Habitat preference of the African grass rat, *Arvicanthis dembeensis* (Rodentia, Muridae) in Koka, Central Ethiopia

Tilaye Wube

Afework Bekele

Introduction

A number of studies have been carried out on the ecology of African small mammals. These studies were more inclined towards the understanding of their breeding biology, activity pattern, population dynamics, feeding behaviour and interactions (CHAPMAN *et al.*, 1959; SOUTHERN and OLIVER, 1963; DELANY 1964a; COETZEE, 1965; OKIA, 1973; HAPPOLD, 1974; MULLER, 1977; NEAL, 1977, 1981, 1986; CHIDUMAYO, 1980; SWANEPOEL, 1980; GHOBRIEL and HODIEB, 1982; LEIRS *et al.*, 1990, 1993; FISHER, 1991; PERRIN *et al.*, 1992; SICARD *et al.*, 1994; AFEWORK BEKELE and LEIRS, 1997). However, studies on habitat use and distribution patterns of African small mammals seem to be neglected. There are only very few investigations carried out on these areas (SENZOTA, 1982; BOND *et al.*, 1980). Fragmentary information is available in the literature as introductory or supplementary part of reports which usually concentrate on any of the above mentioned ecological features (e.g. TAYLOR and GREEN, 1976; DELANY and MONRO, 1985).

Arvicanthis is a genus distributed in tropical Africa all the way from Senegal to Somalia and along the Nile basin from Egypt to Tanzania.

It is an opportunistic breeder which reaches an outbreak population size during maximum reproduction. The genus is usually associated with grassland habitats. It feeds on a wide variety of food items ranging from grasses and seeds to animal matter, particularly insects (NEAL, 1970; DELANY, 1964b; CHEESEMAN 1977; SICARD *et al.*, 1994; RABIU and FISHER, 1989). Presently, the number of species recognized for the genus reaches the maximum number of 6 (CORTI and FADDA, 1996). On the other hand, some investigators have also lumped all the taxa into one species i.e. *Arvicanthis niloticus* (MISONNE, 1971; HONACKI *et al.*, 1982). The variation in the number of species described for the genus suggests that there is a need for further taxonomical investigation. However, there is a common understanding that populations from the Nile delta and West Africa belong to *A. niloticus* while those from East Africa and the Horn belong to any one of the six species *A. blicki, A. abyssinicus, A. dembeensis, A. somalicus, A. nairobae,* and *A. testicularis* (CORBET and HILL, 1991; MUSSER and CARLETON, 1993).

VOLOBOUEV *et al.* (1988) provisionally grouped populations of *A. niloticus* into three cytotypes. Populations of *A. dembeensis* have been observed to be similar to the ANI -1 cytotype (CORTI *et al.*, 1996). Following this, it is strongly believed that *A. dembeensis* is a geographical variant of *A. niloticus* (CAPANNA *et al.*, 1996).

This paper is an attempt to add to the already existing few studies on habitat use of African small mammals. It is also targeted to initiate further research in this area so that a balance could be maintained between the various fields of ecological research on small mammals. Habitat use in *Arvicanthis* has not been studied in such details as in other small mammals. The present study is an initiative to fill some of the existing gaps in this knowledge.

Materials and methods

The study was carried out in the Koka Dairy Farm Enterprise located near Koka town, Central Ethiopia (08° 25' N, 39° 02' E) at an altitude of 1700 m a.s.l. The vegetation of the area represents a typical

degraded savanna woodland. The farm compound, however, incorporates various modified habitats as a result of plantations of various vegetation like reeds, sisal, maize, and pastoral grass species. These provided the opportunity to investigate the habitat use of *Arvicanthis* in both natural and modified habitats.

Fifteen quadrats, each with an area of 15 x 15 m, were selected to represent the study sites. A number of vegetation parameters that could influence rodents were considered while selecting the quadrats. These were: plant species composition; ground vegetation cover; aerial vegetation cover.

