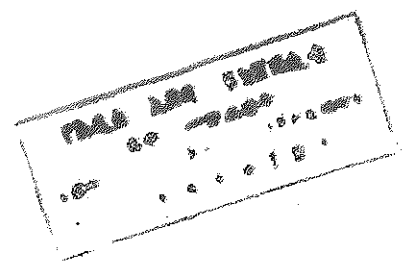


DISTRIBUTION AND RELATIVE ABUNDANCE OF THE AFRICAN GRASS
RAT, *Arvicanthis dembeensis*, AMONG SELECTED HABITAT TYPES OF THE
KOKA REGION, CENTRAL ETHIOPIA



A Thesis

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By
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CONTENTS

	Page
Acknowledgements.....	i
Contents.....	ii
List of tables.....	iii
List of figures.....	iv
Abstract.....	v
1. Introduction.....	1
2. Study area.....	7
3. Materials and Methods.....	10
4. Results.....	16
4.1 Diversity of the small mammals captured.....	16
4.2 Relative abundance, age and sex distribution of the different small mammals captured.....	16
4.3 Reproductive activity	18
4.4 Body measurements.....	18
4.5 Distribution of catches among the sites.....	31
4.6 Statistical analyses.....	35
5. Discussion.....	40
6. List of references.....	50
7. Appendix.....	56

LIST OF TABLES

		Page
Table 1.	Habitat description of each trapping site in the dry seasons.....	14
Table 2.	Number of small mammals caught in each season.....	17
Table 3.	Range and mean weight (g) of <i>Arvicanthis</i> in each site during the 1st dry season.....	28
Table 4.	Range and mean weight (g) of <i>Arvicanthis</i> in each site during the 2nd dry season.....	29
Table 5.	Range and mean weight (g) of <i>Arvicanthis</i> in each site during the wet season.....	30
Table 6.	Range and mean head and body length (mm) of <i>Arvicanthis</i> during the 1 st dry season.	32
Table 7.	Range and mean head and body length (mm) of <i>Arvicanthis</i> during the 2 nd dry season.....	33
Table 8.	Range and mean head and body length (mm) of <i>Arvicanthis</i> in each site during the wet season	34
Table 9.	Total number of <i>Arvicanthis</i> and <i>Mastomys</i> caught during the dry seasons.....	36
Table 10.	Total number of <i>Arvicanthis</i> and <i>Mastomys</i> caught during the wet season.....	37

LIST OF FIGURES

	Page
Figure 1. Climate of the study area during the study period.....	8
Figure 2. Map of the study area.....	9
Figure 3. Placement of traps within the sites.....	11
Figure 4. Sex distribution of <i>Arvicanthis</i> during the dry seasons.....	20
Figure 5. Sex distribution of <i>Arvicanthis</i> during the wet season.....	21
Figure 6. Sex distributions of <i>Mastomys</i> during the dry seasons.....	22
Figure 7. Sex distribution of <i>Mastomys</i> during the wet season	23
Figure 8. Age distribution of <i>Arvicanthis</i> during the dry seasons.....	24
Figure 9. Age distribution of <i>Arvicanthis</i> during the wet season.....	25
Figure 10. Number of reproductively active and quiescent <i>Arvicanthis</i>	26
Figure 11. Number of reproductively active and quiescent <i>Mastomys</i>	27
Figure 12. Daily catches of each site used in the C.D. analyses (Dry seasons).....	38
Figure 13. Daily catches of each site used in the C.D. analyses (wet season).....	39

ABSTRACT

Data was collected on the distribution and relative abundance of *Arvicanthis dembeensis* among selected habitat types in the Koka region, central Ethiopia.

Fifteen habitat types were selected to be study sites. The selection was made with reference to vegetation density, height, and species composition.

A total of 365 small mammals which belong to two orders, Rodentia and Insectivora, were captured. The rodent species were; *Arvicanthis dembeensis*, *Mastomys erythroleucus*, *Tatera robusta* and *Rattus rattus*. There was only one insectivore species- *Crocidura olivieri*.

The catch distribution was compared using a two way ANOVA ($P=0.05$). The result showed that the catch records among the selected habitat types were significantly different. A critical difference (C.D.) analysis was conducted to rank the sites and it was observed that habitats with moderate vegetation cover had high catch values while very dense bushes and totally open fields were less inhabited.

The observed difference in the catch distribution among the sampling sites is discussed on the basis of habitat preference particularly with emphasis to the importance of vegetation cover in the habitat use of *Arvicanthis*.

1. INTRODUCTION

It is estimated that 5000 species of mammals exist all over the world. Of these, 2000 are rodents. This makes 40% of the entire group (Meehan, 1984). Rodents are the most diverse groups among mammals. They exhibit a wide array of morphological forms. Most rodent species are known for their troublesome nature to man. They consume food meant for human consumption, destroy infrastructures and spread diseases (Leirs, 1995; Rosevear, 1969 and Weber, 1982). Man has tried every available means to minimize the damage caused by rodents. Different types of traps, poisons, barriers, repellents and predators have been tried. In spite of all these, rodents have continued the damage (Leirs, 1995). With the advancement of technology and better understanding of the biology of rodents, the fight has continued. The concern is particularly high in the developing countries where many people die from starvation because of shortage of food production. To make things worse, rodents avail themselves to take their share. Recently, the biological method of pest control is getting more popularity. The success of the method depends on the knowledge of the ecology of rodents. It is towards this end that the present study tries to make a contribution.

Arvicanthis (Rodentia, Muridae) is a genus distributed in Africa south of the Sahara all the way from Senegal to Somalia, and along the Nile basin down from Egypt to Tanzania (Delany and Monro, 1986). *Arvicanthis* commonly weighs from 50-150 g. Specimens which weigh 200 g were also recorded (results in the present study). The genus is an

important agricultural pest and disease carrier. The extent of damage caused to agricultural products however, is not well documented (Buckle & Smith, 1994). Many authors identify the genus as herbivorous and diurnal (Neal, 1970; Delany, 1964b and Cheeseman, 1977). However, observations have shown that animal matter, particularly insects, are included in the diet (Sicard *et al.*, 1994 and Rabiou & Fisher, 1989). *Arvicanthis* reaches sexual maturity within 36-50 days (Delany & Monro, 1985a). Some authors, however, reported a period of 3-4 months for the young to become sexually matured (Ghobriel & Hodiab, 1982). The genus exhibits remarkable physical variation with regard to body size, coat color and size of skull bones (Neal, 1981). But, commonly it has agouti coat colour (Yalden *et al.*, 1976).

The systematics of the genus is controversial. It has been presenting a formidable challenge to researchers. There has been an oscillation in the number of taxa recognized for the genus. Allen (1939), for example, recognized 37 forms out of the then identified 6 species. Nevertheless, he did not try to determine the exact taxonomic status of these forms (i.e as distinct species or subspecies). Then, Missonne (1971) drastically reduced the number of species into one. According to Missonne, there is only one species, *Arvicanthis niloticus*, representing the genus. Later, Yalden *et al.*, (1976) recognized 5 species (*A. niloticus*, *A. blicki*, *A. abyssinicus*, *A. dembeensis* and *A. somalicus*). Honacki *et al.*, (1982) reduced the number of species into one once again, recognizing only *A. niloticus*. Musser and Carleton (1993) identified 5 species. But this time they denied *A. dembeensis* its status as a distinct species and lumped it with *A. niloticus*. They recognized *A. nirobae* instead.

The taxonomic revision had been concentrated on *A. niloticus*, a species which represents the genus in most of its ranges. A number of cytological, karyotypic, and morphometric studies have been made to review the taxonomic status of different populations which are grouped under this species (Cappana & Civitelli, 1988; Volobouev *et al.*, 1988; Rousseau 1983 and Ducroz *et al.*, 1997). The results point out that the different populations studied from various localities are distinctly different groups. Consequently their taxonomic status is suggested to be up dated into a rank of a species or subspecies.

In Ethiopia, the presence of 4 species was reported by Yalden *et al.*, (1976). *A. somalicus* and *A. dembeensis* are low altitude species (0-2000m a.s.l.). *A. abyssinicus* occurs at medium altitudes (2000-3400m a.s.l.) While *A. blicki* occurs at higher altitudes (3400-4300m a.s.l.) (Corti & Fadda, 1996). Volobouev *et al.*, (1988) add a fifth species, *A. niloticus*, to the Omo river valley in the south western part of the country. Quite a number of studies on the systematics of the genus have been made in Ethiopia. The studies used various approaches; morphometrics (Afeework Bekele *et al.*, 1993 and Corti and Fadda, 1996), cytogenetics (Corti *et al.*, 1996) and multi disciplinary (Cappana *et al.*, 1996). The study outcomes confirm that the various species recognized for the region are distinct species. *A. abyssinicus* and *A. blicki* have closer genetic relationship although they exhibit wide karyotypic differences (n=62 and 48 respectively). They show remarkable morphological differences which are reflections of their adaptation to different altitudes.

beginning of the dry season; when food and water is plenty (Fisher, 1991; Ghobriel & Hodiab, 1982 and Delany, 1964a). The same observation was made in different populations of *Mastomys* (Neal, 1977; Coetzee, 1965; Chapman *et al.*, 1959 and Chidumayo, 1980) and in other different African murid rodents (Okia, 1973; Neal, 1986; Southern & Oliver, 1963; Happold, 1974 and Perrin *et al.*, 1992). However, some studies like those made in Ethiopia and Burkina Faso reported quite the reverse (Muller, 1977 and Sicard *et al.*, 1994) where *Arvicanthis* bred only in the dry season.

The genus is commonly called the grass rat. The naming has to do with its natural habitat use. *Arvicanthis* is mostly found in the savannas and grasslands of Africa. Except for very few studies, nothing else has been done to understand its distribution and relative abundance in specific habitat types. The present study is designed to contribute to existing knowledge in this regard. The study tried to collect data on the spatial distribution and relative abundance of one of the low land species, *Arvicanthis dembeensis*, in selected habitat types of the Koka region, central Ethiopia.

Mastomys erythroleucus, a widely distributed and agriculturally important pest (Leirs *et al.*, 1990; Leirs *et al.*, 1993 and Swanepoel, 1980), which was also present in the study area with *Arvicanthis* has also been studied using similar procedure and the data is presented in the text for comparison.

The present study is aimed to describe the distribution and relative abundance of *Arvicanthis* in selected habitat types in a protected dairy farm compound located in the Koka region, central Ethiopia. An account is given to explain the observed catch distributions based on habitat preference.

The study is believed to provide basic information on the habitat use of *Arvicanthis* and as such will serve as a spring board for further studies.

