STUDIES OF THE DISTRIBUTION AND FEEDING ECOLOGY OF SMALL MAMMALS IN NGONG HILLS

BY

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DECLARATION

I, Issa Aggundey Ramadhan Nzui, declare that this Dissertation is my original work and has not been presented for a degree in any other University.

Signature---Aggundey R.--------- Date---1st. July 1994---

I, professor Romanus O. Okelo, Dean, Faculty of Science, Kenyatta University,

Signature------------------------- Date---4/7/94---

declare that this Dissertation has been submitted for examination with my approval as University supervisor.

DEDICATION

To the conservation of neglected small mammals

SUMMARY

The study was carried out in Ngong Hills about four kilometres from Kiserian shopping centre off Magadi road in the University of Nairobi forest station 1°_ 26'S. 36° 38'E. at an altitude of 2250m. According to Pratt and Gwynne [1977] the site was classified as a dry sub-humid grassland zone with average rainfall of 800mm per annum and average temperature of 19.5°c.

The study area was divided into 130 contiguous quadrats each measured 10x10m. Their corners were demarcated with flagged sticks for easy recognition of boundaries and each of them was given a reference number. Vegetation identification and distribution was carried out and a sketch of the four different plant communities was prepared. Only 126 quadrats were sampled due to a shortfall in the number of traps. A mixture of small mammal traps were used namely 30 large Sherman, 72 medium Sherman and 24 Longworth. A mark-recapture method was used whereby one digit per limb was amputated as per the system which was developed by French [1964] and illustrated by DeBlase and Martin in their Manual of Mammalogy [1981].

The field study was conducted between 21st October to 20th December 1993. During that period a total of 49 days were used for trapping. The trapping sessions were divided into 7 day-units of continuous trapping followed by a pause of one or more days. In all there were a total of 6174 trap-nights during which 213 animals were marked and subsequently

recaptured severally. Overall recaptures were 2852 which was nearly 46% success. A total of 8 species were involved and the number of animals marked per species were 137 *Rhabdomys pumilio*, 29 *Otomys tropicalis*, 13 *Mus minutoides*, 11 *Lophuromys flavopuntatus*, 9 *Dendromus mesomelas*, 5 *Lemniscomys striatus*, 3 *Grammomys dolichurus* and 6 *Crocidura bicolor*. *R. pumilio* was a cosmopolitan species; it occurred in 75 out of 126 quadrats besides being the most abundant species in the site. There was no difference in the species trap-responses between large Sherman and Longworth traps [$t=_{12}$ 1.13, p 0.05]. However the species was more trappable by medium Sherman traps than by either Longworth ($t=_{12}$ 8.5 $p>$ 0.05) or large Sherman traps ($t=_{12}$ 7.8; $p<0.05$). There was no sexual difference in trappability. Both *O. tropicalis* and *G. dolichurus* were not caught in Longworth traps. Probably their entrances were too small to accommodate the sizes of both species. With regard to time span between captures in day as follows:- *R. pumilio* 3.36, *O. tropicalis* 4, *M. minutoides* 3.35, *L. flavopuntatus* 3.72 and *D. mesomelas* was 3.76. Their biomass and densities were as follows:-

SPECIES	DENSITY ind/h	BIOMASS/kg/h
R. pumilio	108	2.7
O. tropicalis	23	2.76
M. minutoides	11	0.143

The distributions of the various species were confined mostly to areas where their preferred micro habitats occurred. *R. pumilio* was found in grass and light bush plant communities while *O. tropicalis* was found in the ecotone zones between grassland and bush areas. Both *G. dolichurus* and *D. mesomelas* occurred in bush and gallery forest areas with *G. dolichurus* showing preference to gallery forest while *D. mesomelas* mostly occurred in bushy areas. *M. minutoides* inhabited grassland and light bush areas while *L. flavopunctatus* was mostly found in the thick bushes and forest. *L. striatus* were trapped in light bush areas and *C. bicolor* occurred in most of the areas except deep inside gallery forest. Both *R. pumilio* and *O. tropicalis* made distinct runways which were used as both home ranges and territories. *L. flavopunctatus* also made runways but in some parts they were not clearly defined. *M. minutoides* and *C. bicolor* did not have discernible runways. *L. striatus* were few and were not caught in one place therefore attempts to find their runways were unsuccessful. All the above species were terrestrial and they lived in burrows, holes or cracks in the ground. Both *O. tropicalis* and *R. pumulio* also made grass nests on the ground. On the other hand both *D. mesomelas* and *D. dolichurus* were arboreal and nocturnal. and made nests on vegetation. They only descended to the ground occasionally.

The feeding habits of the both *R. pumilio* and *O. tropicalis* were established by:-

1. direct observations through binoculars
2. feeding experiments
3. faecal and stomach content examination

O. tropicalis was found to be a grazer feeding mostly on grasses such as *Digiraria macroblephara, Sporobolus macranthelus, Cynodon aethiopicus* and *Panicum sp.* They mostly fed on leaves and stems and they had caeca which helped them in microbial digestion of cellulose. *R. pumilio* was found to be omnivorous feeding on grasses, dicots and insects. As far as the other species were concerned, *L. flavopunctatus* fed on grasses and insects, *M. minutoides* fed on seeds and insects. The same case also applied to both *G. dolichurus* and *D. mesomelas.* But *C. bicolor* was insectivorous.

During most of the early parts of the study period neither pregnant nor lactating females were caught. But one notable change was noticed ten days after the rains. Many females of *R. pumilio* and *O. tropicalis* were observed having relaxed vaginal openings a phenomenon which was not apparent hitherto. The coincidence of the relaxed vaginal openings after the onset of rains probably indicated the species concerned were oestrous. Delany (1964), Okia (1973) and Southern and Hook (1963) in their studies of rodents recorded tendencies of various rodent species to have breeding peaks after the onset of rains. The observation at Ngong Hills could probably be an indication that the species were starting to breed. Examination of carcasses of females in December showed early pregnancies.

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CHAPTER 1

1.0 GENERAL INTRODUCTION AND LITERATURE REVIEW

Rodents or gnawing mammals belong to the order Rodentia in the class mammalia within the animal kingdom. They comprise over forty per cent of all species within the class mammalia. They are distributed in most parts of the world where they are native to most land areas except some Arctic, Oceanic islands, New Zealand and Antarctica. Any rodent species that might be found in those places is not indigenous but might be there as a result of human activities (De Blase and Martin, 1981).

Rodents have undergone a tremendous adaptive radiation a phenomenon which has enabled them to exploit niches which occur in fossorial, terrestrial, sultatorial, arboreal, and semi-aquatic habitats. In order to cope with the conditions which prevail in those habitats the relevant species evolved extreme morphological, physiological and behavioural adaptations. As a result their social structures range from solitary pairs, communal warrens to extremely sophisticated eusocial communities (this is a phenomenon which had been hitherto known only among social insects such as bees and termites). An example of eusocial mammal is the fossorial species called the naked mole rat (*Heterocephalus glaber*) which is endemic in the arid areas of eastern and northern Kenya, southern Ethiopia and Somalia (Jarvis, 1990). The rodents, as a result of their morphological and physiological modifications, range in size from the smallest mice which weigh only a few grams (e.g. *Micromys*, *Baiomys* and *Mus*) to the largest living rodent on earth, the South American rodent the capybara [*Hydrochoerus* *hydrochoeris*] a pig sized animal which weighs up to 50 kg (De Blaise and Martin, 1981).

1.1 TAXONOMIC POSITION OF RODENTS

There are a total of thirty three living families of Rodentia in the world and Kenya is a host to eleven of them, ten of those namely; Bathyergidae, Rhizomyidae, Hystricidae, Anomaluridae, Pedetidae, Cricetidae, Muscardinidae, Sciuridae, Thryonomyidae and Muridae are indigenous while Myocastoridae is an exotic one which was introduced by colonial settlers who had hoped to trade in their fur but the climate in this country was not cold enough to induce them to grow fur and as a result they were abandoned and have since colonised lake Naivasha (Anderson, 1967).

There are about seventy three species of rodents in Kenya and like rodents in other parts of the world the Kenyan species have also undergone considerable adaptive radiation and thus are able to exploit the numerous micro habitats which are available in various habitats. It is interesting to note that although Kenya lies on the equator it is endowed with a variety of habitats such as alpine and montane forests which occur on Mts. Kenya and Nyandarua range, Savannah bushlands, a West African type of tropical rain forest in Kakamega, humid coastal forests, mangrove swamps in some parts of Kenya coast, fresh water swamps such as the Yala swamp in Lake Victoria and the swamp on the northern shore of lake Naivasha, as well as the Chalbi desert in Marsabit district.

Those habitats are exploited by various species of rodents for example the arid desert type of habitat is inhabited by gerbils and the naked mole rats, the West African type of tropical forest is exploited by the flying squirrel *Anomalurus derbianus* which uses its patagium to glide from one tree to another across open glades; the grassland savannah is utilised by sultatorial spring hare *Pedetes capensis.*

1.2 HISTORICAL BACKGROUND OF RODENT STUDIES

Interest in rodents of Kenya started from the last two decades of the 19th century as evidenced by accounts by early explorers in literature for example the accounts of three expeditions to Mt. Kenya Gregory (1893), and Mackinder (1900) where they collected various species of rodents. There were also other expeditions to other parts of the country such as the exploration and discovery of lakes Rudolf and Stephania by Hohnel (1894) and the Dundas Exploration up the Tana River (Dedge, 1892). In all those expeditions rodents were collected for study purposes besides other exploration activities. The history of rodent interest in Kenya can be divided into two phases namely, phase one which covers the period between late 19th century to about mid 20th century and phase two which covers the period from about 1950 until the present time. The main theme of the first phase was exploration and discovery of new species. Rodent specimens were collected by various groups of individuals. One such group was composed of explorers who undertook expeditions into various parts of the country. Most of the time they had other objectives and rodents collection and studies were incidental but nevertheless yielded valuable specimens for example " The Lake Rudolf Rift Valley Expedition by St. Leger (1934)." Although this was a geological exploration exercise several rodent species were collected as an offshoot. In addition to above groups various individuals such as pioneer settlers, colonial civil servants, businessmen, professionals and others were engaged in collecting rodent specimens and a lot of valuable information was accrued as evidenced by numerous accounts published in the Uganda and East Africa Natural History Journal. The various groups and individuals mentioned above had diverse motives in their pursuit of rodent interest. Some were motivated by the desire for fame of being the first person to discover a new species which was hitherto unknown to science and thus have the honour to name it. Others were doing so out of sheer curiosity. While farmers, medical doctors and veterinarians were interested in rodents either as crop pests or vectors of diseases which afflict livestock.

