECT OBSERVATION....23

3.2.1 Habitat....23

University of Ghana http://ugspace.ug.edu.gh

3.2.2 Diet composition.....25

3.2.3 Feeding sites.....31

3.2.4 Feeding habits.....31

3.2.5 Activity pattern.....32

3.2.6 Effect of temperature on the major bushbuck activities......39

3.2.7 Choice of resting and bedding sites.....39

3.2.8 Bushbuck relationships.....49

3.2.9 Foods eaten by other species in the study site.....51

4. DISCUSSION.....52

4.1 COMPARISON OF INTERVIEW DATA AND DIRECT OBSERVATION.....52

4.2 DIRECT OBSERVATION.....54

4.2.1 Habitat.....54

4.2.2 Diet composition.....55

4.2.3 Feeding habits.....56

4.2.4 Activity pattern.....57

4.2.5 Effect of temperature on bushbuck activities.....59

4.2.6 Choice of resting and bedding sites.....59

4.2.7 Bushbuck relationships.....60

5. CONCLUSIONS AND RECOMMENDATIONS.....61

5.1 RECOMMENDATIONS.....62

LITERATURE CITED.....64

APPENDIX I Guide for interviews.....67

APPENDIX II Species found on the major feeding sites.....68

APPENDIX III Interview data.....70

University of Ghana http://ugspace.ug.edu.gh

APPENDIX IV Chi-square & Multiple regression.....71

APPENDIX V Resting and bedding site parameters.....72

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TABLES

PAGE

TABLE 2-1 SCALE FOR PERCENTAGE COVER. 18

TABLE 2-2 CRITERIA FOR VEGETATION DENSITY. 18

TABLE 3-1 PLANT SPECIES AND PLANT PARTS EATEN BY BUSHBUCKS IN THE WET AND DRY SEASONS. 22

TABLE 3-2 SIGHTINGS IN DIFFERENT HABITAT TYPES 25

TABLE 3-3 FREQUENCY OF CONSUMPTION OF FOOD BY BUSHBUCK FROM MAY TO AUGUST, 1998 BASED ON DIRECT OBSERVATION IN MOLE NATIONAL PARK, GHANA. 27

TABLE 3-4 TIME SPENT BY BUSHBUCKS PERFORMING VARIOUS ACTIVITIES. 33

TABLE 3-5 DISTANCE OF TREES WITH DBH GREATER THAN 20CM FROM THE RESTING SITES.42

TABLE 3-6 TREE SPECIES PRESENT AT RESTING AND BEDDING SITES IN MOLE NATIONAL PARK, GHANA. 43

TABLE 3-7 DENSITY OF VEGETATION CHOSEN AS BEDDING/RESTING SITES. 44

TABLE 3-8 SINGLE AND INTRA-SPECIFIC ASSOCIATIONS RECORDED WITH FREQUENCY GREATER THAN ONE OCCURRENCE. 50

TABLE 3-9 ANIMALS FOUND IN ASSOCIATION WITH BUSHBUCKS 51

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FIGURES

PAGE

FIGURE 1-1 THE BUSHBUCK. 3

FIGURE 1-2 DISTRIBUTION OF THE BUSHBUCK IN AFRICA. 4

FIGURE 2-1 LOCATION OF MOLE NATIONAL PARK. 10

FIGURE 2-2 LOCATION OF STUDY SITE. 11

FIGURE 2-3 COMMUNITIES SURROUNDING MOLE NATIONAL PARK SHOWING THE NINE COMMUNITIES INVOLVED IN THE STUDY. 13

FIGURE 3-1 EXAMPLES OF SOME OF THE PLANTS EATEN BY BUSHBUCKS. 30

FIGURE 3-2 SCHEMATIC DIAGRAM OF BUSHBUCK ACTIVITIES. 33

FIG. 3-3(A, B, C.) DIURNAL ACTIVITIES OF BUSHBUCKS 36

FIGURE 3-4 OBSERVED ACTIVITY AREA OF BL, MBB AND HM. 38

FIGURE 3-5 RELATIONSHIP BETWEEN TEMPERATURE AND MAJOR BUSHBUCK ACTIVITIES. 39

FIGURE 3-6 EXAMPLES OF THICKETS AND TREES/SHRUBS USED AS BOTH BEDDING AND RESTING SITES. 48

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DEDICATION

To

My dear husband Abbas Dankwa Wiredu, daughter Chrystal and my family with love.

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A CAUTION TO THE READER

This M.Sc.F thesis has been through a semi-formal process of review and comment by at least two faculty members.

It is made available for loan by the faculty for purposes of advancing the practice of professional and scientific forestry.

The reader is reminded that opinions expressed in this thesis are the opinions and conclusions of the author and do not necessarily reflect the opinions of the supervisor, the faculty of Forestry or the University.

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1. INTRODUCTION

Ghana lies in a central position on the coast of West Africa. It covers an area of 238,583 km^2 and is bounded to the West by Cote d'Ivoire, the East by Togo, the North by Burkina Faso and the South by the Gulf of Guinea. The vegetation varies across the country from the evergreen forest in the West to the savanna in the North. This wide variety of vegetation means a rich endowment of biodiversity. Several species of mammals: elephants (*Loxodonta africana*), monkeys and apes (*Primate sp.*), antelopes (*Antelopinae sp.*), duickers (*Cephalophini sp.*), and rodents (*Rodentia sp.*), are found in all the vegetation zones. Other species such as lion (*Panthera leo*) occur only in the forest. In addition to these, a large number of amphibians, reptiles, birds, insects and other small wildlife are also present. Wildlife plays a crucial role in the lives of the people and all wildlife resources are important ecologically, economically and culturally.

1.1 PURPOSE OF THIS THESIS

Considering the important role wildlife plays in the lives of the Ghanaian people and the tourist industry, an understanding of these animals is required to ensure effective management. Unlike common species such as the elephant, the bushbuck, *Tragelaphus scriptus*, which also occurs all across Africa, has not been the subject of many research studies. As a result, little is known about the habitat requirements and behavior of this mammal in Ghana. This thesis is the first study to examine the activities and habitat of bushbucks in Mole National Park, Ghana. The purpose of the thesis was to collect data on habitat selection, foraging behavior and other activities of bushbuck during the rainy season in Mole National Park.

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1.2 THE BUSHBUCK (*TRAGELAPHUS SCRIPTUS* PALLAS)

1.2.1 General description of the bushbuck

The bushbuck is one of the many mammals occurring in Africa. It is an even-toed ungulate (*Artiodactyla*) belonging to the family *Bovidae* and subfamily *Tragelaphini*. The head-body length is 105-150 cm on average, with a short woolly tail of length 19-25 cm, a shoulder height of 61-100 cm and a weight of between 24-60 kg for females and 30-80 kg for males (Kingdon, 1997). Females and young are mainly red and males become progressively darker with sexual maturity and age. Both sexes and all ages have a white underside to the broad, woolly tail, white flashes above black hooves and white markings on face and ears. The Western forest forms are 'harnessed', with both vertical and horizontal stripes and numerous spots on the haunches (Figure 1-1). Eastern and Southern 'sylvan' populations are sometimes plain and often sparsely marked with a few light spots and streaks on flanks or haunches. Only the males have horns with average length of between 25-57 cm (Kingdon, 1997). The horns vary from being very short, thick and nearly straight to longer and thinner with two marked kinks in the spiral. Montane and forest forms are blacker and/or redder while those from the driest areas are yellower. There are ten subspecies and intermediates, and due to variations, twenty seven races listed. The sub-species occurring in Ghana is *Tragelaphus scriptus scriptus* (Harnessed bushbuck).

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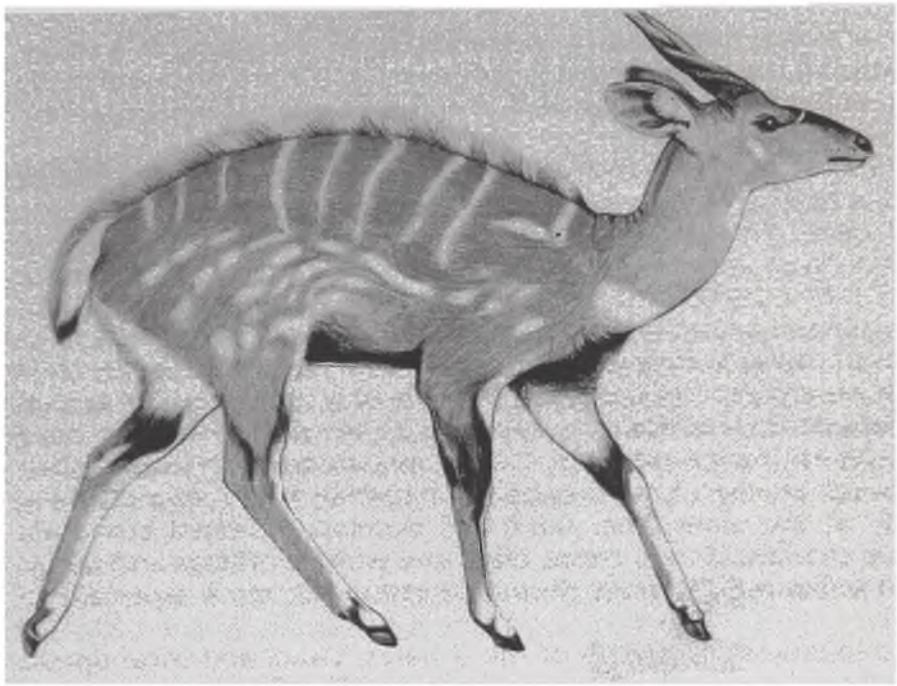

Figure 1-1 The bushbuck.

1.2.2 Distribution of the bushbuck

Bushbucks are one of the most widely distributed ungulates in Africa. Their range covers the whole of sub-Saharan Africa except the south-west, Kalahari desert and Somali arid regions (Figure 1-2). Locally, the bushbuck is absent from dry, open country simply because they are water-dependent. In Ghana, bushbucks can be found across the country (from forest to savanna) except in areas where desertification has left the land bare, open and dry. Bushbucks are more abundant in reserves than outside reserves due to hunting.

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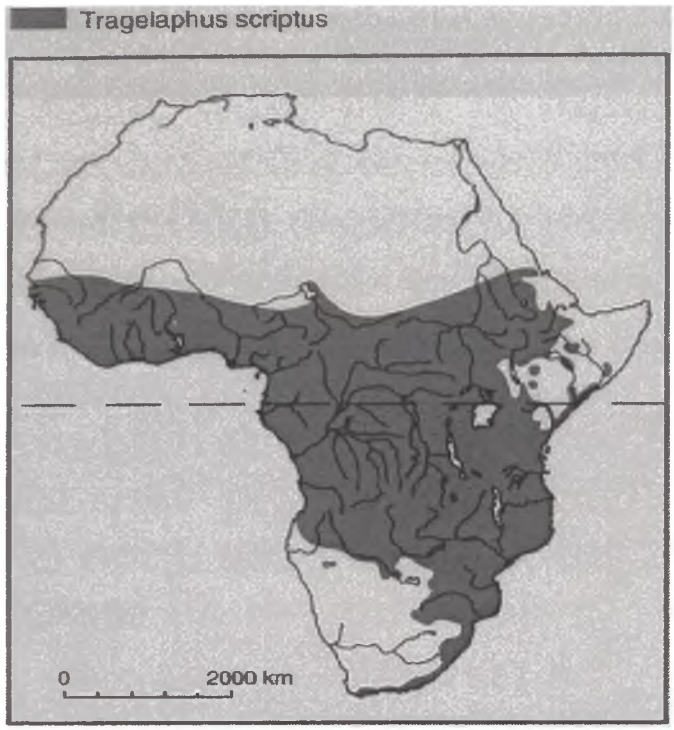

Figure 1-2 Distribution of the bushbuck in Africa.