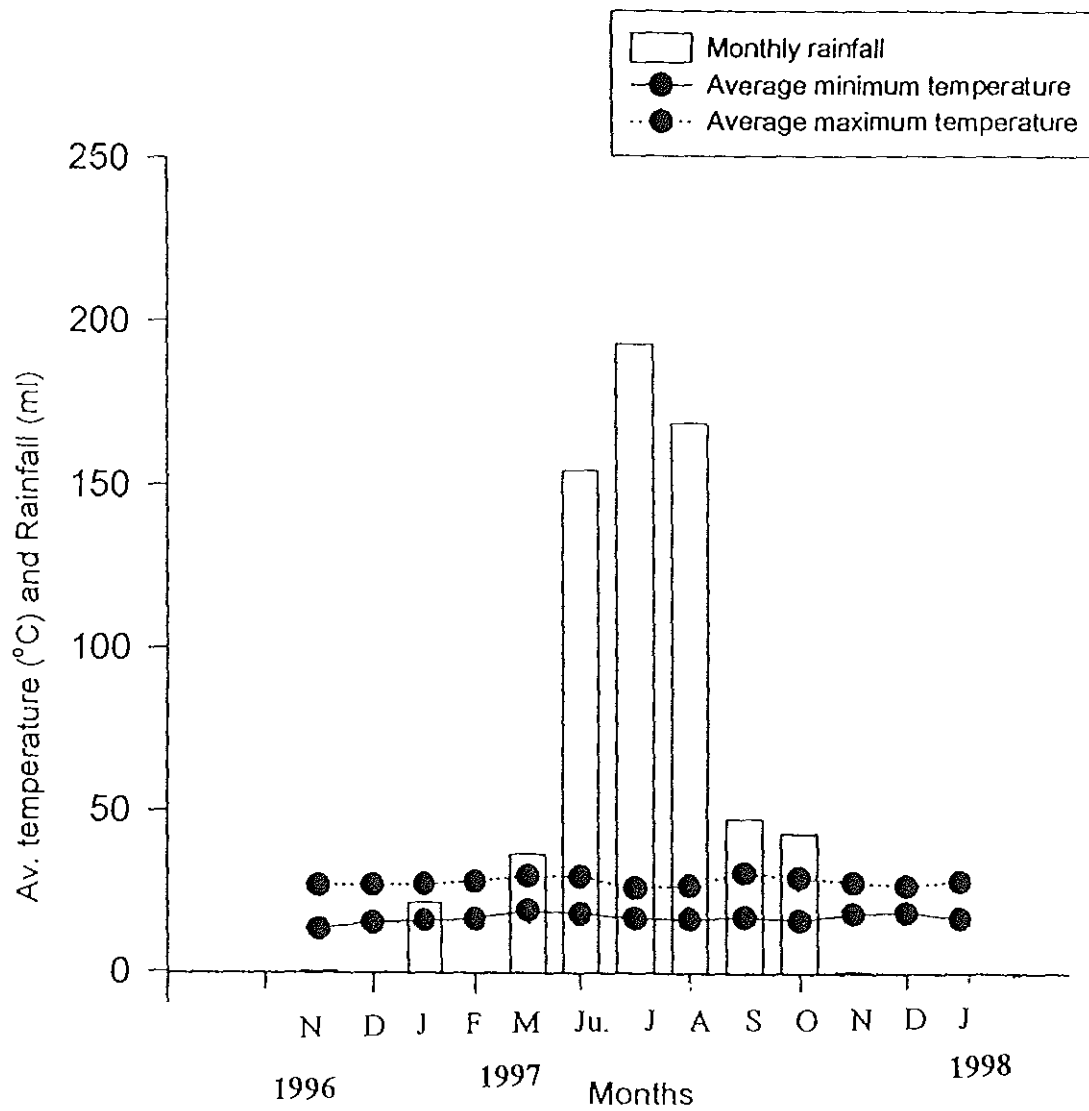


Figure 1. Climate of the study area during the study period

3. MATERIALS AND METHODS

Fifteen habitat types were selected for trapping. They mainly differed in their: ground and aerial vegetation cover and plant species composition. Each site was separated at least with a distance of 100 m to avoid edge effect. The 15 sites were given alphabetical names ('A' to 'O').

Trapping was carried out from February 1997 to February 1998 on a six month interval. The first trapping was conducted on February 1997 and the second on August 1997 and finally the 3rd between January and February 1998. The Jan./ Feb. Trapping fall in the dry season while the August was in the wet season. Consequently, the February 1997 trapping was also identified as the 1st dry season, the Jan./ Feb. 1998 trapping as the 2nd dry season and the August 1997 as the wet season.

Traps were set on four trapping lines. Each trapping line had four trapping stations at 3 m intervals. Hence, a total of 16 trap stations were established in each site Fig 3.

Victor Holdfast mouse traps were used. They were set in the late afternoon (3:00-4:00 pm) and left in the field for three consecutive days and nights. Peanut butter was used as bait

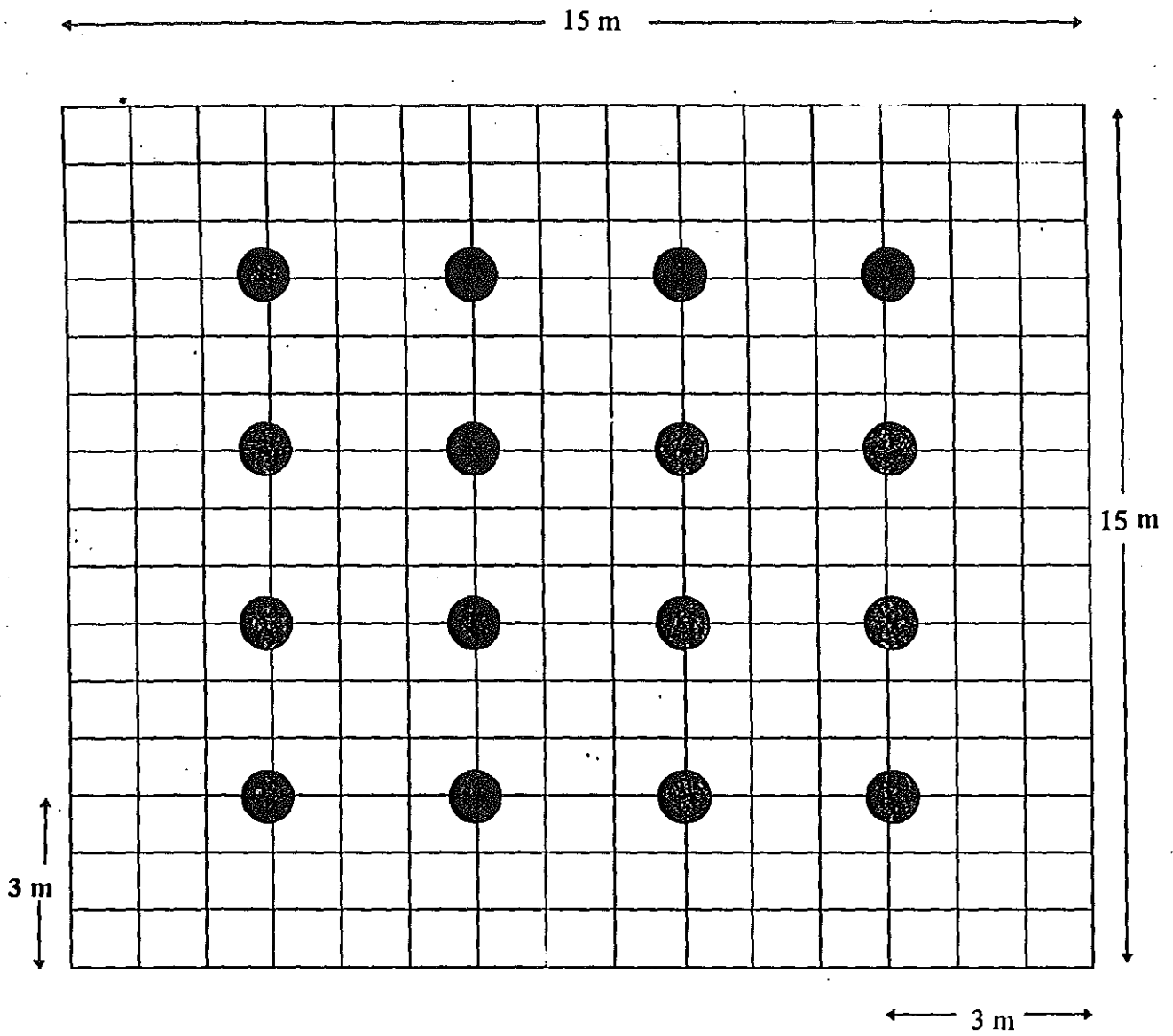


Figure 3. Placement of traps within the sites.

The captured specimens were retrieved early in the morning (6:00 - 8:00 am) and late in the afternoon (4:30-6:00 pm). The bait was renewed when necessary.

The rats were sexed, measured, and weighed. Measurements included lengths of head and body, ear, tail, and hind foot. The vagina was examined and classified as perforate or closed. The nipples were categorized as small or lactate. The uteri were examined and identified as filiform (if not vascularized at all), normal (if poorly vascularized), oestrus (if highly vascularized), and pregnant (if implanted embryos were present). Implanted embryos were counted and measured. The testes were classified as scrotal or abdominal, the epididymal tubules as visible or non-visible, the seminal vesicle as large or small. The length of the testes was also recorded.

The dominant species, *Arvicanthis dembeensis* and *Mastomys erythroleucus* were categorized into different age groups based on their body weight. *Arvicanthis* specimens that weighed <26 g were classified as juveniles, those between 27 and 60 g as subadults, and those >60 g were classified as adults. *Mastomys* specimens weighing more than 45 g (females) and 50 g (males) were considered as adults. The age group demarcation also considered reproductive parameters (Taylor & Green, 1976). Females with pregnant or oestrus uteri, visible placental scars and lactating nipples were identified as reproductively active while those with filiform or normal uteri and small nipples were considered quiescent. Males with scrotal testes, large seminal vesicle, and visible epididymal tubules were taken as active while those with abdominal testes, non-visible epididymal tube and

small seminal vesicle were taken as quiescent.

Habitat description of the study sites was made qualitatively. Everything observed in the habitats was described during the trapping process. A brief description of the 15 sites is given in Table 1.

Major plant species found in each site were collected and identified to the species level by a staff member of the National Herbarium, Biology Department, Addis Ababa University. See appendix for the list.

The total number of catches, the sex distribution and body measurements were compared using two way ANOVA both among the 15 sites. The catch records of each site within each day of the three-day trapping sessions were used in the analysis. For the purpose of ranking the sites based on catch records, Critical Difference (C.D.) analysis was conducted. The mean values of the catches were compared and accordingly those with significant differences were categorized in different groups.