A minimum of 100 m distance was maintained between the sites to secure independent catch records. The fifteen sites were labeled "A" to "O". The field data collection was carried out from February 1997 to February 1998 on a six month interval. Consequently, three trapping periods were covered i.e. February 1997 (1st dry season), August 1997 (wet season) and February 1998 (2nd dry season).

Trapping was carried out using Victor mouse traps. Peanut butter was used as bait. The trapping stations were established at 3 m intervals along four trapping lines. Consequently, a total of 16 trap stations were established in each site. Traps were set late in the afternoon (3:00-4:00 p.m.) and kept for three consecutive days and nights. Seven of the sites were trapped for the first three days and nights and then the remaining 8 were trapped for the same duration. The animals were retrieved early in the morning (6: 00-8: 00 a.m.) and in the late afternoon (4: 00-6: 00 p.m.). The captured specimens were sexed, weighed and measured. Then, they were categorized into their age groups based on their weight and reproductive condition. Individuals which weighed < 26 g were considered as juveniles, between 26 and 60 as subadults and > 60 g as adults.

The habitat structure of each site was thoroughly described during each trapping session (table 1). Major plant species were collected from each site and identified at the National Herbarium, Biology Department, Addis Ababa University (table 2). Catch records of each site were compared using two-way ANOVAs ($P = 0.05$) and Critical Difference (C.D.) analyses.

Sites	Description
A	Thick bushes, about 1.5 m high, dominated by sisal plants (*Agavae sisalina*) and other shrubs and scrubs. The ground cover within the range of 1-20 cm height was scanty. The bush was continuous on both right and left hand sides while the back and the front sides were open grass fields.
B	Thick bush, about 1.75 m high, entirely dominated by *Achyranthus aspera* with well covered ground. 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 1 m high, with ground well covered by dried grasses, about 30 cm high. It was dominated by *Solanum* spp. The front and back sides were fairly open while left and right sides were continuous about 10 m on both sides.
D	Extremely dense bush, about 2 m high, with a number of shrub, scrub and grass species. The ground was also very thick and dark. On each of its four corners it was surrounded by fields of cut grasses. It appeared like an island of thick bush.
E	Had fairly thick ground cover, about 40 cm high, provided by dried grasses. It was full of dried unbranched, leafless Castor oil trees (2.3 m high). However, they didn't provide any good aerial cover.
F	Except its species composition, it had quite similar vegetation structure as site B. The ground was devoid of any growth but only dried fallen leaves. It was surrounded by acacia trees (about 4 m high) and bushes (about 1.5 m high), part of an extensive bush system composed of shrubs and scrubs.
G	A fallow land with bare ground. There were only few individuals 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 70 cm 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 60 cm high) which form a nest like harbour. Further out 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 2.5 m. 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 2 m high). Both the ground and aerial cover were provided by the grasses. There were also orange trees which bore fruits (about 3 m 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.

Table 1
Habitat description of each trapping sites.

Sites	Plant species
A	*Gloriosa simplex, Agavae sisalina,*
B	*Cynodon dactylon, Achyranthus aspera, Bidens pilosa, Ficus sur*
C	*Tagetus minuta, Cynodon dactylon, Solanum incum*
D	*Ehretia cymosa, Vernonia leoploidii, Cynodon dactylon, Sesbania sesban*
E	*Amaranthus hybridus, Cynodon dactylon, Solanum marginatum, Solanum incum, Racinus comunis*
F	*Abutilion bidentatum, Leucas abyssinica, Balanites aegyptica, Cynodon dactylon, Solanum shimperi, Eheretia cymosa*
G	*Commeline bengalensis, Datura sramonium*
H	*Eheretia cymosa, Cynoglossum geometricum, Cyathula cylindrica, Crotalaria laburnifolia, Dactylectenium aegypticum, Cynodon dactylon, Sporobolus pyramidalis*
I	*Flaveria trinervia*
J	*Eheretia cymosa, Capparis tomentosa, Cenchrus setigerus, Acacia albida*
K	Sterile grass species, *Citrus sinensis*
L	Sterile grass species, *Achyranthus aspera*
M	*Zea mays*
N	*Eheretia cymosa, Cynodon dactylon*
O	*Bidens pilosa, Ipomoea cairica*

Table 2
Major plant species identified from the fifteen sites.