1.2.3 Behavior and adaptations.

Bushbucks are usually solitary animals. Though normally residential, they are not territorial, even at densities of up to 26 per km^2 (on a fertile bushy peninsula). This remains a contentious issue as some studies (Verheyen 1955; Walther 1964; Jacobsen 1974) indicate some degree of territoriality while others (Burt, 1943; Allsopp, 1978) do not. Deaths, the incursion of immigrants, maturation of males and coming in season of females are potentially disruptive. Females form regular associations with other females and a small number of males.

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Males have a loud, deep, roaring bark which serves to intimidate predators, as well as to challenge or alert other bushbucks. Females also bark, but less loudly and less frequently. When uttered repeatedly by a moving animal, barks indicate change of movement. Unlike other ungulates, neighboring bushbuck scarcely ever bark in response but usually change direction or seek shelter. While courting, males utter a twittering call. There is no specific rut season. One young is born after a gestation period of about six months. Juveniles are kept well hidden for up to four months and sexually mature by one year, although male horns only reach adult size at about three years (at which time, coloring and behavior also change). Bushbuck can live for twelve years or more (Kingdon, 1997).

The survival of bushbucks in settled, agricultural areas and their very wide distribution, has been attributed to the fact that their small size, 'freezing' and crouching strategy help to conceal them from both humans and carnivores (Jacobsen, 1974; Kingdon, 1997). A versatile diet and their ability to subsist on both grass and browse also contributes to their success.

1.2.4 Habitat and Food

Bushbucks are essentially dependent on thick cover, even if this is no more than small thickets centering on termitaries. They sometimes live in reedbeds and can subsist on dew. Their food consists largely of shrubs, leguminous herbs, and grass (a nocturnal preference - Kingdon 1997), as well as pods and fruits of many species. Feeding patterns are strongly influenced by disturbance and predators.

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1.3 BACKGROUND ECOLOGY

Relationships between animal populations and their food supplies form a central problem both in theoretical ecology and for the management of natural and man-modified ecosystems. Various studies have been conducted (e.g. Heth et al. 1989; LeClerk 1991; Brunner & Kacelnik 1992; Phelan & Baker 1992) and principles of evolutionary optimization have been brought to bear on this problem.

Foraging behavior is an individual phenomenon, and is the result of the complex interactions between an animal and it's environment. However, differences between individuals within a population are often ignored in ecological theory. When individual variation is trivialized, foraging is implicitly treated as a population level phenomenon. This may lead to incorrect understanding of individuals and consequently the entire population, and perhaps, poor management decisions. Each animal within a population must develop strategies and tactics that allow it to become a successful forager.

Conventional approaches to studying foraging strategies are based on evolutionary assumptions and are of limited utility for exploring tactical questions of interest to biologists and managers. To increase the utility of this study, broad-based strategic assumptions were avoided and emphasis was placed on the influence of temporal and spatial heterogeneity on the foraging tactics and efficiency of individual bushbucks. It must be noted that the combination of a temporally and spatially heterogeneous habitat, the 'information available to the forager' and simple foraging rules, produce complex behavior.

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Herbivores, especially those in poor quality habitats, are often time-constrained due to their digestive physiology. Random movement through a habitat is rarely a productive method of finding or exploiting resources, so the need to search for high quality forage is critical. Consequently, movement patterns are of interest. Conventional foraging models often ignore or trivialize movement patterns by assuming that the animal has "complete knowledge" of the habitat. It is more likely, however, that behavioral mechanisms (tactics) have evolved to improve the efficiency of finding high quality forage without requiring omniscience.

Studies conducted by Haschick and Kerley (1996, 1997) using captive animals, have shown that bushbuck feed at/or near head height and use mainly single bites, with smaller proportions being made up by cheek bites, while front bites were rarely used. Though these observations are very useful, they have not been verified in the wild. Given the difficulty in transferring laboratory results to the field, or obtaining the same results in the field as obtained in the laboratory for many wildlife studies, these observations have to be verified. Thus, to verify these findings and help curtail the problems mentioned above, further studies are required.

1.4 RESEARCH OBJECTIVES

The bushbuck is one of the many wildlife species occurring in Ghana. Though not considered endangered in Africa, desertification, habitat loss and hunting in Ghana have resulted in a decline in numbers both within and outside reserves. Bushbucks play an important role in the tourism industry and bushmeat trade. For instance, out of the 2,119 animals killed illegally for bushmeat from Mole National Park between April 1993 and

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April 1994, 176 were bushbucks (Mason, 1993). While the large mammals occurring in Mole National Park and the other reserves are already quite well known by the park staff, no species in particular has ever been studied in any great detail and almost nothing is known of the size of the populations of various species. However, a number of reports on various zoological aspects of the park have been produced over the years notably: Aberdeen University Expedition reports (1973-1978), Arlangdon (1986), FAO (1968) Gelman (1989), Jamieson (1971), Komoah (1987) and Pegg (1969). Most of these studies have dealt with larger mammals and birds. The small mammals together with reptiles, amphibians, insects etc. are very poorly known. Ghana is a signatory to the Convention on Biological Diversity and therefore committed to protecting all its biodiversity, whether rare, endangered or otherwise.

To be able to manage bushbuck to meet the requirements of both food and tourism, sound scientific knowledge is required. This is totally lacking in Ghana and even across Africa, very few projects have been conducted on this species. The study of the harnessed bushbuck was carried out in Mole National Park with the following objectives:

- To record movement patterns of bushbuck during activity periods.
- To record the activities and to quantify and systematically describe the structure and composition (plant communities) of foraging sites and activity areas.
- To examine both general habitat use and specific space use patterns.

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2. MATERIALS AND METHODS

2.1 STUDY AREA

Mole National Park (MNP) is the largest park in Ghana covering an area of 4,840 km^2. It lies largely within the West Gonja District of the Northern Region of Ghana (Figure 2-1) and is situated between latitudes 9° 12' and 10° 06' North and longitudes 1° 25' and 2° 17' West. The main entrance is approximately 146km West of Tamale, the Northern Regional capital, and 24km North-West of Damango, the West Gonja District capital.

The park is situated astride the western rim of the Volta Basin and the generally undulating topography with flat topped hills is dominated by the Konkori escarpment which runs north-south through the park and reaches up to 250 m in altitude. Numerous rivers and streams run across or originate in the park and drain into the White Volta river. There is a single rainy season between April and October, with peaks in July and September. The dry season lasts for five months and the mean annual rainfall is 1,104 mm. The mean monthly temperature varies little (i.e. between 26.1°C and 30.5°C) yielding a mean annual temperature of 27.8°C while the average diurnal range is as much as 13.3°C. The hottest month is March, while December is the coldest.

MNP falls within the Guinea Savanna Zone of Ghana. The vegetation is open savanna woodland with a grass-layer that can reach up to 3m in height during the rainy season and which is burnt annually. Low, open grassland, so-called 'boval', is found on areas with shallow soils and iron pan. Narrow bands of riverine forest grow along most of the streams. Other plant communities such as swamps and flood-plains cover only small

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areas. Out of the 734 species of flowering plants found in the park, 148 are trees, 61 shrubs, 166 grasses, 284 herbs and 75 climbers (Schmitt and Adu-Nsiah, 1993). So far, 93 species of mammals, 304 species of birds, 9 species of amphibians, and 33 species of reptiles have been recorded in the park (Aberdeen University Expedition Report, 1973-1978).

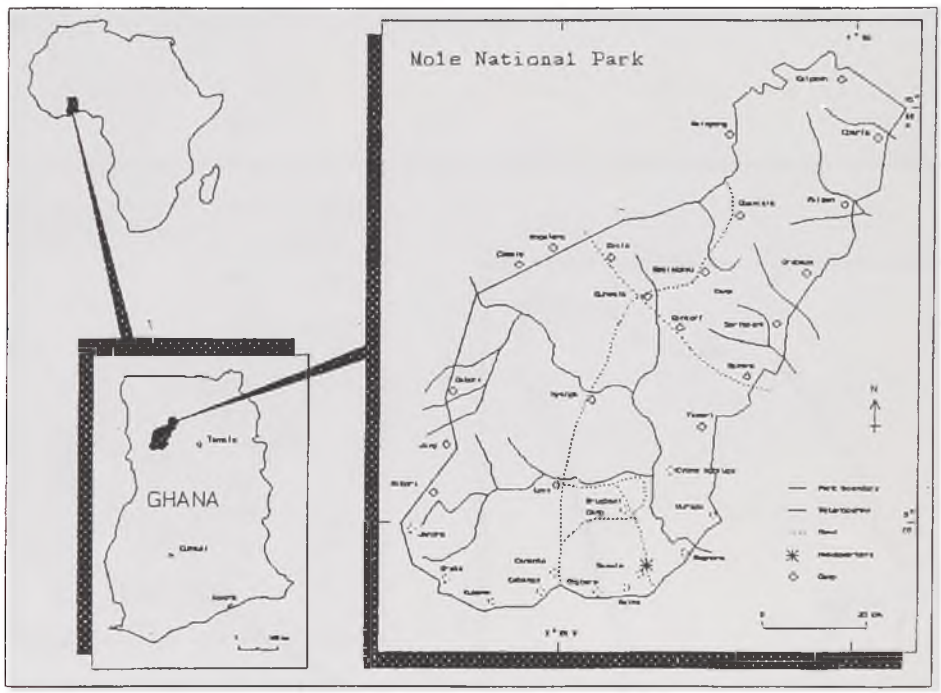

Figure 2-1 Location of Mole National Park.

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2.1.1 Study site

The study site falls within the Kanato administrative range and covers an area of 10km^2 (Figure 2-2). The site is made up of hills and lowland area within which can be found marshes, riverine forests and open savanna woodland. The hills have shallow soils and are covered by lateritic hard pans and boulders. The slopes are rich in herbs and grasses. Running through the site is the Mole river and some streams as well as two watering holes.

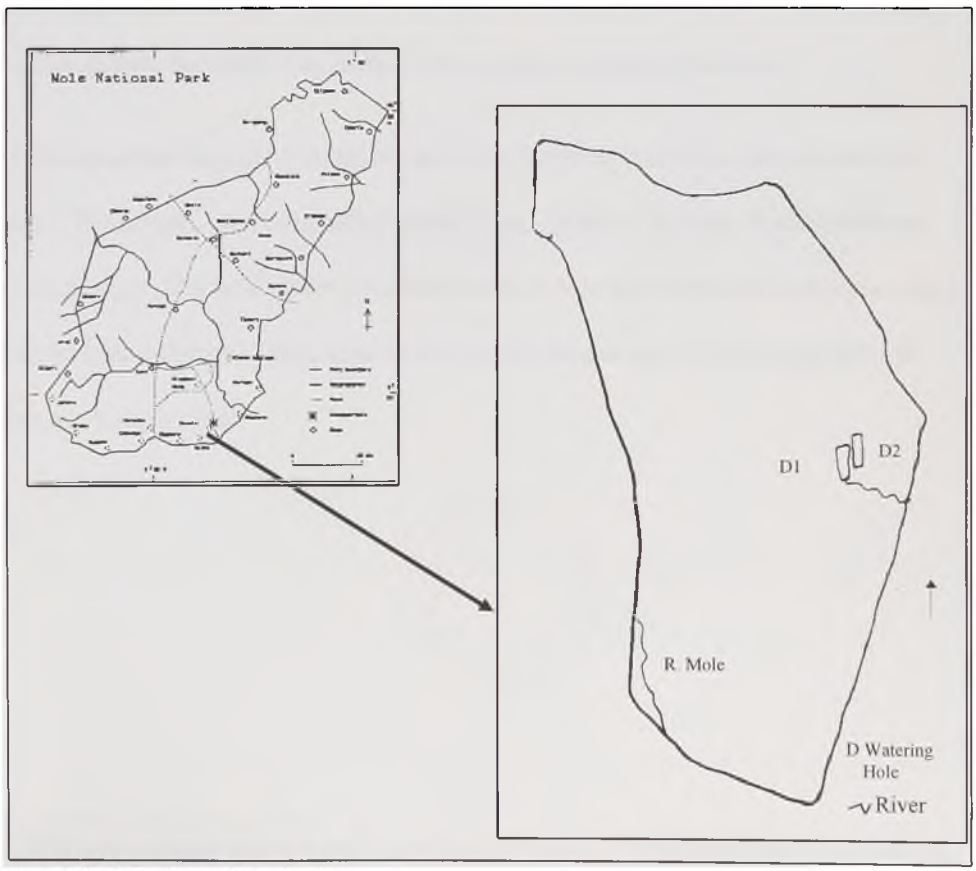

Figure 2-2 Location of study site.