Table 1. Habitat description of each site in the dry seasons

SITES	DESCRIPTION
A	Thick bushes, about 1.5m high, dominated by sisal plants (<i>Agavae sisalina</i>) and other shrubs and scrubs. The ground cover with in the range of 1-20 cm height was scanty. The bush was continuous on both right and left hand side while the back and the front sides were open grass fields.
B	Thick bush, about 1.75m high, entirely dominated by <i>Achyranthus aspera</i> . The ground was dark and well covered by the bush. However, there was no ground vegetation in the form of hedges and grass strips. Almost at the center of the site there was a big Ficus tree whose branches shade the entire site. The very ground is covered with dried, broad leaves which fall down from the Ficus tree.
C	Relatively open bush, about 1m high, with well covered ground by dried grasses, about 30 cm high. It was dominated by <i>Solanum</i> spp. The front and back sides were fairly open while left and right sides were continuous about 10m on both sides.
D	Extremely dense bush, about 2m high. It was composed of a number of shrub, scrub and grass species. The ground too was very thick and dark. On each of its four corners it was surrounded by fields of cut grasses. Consequently, it appeared like an island of thick bush.
E	Had fairly thick ground cover, about 40cm high, provided by dried grasses. It was full of dried unbranched, leafless Castor oil trees (2.3m high). However, they didn't provide any good aerial cover.
F	Except its species composition, it had quite similar vegetation structure with site B. The ground being devoid of any growth but only dried fallen leaves. It was surrounded by acacia trees (about 4m high) and bushes (about 1.5m high). It was just part of an extensive bush system composed of shrubs and scrubs.

G	A fallow land with bare ground. There were only few individuals of a kind of herb species. It was well exposed.
H	Totally covered with grasses. However, the grass cover was fairly spaced. The aerial cover was non-existent. The total vegetation canopy was about 70cm high.
I	An open field similar to site G. The ground was covered with sand grains. Some stations, however, were fairly shaded with grasses (about 60cm high) which form a nest like harbour. Further out side of the site, along these fairly shaded stations, there was a dense bush. Opposite to this end of the site there was a pile of harvested waste of maize.
J	It was part of an extensive acacia bush. The average height of the vertical growth was 2.5m. The ground was covered with dense grasses where ever there was an acacia tree. But on those spots where the acacia trees were not present, the ground was bare.
K	Extremely thick bush dominated by very tall grasses (about 2m high). Both the ground and aerial cover were provided by the grasses. There were also orange trees which bore fruits (about 3m high)
L	Dominated by the grass which was also found in site K. But the thickness was reduced in L. The aerial cover was very thick which was made by reed plants.
M	It was a harvested maize field composed of dried, falling maize plants and grasses. The ground was covered by these dried grasses and maize plants. The aerial cover was very poor.
N	An open field of cut grasses. No ground or aerial cover was present.
O	Quite similar with site B both with regard to vegetation structure and species composition. However, the Ficus trees were absent in O.

4. RESULTS

4.1 Diversity of the small mammals captured

Four rodent and one shrew species were caught in the entire trapping sessions. These were: *Arvicanthis dembeensis*, *Mastomys erythroleucus*, *Tatera robusta*, *Rattus rattus* and *Crocidura olivieri*, respectively. *Arvicanthis dembeensis* and *Mastomys erythroleucus* were by far the most abundant species. *Tatera robusta* and *Crocidura olivieri* were caught occasionally while *Rattus rattus* was captured very rarely.

4.2 Relative abundance, age and sex distribution of the different small mammals captured

A total of 365 small mammals were caught. Of these 174 were *Mastomys erythroleucus*, 161 *Arvicanthis dembeensis*, 17 *Tatera robusta*, 9 *Crocidura olivieri* and 4 *Rattus rattus*. One hundred and eighty six (50.9%) animals were caught in the 1st dry season, 99 (27.1%) in the 2nd dry season and 80 (21.9%) in the wet season (Table 2). The captured specimens were grouped into their sex categories except the damaged ones. In the 1st dry season, 57 male (30.1%) and 41 female (21.5%) *A. dembeensis*, and 38 male (20.4%) and 24 female (12.9%) *M. erythroleucus* were caught. In the 2nd dry season, 12 male (12.1%) and 25 female (25.3%) *A. dembeensis*, and 13 male (13.1%) and 8 female (8.1%) *M. erythroleucus* were captured. In the wet season, 10 male (12.5%) and 9 female (11.25%) *A. dembeensis*, and 32 male (40.0%) and 17 female (21.25%) *M. erythroleucus* were captured (Figs. 4-7). *Arvicanthis* specimens, whose age could be estimated from their weight and reproductive organs have been categorized into different age groups.

Table 2. Number of small mammals caught in each season

Species	1 st dry season	2 nd dry season	Wet season
<i>Arvicanthis</i>	98	43	20
<i>Mastomys</i>	78	41	55
<i>Tatera</i>	2	11	4
<i>Crocidura</i>	6	3	-
<i>Rattus</i>	2	1	1
Total	186	99	80

Out of these, 56 (57.1%) were adult males, 41 (41.8%) adult females and 1 (1.0%) subadult male (1st dry season). In the 2nd dry season, the figure was 12 (27.9%) adult males, 24 (55.8%) adult females and 1 (2.3%) subadult female. In the wet season, 8 (40.0%) adult males, 9 (45.0%) adult females and 2 (10.0%) subadult males were recorded. No juvenile was caught in all the trapping periods (Figs. 8 & 9).

4.3 Reproductive activity

The captured specimens were categorized into different reproductive groups. In *Arvicanthis*, 8 (19.5%) females & 11(19.3%) males were sexually active and 31(75.6%) females & 38 (66.6%) males were quiescent (1st dry season). In the 2nd dry season, 5 (20.0%) females & 6 (50.0%) males were sexually active while 17(68.0%) females & 6 (50.0%) males were quiescent. During the wet season, 9 (100%) females & 7 (70.0%) males were sexually active and 3 (30%) was quiescent. During this season, no quiescent female was observed. In *Mastomys*, 18 (75.0%) females & 15 (39.5%) males were quiescent during the 1st dry season. No active female was caught during this time while 15 males (39.5%) were active. In the wet season, 4 (23.5%) females & 28 (87.5%) males were active while 8 (47.1%) females were quiescent. No quiescent male was caught during this period (Figs. 10 & 11).

4.4 Body measurements

In the 1st dry season, the heaviest individual among the *Arvicanthis* specimens was 200 g while the smallest was 54 g. Both of these specimens were males. The average weight for

females and males was 102.2 and 111.7 g respectively. In the 2nd dry season, the heaviest weight was 187 g while the smallest was 76 g. These were a male and a female respectively. During this season, the mean body weight for females was 118.7 g and for males, it was 121.3 g (Tables 3 & 4). In the wet season, the biggest specimen weighed 181 g while the smallest 78 g where the heaviest was a female while the smallest was a male. Females weighed 138.3 g on the average while males weighed 147.3 g (Table 5). Males weighed more than females in all the seasons on the average, however, the differences were insignificant ($p > 0.05$). However, the rats weighed significantly more in the wet season than in the dry season ($p < 0.05$) Tables 6-8 give the range and the mean head and body length of *Arvicanthis* for both the seasons. No significant ($p > 0.05$) size difference was observed both among the sexes and the seasons.