It is therefore, no wonder that most of the literature from that era were either of descriptive taxonomic accounts with scanty details on ecology and zoogeography or on important crop pest species or disease vector species. There is no doubt a lot of those pioneers became very keen naturalists and they formed the Uganda and East African Natural History Society where members exchanged information through their journal and deposited their specimens in a room which then became available to other members to study. The deposited specimens became the precursor of the former Coryndon Museum which later changed name to the present National Museums of Kenya.

By about 1950 there was a gradual shift in the theme on rodent interest. More emphasis was placed on the study of species beyond taxonomy. The division of the account of the historical background of rodent studies into two phases was done by myself purely for convenience in discussion of the trends in search for knowledge on rodents. By 1950 most rodent species which were hitherto unknown to science had already been discovered, described and named so the general trend of rodent study was more inclined to research on other aspects such as biomedical, physiological, behavioural, ecological, zoogeographical and pest control. The approach also changed from taxonomic and broad spectrum investigations on rodents in general to studies on one or a few species at a time. That was done mostly by scientists and students who preferred to focus their attention to particular aspects. The result was an increase of flow of information, for example, on the ecology of alpine zone of Mt. Kenya, especially on multi-species utilization of micro habitats (Coe 1964, 1967). Similarly detailed studies on individual species were carried out on such aspects as ecology, physiology and diets of rodents (Jarvis 1969, 1973a, 1973b, 1985, 1990). During her studies quoted above Jarvis studied three species of mole rats namely *Tachyoryctes splendens*, *Heliophobius argenteocinereus* and *Heterocephalus glaber*. Other scientists did the study of other species elsewhere for example studies were carried out on the population ecology of rodents at an old quarry in Zambia (Chidumayo 1980), a study of small mammals in a Kenyan grassland (Martin and Dickinson 1985 and Oguge 1985).

Besides the above sources of information on rodents there have also been other information which emanated from recent expeditions such as the Oxford University expedition to the Cherangani Hills (1967), the Kenya Exploration Society Expedition to the Loita Hills (1970), the Joint Aberdeen Kenyatta Universities Project - a survey of forest patches on the south coast between Mombasa and Shimoni (1988); and the University of Exeter Expedition to Kenya - an ecological survey of some small mammals (1980).

1.3 IMPORTANCE OF RODENTS TO MAN

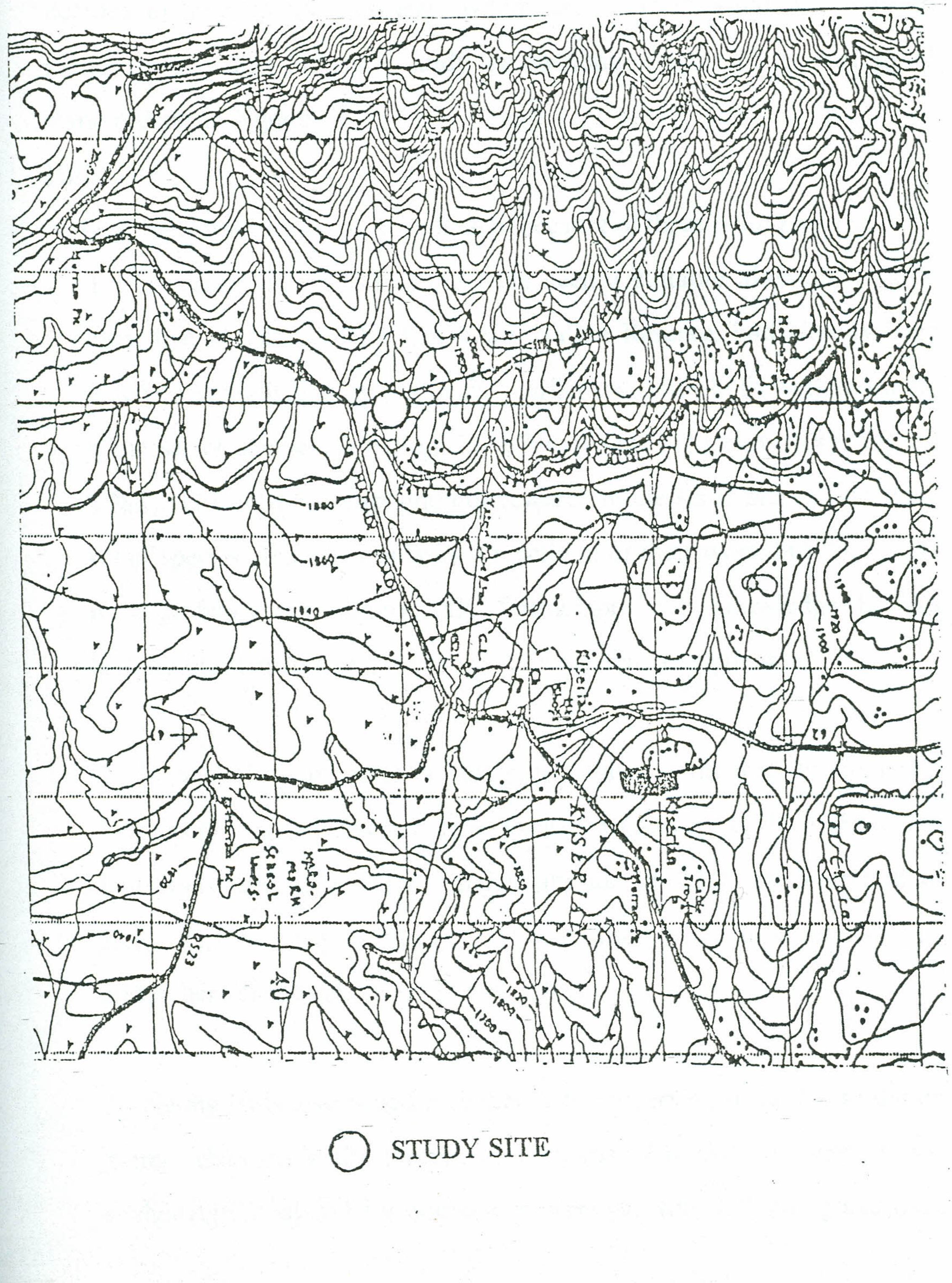
Rodents have been of major importance to man both biomedically and economically. For example some species such as the common house rat (*Rattus rattus*) and mice (*Mus sp.*), both commensal species, inflict damage to stored food by both eating and soiling food; they also damage house hold goods such as fabrics and are carriers of diseases such as Chaggas disease which is transmitted to man by rat flea. While another species *Mastomys natalensis* which is a semi-commensal rodent is known also to damage crops and act as a vector of plague and lassa fever. The ground squirrel, *Xerus erythropus*, is also famous for its notorious habit of destroying germinating maize crops in Kenya's central and eastern provinces. On the other hand some species such as the mole rats (*Tachyoryctes splendens* and *Heterocephalus glaber* are both beneficial and harmful. Their beneficial effects are derived from their fossorial habits which involves digging extensive subterranean burrow systems which facilitate aeration of the soil and the penetration of rainwater into the subsoil. While excavating burrows they bring subsoil to the surface of the soil in form of mounds and thus bring nutrients out. Their negative effects arise from their feeding habits which involves eating rhizomes, tubers and underground portions of plant stems. While in quest for their food they damage sweet potatoes, cassava and maize. The other beneficial species is the harsh-furred rat *Lophuromys flavopunctatus* which feeds on insects and thus helps to reduce the population of insect-pests. Some African tribes such as the Giriama feed on rodents as a source of food. The most cherished is the cane rat *Thryonomys sp.* Man also uses albino rats and mice for biomedical research.

1.4 CONCEPTUAL BASIS OF THE DISSERTATION

During the past 23 years I have been engaged in curatorial work involving mammals of Kenya and as a result I developed a keen interest in the study of small mammals and hence my decision to study rodents.

Out of 73 recorded indigenous rodent species from Kenya less than ten have been studied in some detail with *Mastomys natalensis*, *Tachyorctes splendens*, *Xerus rutilus* and *Heterocephalus glaber* being the most intensively studied. With regards to the rest of the species there is little information beyond their taxonomic descriptions and the names of the localities where they were collected

FIG 1.1 MAP OF STUDY AREA.



STUDY SITE

There was, therefore, a need to carry our research on some of the other species in the hope of broadening the scope of knowledge on them. I thus decided to take up the challenge within the limits imposed by time and money among other factors to study the distribution and feeding ecology of some rodents in Ngong
Hills.

Ngong Hills was chosen as a study area because of three main reasons:

1. The other place which could have been a suitable alternative study area, that is the Kenyatta University Nature Reserve, had already been extensively studied by two scientists earlier on. They both worked on the same set of species although at different times (Martin 1985; Oguge 1985). Therefore my carrying out research in the same site on the same set of species would not only be a repetition of their work but the results may probably not significantly furthermore our knowledge besides lacking the elements of challenge to venture into a virgin area.

2. Ngong Hills is quite a different habitat compared to Kenyatta University nature reserve. It is located 80 km away from Kenyatta University and at a much higher attitude of 2250 m compared to Kenyatta University's altitude of 1500m, also with a different soil type and richer vegetation cover (Figure 1.1).

3. Ngong Hills also posed a challenge to conservationists due to the on going changes in the pattern of land use. Whereas formerly it was exclusively inhabited by nomadic pastoralists who did not graze their

animals on any part of the area intensely and thereby causing minimum damage to the environment, presently agricultural communities from outside the area have bought a lot of land there and have undertaken intensive cultivation of land and thus the pattern of land use has changed. Much of the natural vegetation cover has been interfered with and consequently probably the small mammals within the area have been adversely affected.

1.5 OBJECTIVES

1. To determine the rodent species composition of the Ngong Hills study area.
2. To determine the spatial and temporal distribution of the rodents within the study area.
3. To compare the responses of the rodent species to various baited rodent traps.
4. To determine the trophic niche separation among rodents.