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2.2 SURVEY PROCEDURES

The study was conducted in two major parts. The first involved interviewing people living in the communities around Mole National Park. The second part involved the direct observation of the bushbuck and sampling of vegetation. These two procedures combined were meant to provide a base on which further studies can be built.

2.2.1 Interviews

There are a total of twenty six communities surrounding Mole National Park (Figure 2-3). Due to problems of accessibility of the communities and wildlife camps[1] on the Northern side of the park - beyond Dabori on the West and Bawena on the East - during the rainy season, the study was limited to the southern portion of the park.

The communities were given numbers and a random sample of nine communities was drawn. These were Jang, Mognore, Dabori, Kong, Jellakon, Murugu, Kaden, Bawena and Larabanga. The wildlife camps within the area were also coded and a random sample of five camps selected. These were Samole camp, Jang camp, Dabori camp, Bawena camp and Kanato camp.

[1] Wildlife camp: a wildlife station at which a number of park rangers, technical assistants and an assistant wildlife warden live. A management area is assigned to each camp and the responsibility of the staff includes management , censuses, and monitoring of activities within the area.

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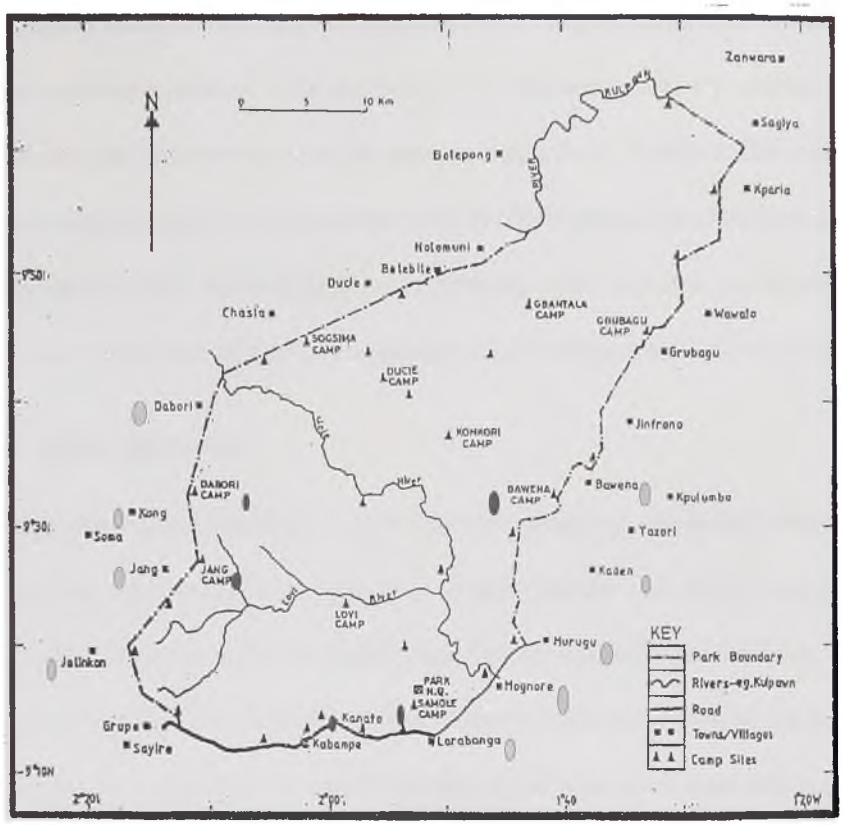

Figure 2-3 Communities surrounding Mole National Park showing the nine communities involved in the study.

Within each community a forum was held in the chief's palace to explain what the project was about and obtain permission from the chiefs to conduct the interviews. This was done to help alleviate any fears that the people might have (since a Wildlife Department vehicle was being used) and encourage the people to give as much information as possible. Since women are not involved in hunting and had to obtain permission from

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their husbands before talking to my assistant and I[2], the interviews were restricted to the males in the communities. After the forums, ten men were randomly selected from each community and interviewed using the guide in Appendix I. In the wildlife camps, two rangers were selected and interviewed to find out their perception of bushbuck numbers and foods consumed within their area of operation. In all, a total of one hundred people were interviewed and another fifty volunteered information which proved useful.

2.2.2 Direct observation

The method of direct observation plays a curious and unique role in behavioral science. It is the necessary link between laboratory research and the 'real-world', and the bane of our aspirations for more accurate, more objective information about behavior. The often sequential nature of data collection can be a benefit in the elucidation of animal behavior. Examining the sequential behavior of individuals provides much more information on how the animal exploits it's environment than does lumping of observations. Due to financial constraints and the lack of adequate equipment to carry out comprehensive night studies, the study was done mainly during the day between April and September of 1998.

2.2.2.1 Preliminary survey

The interviews indicated that the only places where a large number of bushbuck could be located were Jellakon and Samole areas. These two areas were then surveyed to determine which one was most suitable for the study based on bushbuck numbers and availability of assistance.

---

[2] Each community surrounding the park speak a different dialect. Since I do not understand or speak any of these, I had a technical assistant who spoke all the different dialects.

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Samole was decided upon and a preliminary survey - both walking and driving - was undertaken to determine the most suitable area for the study. Using a Garmin 80 portable GPS, the area was mapped out for the study.

2.2.2.2 Capture, tagging, radio-tracking and identification

Three different capture methods were used - nets, night drives and capture by hand. Nets of a total length of one hundred meters were set up in different areas within the site and bushbucks were driven from a distance of between thirty and fifty meters towards the nets during the day. Nets were set up in the areas determined as bedding sites for night drives. By the use of powerful flashlights, bushbuck were driven out of the bedding sites towards the nets. Capture by hand involved people surrounding a bushbuck and one group driving the animal towards the capture group. A radio transmitter attached to a plastic ear tag was fitted to the ear of a captured bushbuck (after being dipped into an anesthetic). The sex was determined, body measurements[3] taken and then the animal was released.

Only one female bushbuck (BL) was captured and fitted with a radio ear tag. The radio ear tag was programmed with frequency of 164.410MHz. for a Telonics T4 receiver. By setting the receiver to this frequency, the bushbuck was located and followed for further observation. In undulating landscapes, readings were taken on the high points since the signal was attenuated or was distorted in the valleys.

[3] The animals could not be weighed or aged since there was no weighing scale available or any qualified person to determine the actual age of the animal. One could only say whether the animal was mature, a juvenile or a calf.

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Bushbucks were also identified using the spot and line markings on their body and any defect which the bushbuck had. Three mature bushbucks (one female and two males), identified by this means also served as focal-animals for the study. These focal-animals were followed at a distance between twenty to fifty meters[4] and observed directly (for a total of 260 hours) using a 8.5 x 44 extra wide field Swift binoculars for as long as the animal was in view. The bushbucks activities were recorded on a time basis during each observation period and their positions recorded with a GPS. Plants or foods eaten by the bushbuck were either identified and recorded or samples were taken, pressed and sent out for identification.

Aside from this focal-animal sampling, four observation points were established in the study site. From these points, other bushbucks and ungulate species within the area were observed for forty hours and their activities recorded. Plants eaten by these animals were also either identified or samples collected, pressed and sent out for identification. Ten walks (a total of forty hours) were also taken along permanent transect lines within the area of study and bushbuck activities were observed on either side of the transects and recorded. All observations were done within four-hour time frames : 6.00am - 10.00a.m., 10.00a.m. - 2.00p.m., and 2.00p.m. - 6.00p.m.

[4] The terrain was such that at distances further than fifty meters observations were difficult, except when the observer was on a hill and the animals were in an open area in the valley. The bushbuck in the study area were comparatively less wary of people since they came into contact with tourists and park staff everyday.

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2.2.2.3 Vegetation sampling

Areas where more than five bushbucks were observed feeding for more than an hour at a time each day were established as feeding sites. Within each of the feeding sites, between five and ten 1m x 1m quadrats were randomly laid and species composition and percentage cover determined using the scale in Table 2-1. Samples of vegetation that could not be identified were collected, pressed and sent out for identification. Different grass species (except *Andropogon sp.*)were lumped together (simply called grass) since none had any inflorescence to aid identification. Other species present in the feeding sites but not found in the randomly placed quadrats were also recorded. In order to aid comparison to adjacent areas, between one and five 1m x 1m quadrats were randomly laid in areas within $3m^5$ of the feeding sites and the same procedure followed. No quadrats were laid in adjacent areas which were water, bare ground or forested. The difference in height of the vegetation on the feeding sites and adjacent areas were also taken into account where the two looked similar.

During the course of the observations, plant species found in the places used as resting sites by the bushbuck were recorded. The air temperature under the vegetation in the resting sites was compared to places in the open within two meters of the resting sites. The vegetation density of shrubs/trees in the resting sites was estimated using ocular methods based on the criteria in Table 2-2 established by the observer and a 1.5 x 0.6m density plywood board divided into 30 cm squares. The base of the board was placed on

[5] Feeding sites having similar vegetation adjacent to them had much shorter plants than the adjacent areas. In addition some feeding sites had permanent animal trails, or water and or bare ground surrounding them, while other sites had totally different vegetation from that in the feeding sites.

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the ground and the entire length observed from the opposite side of the vegetation. Since the bushbuck were not taller than 1.5m, vegetation density above this point was irrelevant in observing activities/possible danger outside the resting sites. Three different readings of vegetation density were taken for each resting/bedding site and the average score used.

Table 2-1 Scale for percentage cover.

Value	Range of % cover
1	<4 Scarce*
2	<4 Occasional**
3	<4 Frequent***
4	4 - 11
5	11 - 25
6	25 - 33
7	33 - 50
8	50 - 75
9	75 - 90
10	90 - 100 (about 100%)

*Scarce - up to four individual plants
**Occasional - up to seven individual plants
***Frequent - up to ten individual plants

Table 2-2 Criteria for vegetation density.

Proportion of density board seen	Score	% Range of density
Not seen at all	1	100
Small glimpses	2	80 - 99
Large areas	3	60 - 79
About half	4	40 - 59
More than half	5	20 - 39
Totally seen	6	0 - 19

The height of the plants was measured using a Haga altimeter where possible. The diameter at breast height (dbh) was also taken using a diameter tape where possible. The

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height of the first branch from the ground was measured using a tape measure. The width of the crown of the trees was taken using a tape and the shape of the crown was also recorded. The availability of the various habitat types were measured using a GPS.