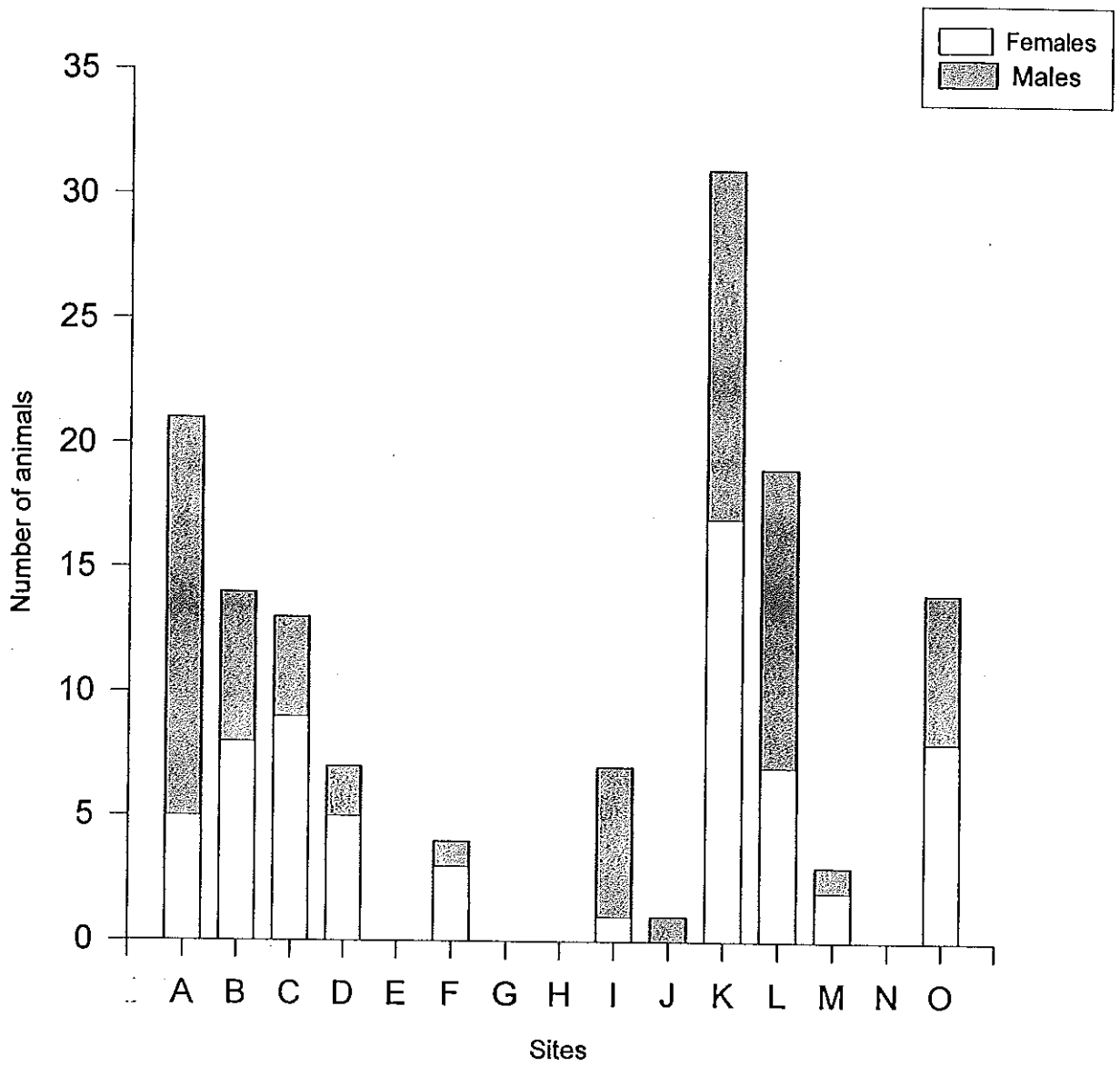


Figure 4. Sex distribution of *Arvicantthis* during the dry seasons

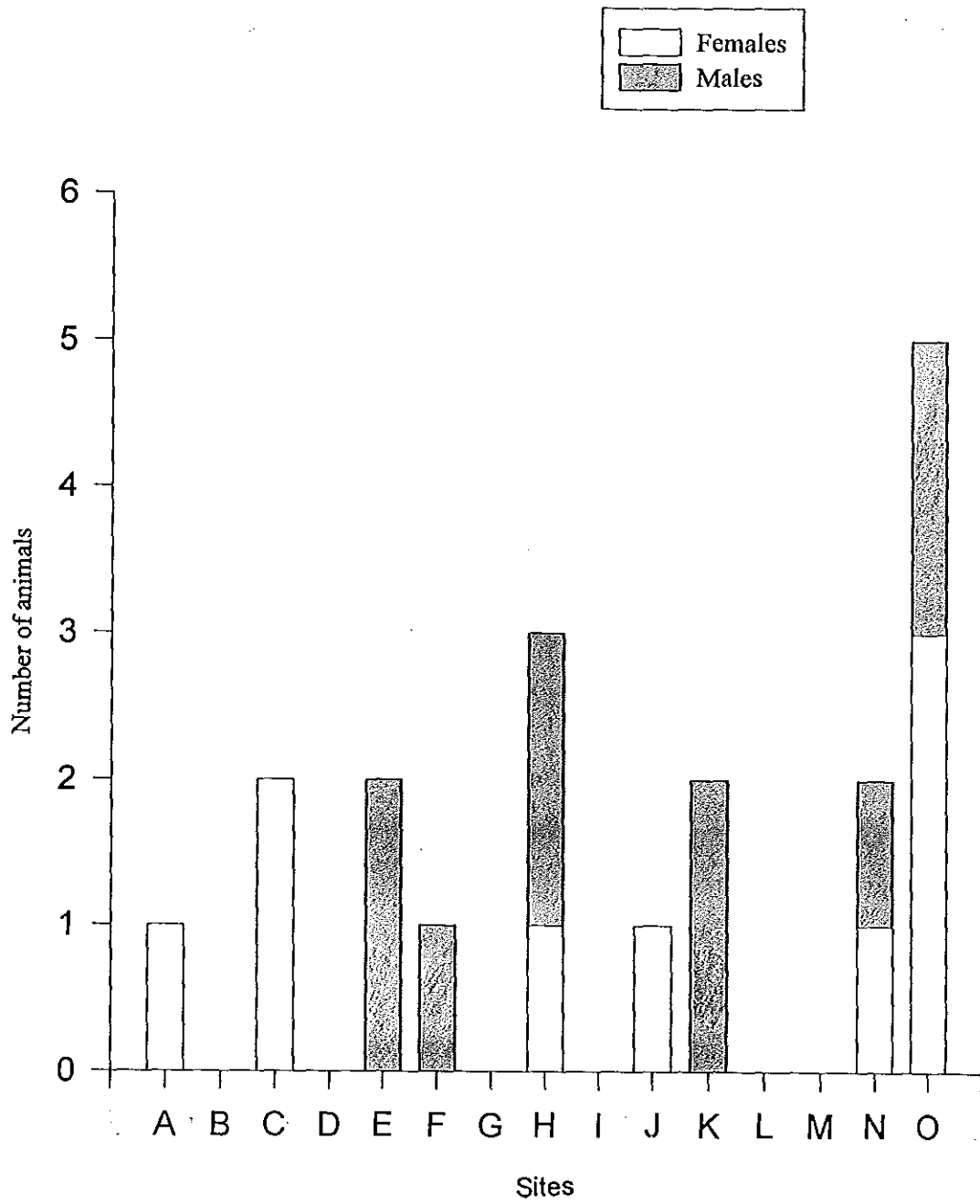


Figure 5. Sex distribution of *Arvicantis* during the wet season

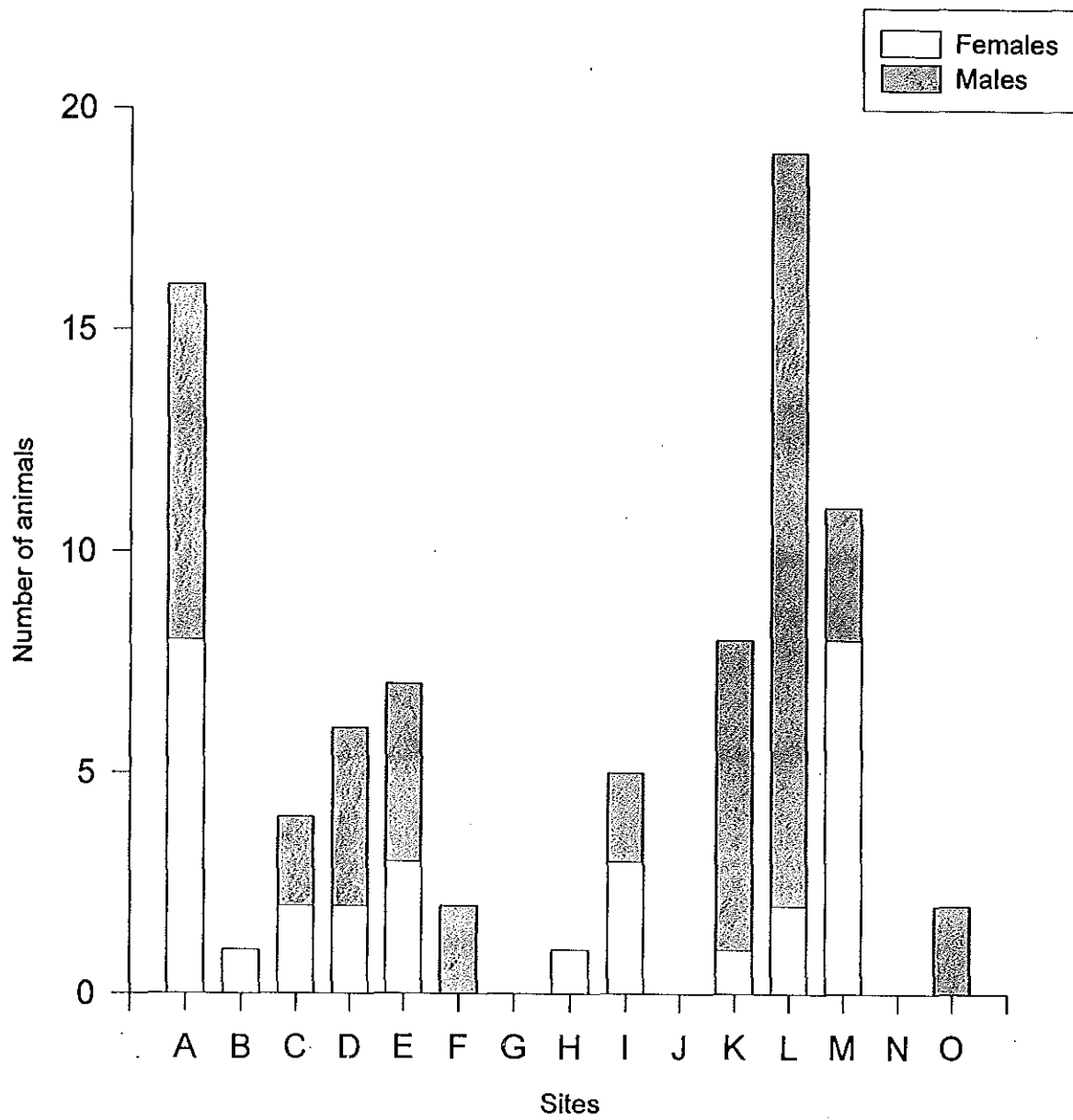


Figure 6. Sex distribution of *Mastomys* during the dry seasons

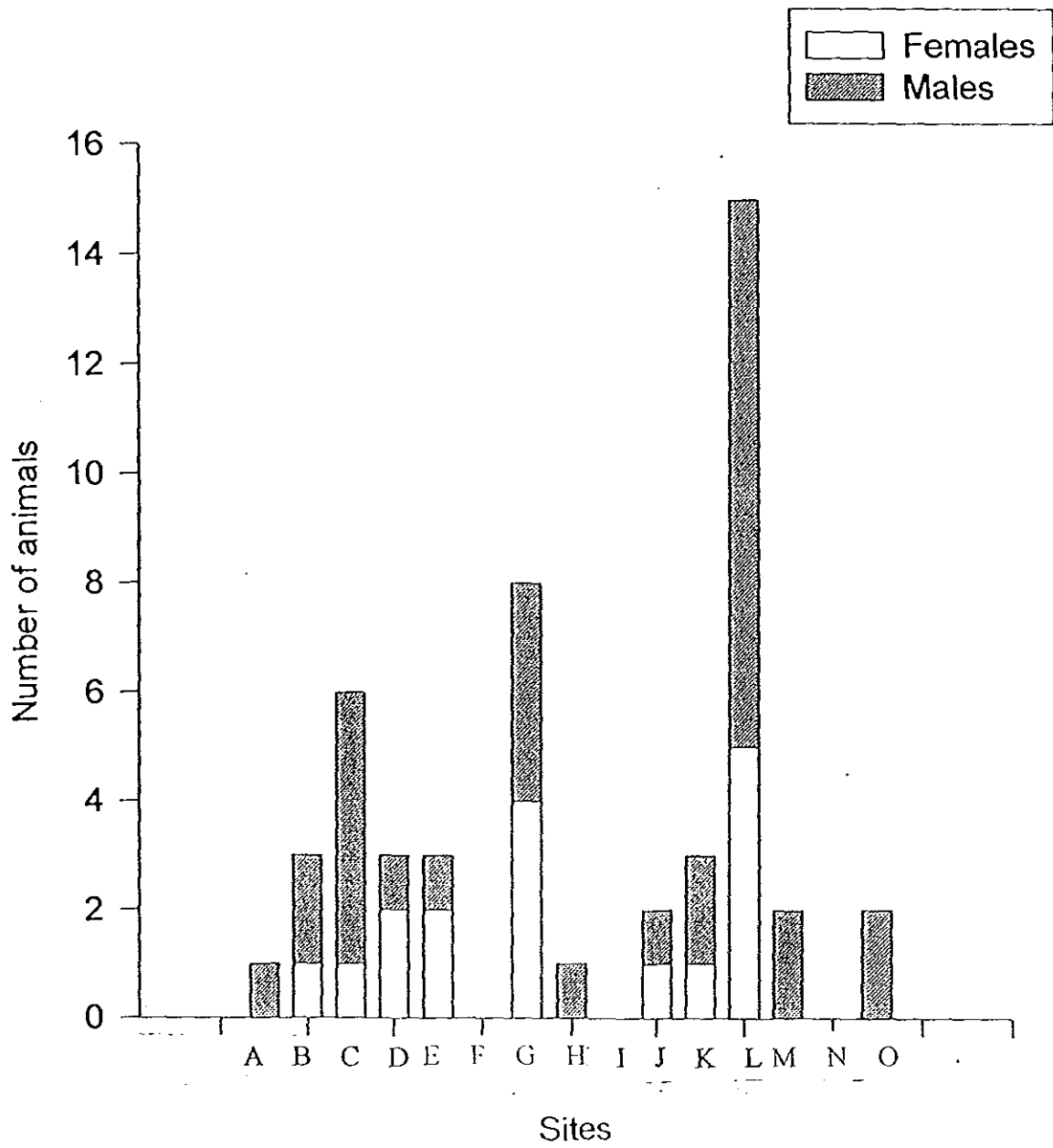


Figure 7. Sex distribution of *Mastomys* during the wet season.