CHAPTER 2

2.0 TRAP RESPONSE

2.1 INTRODUCTION

The study area was inhabited by eight species of small mammals namely *Rhabdomys pumilio, Otomys tropicalis, Mus minutoides, Dendromus mesomelas, Lophuromys flavopunctatus, Lemniscomys striatus, Grammomys dolichurus* and *Crocidura bicolor*. Although they were all small they were of different sizes with varying head-body and tail lengths (Kingdon, 1974) as follows:

	HEAD-BODY	TAIL
R. pumilio	90-135mm	80-135mm
O. tropicalis	124-216mm	69-112mm
M. minutoides	45-77mm	36-70mm
D. mesomelas	69-110mm	85-113mm
L. flavopunctatus	98-140mm	102-155mm
L. striatus	95-129mm	146-193mm
G. dolichurus	100-124mm	58-94mm
C. bicolor	50-60mm	38-67mm

They also had different behaviours, temporal and spatial distributions as well as individual species micro habitat preferences.

2.2 MATERIALS AND METHODS

2.2.1 Quadrats

The study area was divided into 130 contiguous quadrats each measuring 10x10 meters and they were arranged in such a way that the breadth had a total of 10 quadrats while the length had 13. All the four corners of each quadrat were pegged with thin sticks of about one meter in height. They were each flagged with orange ribbons for easy sighting of boundaries. Each quadrat was given an individual reference number and in order to facilitate their easy recognition each quadrat number was printed on a small strip of plastic tape and then the same were threaded and suspended from sticks planted in the middle of each quadrat in accordance with their corresponding quadrat number. That was done to facilitate easy recognition and recording of particular quadrats where particular individual animals were caught.

2.2.2 TRAPS

Since only 126 traps were procured only 126 quadrats out of 130 were used during the exercise. Out of those traps, 30 were large Sherman traps each measuring 30 X 9 X 7 cm^3, 72 were medium Sherman traps each measuring 23.5 x 8 x 7cm^3 and 24 were Longworth traps. The traps were given individual numbers and the numbering system was devised in such a way that it was possible to identify its type from its number. The large Sherman traps were given numbers from 101 to 130, the medium Sherman were numbered from 201 to 272 and the Longworth from 1 to 24.

The traps were laid out one per quadrat and their distributions within the study site were randomised. Once every week all traps were collected from the study site and were thoroughly cleaned and thereafter were returned to the site. They were randomly distributed irrespective of both trap-types and

TABLE 2.1 RECAPTURES OF RODENTS BY THREE TRAP TYPES

Species	Total marked	Trap nights	Total recaptures	Sex	Recaptures	TRAP TYPES		
						L.S	M.S	Lg
Rhabdomys pumilio	137	6174	1998	m	932	215	548	169
				f	1066	243	599	224
Otomys tropicalis	29	6174	347	m	179	48	131	0
				f	168	40	128	0
Mus minutoides	13	6174	190	m	88	18	56	14
				f	102	21	64	17
Lophuromys flavopunctatus	11	6174	145	m	52	32	84	29
				f	93	22	56	15
Dendromus mesomelas	9	6174	117	m	71	17	39	15
				f	46	11	25	10
Lemniscomys striatus	5	6174	32	m	17	3	11	3
				f	15	5	8	2
Grammomys dolichurus	3	6174	13	m	13	4	9	0
				f	-	-	-	-
Crocidura bicolor	6	6174		m				
				f				

LEGEND: Ls. - Long Sherman. Ms. - Medium Sherman.
Lg. - Longworth

the quadrats where they were previously located. A mixture of peanut butter and broken maize was used as a bait.

During the retrieval of the animals from the traps, the following procedure was followed for each individual: records were made of the individual's identification number, the number of the trap in which the individual was caught, the reference number of the quadrat where the animal was caught as well as the time of retrieval.

2.2.3 COSMOPOLITAN SPECIES

The reaction of a cosmopolitan species to the three trap-types was statistically analysed using t-test to confirm recorded observations. The same was also done for both sexes of the species.

2.3 RESULTS

Trapping exercise was carried out for a total of seven weeks during which there were a total of 6174 trap-nights which involved a total of 213 marked animals and an overall recapture of 2852 individuals. The result of recaptures for each species as well as their sexes per trap-type were tabulated in Table 2.1

2.3.1 SPECIES VERSUS TRAPS

From the results of recaptures, Table 2.1 *R. pumilio* was the most cosmopolitan species. It occurred in 75 quadrats and had the highest number of individuals marked. That was 137 out of a total of 213 animals marked during the entire study period that was about 64% and it was caught in all three trap-types. On the other hand *O. tropicalis* was only caught by two trap-types - the large and medium Sherman traps and was never at any time during the entire trapping period caught in Longworth traps. The same case applied to *G. dolichurus;* the species was not caught in Longworth.traps. As far as the rest of the species that is *M. minutoides, D. mesomelas, L. flavopunctatus, L. striatus, C. bicolor* and *G. dolichurus,* were concerned they were caught by all three trap-types.

2.3.2 COSMOPOLITAN SPECIES RESPONSE TO TRAPS

There was no difference between the large Sherman and Longworth traps when the responses of *R. pumilio* to them were compared (t_{12} =1.13; $p>0.05$). However this rodent species was more trappable by medium Sherman traps than by either the Longworth traps (Table 2; t_{12} = 8.5; $p<0.05$) or the large Sherman traps (Table 2. t_{12} = 7.842; $p<0.001$). There was no difference in trappability of males and females when considering large Sherman traps
(Table 2; t_{12} - 1.18; $p>0.001$), medium Sherman traps (Table 2; t_{12} = 0.8, $p>0.05$) and Longworth traps (Table 2.1 t_{12} - = 356; $p>0.05$).

2.4 DISCUSSION

The overall picture showed that there were more females caught than males in all the three trap types. Probably the females were more attracted to the scent of peanut butter than the males or else there were more females than males in the study area. That could only be established if a study on the social organisation of the rodents concerned was carried out to ascertain if the dominant males evicted other weaker ones from their territories and thus reduce the male population.

With regard to *R.pumilio's* response to individual trap-types, it was established that there were different reactions. Statistical analysis of comparative trap response showed that the species reactions between the large and medium Sherman traps showed a bias towards the latter. Similarly comparison involving medium Sherman and Longworth traps showed the species preference to medium Sherman traps. On the other hand a comparison between large Sherman and Longworth traps showed there was no biased favour towards either of them. Similar analysis was done to test sex bias towards the latter two trap-types and statistical analysis showed that there were no bias at all.

If all the three trap-types which were used were equal in numbers any species bias towards any trap-type would have probably been noticed and attempt to determine the reason would have been done but since there were disparities in the numbers of the trap-types used it was difficult to suspect any bias during the field work. The element of bias came to light during data analysis after the conclusion of the field work. Further analysis of data pertaining to times when each specimen of *R. pumilio* was caught on hourly basis showed that between 7.30 - 11.00 a.m. and 3.00 - 600 p.m. there were no significant differences in bias towards all trap-types but between 11.00 a.m. and 3.00 p.m. there was bias towards medium Sherman traps. Since all traps were metal and the fact that *R. pumilio* was found in places with mostly grass cover and light bush probably the effect of incident sunlight on the traps influenced the ambient temperatures inside them. The large Sherman traps had more surface area exposed to sunlight than both the medium Sherman and the Longworth traps and thus was bound to absorb relatively more heat than the others. Hence the possibility of higher ambient temperatures. On the other hand the Longworth traps had very small entrances compared to the medium Sherman traps and probably the hot metal surfaces around the narrow entrances plus relatively hot air inside the main chamber of the Longworth traps discouraged the rodent from entering into the traps during the hottest period between 11.01 a.m. to 3.00 p.m. But this can only be confirmed in future field work.

As far as *O. tropicalis* and *G. dolichurus* were concerned they were fairly big in size relative to the other six species mentioned above and they probably found the entrances into the Longworth traps too small for them to enter. The above statement should be treated with caution as far as *G. dolichurus* is concerned since only three adult males were caught and moreover the species was arboreal and it probably spent alot of its time on trees and bushes and it only descended to the ground occasionally and thus its chances of coming across the traps were limited.

CHAPTER 3

3.0 POPULATION DYNAMICS

3.1 INTRODUCTION

The study area had four different vegetation types. Figure 3.1 which was composed of various species of plants and it was a home to seven different species of rodents and one insectivorous species *Crocidura bicolor*. Since they were of different sizes, behaviour and dietary habits, they would be expected to space themselves according to their micro habitat preferences. That in turn would be reflected in their spatial and temporal distributions as well as their biomass.

3.2 MATERIALS AND METHODS

The types of traps used, their layout in the study area, animal marking technique and data recording were carried out as described in Chapter 2 where each marked individual had its own data sheet.

Initially the traps were inspected at two hour intervals until the pattern of the animals diurnal activities had been established and thereafter the schedule of trap inspections was adjusted to four times a day. That was at 7.00 a.m., 11.00. a.m., 2.00 p.m. and 6.00 p.m. Night inspections were also carried out on seven different occasions between 8.00 p.m. and 5.00 a.m.

A search for the runways and burrows which were being used by various species was done, their pattern and distribution in relation to various vegetation types were recorded. The locations of burrows along the runways

TABLE 3.1 RECAPTURE FREQUENCIES

Species	Total Trap-nights	%Total Trapnights	%Male Recaptures	%Female Recaptures	%Large Sherman		%Medium Sherman		Longworth	
					M	F	M	F	M	F
Rhabdomys pumilio	6174	32.36	15	17	3.4	3.9	8.9	9.7	2.7	3.6
Otomys tropicalis	6174	5.6	2.9	2.7	0.8	0.64	2.12	2.07	0	0
Mus minutoides	6174	3	1.42	1.62	0.29	0.34	0.9	1	0.23	0.28
Lophuromys flavopunctatus	6174	2.35	0.84	1.5	0.5.2	0.36	1.36	0.9	0.47	0.23
Dendromus mesomelas	6174	1.9	1.15	0.75	1.28	0.18	0.64	0.40	0.24	0.16

were also noted. The lengths of the runways were measured using sisal strings which were laid along them.