An area within thirty meters of each resting site was assessed to find out whether any trees greater than 20 cm dbh existed, since such trees were bound to impair vision. Such trees were recorded and the height of the first branch from the ground taken if it was below two meters. During the night, bedding sites were also identified, marked and similar measurements taken.

2.3 ANALYTICAL METHODS

The analysis of the data for this study involved both qualitative and quantitative analytical procedures. Qualitative research/analysis is defined as that which produces findings not arrived at by means of statistical procedures (Corbib and Strauss 1990). It can refer to research about people's lives, stories or behavior, but also organizational functioning, social movements, or interactional relationships. Rural people have in-depth knowledge about nature, yet this knowledge is mostly underrated or not acknowledged. Chambers (1983) stated that "...it is only by traveling, talking, listening, observing and doing all these together that researchers and rural people can effectively learn from each other." Mustafa and Kasam (1982) point out that the qualitative data technique tends not to be structured even with interviews of large numbers of people. Instead of looking for statistical significance, an in-depth knowledge to understand the full ramifications of what is happening in the ecosystem or what people say, do and think, and the social

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systems they develop, are actually sought. Qualitative research is often referred to as an elucidation interpretive study, hermeneutics or idiographic description.

Interview data were analyzed mainly through qualitative means. Due to the fact that most of the data collected were based on direct observation, qualitative analysis was mainly used. Regression was used to assess the effect of five factors (tree height, vegetation density, height of first branch from ground, crown shape, and crown width) on the choice of resting and bedding sites.

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3. RESULTS

3.1 INTERVIEWS

A total of one hundred people were interviewed during the study period. According to all the interviewees, bushbucks were present in their areas. Respondents from eight communities and four wildlife camps - Jang , Mognore, Dabori, Kong, Murugu, Kaden, Bawena, Larabanga, Jang camp, Dabori camp, Bawena camp and Kanato camp - specified that bushbuck numbers had declined over the years. They attributed this to increased hunting pressure. Respondents from Jellakon and Samole camp on the other hand mentioned that bushbuck numbers have been increasing over the years and it is now much easier to see these animals. Sightings for this study and by rangers from the various wildlife camps confirmed this trend.

With regard to habitat use, 40% of the respondents stated that bushbucks use the same habitat all year round while 46% said different habitats are used by the bushbucks in the dry and wet seasons. The remaining 14% mentioned that bushbucks use different foods during the two seasons but stay roughly within the same area. They came to this conclusion because they had observed some bushbucks with disabilities within the same area all year round.

In talking about food eaten by the bushbuck, all respondents mentioned okro *Hibiscus esculentus*, pepper *Capsicum sp.,* and *Afzilia africana* as the major foods eaten by the bushbucks. In all, thirteen plant species and salt licks were mentioned. All these foods

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are, however, not eaten at the same time of the year (see Table 3-1) since bushbucks eat different parts of the plants, depending on seasonal availability.

Table 3-1 Plant species and plant parts eaten by bushbucks in the wet and dry seasons.

Wet season		Dry season	
Food	**Parts eaten**	**Food**	**Parts eaten**
Okro *Hibiscus esculentus*	Leaves, fruits	*Afzilia africana*	Flowers, fruits
Pepper *Capsicum sp.*	Leaves	*Vitex sp.*	Leaves, fruits
Groundnuts *Arachis hypogea*	Leaves	*Cassia sp.*	Flowers, fruits
Yam *Dioscorea sp.*	Leaves	*Pterocarpus sp.*	Leaves, flowers
Cassava *Manihot esculentus*	Leaves	*Daniellia oliveri*	Leaves, flowers
Vitex sp.	Leaves	*Terminalia sp.*	Leaves
Euphobia sp.	Leaves	Salt licks	
Haematostaphis barteri	Leaves		
[6]Salt lick			

Most of the wet season foods mentioned were agricultural crops. Since these are planted in the rainy season, farmers are more prone to identify these as foods eaten by bushbucks (which disturb their farms) than non-cultivated species. Dry season foods were composed mainly of flowers and fruits from large savanna trees, while the wet season food were composed mainly of leaves. Approximately 90% of respondents said bushbucks drink water often while the remaining 10% had no opinion.

All respondents mentioned that between 11.00 a.m. and 3.00 p.m. bushbucks were not active and would be seen resting under the shade of trees. Twenty percent of respondents said bushbucks were most active between 4.00 and 7.00 p.m., 22% mentioned 5.00 -

[6] All salt licks in and around the park were natural.

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11.00 a.m., 6% mentioned nights while 25% mentioned two periods - 5.00 - 10.00 a.m. and 3.00 -7.00 p.m.

According to 80% of respondents, bushbucks were strictly solitary animals but could be found associated with other animals at watering holes and salt licks. Out of the remaining respondents, 12% mentioned that during the dry season, bushbucks often associated with baboons. They said this was probably because the bushbucks fed mostly on fruits and flowers which were high up in trees. Thus, associating with baboons may give them a better chance of obtaining food. In addition baboons served as good lookout and thus the bushbucks had a better chance of avoiding predators.

With regard to bushbuck predators, respondents mentioned man, lions, pythons, *Python spp.*, leopards, *Panthera pardus*, spotted hyaena, *Crocuta crocuta,* and African wild dogs, *Lycaon pictus*. Only the elderly mentioned wild dogs and they pointed out that these carnivores are no longer present in their areas. Generally, bushbucks are used for food, medicine, and their skins sold to generate revenue. In Jellakon, however, bushbuck is a totem animal.

3.2 DIRECT OBSERVATION

3.2.1 Habitat

The bushbucks within the study area occupied three major vegetation types: marshes, riverine forest and open savanna (Table 3-2). Within the marshes, *Mitragyna inermis*[7],

[7] Most of the plant species in and around the park do not have common names. Common names are used where available.

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was the main tree species. Many different species of grass, forbs and herbs occurred, with the major species being *Cladium leploslachyium* and *Cissus sp.1*[8]. Different tree and shrub species occurred in the riverine forest. This included *Daniella oliveri, Afragle paniculata, Allophyllus africanuss, Cassia seiberiana,* and *Ziziphus mauritiana.* Various herb and grass species were also found here. In the open savanna, shrubs such as *Nauclea latifolia*, and trees such as *Afzelia africana, Burkea africana*, *Anogeissus leicocarpus* and different *Combretum sp*. were present. Many grass species dominated by *Andropogon sp*., various species of herbs and the climber *Cissus sp.2* were also found.

The sighting data revealed that bushbucks used the moderately dense vegetation (marshes and open savanna), where both food and cover were available, to a significantly greater extent than the dense riverine forests (Table 3-2, χ^2 >5.99 - Appendix IVa). The marshes and open savanna were utilized to a similar extent (Table 3-2) while the forest was utilized much less. The marshes had the highest ratio of use to availability (1.8), while open savanna and riverine forest had similar ratios (0.7 and 0.8 respectively). Thus the sighting data probably indicates that marshes are either preferred over open savanna and riverine forests or that the latter are avoided due to certain factors which were not measured. However, because open savanna was the most available habitat, it was used more than the forest.

[8] There are two different *Cissus* species in the park. The specific species have not been identified and thus are referred to by the numbers 1 and 2 by the park staff to differentiate them.

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Table 3-2 Sightings in different habitat types

Habitat type	Availability* (% Total habitat)	(No. of sightings)	Use** (%)	Ratio (Use/Avail)
Open savanna	65	171	45.5	0.7
Marsh	26	177	47.1	1.8
Riverine forest	9	28	7.4	0.8

*Availability: expressed as a percentage of total habitat.
**Use: expressed as a percentage of the total number of sightings.

3.2.2 Diet composition

A total of twenty six plant species were used as food by the bushbucks (see Table 3-3). From this number, four could not be identified and thus are referred to by their field numbers and two were agricultural crops. Most of the remaining plants were herbs together with one forb and one bulb (Figure 3-1). Grass was not used as food by any of the bushbucks observed during the study period. Generally only the leaves of the food plants were consumed. Using the number of times bushbuck were observed feeding on a particular species as a measure of the frequency of consumption, *Raindia captiatum, Raindia macaritha, Cnestis sp.* and *Eurena lobata* were the most widely eaten plants (Table 3-3). The forb *Exacum marcathium* and the bulb *Colocasia antiquciorium* were consumed only in the evening, on the way to the resting sites. Hb - Y was observed to be consumed only once in June. All the other species were consumed on a consistent basis throughout the duration of the study. With the exception of *Raindia captiatum, Raindia macaritha, Cnestis sp.* and *Eurena lobata* which were eaten at the highest rates, the frequency of consumption of the other species fluctuated from month to month (Table 3-3). Despite this high frequency of consumption, these species were not the most preferred. *Servia sp.* was the most preferred species (a rating of 11.10) followed by

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Euphobia hecta, and *Eurena lobata*. *Raindia macaritha* ranked fifth on the preference scale while *Raindia captiatum,* and *Cnestis sp.* ranked ninth and eleventh respectively. *Cnestis sp*. and Hb - 4 had the same preference (1.11) and Hb - Y was the least preferred species.

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Figure 3-1a. *Exacum marcathium*

Figure 3-1b. *Colocasia antiquciorium*

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Figure 3-1a. *Exacum marcathium*

Figure 3-1b. *Colocasia antiquciorium*

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Figure 3-1d. *Cnestis sp.*

Figure 3-1 Examples of some of the plants eaten by bushbucks.

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3.2.3 *Feeding sites*

The feeding sites for the purpose of this study are defined as: areas where more than three bushbuck feed for at least thirty minutes at each particular feeding. The plant composition within some of the feeding sites was similar to that in the adjacent areas (Appendix II) but contained a greater proportion of the species which the bushbuck fed on. In addition, the vegetation in the feeding sites was less dense and much shorter (by approximately 10cm) than in the adjacent areas making it easier for the bushbuck to clip off shoots and leaves. This difference may be due to repeated cropping of the plants in the feeding sites.

3.2.4 Feeding habits

Bushbucks were observed to use mainly single bites during the study. On two occasions, the use of front bites was observed. Bite types are based on descriptions by Cooper and Owen-Smith (1986) and include: 'single bites' - where a single leaf or individual leaf clusters are plucked between the lips and lower incisors; 'front bites' - where leaves or leaves and stems are plucked between the lips and lower incisors; and 'cheek bites' - where terminal buds and attached leaves are bitten off with the premolars or molars. There was a lot of movement when feeding. This was very slow in the feeding areas and thus it appeared the bushbuck only turned around without any active movement. Outside the feeding sites, however, bushbuck moved quickly and only stopped from time to time to clip leaves from some plants.

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Generally bushbuck did not feed from the same plant twice in a day or on two consecutive days. It was observed that the bushbuck returned to a particular plant between two and three days after it was first fed on. On certain occasions, shoots were left for up to a week. This was mainly observed for seedlings or shoots of large trees or shrubs. This allowed the plants to grow new, more succulent shoots which may have been more palatable. In addition, the bushbuck only fed on shoots which were upright. If a shoot was growing sideways on a plant, the bushbucks hardly fed on it. Bushbuck were observed to feed on salt licks throughout the period of study. However, this occurred only when it did not rain for a few days. If it rained bushbuck did not feed at the lick.

3.2.5 Activity pattern

Bushbuck were found to be involved in the following activities: feeding, moving, resting, drinking, grooming, playing, horning of bushes (males only), mating, and watching for danger. In general, feeding, moving and resting were the major activities embarked upon and these represented about 85% of observed activity (Table 3-4). The other activities, though essential to the bushbucks life, took very little time. Figure 3-2 shows a schematic diagram of bushbuck activities.