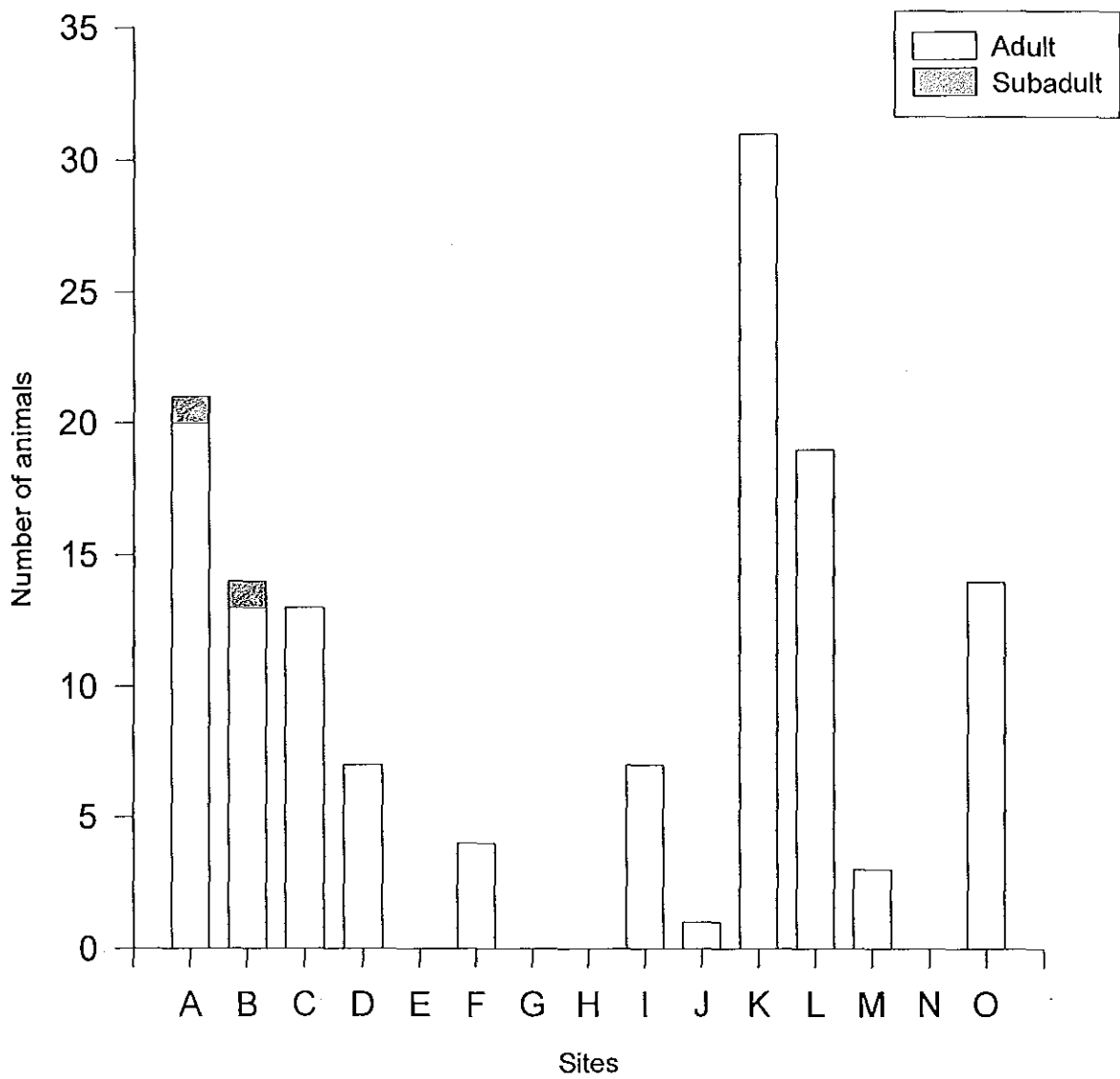


Figure 8. Age distribution of *Arvicantthis* during the dry seasons

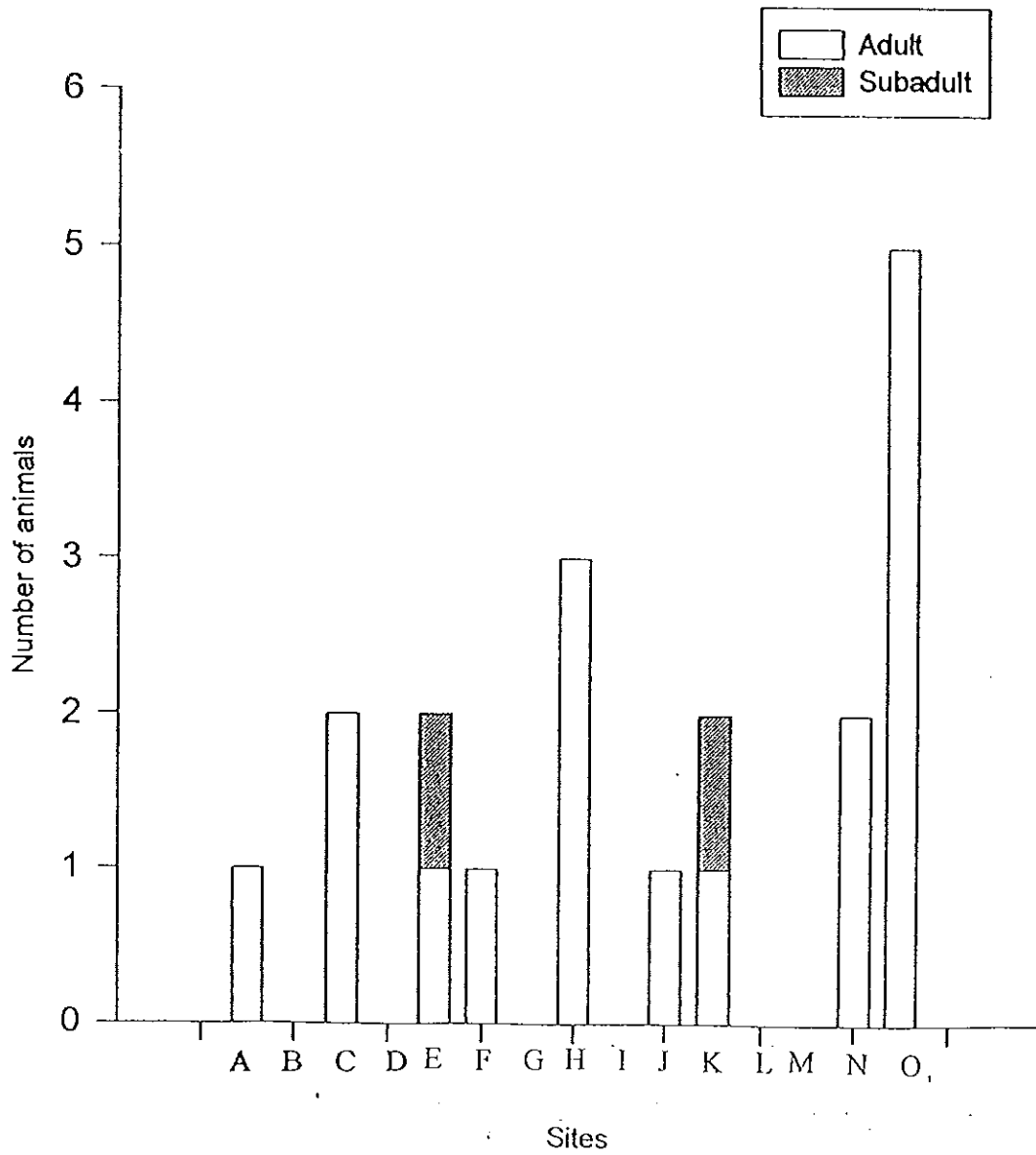


Figure 9. Age distribution of *Arvicantis* during the wet season

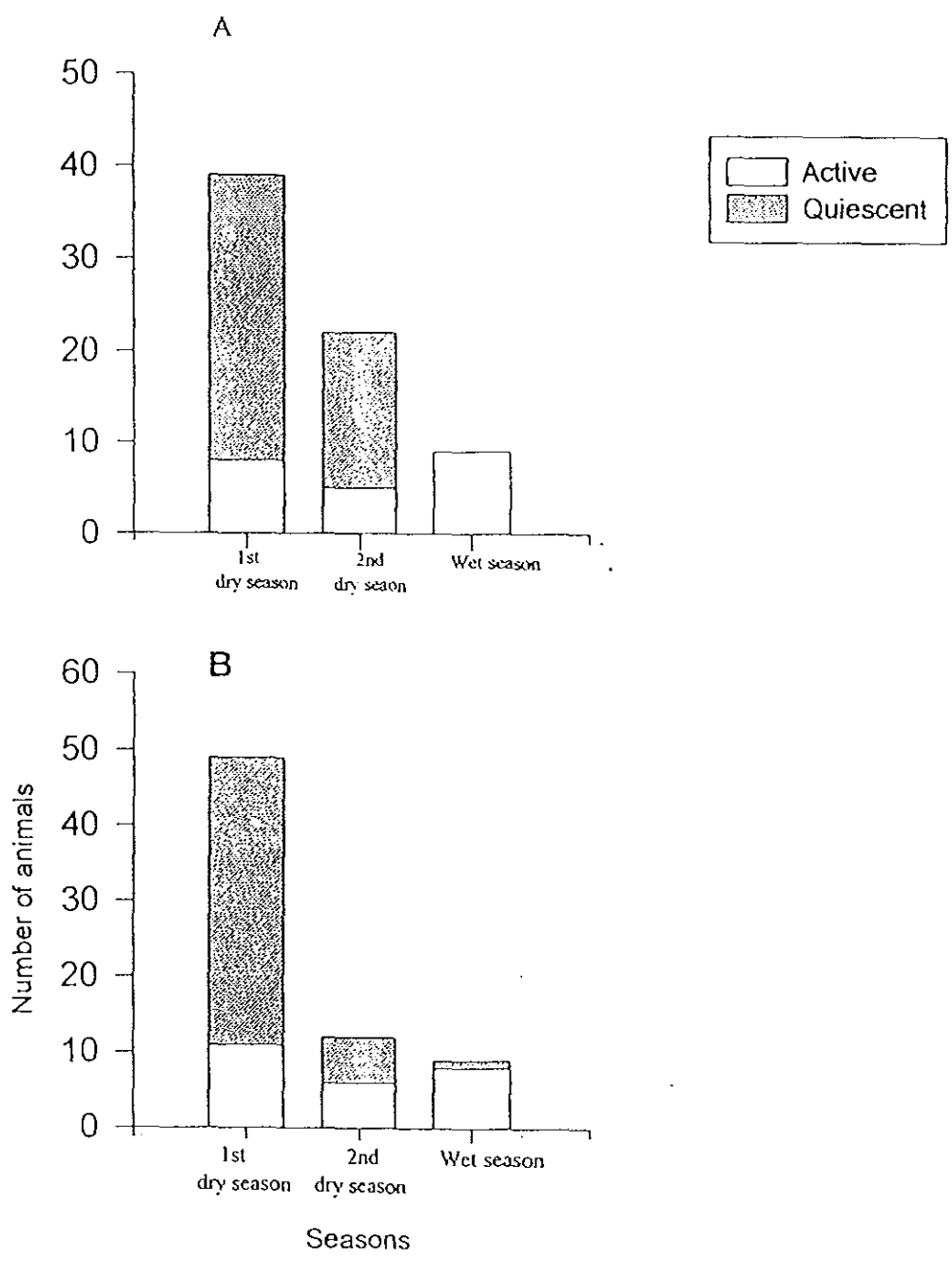


Figure 10. Number of reproductively active and quiescent *Arvicanthis* - females (A) and males (B)