The data on individual animals were used to establish the numbers of animals which were caught once, twice or thrice per day. In addition to that the distances moved by the various individuals, time span between recaptures and their biomass were calculated and tabulated.

3.3 RESULTS

3.3.1 DISTANCE MOVED

From the records of recaptures of various individuals from different species the average distances moved by each of them were worked out and the results were as follows:-

SPECIES	DISTANCES MOVED IN METERS
Rhabdomys pumilio	20 - 30
Otomys tropicalis	25 - 40
Mus minutoides	- 20
Lophuromys flavopunctatus	18 - 28
Dendromus mesomelas	- 12

3.3.2 RECAPTURES FREQUENCIES

During the field work a total of 213 animals from 8 species were involved. Trapping was carried out over a period of 49 days using a total of 126 traps.

TABLE 3.2 MULTIPLE RECAPTURES PER DAY FOR EACH TRAP - TYPE

Trap type	Frequencies	R. pumilio	O. tropicalis	M. minutoides	L. flavopunctatus	D. mesomelas	C. bicolor
L Sherman	Once	23	5	4	5	3	7
	Twice	2	0	0	0	0	2
	Thrice	0	0	0	0	0	0
M. Sherman	Once	40	12	10	9	8	11
	Twice	15	0	0	0	0	3
	Thrice	2	0	0	0	0	1
Longworth	Once	16	0	3	2	4	5
	Twice	3	0	0	0	0	1
	Thrice	3	0	0	0	0	0

There were 1998 recaptures out of a total of 6174 trap nights. The results are shown in Table 3.1

3.3.3 INCIDENTS OF SOME INDIVIDUAL RECAPTURES

From the data sheet which had all the records of recaptures three categories of recaptures were picked as follows:-

1. Those animals which had incidents of being captured only once per day during the study period and when the occasion arose.

2. Those animals which had incidents of being caught twice per day on some occasions.

3. Those animals which had incidents of being caught thrice per day during the course of the study period.

From each of the above categories one individual from each species with the highest score in recapture record was picked and its frequencies of recapture per trap was tabulated as shown in Table 3.2.

3.3.4 TIME SPAN BETWEEN RECAPTURES

The time lapse between captures were also calculated from data on overall daily captures per species over the entire study period. The totals of individual recaptures for the entire study period were calculated. And to get the time span between captures the number of days the traps were set was multiplied by the number of marked individuals of that species and divided by the total recaptures for the same.

SPECIES	TIME LAPSE IN DAYS
R. pumilio	3.36
O. tropicalis	4
M. minutoides	3.35
L. flavopunctatus	3.72
D. mesomelas	3.76

3.3.5 BIOMASS

Since the number of marked individuals of each species in the study area was known as well as their sexes and weights the estimation of their densities and biomass per hectare were calculated directly.

SPECIES	DENSITY Indiv/h	BIOMASS kg/h
Rhabdomys pumilio	108	2.7
Otomys tropicalis	23	2.76
Mus minutoides	11	0.143

3.4 DISCUSSION

According to the results of frequencies of recapture by a total of 126 traps over a period of 49 days there were a total of 6174 trap-nights and by dividing the total recaptures of each species by the total number of trap-nights then multiplied by 100 gave relative percentage of capture frequencies as follows:- *R. pumilio* 32.6%, *O. tropicalis* 5.6%, *M. minutoides* 3%, *L. flavopuntatus* 2.35%, *D. mesomelas* 1.9%. It was noted that *R. pumilio* which was a cosmopolitan species occurred in 75 out of 126 quadrats while *O. tropicalis*, *D. mesomelas*, *M. minutoides* and *L. flavopunctatus* occurred in 23, 9, 13, and 9 quadrats respectively. The frequencies were probably influenced by vegetation cover which determined suitable micro habitat for each species. this resulted in some species being restricted to particular parts of the study area and thus gave the impression of having a clumped distribution e.g. *O. tropicalis.* The low capture frequencies depicted by *O. tropicalis* could probably be attributed to two factors namely the species behaviour towards traps and its inability to enter the Longworth traps because their entrances were too small to accommodate the size of the species. While on the other hand, *D. mesomelas* low recapture frequency might be due to two reasons namely the restricted distribution of bushy vegetation within the study area which provided suitable micro habitat for the species and secondly the arboreal habit of the species which meant that the species spent part of their time up in the bushes thus limiting their availability on the ground and hence reduced chances of being caught. On the other hand, *Mus minutoides*, although they were few in numbers, occurred in 13 quadrats which were spread widely in all micro habitats of the study area except the forest gallery zone. Their low frequency was probably due to competition for traps with other species such as *D. mesomelas* which was nocturnal like *M. minutoides* and *O. tropicalis* and *L. flavopunctatus* both of which were crepuscular and probably nocturnal.

When considering the frequencies of individual recaptures under the above three categories, that is, those that were caught once, twice and thrice per day, it was noted that *R. pumilio* had the highest incidences of being caught once, twice and thrice per day followed by *C. bicolor*. While the other species *O. tropicalis, M. minutoides, Mus, lophorumys, L. flavopunctatus* and *D. mesomelas* were only caught once per day. In fact *O. tropicalis* was never caught in Longworth traps.

One possible explanation for some *R. pumilio* specimens getting caught more than once per day was because the traps were inspected four times during the day-time and the same individual who had been released from a trap in the morning could still be caught over lunch hour and later in the afternoon. Another possibility was that the species had learnt that no harm would befall them when caught in the trap and there was food always available in the trap and therefore they were not afraid of entering the trap repeatedly. In fact on some occasions the traps had to be relocated elsewhere within the affected quadrats to stop the possibility of the same animal of *R. pumilio* being caught several times on the same day. With regard to *Crocidura bicolor* although they were mostly nocturnal once a specimen which was caught over night was released in the morning and then the same trap was reset without being washed in the same vicinity, the released *Crocidura bicolor* re-entered the trap repeatedly. But once the trap had been cleaned and thoroughly rinsed no such behaviour was noticed. Probably the species uses its scent to mark a place where food can be found.

As far as the other species were concerned, *O. tropicalis M. minutoides, D. mesomelas* and *L. flavopunctatus,* their chances of being caught more then once were limited by the fact that they were mostly crepuscular or noctural and in many cases trap inspections were not done between 7.00p.m. and 6.00a.m.

The distances moved by various individuals of each species were determined from their records of recaptures. The distances moved between various recapture positions were measured and were also related to the entrances of burrows within the runways systems. It was noted that the distances moved by both *Rhabdomys pumilio* and *O. tropicalis* were consistent with the spread of their runway systems. *Rhabdomys pumilio* runways pattern were more or less circular with several burrow entrances located along runways. But *O. tropicalis* runways were not necessarily circular in pattern but were more orientated towards sources of plant food and shaded areas. No particular pattern could be established from observations of their runway-systems. In general adult males and females of *R. pumilio* and *O. tropicalis* especially the latter were confined to the vicinity of their runway systems. That was with exception of subadult males especially of *R. pumilio* some of which moved over considerable distances covering many quadrats probably in search of new settlements either as a result of being expelled from their home or as part of species exploratory behaviour.

As far as *M. minutoides* and *D. mesomelas* were concerned, they were more or less confined to areas with radii of 10-20 meters. Both species did not have runways. On the whole, the distances moved were generally in response to search for food and the more abundant the source of food supply the shorter would be the distances. From the records, those animals which lived in places with plenty of their food-plants tended to move shorter distances.

The average time lapse between successive recaptures for various species probably reflected the behaviour and abundance of the species plus the availability of traps. In the case of *R. pumilio*, there were more individuals in the study area than the number of available traps and besides that they did not have a serious competitor for the same traps during daytime. So as a result the species had better chance of entering the traps and given its cosmopolitan distribution the 3.36 days time lapse between catches was reasonable. On the other hand the 4 days time-lapse between captures for *O. tropicalis* was probably due to several factors e.g. its clumped distribution and the general apathy exhibited by the species towards traps. The trap-lapse for *L. flavopunctatus* could have been affected by its distribution which was confined to the lower part of the study area along the gallery forest zone. The affected quadrats might not have covered the whole of their home ranges since the runways extended beyond the quadrats into the forest. It was therefore possible that their time-lapse was not an indication of the true situation. With regard to both *M. minutoides* and *D. mesomelas* which were numerically few, their average time-lapse of about 3.35 and 3.76 days respectively were probably a fair reflection of the prevailing conditions.

Due to the brief period of study (October-December 1993) it was not possible to get detailed overall picture of trends in seasonal changes in population structure and densities. Nevertheless the high recapture rate tends to suggest that there was low migration and death rate during the study period.

CHAPTER 4

4.0 TERRITORIAL BEHAVIOUR AND HOME RANGE

4.1 INTRODUCTION

The home range of an animal is the area that it occupies during the course of its life, exclusive of migrations and unsual erratic wanderings (Brown and Orian, 1970). Burt (1943), in differentiating the concept of home range from the related concept of territory defined home range as the area traversed by an individal in its normal activities of food gathering, mating and caring for the young. The sizes of home ranges are related to the energy demands of the species concerned with croppers having smaller ranges than hunters (McNab 1963, Harestad and Būnnel, 1979).

On the other hand a territory is an area which is defended by an individual or a group. According to Brown and Orians (1970), a territory should posses the following characteristics:-

1. A fixed area that may change slightly with time
2. The possessor of the territory exhibits acts of territorial defence that are either to evert such as attacks, vocalizations, or displays; or indirect for example scent-marking.

Pitelka (1959) argued that a territory should be defined as an exclusive area without necessarily involving overt defence. A territory may be an individual and involve a fixed or changing area (spiral territory). It may also be a nidic territory which involves only the immediate area around a home site and is often possessed by females; or it may be arena territory which is found in species with polygamous mating.

4.2 MATERIALS AND METHODS

The trapped animals were identified to species level, sexed, weighed and their body measurements such as head, body, tail and ear lengths were taken; and then they were each marked with individual numbers using the toe-clipping technique which was developed by French (1964). The technique involved amputations of not more than one toe per limb. That way it was possible to get a total of upto 899 combinations of individual sets of numbers. The marks were permanent and easy to read. A data sheet was opened for each marked individual bearing its particulars as stated above. The time, date and quadrat where it was caught were also recorded in the data sheet.