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Table 3-4 Time spent by bushbucks performing various activities.

Activity	% Total time		
	BL	MBb	HM
Feeding	43	53	60
Drinking	1	*	1
Playing	3	*	*
Moving	16	25	15
Resting	34	20	19
Grooming	2	1	1
Licking salt	1	1	*
Bush horning	0	0	4
Nursing	*	0	0

* = activities which were not observed but likely to have taken place at other times when the bushbuck was not being observed.

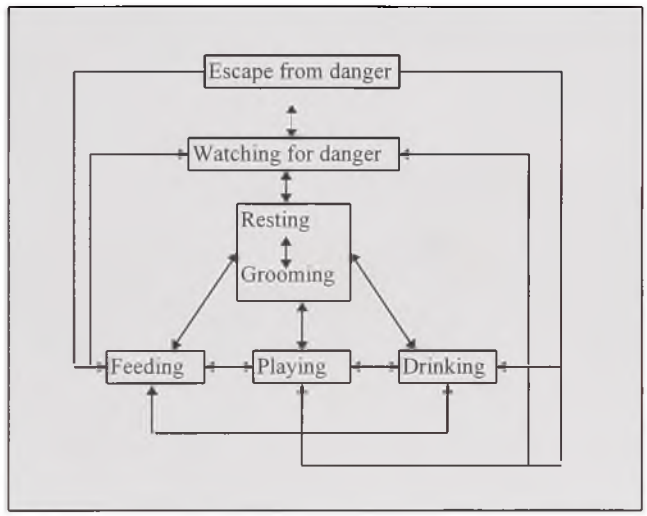

Figure 3-2 Schematic diagram of bushbuck activities.

Mating was observed only once during the study period and thus cannot be looked at in detail. The male and female in question formed a bond for three days, during which period the male started sniffing under the female's tail. On the third day, the male tried to

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herd the female into a secluded area by pushing her from behind . The female initially ran off in several directions when the male did this, but after an hour and a half, she finally stood quietly and allowed the male to mount her.

Suckling of young bushbuck was also observed on two occasions in the evenings. During the course of the day, young bushbuck were not seen with their feeding mothers. Instead, as the mother approached the feeding site, the young ran off to hide under a thicket. The mother spent most of the day away from this thicket and would approach it two or three times before the evening, when the young joined it and they moved towards the resting site. It was only in the safety of the slopes leading to the resting sites that suckling was observed[9].

Four mature bushbuck -two females (BL and MBb) and two males (HM and OM)- were selected for detailed observation. However, three will be discussed in greater detail since OM[10] was seen and observed on a few occasions (mostly in the evening) for a total of 20 hours. The three bushbucks studied in detail (for approximately 80 hours each) during the study period had similar activity patterns (Figures 3-3 a, b, c.). All three bushbuck had two feeding peaks. In the morning this peak varied from 7.00-8.00 a.m. for BL and HM, and 6.00-8.00 a.m. for MBb. In the evenings, however, all three fed the most around 5.00 p.m.. While BL started feeding very little around 5.00 a.m., HM only started

[9] It is not possible to determine the frequency of suckling or time between suckling bouts since only two observations of two different females was observed. It cannot be assumed that whenever a female approached a thicket, it was to suckle the young.

[10] Due to the time constraint, selecting another bushbuck late in the study, would not provide enough time for 80 hours of observation. In addition there was no guarantee that another bushbuck would stay within the study site.

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feeding after 6.00 a.m. and MBb was already actively feeding by 5.00 a.m.. On mornings following a full moon, all the bushbucks started to feed at a later time than usual. Some bushbucks were observed feeding on full moon nights. However, the light was insufficient for complete observation or identification.

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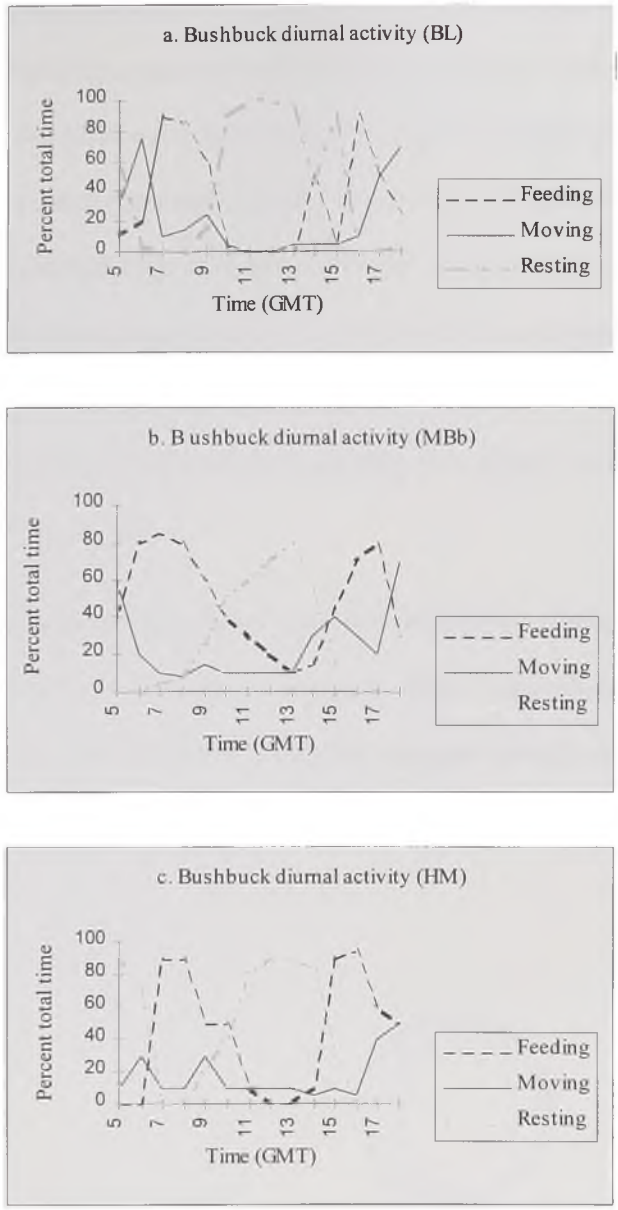

Fig. 3-3(a, b, c.) Diurnal activities of bushbucks

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Of the three bushbuck, MBb moved around most of the time while BL moved least and HM had quite a constant movement throughout the day. This pattern is probably due to the fact that MBb was a single female visiting more feeding sites within her large observed activity area and could afford to move around more than BL which had a young one and also had a leg deformity. HM on the other hand stayed roughly within a smaller observed activity area (Figure 3- 4). Territoriality was not observed during the study. In general, however, the movement pattern established during the day was from bedding sites, down the slopes to the feeding/resting sites and back up the slopes to the bedding sites in the evening.

The maximum resting periods ranged from 10.00 a.m. -1.00 p.m. for BL, 11.00 a.m. -2.00 p.m. for HM and 11.00 a.m. - 1.00 p.m. for MBb. MBb had the least rest during the day with just one peak followed by HM with two peaks and BL with three.

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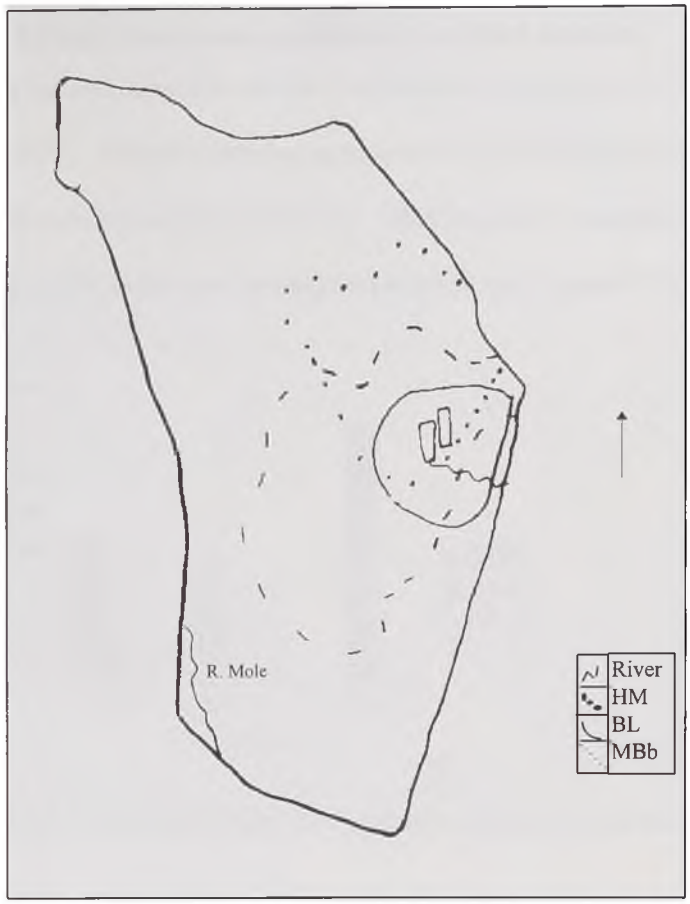

Figure 3-4 Observed activity area of BL, MBb and HM.

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3.2.6 Effect of temperature on the major bushbuck activities.

During the study period it was observed that bushbucks were most active at temperatures below 30°C. When the temperature exceeded 31°C bushbucks retreated to the bushes to rest and chew on the cud (Figure 3-5). There was always a temperature difference of between 2-5°C in the open as compared to the shade (Appendix Vb).

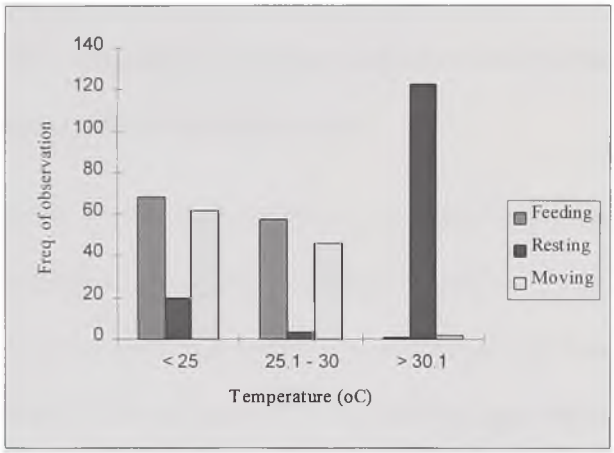

Figure 3-5 Relationship between temperature and major bushbuck activities.

3.2.7 Choice of resting and bedding sites

Six factors - plant species, height, height of first branch, crown shape, vegetation density and crown width -were considered with regard to the choice of resting and bedding sites by bushbucks (Appendix Va). Resting sites were used for short periods during the day while bedding sites were used at night and for a longer duration. Choice was quantified by the frequency of use of resting/bedding sites. The correlation coefficient of crown shape was 0.42 while that for height, height of first branch , crown width and vegetation

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density were 0.27, 0.14, 0.07, and 0.04 respectively (Appendix IVb). Crown shape correlated more highly with resting and bedding sites than the other variables. Norusis (1993), notes that the larger the absolute value of the correlation coefficient, the stronger the linear association. Height, density and width, however, had negative correlation to choice. This implies that the shorter the plant, the lower the vegetation density, and the smaller the crown width, the higher the chances of being chosen as a resting or bedding site. Although the correlation coefficients were not high, they do indicate promising avenues for further investigation.

At the 95% level of significance, the analysis of variance from the regression did not indicate any significant relationship (Sig. F = 0.23) between choice of resting/bedding sites and tree height, height of first branch, crown shape, vegetation density and crown width. Thus the choice of resting/bedding sites may have been random or by chance in this study.