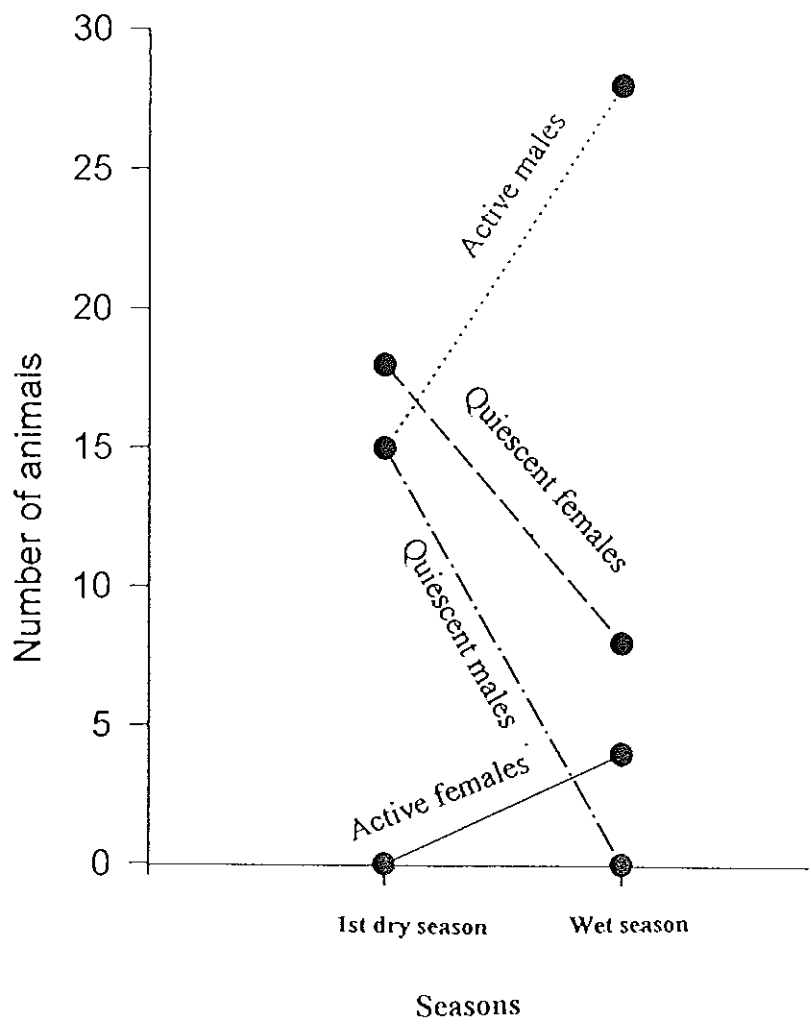


Figure 11. Sexually active and quiescent *Mastomys*.

Table 3. Range and mean weight (g) of *Arvicanthis* in each site during the 1st dry season

Sites	Range		Mean	
	Females	Males	Females	Males
A	97-121	54-153	89.7	116.6
B	97-121	115-147	109.0	126.0
C	92-130	68-150	99.6	139.0
D	120*	102-110	120.0	106.0
E	-	-	-	-
F	116-140	-	128.0	-
G	-	-	-	-
H	-	-	-	-
I	98*	106-150	98.0	121.2
J	-	70*	-	70.0
K	88-129	77-162	101.1	108.0
L	78-155	72-200	107.4	134.7
M	78-81	88*	79.5	88.0
N	-	-	-	-
O	60-112	70-130	89.5	107.3

* Only a single specimen was considered

Table 4. Range and mean weight (g) of *Arvicanthis* in each site during the 2nd dry season

Sites	Range		Mean	
	Females	Males	Females	Males
A	96-106	122*	101.0	122.0
B	143-160	101-168	151.7	124.0
C	116*	118-187	116.0	141.7
D	102-156	-	119.5	-
E	-	-	-	-
F	114*	123*	114.0	123.0
G	-	-	-	-
H	-	-	-	-
I	76*	-	76.0	-
J	-	-	-	-
K	106-130	82-148	116.2	117.3
L	155*	100*	155.0	100.0
M	-	-	-	-
N	-	-	-	-
O [#]				

* Only one specimen was considered

Not trapped during the season

Table 5. Range and mean weight (g) of *Arvicantthis* in each site during the wet season

Sites	Range		Mean	
	Females	Males	Females	Males
A	98-106	128*	102.0	128.0
B	-	-	-	-
C	150-165	-	157.5	-
D	-	-	-	-
E	-	178*	-	178.0
F	-	169*	-	169.0
G	-	-	-	-
H	181*	179*	181.0	179.0
I	-	-	-	-
J	146*	-	146.0	-
K	-	78*	-	178.0
L	-	-	-	-
M	-	-	-	-
N	132*	169*	132.0	169.0
O	120-149	130*	135.0	130.0

* Only a single specimen was considered

4.5 Distribution of catches among the sites

Different catches were recorded from the 15 sites considered. During the dry seasons, more *Arvicanthis* was captured from site K (32 individuals). This makes 22.5% of the total catches of *Arvicanthis*. No small mammal was caught in sites G and N. For *Mastomys*, site L recorded the highest number (25 individuals). This comprises 21.0% of the total number of *Mastomys* caught in the season (Table 9).

The wet season catches were very low. For *Arvicanthis*, the maximum number of animals caught per site was only 5 (site O) which makes 25% of the catches of the season. During this same season, no *Arvicanthis* was captured from sites B, D, G, I, L and M (Table 13). Fifteen individuals of *Mastomys* were captured from site L during the season (27.3%) which represents the maximum catch for the season. On the other hand, no *Mastomys* was captured from sites F, I and N (Table 10).

Table 6. Range and mean head and body length (mm) of *Arvicanthis* during the 1st dry season

Sites	Range		Mean	
	Females	Males	Females	Males
A	136-141	115-167	139.0	138.8
B	130-136	145-159	133.0	149.3
C	140-158	130-165	150.0	147.5
D	143*	148-152	143.0	150.0
E	-	-	-	-
F	149-160	-	154.5	-
G	-	-	-	-
H	-	-	-	-
I	140*	140-165	140.0	138.0
J	-	115*	-	115.0
K	127-146	129-167	139.6	143.5
L	121-159	116-167	139.8	151.5
M	130*	138*	130.0	138.0
N	-	-	-	-
O	133-140	150-166	135.6	125.4

* Only one specimen was considered

Table 7. Range and mean head and body length (g) of *Arvicantis* during the 2nd dry season

Sites	Range		Mean	
	Females	Males	Females	Males
A	129-132	150*	130.5	150.0
B	100-172	143-160	146.4	149.3
C	154-159	142-173	156.5	155.7
D	135-161	-	144.0	-
E	-	-	-	-
F	130*	154*	130.0	154.0
G	-	-	-	-
H	-	-	-	-
I	135*	-	135.0	-
J	-	-	-	-
K	139-151	122-169	144.0	145.7
L	148-160	151*	154.0	151.0
M	-	-	-	-
N	-	-	-	-
O [#]				

* Only a single specimen was considered

Not trapped during the season

Table 8. Range and mean head and body length (mm) of *Arvicanthis* during the wet season

Sites	Range		Mean	
	Females	Males	Females	Males
A	140*	155*	140.0	155.0
B	-	-	-	-
C	154-175	-	164.5	-
D	-	-	-	-
E	-	165*	-	165.0
F	-	161*	-	161.0
G	-	-	-	-
H	164*	157-174	164.0	165.5
I	-	-	-	-
J	140*	-	140.0	-
K	-	95-160	-	127.5
L	-	-	-	-
M	-	-	-	-
N	156*	168*	156.0	168.0
O	140-153	156*	145.0	156.0

* Only a single specimen was considered

4.6 Statistical analyses

The dry season catches of *Arvicanthis* compared both among the sites and groups were significantly different ($p < 0.05$). The C.D. analysis showed that sites E, G, H, N and J recorded the lowest catches while K, A and L the highest (C.D. value of 0.95). More males were caught than females in both the seasons for both species but the difference was only significant for *Mastomys* in the wet season ($p < 0.05$). Sites G, H, J and N recorded the lowest catches while A, L and M, the highest for *Mastomys* in the dry seasons (C.D. 0.65). In the wet season, sites B, D, G, I, L and M recorded the lowest while site O alone recorded the highest catch for *Arvicanthis* (C.D. 0.34). For *Mastomys*, least capture was obtained on sites A, F, I, and N while the highest was on site L (C.D. 0.95) (Figs. 12 & 13).