4.3 RESULTS

4.3.1 SPATIAL DISTRIBUTION

LENGTHS OF RUNWAYS IN METERS

OTOMYS	RHABDOMYS
35	26
28	21
19	15
23	17
Mean= 26.25$\pm$3.45SE	Mean= 19.75$\pm$2.43SE

Inspection of the study site showed that there were three species which had runways namely *O. tropicalis, R. pumilio* and *L. flavopuntatus.* The runways of both *O. tropicalis* and *R. pumilio* were well defined with the one of the former being relatively wider (about 6cm) and were littered with droppings while the one of *R. pumilio* the latter was about 3cm wide but the ones of *L. flavopuntatus* were not well marked and in some parts they disappeared altogether. It was thus difficult to measure them. Four runways from *O. tropicalis* and *R. pumilio* were

FIG. 4.1

RUNWAYS OF OTOMYS AND RHABDOMYS

measured respectively. Their lengths ranged between 19-23m for *O. tropicalis* and 15-26m for *R. pumilio* and the difference in lengths of the runways of the two species did not differ significantly ($t_4 = 1.55$; $P>0.05$).

According to the record of recaptures it appeared that each runway system was occupied by a group of particular individuals consistently. In the case of *O. tropicalis* there were up to 6 members per runway while *R. pumilio* had upto 11 individuals.

The runways of *R. pumilio* were generally radiating from a central part with one main hole and there were two to three subsidiary holes which were located along the runways at various points (Fig. 4.1). The pattern of their runways gave an impression of an irregular circle. On the other hand *O. tropicalis* had runways which did not appear to originate from a central location. they appeared to be orientated towards sources of food-plants and were aligned along ecotone zones between grass-land and bushes. There were some holes which were located along the runways. In both species the runways were dynamic in that some parts were abandoned and new ones opened.

4.3.2 HOME RANGE

The home ranges of both *O. tropicalis* and *R. pumilio* were confined to the vicinity of their respective runways. All catches of *O. tropicalis* were made adjacent to the runways and were not at anytime during the entire study period caught in traps which were set at distances of upto 2 meters from the runways.

4.3.3 TERRITORIAL BEHAVIOUR

According to the data on recaptures it appeared that the occupancy of each runway system was confined to a specific group of individuals who tolerated each other. Occasional newcomers did not stay for a long time in the vicinity of the foreign runway. It appeared that both species defended their runways and thus they were also serving as their territories as well as home range.

There were several observations of *R. pumilio* chasing each other along the runways but it was not possible to confirm whether such behaviour was part of play between the parties concerned or was a tussle between members of their groups to establish some form of hierarchy or was aggression towards an intruder. During the study period most of the members of each group were caught within the vicinity of their runway system and the different runways did not overlap each other.

4.4 DISCUSSION

The spatial distribution of *O. tropicalis* was probably influenced by the species preference for places with lush vegetation which was composed of mostly grassy patches intermingled with bushes. Their runways were found amid such grass species as *Setaria sphacelata, Panicum sp.* and *Digitaria macroblephara*. Unlike *R. pumilio* runways which were radiating from a central place, probably for quick retreat in case of security risk. the *O. tropicalis* runways pattern were probably influenced by the source of food-plants and were not conforming to any particular pattern and did not have a central locus. The fact that plenty of nibbled vegetation was seen along the sides of their runways tended to confirm that they were primarily used for foraging purposes.

The sizes of home ranges both *O. tropicalis* and *R. pumilio* were probably influenced by the energy demands of individual species. That was in turn dependent on the availability of food plants, the body sizes and its members and the number of animals in the group. Animals with big body sizes would need more food than the smaller ones. Since *O. tropicalis* weighted between 100-200g. and *R. pumilio* was 30-40g, that would probably infer that *O. tropicalis* ate more food than *R. pumilio* and moreover that fact was compounded by it being a grazer and it would thus need to eat bulky food compared to *R. pumilio* which was omnivorous with flexibility of changing its dietary habits according to seasonal availability of food. It could probably gain as much protein and carbohydrates from a meagre diet of arthropods and plant seeds as *O. tropicalis* obtained from eating grass stems and leaves.

Given the fact that each runway system was consistently occupied by specific groups of individuals it was probably defended by the group against intruders. But that can be ascertained by further studies which should be of a much longer duration (a whole year). Since during the most part of 1993 the area received poor rainfall and especially the drought period prior to the late November poor rains, the rodent population probably underwent reduction and probably the animals which were studied were not at their population peak and had therefore more room to space themselves and hence there were no overlaps in runways.

CHAPTER 5

5.0 FEEDING ECOLOGY

5.1 INTRODUCTION

The study area was inhabited by seven different species of rodents and one shrew. They were of different sizes with different dentition sizes and shapes. They also preferred different micro habitats and were active at different times and consequently their food preferences were varied.

5.2 MATERIALS AND METHODS

Four different approaches were followed namely direct observations, germination of seeds in the faeces, examination of stomach contents and lastly feeding experiments.

5.2.1 DIRECT OBSERVATION

Direct observatios were carried out in two stages. First there were direct observations in two genera namely *Rhabdomys* and *Otomys* using field glasses to ascertain the various plants species which they appeared to nibble. The plants were thereafter examined for teeth marks to verify that they were actually nibbled and upon confirmation some samples of the plants were picked, labelled and taken for identification. Secondly the runways were inspected for remains of chewed plants, which were then collected and treated as suspected food plants. Both *Rhabdomys* and *Otomys* were chosen for direct observations because they had well established runways and it was possible to see them during daytime. The other genus, *Lophuromys*, which could occasionally be seen during daytime especially late afternoon inhabited areas which were covered with thick vegetation and it was difficult to follow their activties.

5.2.2 GERMINATION OF FAECAL MATERIAL

Another approach used to determine food plants was by attempting to germinate seeds in the faeces. Samples of the faeces were picked from traps as well as from the runways and they were covered with thin layers (1 cm) of soil and were watered for several days. Some of the droppings were watered on site while others were taken to Nairobi Museum where they were taken care of in the laboratory.

5.2.3 STOMACH CONTENT ANALYSIS

During the final part of the field work some animals were made into voucher specimens for future reference and during the course of skin preparations stomach contents were collected and preserved in bottles with 70% alcohol so that the contents could be analysed for traces of food eaten.

5.2.4 FEEDING EXPERIMENT

Lastly, having compiled a list of suspended plant foods, samples of the same were weighed (100gm) for each plant species and then they were placed in wooden experimental feeding boxes. One rodent was introduced into the box and left for a 24 hour period. Control boxes were also set up with the same quantities of food plants and left for 24 hours under the same conditions as the boxes with animals. At the end of the 24 hour period the animals were taken out and the plant remains were carefully collected specieswise and weighed separately to determine the amounts eaten per species. Also the plants in the control boxes were weighed to determine moisture loss. The amount of water loss per gram of plant materials gave an indication of waterloss per plant species and that was used in adjusting weight loss due to water evaporation in various food plants which were retrieved from the feeding boxes. The amounts of food plants which were actually eaten were therefore determined (Table 5.1).

TABLE 5.1 FEEDING EXPERIMENT - AMOUNT OF PLANTS CONSUMED IN GRAMS

ANIMAL \ PLANT	CYNODON AETHIOPICUS	THEMEDA TRIANDRA	SPOROBOLUS MACRANTHELUS	SETARIA SPHACELATA	CUCUMIS FIGAREI	THUNBERGIA ALATA	ACHYROPSIS FRUTICULOSA	VERNONIA LASIOPUS	LANTANA TRIFOLIA	DIGITARIA MACROBLEPHARA	LIPPIA JAVANICA	AJUGA REMOTA	ACHYRANTHES ASPERA	MARISCUS SP.	SOLANUM NIGRUM	PANICUM SP.	TOTAL
RHABDOMYS	0.6	0.7	1.1	2	2.2	1.2	-	1	-	0.8	1	-	0.6	-	1.5	1.1	13.8
OTOMYS	7	2.3	1.8	1.5	4	5.6	-	1.2	-	2.9	-	1.2	-	0.5		3	32
MUS	-	-	2.5	3	1.5	1.6	-	-	-	-	-	-	-	-	1.8	-	10.4
DENDROMUS	-	-	0.6	1.5	-	-		1.3	-	-	-	1.2	-	1.4	-	2.1	8.1

5.3 RESULTS

During the earlier part of study, that is from 21st October to the 20th November 1993 when the weather was dry, the major food items of *R. pumilio* were dicotyledonous plants, seeds and some grass leaves. This was established through observations and the seed coatings detected in faecal material. The same incidences of seeds eaten were detected in faeces of *M. minutoides* and *D. mesomelas*. The seeds of *Solanum nigrum*, *Achyranthes aspera* and *Cucumis figarei* featured prominently although the bulk of food was composed of grasses. After the onset of the short rains the diet of *R. pumilio* showed increased leaves of grasses and herbs especially *Thunbergia alata* as well as significant amounts of arthropods. The proportion of seeds was very little. The most relished grass species were *Sporobolus macranthelus. Digitaria macroblephara and Themeda triandra.*

On the other hand *O. tropicalis* showed preferences for stems and leaves of *Panicum sp. Cymbopogon excavatus* and *Digitaria macroblephara*. Small quantities of both *Mariscus sp.* and *Setaria spacelata* were included in its diet. Like *R. pumilio, O. tropicalis* also relished eating the fruit of *Cucumis figarei* and leaves of *Thunbergia alata* which was heavily grazed on. In addition to that both *O. tropicalis* and *R. pumilio* were observed feeding on the barks of *Vernonia lasiolus*, *Lantana trifolia* and seedlings of *Pinus sp.* The latter exotic species was being planted as part of University of Nairobi afforestation project. Both *V. lasiolus* and *O. trifolia* appeared to be able to survive severe debarking but *Pinus sp.* was killed.

The quantities of food eaten during the feeding experiment were as follows:- *R. pumilio* 13.8g., *O. tropicalis* 32g., *Mus minutoides* 10.4g. and *D. mesomelas* 8.1g. The quantities of food eaten per food plant were shown in table 5.1.