In addition, trees with a dbh greater than 20cm did not occur within 10m of the resting sites. Such trees occurred within 20-30m from the resting places and had first branches above 1.5m (Table 3-5).

Generally, plant species did not appear to influence the choice of resting and bedding sites. Several species (Table 3-6) were present at areas which were chosen as resting and bedding sites. In cases where thickets along ravines were used, a cluster of many different species occurred. Even climbers - the two *Cisus sp*.- were used as resting and bedding sites. Many of the bedding sites observed during the study were within 100m of

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human habitation and were on hills. This may be a predator avoidance strategy since many of the large predators did not come close to human settlements.

Sites with trees ranging in height from 1m to 10.5m were all selected as resting and bedding sites (Appendix Va). However, the shorter the plant, the higher the chances of it being selected. Trees with first branches between 27 cm and 1m were selected for bedding and resting. Trees with branches above the 1m mark were hardly selected. The few that were chosen had to have branches drooping to the ground. This could be because higher non-drooping branches afforded less security.

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Table 3-5 Distance of trees with Dbh greater than 20cm from the resting sites.

RS	Species of nearest neighbor	Distance from RS (m)
1	*Anogeissus leicocarpus*	22
	Afzelia africana	25
2	*Daniella oliveri*	20
3		
4		21
5	*Mitragyna inermis*	
6		
7		
8	*Anogeissus inermis*	25
9		
10	*Anogeissus inermis*	24
11	*Pterocarpus erinaceus*	20
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22	*Mitragyna inermis*	30
	Mitragyna inermis	21
23		
24		
25		
26		
27		
28		

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Table 3-6 Tree species present at resting and bedding sites in Mole National Park, Ghana.

*Species
Nauclea latifolia
Mitragyna inermis
Anogeissus leicocarpus
Combretum gasilensis
Stereospermum kunthianum
Pterocarpus erinaceus
Cissus sp.
Isobelina doka
Diospyrus mespiliformis
Lannea acida
Piliostigma thonningii
Afzelia africana
Combretum mole
Ziziphus mauritiana
Tectona grandis

* Species do not have common names.

Trees with branches touching the ground were highly selected for resting and bedding. The drooping branches created a shady space underneath and had enough openings to provide a good view of the outside. At the same time, this arrangement made the bushbuck less conspicuous to those outside and provided easy escape routes. In addition, bushbucks can easily remain frozen in this environment and a predator may pass by without noticing them. Trees with horizontal branches were not chosen except where the first branches were below the 1m mark. Trees with vegetation density between 20 and 80% were readily chosen as resting and bedding sites with the greatest preference within the 40 - 59% range (Table 3-7). Trees/thickets with 90% vegetation density were hardly chosen. In two cases where the use of greater than 90% density was observed, bushbucks stayed just at the fringe and ran out even when danger was far off. In the

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morning, trees/thickets with vegetation density between 20 and 40% were readily used as resting sites. As the day wore on, however, higher vegetation densities were chosen. This may be due to the increasing temperature as the day progresses. Some trees/thickets served the dual purpose of resting and bedding sites (see Figure 3-6).

Table 3-7 Density of vegetation chosen as bedding/resting sites.

Density	Frequency of observation*
100	0
80-99	3
60-79	10
40-59	12
20-39	4
0-19	0

*Frequency of observation refers to only one observation per bedding/resting site since the sites were used on a consistent basis and more than one observation does not indicate a new density or site.

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Figure 3-6a. *Cissus sp.* 1

Figure 3-6b. Thicket showing a combination of species - *Tectona grandis*, *Nauclea latifolia* (in fore ground) & *Afzilia africana*

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Figure 3-6c. Thicket showing *Nauclea latifolia* (right) and *Acasia sp.*

Figure 3-6d. HM moving towards a bedding/resting site comprising of *Diospyros mespiliformis, Afzelia africana, Combretum mole, Lannea acida, Cissus spp.*

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Figure 3-6e. *Pilostigma thonningii*

Figure 3-6f. *Combretum sp.*

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Figure 3-6g. OM at the edge of a thicket. Taking a break from the blazing sun.

Figure 3-6 Examples of thickets and trees/shrubs used as both bedding and resting sites.

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3.2.8 Bushbuck relationships

Bushbuck were generally solitary during the study period. However, there were both permanent and temporary associations formed between individuals. Females were found to be more social than males (Table 3-8) and many of these associations appeared to be between related bushbuck e.g. female/young. Both male and female bushbuck were tolerant towards each other and little/no aggression occurred during encounters. On feeding sites, females formed temporary associations which lasted from one to four hours. Males on the other hand, kept a respectable distance from each other (at least 2m). Out of the six male/male associations observed, only one was permanent. The other male associations were of older males moving with younger males temporarily. Males appeared nervous and irritated when they got too close to one another and when there were females around. To show their irritation, males would hunch and raise the hairs on their back. The degree to which the hairs were raised indicated the level of irritation. When this posture was assumed and the flanks presented to the opponent, he usually moved away without incident. On one occasion, however, a young male did not take this cue from an older male and went too close. The older male chased him away. All the observed male/female associations were temporary one lasted at most three days.

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Table 3-8 Single and intra-specific associations recorded with frequency greater than one occurrence.

Association	No. of sightings	%
M	74	19.77
MM	4	1.07
MMM	2	0.53
F	112	29.95
FF	54	14.44
FFF	5	1.33
FFFF	4	1.07
MF	15	4.01
MFF	9	2.41
FY*	58	15.51
Y	17	4.55
FFY	8	2.14
FFFFY	6	1.60
FFFY	2	0.53
MFFFY**	2	0.53
MFFY	2	0.53

M - male; F - female; Y - young.
*It is possible that more FY associations would have been observed at night. However, due to lack of suitable equipment, night observations were limited.
**I did not observe a group with more than five animals. This is not to say that it is not possible for that to happen. It was simply not observed for this study.

Bushbuck were also found in association with other animals (see Table 3-9). They were very tolerant of warthogs (*Phacochoerus africanus*), but tended to move out of the warthog's way to allow them to feed. Bushbucks were mostly found associated with kobs (*Kobus kob*) and they fed together without any conflict. On a number of occasions, bushbuck were found together with baboons (*Papio sp.*). The baboons served as good lookouts for the bushbuck and gave loud barks when danger approached.

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Table 3-9 Animals found in association with bushbucks

Species	No. of sightings.
Kob *Kobus kob*	34
Warthog *Phacochoerus africanus*	16
Baboon *Papio sp.*	22
Waterbuck *Kobus ellipsiprymus*	6

3.2.9 Foods eaten by other species in the study site.

The only item that all species fed on was salt lick/grit. Waterbuck, which is the other browser found in association with the bushbuck had only three food species in common with the bushbuck - *Cnestis spp., Servia spp., Borreria spp.*. Despite this they fed on different parts of the plants. While the bushbuck fed on the new shoots and leaves the waterbuck fed on the more mature stems and leaves. Thus the waterbuck could feed on plants that the bushbuck had already fed on. The kob, an ungulate of comparable size to the bushbuck, was a grazer feeding on different grass species, while warthog fed on leaves, roots, and stems of both grass and herbs other than that used by the bushbuck. The baboons. were omnivores feeding on a variety of foods ranging from snakes to insects, fruits, flowers, leaves and bark of large trees.

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4. DISCUSSION

4.1 COMPARISON OF INTERVIEW DATA AND DIRECT OBSERVATION

As mentioned by Chambers (1983), by talking, listening to and observing, science can learn important information from rural people. Science can be used to confirm local knowledge and provide the scientific basis for knowledge that rural people already have. Generally the information from the two survey procedures used in this study matched along certain lines and diverged on others. This may be due to the small sample size and the fact that direct observations were done over a very short period of time during the rainy season while the results from the interviews cover a long period of experience.

Four types of plants -*Euphorbia sp., Vitex sp.*, okro *H. esculentus* and pepper *Capsicum sp.*- and salt licks observed to be eaten by bushbuck during the study period, were also mentioned by local people. The consumption of the majority of the food plants mentioned by the interviewees could not be verified in MNP because they were food crops and farming is not allowed in the park. However, pepper and okro being raised in a nursery by one of the rangers were observed to be eaten by bushbuck. The various herbs observed were not mentioned by the interviewees perhaps because they did not play an important role in the lives of the people and thus they did not take note of such plants when they observed bushbuck feeding on them. The food eaten during the dry season could not be verified since the study was conducted only during the rainy season.

Bushbuck were found to be present all over the park but the stocking density varied from place to place. It was only in Jellakon and Samole areas that bushbucks occurred in

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substantial numbers and could easily be observed. This observation matched local knowledge. The distribution is due to the fact that hunting pressure is low in the Jellakon (where bushbuck is a totem animal) and Samole (MNP headquarters) areas. Security in these two areas for bushbuck probably caused them to migrate to these parts where they could easily breed. Furthermore, they were not as shy as bushbuck in other parts of MNP and thus observing them was much easier.

The data from the interviews suggested there was a rest period of four hours duration (from about 11.00 a.m. to about 3.00 p.m.). This coincided with the observed rest periods. However, individual bushbuck had their own rest times which fell within the four hour period, but were not always four hours long. Each bushbuck studied had it's own unique time of high activity and thus all the three different time frames (4.00 - 7.00 p.m.; 5.00 - 11.00 a.m.; 5.00 - 10.00 a.m. and 3.00 -7.00 p.m.) mentioned were specific to different animals. In contrast to Allsopp (1978) bushbuck were observed to be more active on full moon nights (as mentioned by the 6% of interviewees) than on moonless nights. As a result of extensive feeding on full moon nights, feeding was delayed by all four focal-animals during the following morning.

The majority of respondents (80%) mentioned that bushbuck were strictly solitary animals. This was confirmed by my observations as 49.72% of the sightings were of solitary animals and the closest association of mother/young was only 15.51% (see Table 3-8). This information is in line with what has been observed by other sources (Allsopp, 1978; Kingdon, 1997). As mentioned by the respondents, bushbuck were often observed

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in the company of baboons, probably as a security measure rather than an association for food. Food was abundant but the tall vegetation made it difficult for bushbuck to see or sense approaching danger when the wind blew in the wrong direction. Thus baboons very likely served as good lookouts and provided the bushbuck the security they needed.

4.2 DIRECT OBSERVATION

4.2.1 Habitat

The study site had three major vegetation zones - marshes, riverine forest and open savanna woodland. These were further divided into *Mitragyna inermis* stands and *Cladium leploslachyium- Cissus* association in the marsh and flood plains; *Ziziphus mauritiana-Daniella oliveri-Afragle peniculata* associations along the rivers; *Combretum-Burkea* associations, *Anogeissus leicocarpus* stands and *Andropogon sp.- Cnestis sp.* association within the open savanna woodland.

Marshes had the highest use/availability ratio, followed by riverine forest and open savanna. This trend was probably due to the fact that few humans were in the marsh and riverine forest. The similar utilization of marshes and open savanna was probably because the study was conducted in the rainy season when water was plentiful. Utilization of habitat was probably determined by the availability of cover and food, given that *Mitragyna inermis* stands, *Cladium leploslachyium- Cissus* association, *Combretum-Burkea* associations, *Anogeissus leicocarpus* stands and *Andropogon - Cnestis* associations provided more of these than the forest. This is because the feeding sites and most of the resting sites were located in these areas. Thus these areas were used

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more than the riverine forest. The use of these moderately dense areas agrees with the findings of McLeod et al. (1996). While observational data were useful in estimating the utilization of the moderately dense vegetation, it may have underestimated that of the dense riverine forests due to poorer visibility. In addition, the bushbuck's secretive behavior may have compounded this problem. It is possible that due to the dense nature of the riverine forest, the bushbuck could crouch and freeze when the observer approached making it difficult for them to be sighted. Thus direct observation of bushbuck may not have reflected habitat use accurately (Allen-Rowlandson, 1985). The bushbuck which was radiotracked did not make use of the riverine forests, thus further studies of longer duration are required to establish habitat use in MNP.