Table 9. Total number of *Arvicanthis* and *Mastomys* caught during the dry seasons

Sites	<i>Arvicanthis</i>	<i>Mastomys</i>
A	21	21
B	14	4
C	13	6
D	8	10
E	1	8
F	5	3
G	-	-
H	-	1
I	8	6
J	1	1
K	32	12
L	21	25
M	3	20
N	-	-
O	14	2
Total	141	119

Table 10. Total number of *Arvicanthis* and *Mastomys* caught during the wet season

Sites	<i>Arvicanthis</i>	<i>Mastomys</i>
A	1	1
B	-	3
C	2	7
D	-	3
E	2	3
F	2	-
G	-	15
H	3	2
I	-	-
J	1	2
K	2	3
L	-	11
M	-	2
N	2	-
O	5	3
Total	20	55

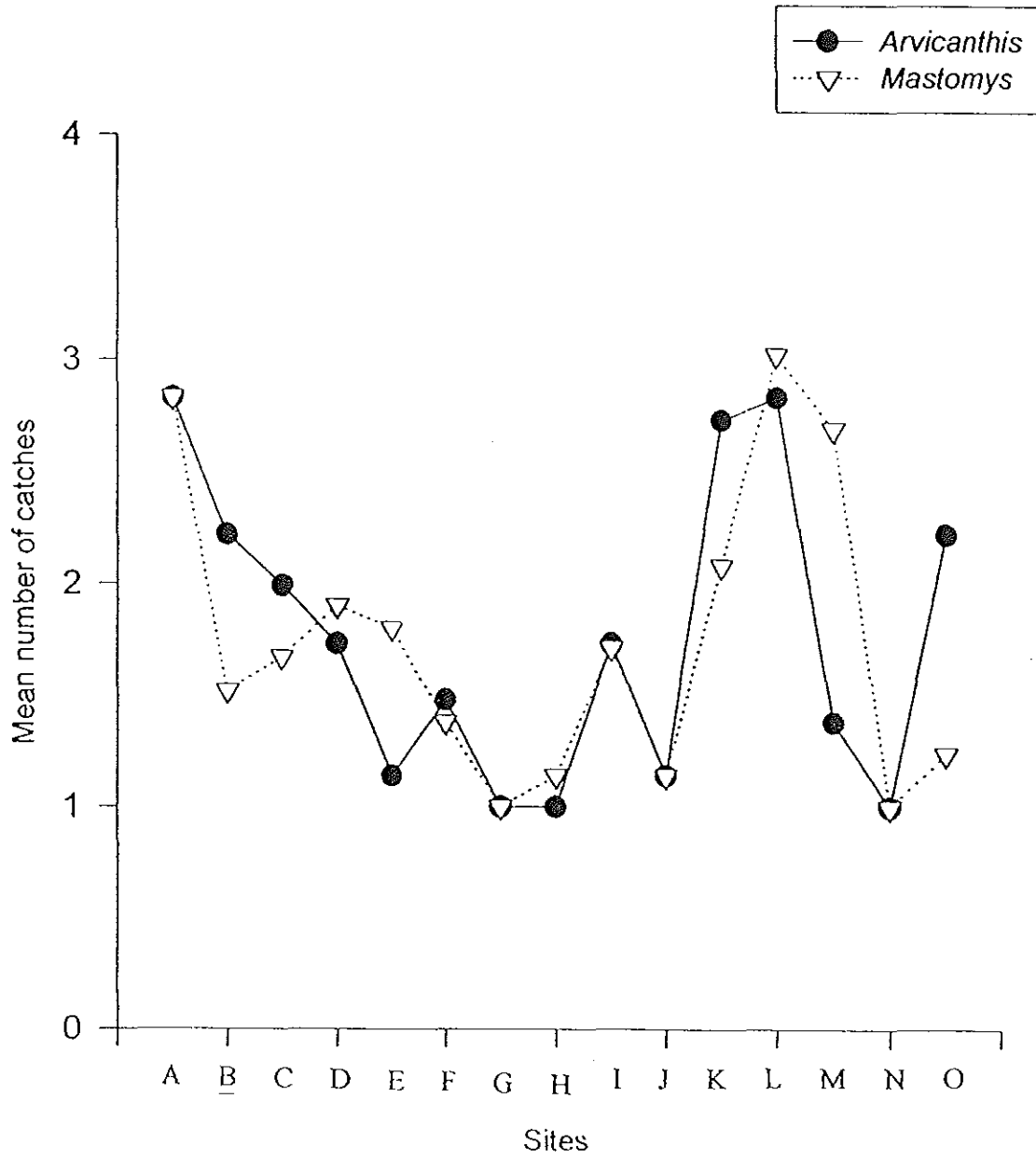


Figure 12. Daily catches of each site used in the statistical analysis (dry seasons)

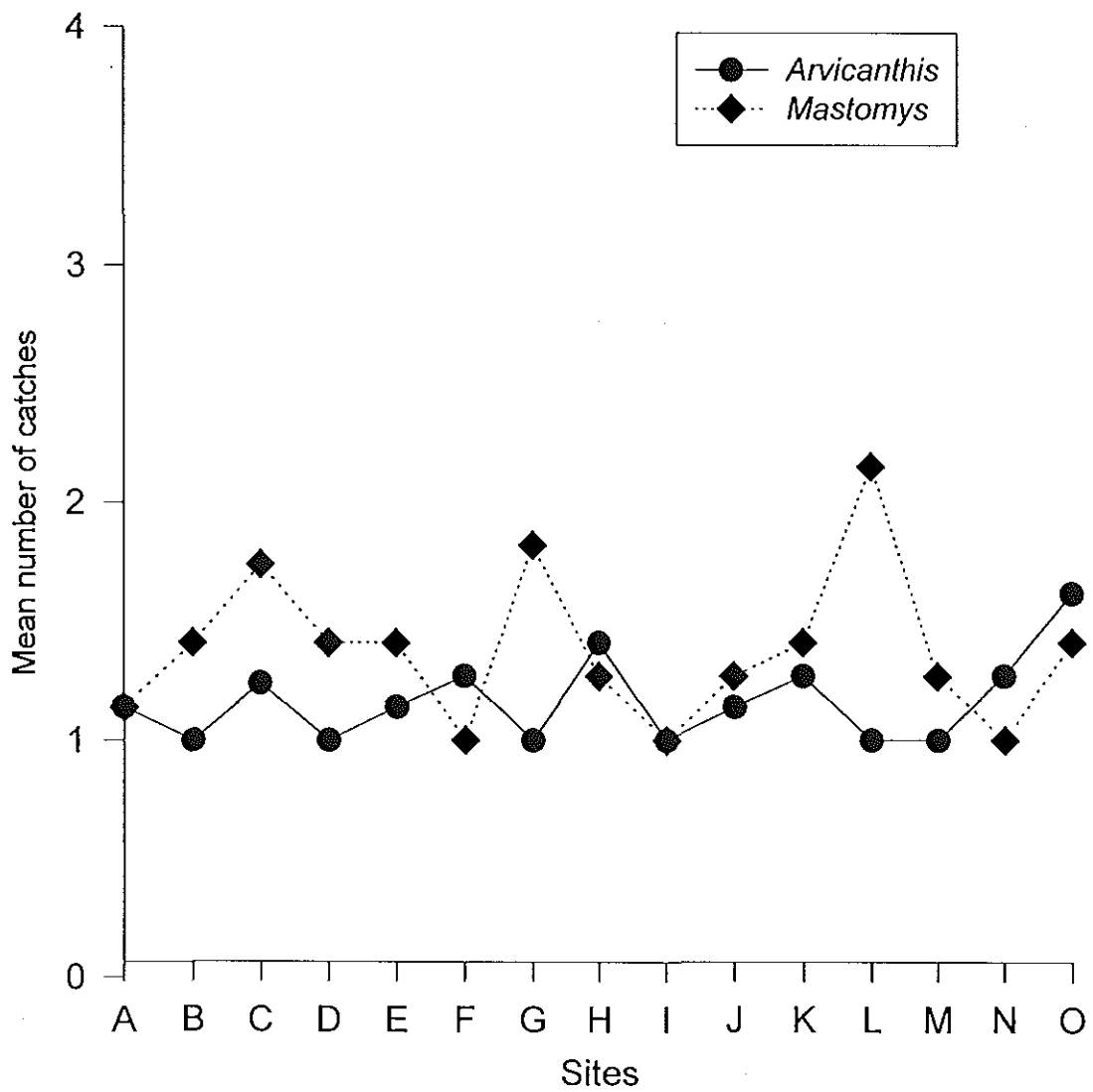


Figure 13. Daily catches of each site used in the C.D. analysis (wet season)

5. DISCUSSION

The results of the present study show that *Arvicanthis* is distributed in all the selected representative habitat types and probably all over the farm compound except in open fields.

The observed catch distribution (relative abundance) of *Arvicanthis* among the 15 sites was significantly different ($p < 0.05$). This could be due to a number of ecological factors. One of these could be the colonization period. Some of the sites might have been colonized long ago while others very recently. As a result, those which fall under the former category would have a well established population and good catch values while the latter are yet in the process of establishment and may be they had a small population size. Although, data is not available on the time of colonization of the entire region by *Arvicanthis*, it seems less likely that it is a recent introduction to the area. It can be assumed that there had been enough time for the entire farm compound to be colonized. Thus, still acknowledging the possibility that the observed catch distribution could be explained by the above mentioned reason, it would be wiser to look for yet another explanation which is more plausible.

The relative abundance of animals is naturally governed with their preference towards a given habitat. This depends on what the habitat provides in terms of food, breeding site, protection (from predators, over heating, cold, etc) and free space. However, the tolerance for these needs is different among different groups of organisms. Large mammals, for example, give priority to food than cover. This is not because they do not need protection but, rather they do it some other way. Most of them run to avoid predators rather than hide.

They can use any standing tree to avoid the sun during the very hot hours of the day. Small mammals on the other hand emphasize the importance of cover in their habitat selection. Usually they avoid predators by hiding or else, if spotted, there is little chance to escape. The observed catch distribution of *Arvicanthis* in the 15 sites of the present study is much likely to have resulted from this tendency of rodents to seek for well covered habitats as their permanent residence. The remaining part of the discussion is based on this scheme of habitat selection.

The results of the present study are in agreement with what has been found by Bond *et al.*, (1980). They emphasized the importance of plant development patterns (vegetation structure) as indicators of rodent abundance than the floristic (species) composition. This shows that rodents give priority to well protected habitats irrespective of the species composition. But what about food? Does their fortifying habitat always provide them with what they need? It is unlikely. Rodents, though are polyphagous, are observed to reject unpalatable food items (Delany, 1964b). Definitely they show some sort of food preference. They probably visit areas with potential food sources once in a while. Obviously, the frequency of visit depends on the safety of the route (Delany & Mongo, 1985b). They may not venture to cross long distance open fields if not forced by prolonged starvation or other deadly phenomena like fire.