Attempts to germinate seeds from faecal material both in the laboratory and under field conditions where the faeces were covered with about 1cm of soil did not succeed. Similarly observations of the multitude of faeces which littered along the runways showed no germination of seedlings from them. Stomach content analysis showed presence of plants shown in Table 5.1. Besides that there were sketetal remains of arthropods in *R. pumilio, M. minutoides, L. flavopunctatus* and *D. mesomelas* faeces. No arthropods were seen in *O. tropicalis*.

5.4 DISCUSSION

During the feeding experiment it was possible the reactions of the animals concerned towards their confinement to the cages and the absence of nests may have affected their feeding behaviours but nevertheless since they fed some idea about their food and food preferences were established.

No water was provided in the cage because under the prevailing conditions no free or standing water was available. The non-availability of free water was observed both during the dry and wet phases of the study period. In fact the wet phase was supposed to be very wet but unfortunately there was very

TABLE 5.2 SKULL MEASUREMENTS IN mm

Species	Sex	Condylobasal	M_1-M_3	M_1 Width	Mean M_1-M_3 Lengths	Mean M_1 Widths
O.tropicalis	f	40.34	8.00	3.00		
	m	38.27	8.32	2.26		
	m	40.5	8.25	2.31	8.26	2.44
	m	41.6	8.40	2.63		
	m	42.04	8.35	2.25		
R. pumilio	f	25.52	5.40	1.70		
	m	27.31	5.10	1.75		
	f	24.46	4.53	1.62	4.99	1.69
	m	27.24	4.90	1.65		
	m	26.19	5.00	1.72		
L. flavopunctatus	m	28.30	5.17	1.61		
	f	28.23	4.51	1.42		
	f	30.08	5.10	1.52	4.99	1.56
	m	31.00	5.20	1.65		
	m	30.53	4.97	1.62		
D.mesomelas	m	20.51	2.44	0.87		
	m	23.26	3.00	0.83		
	f	23.00	2.86	0.90	2.76	0.85
	m	22.71	2.82	0.81		
	f	22.92	2.68	0.84		
M. minutoides	m	21.60	3.40	1.10		
	m	21.00	3.92	1.25	3.26	0.02
	f	18.41	3.00	0.96		
	f	21.03	3.05	0.91		
	f	20.30	2.94	0.89		

little rain and it was assumed the rodents probably got their water supply from their food plants or from sources other than free standing water.

With regard to foraging activities the results of the plant food eaten were combined for both sexes and they were treated as if there was no sexual differences because of two reasons. First it was very difficult to establish the sex when observing the animals foraging and secondly, the feeding experiments were done using a few animals per species due to time constraint and in any case there was no significant differences ($p>0.005$) in food consumption sex wise. *O. tropicalis* only fed on grasses and took very little dicotyledonous plants compared to *R. pumilio*. That was probably because *O. tropicalis* adaptation to grazing habit. It had broad multi-laminated molars which were suitable for masticating leaves and stems and in addition to that they also had large caeca for cellulose digestion (Taylor and Green, 1978): that anatomical adaptation was lacking in *R. pumilio, M. minutoides*, *D. mesomelas* and *L. flavopunctatus*. From analysis of stomach contents and faecal materials of *O. tropicalis* no evidence of arthropods was found which was in contrast to the other four species mentioned above which had arthropod skeletal remains. Of particular interest was *D. mesomelas* which had relatively small weak teeth. It needed diet with high energy and protein contents in order to meet its bodily requirements without having to eat bulky stems and leaves. During the dry period (October-November, 1993), there were high proportions of dicotyledonous diet eaten by *R. pumilio* but after the rains its diet proportion was composed mostly of grass shoots mixed with termites and grass hoppers.

CHAPTER 6

6.0 RELATIONSHIP BETWEEN SMALL MAMMALS AND HABITATS

6.1 INTRODUCTION

For successful growth in an environment plants must adapt to prevailing physical, chemical and biotic factors. That would then result in each plant community being exposed to genetic and environmental filters of selection and hence variation in species composition. Likewise in order to survive in Ngong Hills, plants have to adapt to low temperatures at night, high temperatures during daytime, meagre rainfall and windy conditions during most of the daytime.

6.2 MATERIAL AND METHODS

The traps, trapping method and data recording were as reported in Chapter 2. Vegetation survey was carried out to establish species varieties and their composition within the study site. Samples of vegetation especially the portions with inflorescence were collected and labelled individually and taken to the herbarium at the National Museums of Kenya for identification. A list of identified plants was then compiled. A sketch map of the site showing quadrats layout was prepared and vegetation distribution was depicted thereon. A list of various species of small mammals was prepared from trapping record and their distributions were plotted on the sketch map Fig.6.1. As far as animal list was concerned only the animals which were studied were plotted but the rest were left out.

6.3 RESULTS

6.3.1 PLANTS

The following plant species were found in the study area:-

FAMILIES	SPECIES	COMMON NAME
ACANTHACEAE	*Justicia caerulea*	Kipchichia (Pokot)
	Thunbergia alata	Nyawend-Agwata (Luo)
AMARANTHACEAE	*Achyranthes aspera*	Devil's Horsewhip
	Achyropsis fruticulosa	Botonyi (Masai)
ANACARDIACEAE	*Rhus natalensis*	Kitheu (Kamba)
	Rhus vulgaris	Ilmisig'y'io (Masai)
APOCYNACEAE	*Carissa edulis*	Mukawa (Kikuyu)
BORAGINACEAE	*Ehretia cymosa*	Munkreriot (Okiek)
CAESALPINIACEAE	*Senna didymobotrya*	Mwinu (Kikuyu)
COMPOSITAE	*Aspilia mossambiciensis*	Muuti (Kamba)
	Conyza stricta	Mutumbanguyo (Kamba)
	Gnaphalium declinatum	Eleleshwa-enkop (Masai)
	Gutenbergia cordifolia	Uruti (Kikuyu)
	Vernonia galamensis	Taparkutwo (Pokot)
	Vernonia lasiopus	Muvatha (Kamba)
	Sphaeranthus bullatus	Oleturot (Masai)
CONVOLVULACEAE	*Ipomoea wightii*	Kimoiyat (Dorobo)
	Lepistemonopsis volkensii	Mangaia (Kipsigis)

CRASSULACEAE	*Kalanchoe densiflora*	Sopolwa (Shambaa)
CRUCIFERAE	*Erucastrum arabicum*	Maganate (Kiumbulu)
CUCURBITACEAE	*Cucumis figarei*	Sigirgerwa (Marakwet)
CYPERACEAE	*Mariscus sp.*	Ngonda (Kikuyu)
GRAMINEAE	*Cynodon aethiopicus*	Star grass
	Cymbopogon excavatus	Lemon grass
	Digitaria macroblephara	Couch grass
	Setaria sphacelata	Foxtail
	Sporobolus macranthelus	Olbulugoi (Masai)
	Themeda triandra	Red oat grass
	Panicum sp.	Nyeki ya mbiiru (Kikuyu)
LABIATAE	*Ajuga remota*	Mataliha (Kakamega)
	Leonotis nepetifolia	Nyanyodhi (Luo)
	Ocimum sauve	Kirumbasi (Swahili)
LILIACEAE	*Asparagus africanus*	Empare e baba (Masai)
MALVACEAE	*Abutilon longicuspe*	Mondwe (Kikuyu)
	Hibiscus fuscus	Kirundu (Chagga)
	Pavonia patens	Pelpany (Pokot)
PAPILIONACEAE	*Indigofera arrecta*	Olando (Luo)
	Rhynchosia minima	Muthara kondo (Tharaka)
	Sesbania sesban	Oyieko (Luo)

PRIMULACEAE	*Lysimachia ruhmeriana*	Umuyobora (Kinyarwanda)
RANUNCULACEAE	*Clematis simensis*	Bisinda (Kipsigis)
RESEDACEAE	*Caylusea abyssinica*	Olosaiyet (Masai)
SOLANACEAE	*Withania somnifera*	Olosajeti (Masai)
	Physalis peruviana	Cape Gooseberry
	Solanum incanum	Entuleilei (Masai)
	Solanum nigrum	Olmomoit (Masai)