Results

Four rodent and one insectivore species were caught in the entire trapping sessions. A total of 365 individuals were caught. Of these, 174 (47.7%) were *Mastomys erythroleucus*, 161 (44.1%) *Arvicanthis dembeensis*, 17 (4.7%) *Tatera robusta*, 9 (2.5%) *Crocidura olivieri* and 4 (1.1%) *Rattus rattus* (table 3). The catch distribution of *Arvicanthis dembeensis* in each site is given in table 4 where data were combined for the February 1997 and 1998 trapping periods.

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

Table 3
Number of small mammals caught in each season.

This was done because both periods represent the dry season, with similar vegetation structure for each site. The August 1997 trapping data, however, are presented separately as the habitats changed during this period owing to the climatic change.

The catch records of the 15 sites were significantly different ($P < 0.05$) for both seasons. However, since the wet season sample size was very small, the corresponding data were not analyzed further. Consequently, the C.D. analysis was conducted only for the dry seasons. We have compared the means of the three day captures recorded for each site from the ANOVA table. Figure 1 shows the mean values for each site. Based on the C.D. analyses, it was possible to rank the sites as favoured (high catch records) and disfavoured (low catch records) (table 5). The sites which belonged to the 1st rank recorded from 21 to 32 individuals, 2nd rank 14, 3rd rank 13, 4th rank 8, 5th rank 3-5 and 6th rank 0-1.

Discussion

The present data show that habitat selection of *Arvicanthis dembeensis* is more influenced by the vegetation structure than by its species composition. This is in agreement with what BOND *et al.* (1980) found. Habitats that possessed dependable cover yielded high catch values.

Sites	Dry seasons	Wet season
A	21	1
B	14	–
C	13	2
D	8	–
E	1	2
F	5	2
G	–	–
H	–	3
I	8	–
J	1	1
K	32	2
L	21	–
M	3	–
N	–	2
O	14	5
Total	141	20

Table 4
Catch distribution of *Arvicanthis* among the 15 sites.

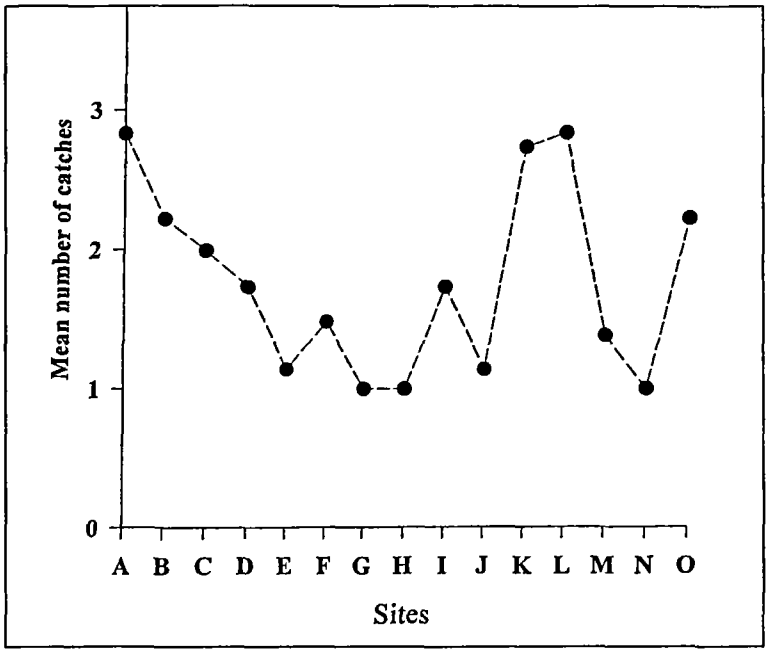
On the other hand, those that did not have fairly thick vegetation were not preferred. In fact, there is an apparent explanation for these observations. *Arvicanthis* is a diurnal rodent. Rodents in general are highly vulnerable to predators, particularly birds as observed in the study area. They can not afford an extended stay in exposed habitats as they will be picked up by the birds. Consequently, their survival is highly dependent on the presence of shelter. In addition, well covered habitats provide them with good nesting sites. The observed catch distribution in the selected habitat types is in good agreement with this simple habitat selection strategy. Those sites which fall in the 1st rank (K, A, and L) had thick bushes with dependable cover. The same was true with those which belonged to the 2nd (B and O) and 3rd ranks (C). However, all these sites were different in their species composition (table 2). These observations could lead one to inquire about food. Does *Arvicanthis* consume whatever plant species is available, or does it completely depend on sources of food other than the vegetation profile? Studies showed that *Arvicanthis* is mainly herbivorous (DELANY and MONRO, 1986; SENZOTA, 1982). However, it also