4.2.2 Diet composition

The diet of the bushbuck observed during the study period comprised mainly herbs. With the exception of *Exacum marcathium*, and *Colocasia antiquciorium*, all the forage species were dicotyledons. This is in accordance with previous studies such as Jacobsen (1974), Odendaal (1983), Allen-Rowlandson (1985) and MacLeod et al. (1996), all of which indicate that bushbuck are largely browsers, eating only a small percentage of monocotyledonous plants. In addition, observing twenty four species (with only four species being widely fed on) indicates a low diversity in the diet. This confirms the findings of MacLeod et al. (1996). However, most of the species identified by MacLeod et al. (1996) were trees and shrubs, while for this study the forage was herbs. This difference may be attributed to the different vegetation types for the two studies - Guinea

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savanna in this study and dune fields/thickets in MacLeod's study. This further confirms the adaptability of bushbuck to different environments.

4.2.3 Feeding habits

As did Haschick and Kerley (1996), this study ascertained that bushbuck mainly used single bites while feeding and fed between ten seconds to three minutes before raising the head to check for danger. For a predominantly solitary animal, this behavior, together with feeding on upright shoots, probably helped to increase vigilance. In addition, following a specific path while feeding and moving around, prevented the tendency of being in unknown territory and thus facilitated escape if danger approached. The fact that bushbuck do not feed on the same part of a plant for two consecutive times ensures that fresh succulent shoots are always available. In contrast to Haschick and Kerley (1997)[11], however, bushbuck were not observed to feed at head height. This may be because they were mainly feeding on herbs and not shrubs/trees. It may be possible that feeding at head height will occur during the dry season when the herb layer has dried up. Conducting studies during the dry season may help to establish this fact.

According to most authors (Stevenson-Hamilton, 1947; Ansell, 1960; Roberts, 1951; Shortridge, 1934; Wilson, 1964) bushbuck are browsers, consuming grass only when young and green. This was not observed in MNP in spite of the mixed diet shown in Table 3-3. The mixed diet enables them to exist in widely differing areas.

[11] The study was conducted using captive animals. Shrubs/trees, previously identified as bushbuck forage, were cut and attached to platforms at various heights for bushbuck to feed on while being observed. Thus it did not provide for the possibility of bushbuck feeding on herbs. It is only during the dry season in MNP that herbs are not present and thus bushbucks would most likely feed on shrubs as indicated by the interview data.

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Like many other animals, bushbuck ingest grit/salt as a supplement for their mineral needs. Bushbuck frequented salt licks on dry days probably because the salt was more concentrated as opposed to rainy days when the salts were less concentrated. Thus a shorter time is spent at the salt licks while reaping maximum benefit and reducing the risk of running into danger in these open areas.

4.2.4 Activity pattern

The highly active nature of the bushbuck in MNP during daylight hours is in contrast to a number of studies (Astley-Maberley 1963; Stevenson-Hamilton 1947; Vaughan Kirby and Sclater 1934 - cited in Shortridge 1934) but agrees with Verheyen (1955) and Jacobsen (1974). In my opinion, bushbuck are diurnal as well as nocturnal as they were seen to move around in the night on several occasions during the study period. When bright lights were used, they were disturbed and thus it was not easy to ascertain what they were doing. According to Jacobsen(1974), the reaction of the eyes of bushbuck to sudden introduction of light is indicative of an animal which is both diurnal and nocturnal.

The bushbuck followed fixed paths within the study site, but occasionally pushed through the long grass. Thus bushbuck did not move about randomly. Since each animal had a specific path it followed, it can be said that even in the small study site, bushbuck did not have absolute knowledge of the entire habitat. These paths are likely to have been developed by each animal over time. Paths leading to and from the bedding sites were along areas of least gradient on the hills. Both bushbuck and kobs used these paths.

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Contrary to Verheyen (1955) bushbuck were not afraid of getting wet. On four occasions, bushbuck were observed to swim across the watering holes to get to the other side when water provided the fastest escape route. This observation agrees with Jacobsen (1974).

Each of the three bushbuck observed, spent different amounts of time doing different activities (see Table 3-4). Individuals have developed their own strategies over time. HM spent more time feeding than BL and MBb probably because it was a male, larger than the females and, therefore, required more food. Even though BL was expected to spend more time feeding than MBb because of her young, the contrary was observed. This may be because BL's leg was broken and spending more time in the feeding areas meant longer exposure to predators in the open. Thus spending more time resting eliminated/reduced the danger. HM spent very little time moving even though he spent a lot of time feeding. This is probably because his resting and bedding sites were close to the feeding sites and food was abundant, therefore, he did not have to roam far. In addition, many of the females within his observed activity area had young and thus were not in estrous. Since mating was not possible, HM did not have to seek out mates and therefore minimum movement was done. In accordance with Jacobsen (1974), bush horning was done only by the males. This was done in a random fashion and did not appear to be an act for marking territory. Contrary to Jacobsen (1974), no distinct odor was detected. In addition, marking by urination or defecation was not observed.

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4.2.5 *Effect of temperature on bushbuck activities*

The bushbuck's major activities were affected by temperature. At a temperature under 30°C, the bushbuck forage remained turgid. However, when the temperature exceeded 31°C, the plants became flaccid due to loss of water. This difference probably did not make the plants as succulent. Thus, staying in the shade and chewing the cud to ensure maximum absorption was more beneficial.

4.2.6 *Choice of resting and bedding sites*

Bushbuck used different plant species, ranging from climbers to trees, as shelter at resting and bedding sites. There was no preference for species at resting or bedding sites. A cone shaped crown with density between 20-80% was used more often because it probably provided a good view of the open areas as well as many escape routes. The shade also provided a cooler temperature than that in the open during the day and a slightly warmer temperature during the night. This probably prevents the bushbuck from being overheated during the day and being too cold during the night. Choosing bedding sites close to human habitation also reduces the risk of predation, since most of the large predators did not come close to such areas. Using sites with trees/shrubs having a dbh less than 20cm in close proximity probably gave the bushbuck a better view of their surroundings and thus a better chance of spotting approaching danger. In accordance with Allsopp (1978) thickets along ravines were highly used as resting and bedding sites. Shorter trees/shrubs were selected more often probably because they were more likely to have drooping branches.

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From the observations, it was obvious that certain factors/characteristics of the shrubs/trees/thickets affected choice of resting and bedding sites. However, statistical analysis did not show any significant relationship between resting/bedding sites and the five factors tested. This may be because of the small sample size and the short duration of this study. It is, therefore, apparent that further research is required in order to reach a definite conclusion.

4.2.7 Bushbuck relationships

Bushbucks shared their habitat with other species such as elephants, kob, waterbuck, baboons and warthogs. Bushbuck were very tolerant of all these species. The bushbuck habitat is not unique. Only the kob is of comparable size to the bushbuck. However, there was little competition between them, basically because kob are grazers. In addition, associating with kob and baboons helped the bushbuck to have other lookouts for danger. Food obtained when bushbuck associated with baboons would have been inaccessible otherwise. Competition between bushbuck and waterbuck was minimal since they fed on different plant parts. Bushbuck shared resting sites with warthogs.

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5. CONCLUSIONS AND RECOMMENDATIONS

This project sought to meet certain objectives. They were to examine the habitat and behavior of bushbucks in Mole National Park during the rainy season. The study has shown that:

- Bushbuck do not waste time moving about randomly but follow specific paths. Thus the bushbucks did not appear to have absolute knowledge of their habitat. Each animal developed specific paths within its home range and followed these while foraging. Occasionally they would push through the vegetation around the paths. Thus random movement was avoided and feeding was done in the shortest possible time.
- Bushbuck diet had little variability - with four species (*Raindia macaritha, Raindia captiatum, Eurena lobata* and *Cnestis sp.*) being the most widely eaten. Of the twenty six species, *Servia sp.* was the most preferred (11.10) followed by *Euphobia hecta* (9.04), *Eurena lobata* (8.79), *Desmodium sp.* (4.76) and *Raindia macaritha* (4.58). Bushbuck showed a preference for dicotyledonous plants and did not feed on grass.
- Bushbuck habitat is not unique but is shared with other species. Bushbucks shared their habitat with kobs, waterbucks, baboons, warthogs, elephants, etc. Little competition occurred among these species since each fed on different foods and thus they could co-exist. However, marshes had the highest use/availability ratio, followed by riverine forests and open savanna. The riverine forests and open savanna

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had similar ratios (0.8 and 0.7 respectively). The open savanna and marshes were used to similar extents while the riverine forest was used very little.

- Temperature affected the major bushbuck activities (feeding, resting, moving). At temperatures below 30°C bushbucks remained active. When temperature exceeded 31°C bushbucks retreated to the bushes/thickets to rest and chew the cud.
- Resting/bedding sites were chosen at random. However, crown shape had the strongest correlation with resting/bedding sites.
- Bushbuck are highly tolerant animals and exhibit very little aggressive behavior towards each other and towards other species in the study area.

5.1 RECOMMENDATIONS

Due to the short time frame of this study and the small sample size, data for many areas of bushbuck behavior were not conclusive. It is therefore recommended that;

- further studies involving more individuals and of longer duration be conducted in MNP and other reserves to determine habitat utilization, reproductive behavior and other behavior during the dry season.
- Further studies be done to compare the foraging strategies of the bushbuck and waterbuck (the other browser sharing the same habitat with the bushbuck).
- Further studies be conducted to determine factors that affect choice of resting/bedding sites.

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- MNP establish trails and look-outs along the hills close to the motel and office to increase the chances of tourists seeing bushbucks.
- To increase the success of bushbuck capture, nets with large holes (30 cm^2) should be used in the future.

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APPENDIX I Guide for interviews

QUESTIONNAIRE

Date:
Community:

1. Do you know anything about bushbucks:

2. Where would you normally see bushbucks-

   in the dry season:

   in the wet season:

3. What vegetation would you find around these areas:

4. Are they diurnal or nocturnal:

5. Do they form herds or are solitary:

6. What do they eat:

7. Do they drink water often:

8. Do they move around with other animals (e.g. baboons):

9. When do they have their young:

10. How many young do they have:

11. What animals prey on them:

12. Do you have any beliefs about the bushbuck:

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APPENDIX II Percent cover of species found on the major feeding sites and adjacent areas.