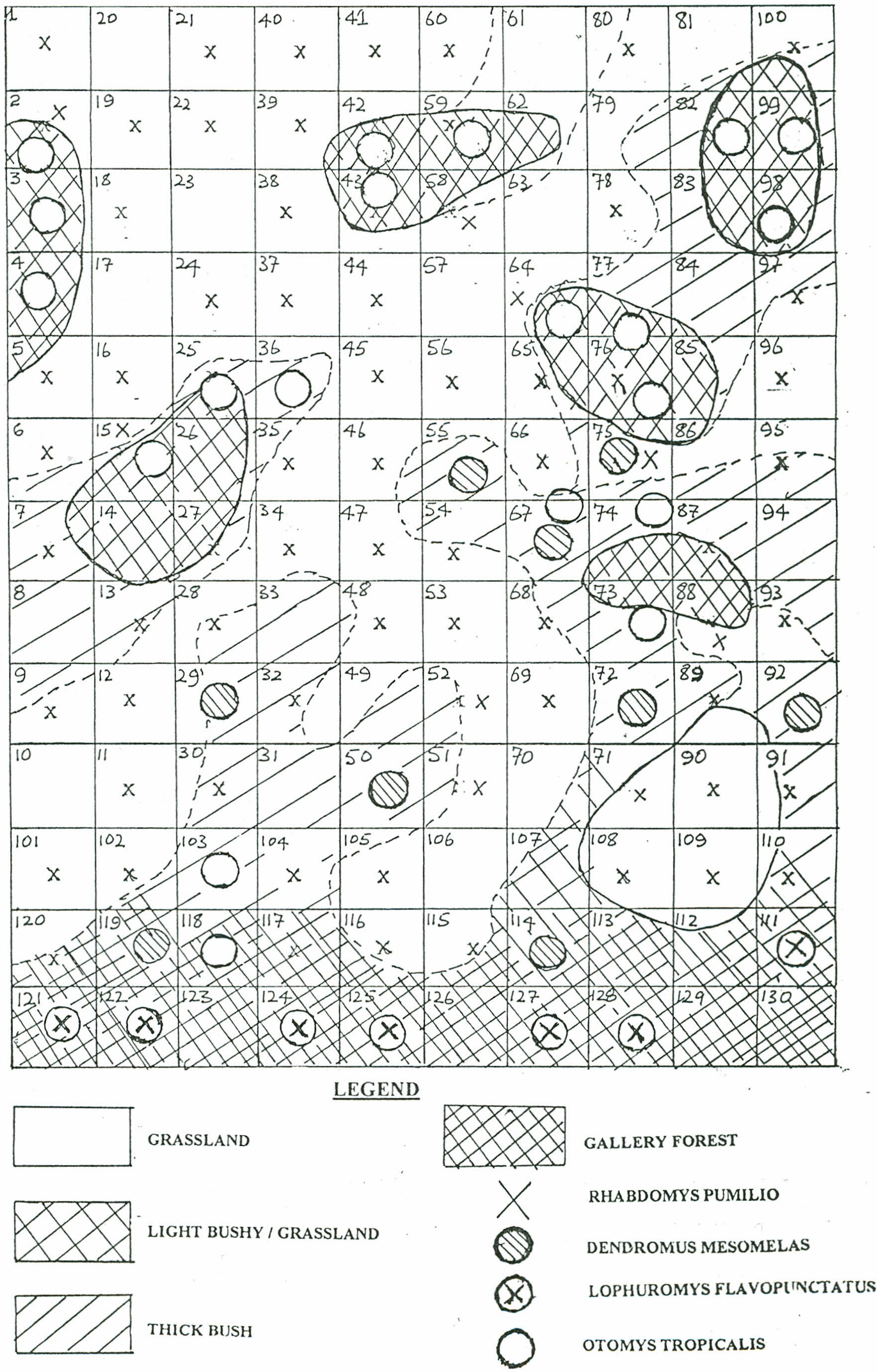
6.3.2 ANIMALS

The following animals were recorded from the study site:

RODENTIA

SPECIES	COMMON NAME
1. *Pedetes capensis surdaster*	Spring hare
2. *Tachyoryctes spendens*	Mole rat
3. *Lophuromys flavopunctats aquilus*	Harshfurred rat
4. *Otomys tropicalis*	Groove-toothed rat
5. *Lemniscomys striatus*	Striped rat
6. *Dendromus mesomelas insignis*	Climbing mouse
7. *Rhabdomys pumilio diminutus*	four striped grass mouse
9. *Mus minutoides*	Mouse
10. *Grammomys dolichurus*	Thicket rat
11. *Hystrix cristata*	Porcupine

FIG. 6.1 VEGETATION AND ANIMAL DISTRIBUTION IN THE STUDY SITE



ARTIODACTYLA

1. *Redunca redunca*	Reeddbuck
2. *Tragelaphus scriptus*	Bushbuck
3. *Sylvicapra grimmia*	Grey duiker

TUBULIDENTATA

1. *Orycteropus afer*	Ant bear

CARNIVORA

SPECIES	**COMMON NAME**
1. *Panthera pardus*	Leopard
2. *Crocuta crocuta*	Hyaena
3. *Ichneumia albicauda*	White-tailed mongoose
4. *Herpestes sanguineus*	Black-tipped mongoose

LAGOMORPHA

Lepus crawshayi	Hare

BIRDS (AVES)

Buteo augur	Augur buzzard

REPTILIA

Python sebae	Python

6.3.3 RELATIVE DISTRIBUTION OF FAUNA AND FLORA

The over view site sketch map showed that the vegetation distribution within the site fall into four distinct plant communities namely grassland, gallery forest, light bush and dense bush. (Fig.6.1).

Similarly the animals distribution in the site showed that various species occurrences concided with particular plant communities. *R. pumilio* occurred in 75 quadrats mostly in the grassland and also to some extent in the light bush plant communities. *O. tropicalis* occurred in 23 quadrats and its distribution was confined to the ecotone zones between the grassland and high bush plant communities. Its distribution was clumped. *D. mesomelas* was found in both light and dense bush areas *L. flavopunctatus* were caught in light bush, dense and gallery forest areas.

While *L. striatus* inhibited mostly light bush area and to some extent grassland and occasionally in the dense bush. *M. minutoides* appeared to prefer grassland area although it was sometimes found in the light bush area. *G. dolichurus* was mostly found in the dense bush and gallery forest area. And lastly, *C. bicolor* appeared to be versatile and was present in all four types of habitats (Table 6.1)

6.4 DISCUSSION

The vegetation distribution pattern in the study area was divided into four distinct communities (Fig.6.1) comprising various species (Table 6.1). The first one was predominantly grassland habitat which was generally less than

TABLE 6.1 SMALL MAMMALS VS HABITAT

Species	Grassland	Light bush	Dense bush	G. forest	Active time	Habits	Dwelling
R. pumilio	+++	++	--	--	Diurnal	Terrestrial	Burrow & nest on ground
O. tropicalis	++	++	--	--	Crepuscular & Diurnal	Terrestrial	Burrow
F. flavopunctatus	+	+	++	+++	Crepuscular & Diurnal	Terrestrial	Burrow & nest on ground
L. striatus	+	++	+	--	Diurnal	Terrestrial	
M. minutoides	+++	++	--	--	Nocturnal	Terrestrial	Burrow
D. mesomelas	--	++	++	--	Nocturnal	Arboreal	Nest in bushes
G. dolichurus	--	--	++	++	Nocturnal	Arboreal	Nest in tress
C. bicolor	+	++	+	--	Nocturnal	Terrestrial	Cracks & holes

Legend:

+++ .... Strong presence

++ .... Moderately present

+ .... Occasionally present

half a meter in height. The predominant species were *Themeda triandra, Sporobolus macranthelus, Setaria sphacelata, Digitaria macroblephara, Cynodon aethiopicus* and *Panicum sp*. Those were invariably mixed with herbaceous undergrowths and to some extent by a few dicotyledonous plants such as *Solanum incanum*. The second type of vegetation community was the gallery forest along the tributary of Kiserian river. The forest was composed of tall trees such as *Acacia tortilis, Ficus natalensis* and *Acacia xanthophloea* in the upper canopy while the middle section was composed of short trees such as *Rhus vulgaris, Rhus natalensis, Ehretia cymosa* and dense growth of *Sesbania sesban*. Then there was the lower layer which was composed of shrubs and herbs which were intermingled with the rest of vegetation. They were predominantly composed of *Carissa edulis, Senna didymobotrya* and *Aspilia mossambiciensis*. Those were in turn covered with various creepers and where there were sufficient light penetration especially along the edges *Cynodon aethiopicus* grew abundantly. The third type of vegetation community was a thick bush which sometimes reached heights of upto three meters. The predominant vegetation were *Lantana trifolia, Abutilon longicuspe* and *Vernonia lasiopus*. Those were intermingled with other vegetation such as *Ipomoea wightii, Asparagus africanus* and *Caylusea abyssinica* to form a dense vegetation cover. This was followed by a fourth type of vegetation community which was intermediate between the thick bush and the grassland. The vegetation height ranged from about two meters and below. Unlike the thick bush where the ground underneath the bushes was almost bare because of heavy shade which was provided by lush vegetation above, the ground cover was full of grasses and other herbs.

The dominant species in that community were *Ocimum suave, Kalanchoe densiflora, Achyropsis fruticulosa, Achyranthes aspera* and *Vernonia galamensis*. Those were accompanied by lush undergrowths of *Ajuga remota, Sphaeranthus bullatus, Conyza strictus* among others. In between the bushes were tussocks of *Sporobolus, Cymbopogon*, and *Panicum sp.* The community was a mixture of both bushes and grasses and it occured in patches which were scattered throughout the study area away from gallery forest. They also sometimes adjoined the dense bush community (Fig.6.1).

As far as the distribution of small mammals in the study area was concerned there was distinct pattern of habitat preference shown by rodent *Rhabdomys pumilio* which was mostly confined to grassland and light bush plant communities. They were not found in thick bush and gallery forest communities. They also showed aversion to shaded area. On the other hand *O. tropicalis* showed strong preference to light bush type of plant community especially the portions where *Sporobolus, Panicum* and *Cynodon* were in plenty. They appeared to like the ecotone zone between the light bush and grassland plant communities.

Both *R. pumilio* and *O. tropicalis* had their runways aligned to their food plants. With regard to *D. mesomelas*, it showed preference to both light and dense bush plant communities. Since the species was arboreal and it made its nest among the bushes the two vegetation communities offered it premium habitats. Likewise the other arboreal rodent, the *G. dolichurus* showed preference for the dense bush and the gallery forest habitats. But unlike the *D. mesomelas* it avoided light bush areas. Both *D. mesomelas* and *G. dolichurus*, despite their arboreal habits, on some occasions, descended to the ground probably in search of fallen seeds or for some other reason. *Mus minutoides* occupied both the light bush and grassland areas but due to the difficulty in discerning its runways it was not possible to discern its movements in relation to various species of plants. *Lemniscomys striatus* was caught in both dense and light bush areas while *Lophuromys flavopunctatus* was caught mostly along gallery forest and to some extent in the dense bush. On the other hand *Crocidura bicolor* which was not a rodent but was an insectivorous mammal with propensity for eating small mice, was trapped in all four types of plant communities. It was a generalist in habitat selection. Since it was insectivorous probably its distribution was in response to availability of insects which occurred all over the study area.

CHAPTER 7

7.0 BREEDING

7.1. INTRODUCTION

There are many factors which contribute to the survival of animals and one of the most crucial aspect is the ability to propagate. Likewise the rodents in Ngong Hills have to breed in order to propagate themselves. During the studies, where 8 species were involved, attempts were made to find out their breeding habits.

7.2 MATERIALS AND METHODS

The same procedure was adopted as described in Chapter 2. But in addition to that physical examination of the testes of all captured males were carried out and particular attention was paid to their sizes. As far as the females were concerned their teats and vaginal openings were examined to monitor their conditions and sub-sequent changes. In order to ascertain possible cases of pregnancies their abdomen were gently pressed using two fingers to feel for the presence of developing foetuses. Examinations for their dental conditions were also taken so as to be able to differentiate sub-adults and their corresponding body weights were also taken.

At the end of the study period some animals were sacrificed to get gut contents for diet analysis as well as to check for possible pregnancies. Their skins were preserved as voucher specimens.