The high catch of *Arvicanthis* recorded in site K in the dry season was in accordance with its vegetation structure. The site was vegetated by very tall grasses. Except the orange trees, the entire site was covered by this grass. The rats are well covered here and probably well nourished, as grasses make the major diet of *Arvicanthis* during the dry season (Taylor & Green, 1976 and Neal, 1981). Adler (1995) also observed an abundance of catches of rodents in well developed, grass-covered habitats in a lowland area in Taiwan. The catch record in site L was also in conformity with that observed in K. The two sites were similar in their species composition except that reed plants substitute the orange trees in L. The vegetation density, however, was quite different being thicker in K. The comparable catch record observed in the two sites seems to suggest the presence of no/or little relationship between density of vegetation and catch records. However, the observed sparsity of grass cover in L might have been augmented by the reed plants which provide a fair shading to the underlying grass. The high catch record in A can't be explained in the same way as in the above two cases. There was little grass in A, otherwise, the entire site was filled with sisal plants (*Agavae sisalina*) growing into a bush. The vegetation thickness was comparable to that observed in K & L. Similar habitat structure with regard to ground density was observed in C, D, E and H. The catch record of C was consistent with what was observed in A, K, and L. The relatively low catch record of site D seems hard to explain. The site was heavily vegetated with a number of shrub and grass species like *Cynodon dactylon*, *Ehretia cymosa*, and *Sesbania sesban*. In fact, it provided even more dependable cover than any of the sites. Probably, the thickness of the vegetation might have been more than what is actually needed. In other words, it might have had a

more negative influence than its advantage as a cover provider. Senzota, 1978 (as mentioned in Senzota, 1982) reported the same result. He observed high densities of *Arvicanthis* (320 individuals/ha) in less dense bushes with 10% bush cover. In heavily congested bushes with 40% bush cover the observed density of rats was only 67 individuals/ha. Heavily congested bushes probably discourage colonization by rodents. Sites E and H recorded very few catches, they had fairly dense ground cover though. However, both the sites were devoid of aerial cover. Both of them were dominated by grasses except that there were dried and falling leafless branches of the Castor oil tree (*Ricinus communis*) and *Solanum* in E. The advantage of the grasses as a structural cover might have been lost due to the absence of a good aerial cover which provides protection from the scorching sun. Moreover, habitats like these are readily revealed to the eyes of predatory birds. Afeework Bekele & Leirs (1997) conducted population ecology study in the same area. They found high densities of *Arvicanthis* in a grassland than in maize fields. The result seems contradictory to what has been found in the present study. However, what they called a grassland was a mixture of dense *Acacia* bushes and equally dense tall grasses. Such habitat structure is actually comparable to sites A & K. The observed high catch records in the two sites is substantiated by the results found by the authors. The catch observed in I was more than expected. Both the ground and aerial cover was scanty. However, some of the trapping stations were bordered by a dense bush on one side and were fairly shaded by some grasses. Almost all animals were captured from these stations. It could be assumed that the rats have been coming from the bush, and usually spend some time in these fairly shaded stations while searching for food. The site was located near the

dairy farm grain store. A pile of harvest waste has been laid down on the other side of the site. The rats caught in the site may probably be visitors of this waste pile which take temporary refuge in the shaded parts of the site and finally return back to their residence - the bordering bush. Site O recorded catches which are in conformity with what has been expected. It was in fact a replica of site B which was totally composed of a bush of *Achyranthus aspera*. However, B differs from O in that, two big trees which belong to the species *Ficus sur* were present in it. The two sites were chosen as trapping grids in order to see the influence of the two trees. Consequently, site O served as a control. The observed comparable catch record among the sites shows the absence of influence from the trees. Adler (1996) also found the same results in Taiwan. According to his observations, vertical growth does not affect rodent abundance. The two sites being almost identical, gave an opportunity to have information on chance effect. Accordingly, the observed catches indicated that the results obtained in either of the sites were more likely to be a reflection of the real habitat preference of the rats than any other reason like trapping error or human interference. Site O was not included during the second dry season. During this period it was totally altered by cutting. Even then, only its catch record of the first dry season considered, it stands as one of the sites with high catches. Site M, though has been a maize field, was an exposed site with regard to both aerial and ground cover. It only had dried maize plants which had been harvested. No maize grain was left either on the ground or on the standing plants. *Arvicanthis* was not expected to visit the area as there was no inviting environment. The observed nil catch record in G and N was consistent with their habitat structure. Site N was a totally open land with no cover at all.

It was a field of cut grasses. Site G was also totally open with only few scattered herbs. The site was used to be planted previously while during the study period, it was fallow. The ground was bare. Senzota (1982) reported an abundance of catches of *Arvicanthis* in a woodland dominated by *Acacia* trees and bushes measuring 1.5m or less. This observation was quite contrary to what has been found in the present study. Senzota's *Acacia* bushes and trees were comparable to the vegetation structure of site J which recorded one of the lowest catches. My result was contrary to what might be expected from such a habitat. The ground of the site was well covered with grasses though it has been interrupted by bare ground in a number of places. However, all trap stations were located under the available grasses that have yielded fair catch records in other sites (e.g. in site I). The same author, Senzota (1982) reported very little catch records of *Arvicanthis* in a pure grassland. This observation was in agreement with what has been recorded in site H. Such habitats, discusses Senzota, don't provide the rats with appropriate hiding places and nesting sites.

Very little *Arvicanthis* was captured during the wet season. This can be due to a low population size which was composed of the breeding stock for the next generation. It is during the wet season that most reproduction takes place in *Arvicanthis* (Neal, 1981 and Taylor & Green, 1976). This is well confirmed by the results of the present study. All the females caught during the season were reproductively active, most of them pregnant. Young are born at the end of the wet season and beginning of the dry season. A population build up could be expected around October and November. From then on, as the dry season progresses, reproduction decreases (confirmed in the present study) and there could probably be high rate of mortality particularly at the end of the dry season during April and May due to physiological stress as a result of short

supply of food and water. The surviving population in June will form the breeding stock for the coming season. Data should be collected on a monthly basis, however, to confirm the hypothesis. Because of the small sample size recorded for the season, it was not possible to correlate catches with habitat use as the statistical analysis would be subjected to bias.

Some discrepancies were observed in the catch distributions of *Arvicanthis* and *Mastomys*. This was particularly true with sites B, E, K, M and O (see Table 12). *Arvicanthis* was dominant in sites B & O. These two sites had quite similar vegetation structure. The absence of *Mastomys* in good number is not easy to explain. The two species usually coexist together avoiding competition mainly by means of partitioning their time of activity. As such, *Arvicanthis* is diurnal while *Mastomys* is nocturnal. The low catch of *Mastomys* in the sites was unlikely to be due to rejection of the habitat either. Almost equal number of *Mastomys* as *Arvicanthis* was captured else where (in site A for example) with a more or less similar vegetation structure as sites B and O. It seems there is no apparent explanation for the observed discrepancy.

In site M, the reverse was observed. *Arvicanthis* was dominated by *Mastomys*. The site lacked fair covering vegetation. For diurnal species like *Arvicanthis*, it is not inviting since they could easily be picked up by predators. Moreover, they will be exposed to the direct rays of the sun which results in thermal stress. All these dangers arising from lack of cover do not exist during

the night. Of course, this doesn't mean that there are no predators at night. But this time they depend more on smell or other senses than sight. As a result, the importance of cover is not significant here. The dominance of the nocturnal species, *Mastomys*, may not be surprising then. In addition, *Mastomys* favors agricultural areas (Lairs and Afforce Bacilli & Lairs, 1997). The site, being a harvested maize field, might have contributed to the observed high density of the species.

The absence of juveniles in all the sampling sessions was surprising. From the breeding rhythm of *Arvicanthis*, it could be expected that young are always present in the population. It is unlikely that juveniles were not caught because they are less active. Sicard *et al.*, (1994) reported quite the reverse. Young are mobile and exploratory. May be the small size of juveniles have rendered them uncatchable. The traps used were weight dependent. Heavy weights were usually favoured than lighter ones. Afework Bekele (1996) caught all age classes of *Praomys albipes*, a species which has even lesser adult weight than *Arvicanthis*. However, he used both the Victor rat traps and the Museum Special traps. Juveniles might have been caught if the latter type were used in the present study. The lack of significant difference in the sex distribution ($p > 0.05$) is in agreement with what has been observed in many African Murid rodents (Meester & Hallet, 1970). The fact that the rats weighed more on the wet season than in the dry season suggests that they are free from environmental stress like shortage of food and water, and high temperature in the wet season than in the dry season. This result, however, shall be substantiated by comparing equal number of samples from both seasons. There was small sample for the wet season in the present study.

The reproductive data on *Mastomys* showed some discrepancies. In the dry season all the females were sexually inactive while almost half of the males were active. In the wet season all the males were active while many of the females were not. This suggests suppressed reproductive activity from the part of the females and a year round activity in the case of the males. Over all, it could be assumed that there was little reproduction in the wet season and nothing in the dry season. The observed high density of *Mastomys* compared to *Arvicanthis* in the wet season is thus hard to explain.

The present study provided pioneering data on the habitat preference of *Arvicanthis*. The study suffered from lack of references. Consequently, the data analyses and interpretation were destined to be crude. However, every possible caution has been made to make the entire study scientifically acceptable.

The study outcome emphasizes the importance of moderate vegetation cover on the habitat use of *Arvicanthis*. Relatively dense bushes with medium height are usually favoured. Totally open fields and heavily congested bushes are observed to discourage colonization. Habitats with scanty vegetation cover expose the animals to predators and direct sun light. Heavy bushes on the other hand, are difficult to walk with in.

The author emphasizes the need for further work on the subject. More research should be carried out to make data available on the ecology of the species. *Arvicanthis*, being one of the wide spread pest species of tropical Africa, is worth extensive studies.

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7. Appendix

List of plant species identified from each site during the wet season

Sites	Plant species
A	- <i>Gloriosa simplex</i> - <i>Agavae sisalina</i>
B	- <i>Cynodon dactylon</i> - <i>Achyranthus aspera</i> - <i>Bidens pilosa</i> - <i>Ficus sur</i>
C	- <i>Tagetes minuta</i> - <i>Cynodon dactylon</i> - <i>Solanum spp.</i>
D	- <i>Ehretia cymosa</i> - <i>Vernonia leopoldii</i> - <i>Cynodon dactylon</i> - <i>Sesbania sesban</i>
E	- <i>Amaranthus hybridus</i> - <i>Cynodon dactylon</i> - <i>Solanum marginatum</i> - <i>Solanum incum</i> - <i>Racinus comunis</i>
F	- <i>Abutilion bidentatum</i> - <i>Leucas abyssinica</i> - <i>Balanites aegyptica</i> - <i>Cynodon dactylon</i> - <i>Solanum shimperi</i> - <i>Ehretia cymosa</i>
G	- <i>Commelina bengalensis</i> - <i>Datura stramonium</i>
H	- <i>Ehretia cymosa</i> - <i>Cynoglossum geometricum</i> - <i>Cyathula cylindrica</i> - <i>Crotalaria laburnifolia</i> - <i>Dactyloctenium aegypticum</i> - <i>Cynodon dactylon</i> - <i>Sporobolus pyramidalis</i>

I	- <i>Flaveria trinervia</i>
J	- <i>Ehretia cymosa</i> - <i>Capparis tomentosa</i> - <i>Cenchrus setigerus</i> - <i>Acacia albida</i>
K	- <i>Sterile grass species</i> - <i>Citrus cinensis</i>
L	- <i>Achyranthus aspera</i> - <i>Sterile grass species</i>
M	- <i>Zea mays</i>
N	- <i>Ehretia cymosa</i> - <i>Cynodon dactylon</i>
O	- <i>Bidens pilosa</i> - <i>Ipomoea cairica</i>