Feeding site 1	Mean ± SD	Adjacent area	Mean ± SD
Servia spp	0.16 ± 0.35	*Cnestis spp.*	6.67 ± 3.06
Exacum macathium	0.7 ± 1.88	Hb - 4	0.12 ± 0.24
Hb - 4	0.67 ± 1.15	*Raindia capitatum*	3.3 ± 1.53
Grivellia bariskii	0.4 ± 0.89	*Borreria spp.*	4.3 ± 3.78
Cnestis spp/ Ferriginea spp	20.8 ±11.3	*Grass*	45 ± 15
Grass	24.6 ± 14.36	*Camphoria eritinus*	4.67± 1.15
Desmodium spp	4 ± 8.94	*Aspilia bussei*	1.3 ± 0.57
Camphoria eritrinus	4.6 ± 5.07	*Andropogon sp.*	3.3 ± 5.77
Cida acuta	0.12 ± 0.26	*Emilia semchifolia*	3.3 ± 2.31
Cerespermum spp	0.12 ± 0.26	Unidentified sp	4.3 ± 3.8
Graderanus nigruma	11.6 ± 15.59	*Cida acuta*	0.12 ± 0.26
Borreria spp	7.8 ± 8.67		
Raindia capitatum	6.4 ± 4.16		
Lumsiana inermis	1.2 ± 2.4		
Sauelantoes batarii	0.12 ± 0.26		
Emilia semchifolia	3 ± 4.2		
Franingia sp.	0.4 ± 0.89		
Vervain guelcuro	2.5 ± 1.24		
Colocasia antiquciorium	0.12 ± 0.26		
Eurena lobata	5 ± 4.47		
Cassia mimosoides	1 ± 2.24		
Unidentified sp.	14.3 ± 14.51		
Hb - 5	1.3 ± 10.8		
Euphobia hecta	0.94 ± 0.12		
Cissus sp.1	0.64 ± 0.26		

Feeding site 2	Mean ± SD	Adjacent area	Mean ± SD
Euphobia hecta	0.56 ± 0.88	*Desimodium spp*	0.31 ± 0.52
Cnestis spp	2.8 ± 2.58	*Aspilia bussei*	0.4 ± 0.33
Eurena lobata	0.4 ± 0.89	*Raindia macaritha*	1.5 ± 0.89
Graderanus nigruma	0.94 ± 0.64	*Camphoria eritrinus*	4 ± 3.51
Raindia capitatum	6.4 ± 4.16	*Cissus spp*	20 ± 14.12
Camphoria eritinus	12.4 ± 17.29	*Grass*	30 ± 14.14
Hb - 4	1.2 ± 0.88	*Calastrium sp*	1 ± 1.25
Verbosina encetoides	1.5 ± 0.90	*Cnestis spp*	3 ± 1.3
Calastrium sp.	2.8 ± 1.50	*Rure tears*	0.1 ± 0.50
Aspilia bussei	3.2 ± 4.6	Unidentified	0.21 ± 0.11
Rure tears	0.8 ± 0.75		
Cida acuta	0.9 ± 1.45		
Raindia macaritha	0.8 ± 1.78		
Grass	52 ± 35.93		
Unidentified	0.4± 0.89		

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Feeding site 3	Mean ± SD	Adjacent area	Mean ± SD
Grass	5.5 ± 4.3	*Mitragyna inermis*	70
Cissus sp.2	54.7 ± 48.83	*Accassia pinatium*	0.7 ± 0.82
Raindia capitatum	14 ± 15.09	*Cissus sp.2*	20 ±
Raindia macaritha	6 ± 5.29	*Typha sp.*	0.1 ± 0.34
Eurena lobata	0.67 ± 1.15	*Piliostigma thonningii*	<1
Cida acuta	0.67 ± 1.15		
Hb - Ww	0.4 ± 0.89		

Feeding site 4	Mean ± SD	Adjacent area	Mean ± SD
Grass	32.5 ± 34.05	*Mitragyna inermis*	10
Raindia macaritha	7.7 ± 8.96	*Casia mamosoides*	5 ± 1.30
Cida acuta	1.42 ± 3.77	*Raindia macaritha*	4 ± 3.80
Accassia pinatium	0.19 ± 0.33	*Grass*	30 ± 5.42
Casia mamosoides	0.11± 0.3	*Raindia capitatum*	6 ± 1.15
Raindia capitatum	8.29 ± 11.57	*Accassia pinatium*	2
Graderanus nigruma	0.07 ± 0.19	Unidentified sp.	0.67 ± 0.82
Cladium leploslachyium	8.86 ± 22.56	*Eurena lobata*	0.1 ± 0.33
Eurena lobata	10.7 ± 1.88		
Unidentified sp.	2.29 ± 3.86		

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APPENDIX III Interview data

Question	Response	Number responding
Presence of bushbuck	Yes	100
Habitat in dry & wet seasons	Same	40
	Different	60
Food	Groundnut *Arachis hypogea*	15
	Okro *Hibiscus esculentus*	100
	Pepper *Capsicum spp.*	100
	Yam *Dioscorea spp.*	70
	Cassava *Manihot esculentus*	75
	Forbs	9
	Afzilia africana	100
	Vitex spp	17
	Accacia spp	18
	Pterocarpus spp	6
	Daniellia oliveri	14
	Salt licks	34
Water requirement	Frequent	100
Association with other animals	No	80
	Yes	20
High activity periods	5.00-11.00am	21
	4.00-7.00pm	20
Reproductive season	August-December	75
Number of young	One	100
Predators	Lions *Panthera leo*	100
	Pythons *Python spp.*	40
	African wild dogs *Lycaon pictus*	51
	Leopards *Panthera pardus*	37
	Spotted hyaena *Crocuta crocuta*	55
Uses of the bushbuck	Food	73
	Medicine	44
	Taboo	27

No. of respondents: 100

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APPENDIX IVa Chi-square analysis.

Observed	Expected
171	244.4
177	97.76
28	33.84

$\chi^2 = 87.28$
$\chi^2_{0.05.2} = 5.991$

APPENDIX IVb Multiple regression

Correlation matrix

	RSBS*	BRANCH	DENSITY	HEIGHT	SHAPE	WIDTH
RSBS*		.135	-.040	-.268	.418	-.068
		.252	.422	.088	.015	.368
BRANCH	.135		-.203	-.097	-.136	.150
	.252		.155	.315	.250	.227
DENSITY	-.040	-.203		-.059	-.119	-.160
	.422	.155		.385	.278	.212
HEIGHT	-.268	-.097	-.059		-.071	-.188
	.088	.315	.385		.363	.174
SHAPE	.418	-.136	-.119	-.071		-.409
	.015	.250	.278	.363		.017
WIDTH	-.068	.150	-.160	-.188	-.409	
	.368	.227	.212	.174	.017	

*RSBS : Resting site, Bedding site.

Correlation coefficient	0.51358
Coefficient of determination	0.26377
Standard Error	7.57799

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	5	432.05417	86.41083
Residual	21	1205.94583	57.42599

F = 1.50473
Signif F = .2308

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APPENDIX V a. Resting and bedding site parameters.

Site	B1 ht (cm)	Dbh (cm)	Tree ht (m)	CW (m) Mean ± SD	D (Score)	Species
1*	33		3.5	6.65 ± 0.9	2	*Nauclea latifolia*
2*	27	14	2.2	4.2 ± 1.1.	2	*Combretum gasilensis*
3	37		2.3	4 ± 1.41	4	*Combretum gasilensis*
4	34	14	4.5	7.2 ± 0.08	3	*Mitragyna inermis*
5	50		4.8	6 ± 1.41	4	*Mitragyna inermis*
6	60		3.5	7.2 ± 1.01	3	*Mitragyna inermis*
7	45		3.2	8.4 ± 0.57	4	*Mitragyna inermis*
8	50		2.4	6.8 ± 0.71	4	*Anogeissus leicocarpus*
9	67		8	7.8 ± 2.55	4	*Anogeissus leicocarpus*
10	51		5	5.2 ± 0.57	4	*Anogeissus leicocarpus*
11*	60		7.5	9 ± 1.13	5	*Anogeissus leicocarpus, Mitragyna inermis, Stereospermum kunthianum*
12*	65	61	3.2	7.2 ± 0.10	4	*Pterocarpus erinaceus, Anogeissus leicocarpus, Nauclea latifolia, Cissus spp.*
13	100	14	3.5	9.1 ± 0.89	3	*Anogeissus leicocarpus*
14*	29	15	3.2	7 ± 1.41	3	*Nauclea latifolia, Anogeissus leicocarpus*
15	30		3	5 ±1.10	4	*Mitragyna inermis*
16	30		2.75	4.6 ± 0.56	4	*Mitragyna inermis*
17*	55	32.2	3.4	5 ± 0.41	5	*Isobelina doka, Cissus spp., Diospyrus mespiliformis, Lannea acida*
18	50		10.5	13.4 ± 1.81	3	*Mitragyna inermis*
19	20		10.5	11 ± 1.45	4	*Mitragyna inermis*
20	20		3.1	6 ± 0.76	3	*Mitragyna inermis*
21	30		5.5	7 ± 0.65	4	*Anogeissis leicocarpus*
22	125		3	7 ± 0.08	4	*Pilostigma thonningii*
23*	100		4	6.3 ± 0.41	3	*Nauclea latifolia*
24*	60		10.7	4.5 ± 0.07	3	*Diospyros mespiliformis, Afzelia africana, Combretum mole, Lannea acida, Cissus spp.*
25	30		2		5	*Ziziphus mauritiana*
26	45	32	3	1.3 ± 0.04	3	*Tectona grandis*
27	34		3	6.7 ± 1.25	2	*Nauclea latifolia*
28*						*Cissus spp.*
29^			5		3	*Tectona grandis stand*
30^						*Cissus spp.*

B1 ht = height of first branch from ground
CW = crown width/thicket width
Dbh = diameter at breast height
D = density of vegetation
* = used as both resting and bedding site
^ = bedding site only

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V b. Temperature

Site	n	Temperature °C Shade (Mean± SD)	Open	Species
1	16	32.0 ± 1.76	35.7	*Nauclea latifolia*
2	6	33.1 ± 1.09	35.7	*Combretum gasilensis*
3	1	*33.0	35.8	*Combretum gasilensis*
4	5	30.3 ± 1.14	34.6	*Mitragyna inermis*
5	2	31.2 ± 1.56	34.0	*Mitragyna inermis*
6	8	33.0 ± 1.75	37.5	*Mitragyna inermis*
7	1	*32.6	37.5	*Mitragyna inermis*
8	2	34.8 ± 1.27	37.2	*Anogeissus leicocarpus*
9	4	34.6 ± 0.76	37.2	*Anogeissus leicocarpus*
10	7	34.4 ± 2.46	36.4	*Anogeissus leicocarpus*
11	18	32.9 ± 2.51	36.4	*Anogeissus leicocarpus, Mitragyna inermis, Stereospermum kunthianum*
12	15	31.0 ± 2.40	34.6	*Pterocarpus erinaceus, Anogeissus leicocarpus, Nauclea latifolia, Cissus spp.*
13	3	31.5 ± 3.5	33.6	*Anogeissus leicocarpus*
14	24	29.5 ± 1.01	32.5	*Nauclea latifolia, Anogeissus leicocarpus*
15	10	29.6 ± 3.27	33.1	*Mitragyna inermis*
16	6	31.0 ± 2.08	35.4	*Mitragyna inermis*
17	12	32.0 ± 1.51	34.5	*Isobelina doka, Cissus spp., Diospyrus mespiliformis, Lannea acida*
18	4	34.6 ± 1.26	37.4	*Mitragyna inermis*
19	3	30.3 ± 1.76	33.4	*Mitragyna inermis*
20	2	32.4 ± 1.30	35.1	*Mitragyna inermis*
21	4	31.0 ± 1.01	33.2	*Anogeissis leicocarpus*
22	1	*31.4	34.5	*Pilostigma thonningii*
23	12	30.2 ± 1.51	34.5	*Nauclea latifolia*
24	27	29.6 ± 1.21	32.5	*Diospyros mespiliformis, Afzelia africana, Combretum mole, Lannea acida, Cissus spp.*
25	1	*32.3	35.4	*Ziziphus mauritiana*
26	1	*30.2	35.3	*Tectona grandis*
27	1	*30.1	32.3	*Nauclea latifolia*
28	1	*31.5	36.1	*Cissus spp.*
29	1	*29.5	33.5	*Tectona grandis stand*
30	1	*32.1	34.3	*Cissus spp.*

* = one observation, thus mean temperature or SD can not be calculated
n = number of observations