TABLE 7.1 FEMALES EXAMINED FOR PREGNANCY

Species	No. examined	No. of females with foetuses					
		0	I	II	III	IV	V
R. pumilio	10	--	--	3	2	5	--
O. tropicalis	6	--	--	1	2	3	--
M. minutoides	6	--	--	1	--	2	3-
F. flavopunctatus	4	--	--	--	1	3	-
G. dolichurus	2	--	--	2	--	--	--
D. mesomelas	1	1	--	--	--	--	--

7.3 RESULTS

All the females of all the six species in Table 7. did not have lactating teats indeed they appeared recessed. There were also no discernible signs of foetuses which could be felt. With regards to vaginal openings all of the females had tightly closed vulvae at the beginning of the studies in the month of October and early November 1993. But they appeared relaxed towards the end of November. As far as *C. bicolor* was concerned their valvae were always relaxed and there was no way of distinguishing males from females from morphology of their external genitalia. The only way that this could be done was in cases where a female was either heavily pregnant or lactating but no such eases were found. The other species, *L. striatus* was rarely caught.

A total of 47 animals were sacrificed - 29 females and 18 males. Budding foetuses were observed in five species and none in one. They had between 2 to 5 foetuses per female. (Table 7.1).

There were 10 *R. pumilio* females all of which were pregnant with 2 to 4 foetuses. Those were followed by 6 female *O. tropicalis*; all of which were pregnant with 2 to 4 foetuses. And then there were 6 *M. minutoides* one of which had 2 foetuses, two had 4 and three had 5 foetuses. The four *L. flavopunctatus* had 3 to 4 foetuses. While the two *G. dolichurus* had 2 foetuses each. Only one specimen of *D. mesomelas* was caught and it was found not to be pregnant.

All male testes were scrotal, subadult males of *R. pumilio* had hairy scrota while the adult ones had no hairs. Due to low number of most of the species which were dealt with it was decided to concentrate on two most abundant species namely *R. pumilio* and *O. tropicalis* as far as testes sizes were concerned. All *O. tropicalis* seemed to have average testes lengths of 23mm and their scrota were not hairy. The testes lengths did not change appreciably during the entire study period. There was also no clear cut cases of suspected subadult males in the group which was handled.

On the other hand there were progressive changes in lengths and volume of testes in *R. pumilio*. Adult male testes grew in size from an average of 4mm to 15mm over the study period. Subadults had their testes also develop from almost rudimentary bud in the scrotal sac to 15mm by the end of the study period.

7.4 DISCUSSION

Rodent breeding behaviour has been studied by a number of people in various parts of Africa and they all noted a tendency towards seasonality in their breeding pattern. Coetzee (1975) reported that the rodent *Mastomys natalensis* in Southern Africa had peak breeding periods towards the end of the rainy seasons and in the beginning of dry season. In another study by Taylor and Green (1976) on the diet and reproduction in African rodents, it was reported that the genera *Rhabdomys, Arvicanthis* and *Mastomys* bred about the middle of the rainy season when fruits, seeds of weeds and grasses became available and they continued into the early part of the dry season.

They also noted that *Otomys* bred throughout the year with peaks during rainy season. Delany (1964) and Delany and Roberts (1978) carried out studies on ecology and breeding of small mammals both in Uganda and Kenya and reported the same general tendency of rodents breeding after the onset of rains and into the beginning of the dry season. The same obsevations were made by Okia (1973) on the breeding pattern of the soft-furred rat *Praomys morio* in Uganda where he observed seasonality in breeding peaks which were related to rainfall pattern.

The study period in Ngong Hills took place at the interface of dry and wet seasons. At the beginning, it was very dry but towards the end there was some rain. The dry season was so severe that most of the herbs and grasses looked dry. That probably affected the rodents breeding behaviour because none of them was seen in breeding condition. The males of *R. pumulio* had regressed testes which was probably the same incident as was reported by Taylor and Green (1976) in their studies on diet and reproduction in African rodents during which they observed that there were cases of testes regression in some rodents during non-breeding season.

Although Taylor and Green (1976) noted that *Otomys* bred throughout the year with peaks during the rainy seasons. the ones in Ngong Hills did not breed during the dry season despite the fact that the males did not undergo testes regression. The females vulvae were tightly closed. That could have been an indication that the females were not ready to mate under such severe environmental stress.

In the meantime all the females of the other species mentioned above did not show signs of either lactations or pregnancies. Their vulvae were tightly closed except *C. bicolor*. The latter species had open genital openings and it was difficult to determine their sexes from external morphology except in obvious cases where the animal was heavily pregnant or lactating but no such cases were observed. On the other hand the regressed testes of *R. pumilio* was probably a clear indication that they were not in breeding condition. But after the onset of rains the testes of *R. pumilio* rapidly increased in size and the vulvae of females relaxed which probably was an indication that both the males and females were attaining breeding conditions. That was probably triggered by nutritive factors in the fresh vegetation growth as a result of the rain. That could be the same situation as was observed by Field (1979) who in his studies on ungulates considered the nutritive value of the diet and concluded that diet was proximal in the seasonal cycle of reproduction of other ungulates and rodents.

According to the results of the sacrificed speciments it appeared that the pregnancies took place after the onset of the rains. That was probably adaptive survival strategy where they bred after the onset of rains a period where there would likely be plenty of seeds and fruits to ensure adequate diet for both mother and offspring.

CHAPTER 8.0

GENERAL DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

The distributions of the rodents in the study area were probably determined by their need for shelter, food and security. Those were in turn evidenced by their physiological and behavioural adaptation to prevailing conditions such as vegetation types and cover, temperatures and wind effect.

It was established that the animals had distinct micro habitat preferences and different temporal activities. *R. pumilio* preferred areas mostly with open grassland and to some extent light bush. The distribution of their runways were closely associated with their food plants. They were active during day time from about 8 a.m. to 5.30 p.m. On the other hand *O. tropicalis* occurred in mixed grassland and light bush type of plant community with some shade. They were mostly crespuscular in activity although they were occasionally seen during day time. Their runways were aligned to their food plants but were not more or less circular like the ones of *R. pumilio*, they were more extensive in lengths. With regard to *Mus minutoides*, it was found to be nocturnal and totally terrestrial. There was micro habitat separation between *M minutoides* and *Dendromus mesomelas* although both of them were about the same in sizes; the latter was arboreal and preferred to nest up on bushes and spent part of their time above ground while the former was terrestrial. Although their temporal activities were similar, their spatial distributions were different. The other rodent species, *L. flavopunctatus* occurred in the thick bush and the gallery forest areas and was mostly caught overnight. Its temporal and spatial activities put it out of contact with both *R. pumilio* and *O. tropicalis*. The other rodent species *L. striatus* and *G. dolichurus* were caught in small numbers and thus not much data was obtained for detailed analysis. As far as their feeding ecology was concerned the rodents showed distinct food preferences which also matched their physiological adaptations. *O. tropicalis* had broad laminated molars and caeca which enabled the animal to chew grass stems and use microorganisms in the caeca to digest cellulose. While *R. pumilio* had comparatively medium sized molars and fed on seeds, dicots as well as grasses but did not have caeca hence the bulk of their food had to be without much cellulose. The same case applied to *L. flavopunctatus* which also ate insects. On the other hand both *M. minutoides* and *D. mesomelas* which were small animals with small molars and thus they took seed and other energy rich parts of the plants to maximize on the energy gained out of food items.

RECOMMENDATIONS

Since there were plenty of wild animals of many species which occurred in the study area as shown in the list in Chapter 6 and given the fact that the area was well fenced and guarded against vegetation destruction by human beings and livestock there is a great potential for students to carry out research in the area in future. The potential for rodent studies is immense especially given the fact that they occurred in substantial numbers and their general response to toe-clipping marking technique was good. Such studies should be carried out at least through two consecutive rainy seasons in order to ascertain their population dynamics and possible changes in their seasonal dietary habits.

The remaining portion of unsettled land on Ngong Hills should be set aside for afforestation and conservation. In view of the fact that the hills form an important water catchment area as evidenced by the number of springs and small streams which come from it as well as the numerous boreholes which have been sunk by farmers. (The boreholes rely on underground water seepage from the hills). The presence of vegetation cover on the hills should be preserved if continued water supply is to be maintained. Careful environmental studies should be done to evaluate suitable trees for afforestation project. Since there are a number of indigenous trees in Kenya which are known to grow on hills in various parts of the country which have had considerable environmental impact, for example the tall trees which grow on top of the Kasigau mountain where mist condense on their leaves and thence fall onto the forest soil in form of water drops and as a result the forest floor is always wet even during dry season. The wetness in the soil has over the years percolated through the ground and given rise to the perennial Bungule river which not only supplies water to the local community around the mountain but also to the surrounding ranches. Such trees if introduced can trap mist on Ngong Hills and boost up the water supply.

The current practise of allowing farmers near the University of Nairobi forest station at Ngong Hills to cut grass to feed their livestock albeit on a small scale should be evaluated to ascertain their long term environmental impact. The farmers, over the years, have realised the importance of the University compound as a fodder reserve which they can fall back to when confronted with drought. That can, if not over exploited, be beneficial to both farmers in saving their livestock and also help the University in reducing the risk of grass fires as well as generating good public relations with their neighbours. On the other hand, if the facility is over exploited that could lead to untold suffering to wildlife especially rodents and ungulates. The current level of wildlife protection should be enhanced by maintaining a permanent presence of game scouts in the area rather than the current occasional patrols. With expected increase in human population in the vicinity incidences of conflicts between human and wildlife interests will be bound to increase and the possibilites of wildlife harassment will be on the rise. Chain-link fencing is highly recommended.

While carrying out field work health precautions should be taken. All wild rodents especially *Mastomys, Tatera* and *Xerus* are potentially dangerous carriers of the plague bacterium *Yersinia (pasturella) pestis* that can be transmitted to human beings through the intermediary of fleas which occur on those animals. There is also Tuleremia which is a bacterial disease, primarily of lagomorphs, that can be transmitted to humans by arthropods or by eating or handling infected animals. Other diseases such as Murine typus, Lassa fever, Salmonellosis, Toxoplasmosis and the Rift Valley Fever can also be transmitted via arthropod bites.

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