1st rank	2nd rank	3rd rank	4th rank	5th rank	6th rank
K	B	C	D	F	E
A	O	–	I	M	G
L	–	–	–	–	H
–	–	–	–	–	J
–	–	–	–	–	N

Table 5
The rank of each trapping site (A - O) based on the C.D. analyses.

includes animal matter, particularly insects, in its diet (RABIU and FISHER, 1989). In the study area, it has been observed feeding on the larvae of termites (casual observations). It also feeds upon grasses, seeds, fruits, and cereals when found near agricultural areas (TAYLOR and GREEN, 1976; RABIU and FISHER, 1989). It is an opportunistic feeder. However, indigestible woody vegetation can not be used as food. All the major vegetation types which were found in our trapping sites fall under these categories. *A. dembeensis* may not use the major plant species as a source of food. Instead, the food source could be insects, small blades of grasses, weeds and fallen leaves which were widely distributed almost among all the sites. It could also be possible that the rats pay short visits to nearby areas with potential food sources and return back to their permanent residence. In fact, the catch record observed in site I could truly illustrate this. The site was a rather exposed area with regard to both aerial and ground cover, and was hardly favoured by rodents. However, along one side of the site, there existed a thick bush which can possibly harbour a good population of rodents. The 8 individuals caught in site I were probably residents of this bush which pay short visit to the nearby site, which in turn was located near a pile of the waste components of harvested maize.

Although most of our results support the idea that vegetation structure is the most important factor determining habitat selection, some of the catch records showed inconsistencies. For example, the catch record of site D was much less than what was expected. It was an extremely thick, well protected and diverse habitat. However, as



I Figure 1
Mean catch values of each site used in the C.D. analyses.

SENZOTA (1982) found out, the site might have discouraged colonization. SENZOTA (1982) observed low catch records (67 individuals/ha) in habitats with 40% bush cover, against 320 individuals/ha in habitats which had 10% bush cover. Probably the rats are discouraged by congested habitats due to lack of free space for movement. The low catch records observed in sites E, H, and J were also surprising. Site E had dense ground cover of dried grasses. However, its poor aerial cover may have made it quite exposed and unfavourable for colonization. Site H, too, had a good vegetation cover dominated by grasses. But, once again it lacked good aerial cover. SENZOTA (1982) also observed little capture values on pure grassland habitats. Such habitats are exposed to predators and provide poor nesting sites. It becomes even more difficult to explain J's case. Both the aerial and ground vegetation were dependable. The *Acacia* bushes of the site had very thick and spreading branches which protected the ground

like an umbrella. The ground was covered with dense grasses which provided good nesting sites and hiding places. One may hypothesize that the area was not fully colonized by *Arvicanthis* yet because it was distantly isolated at the northern boundary of the enterprise's enclosure.

In summary, we emphasize the importance of vegetation structure as the governing factor of habitat selection by *Arvicanthis dembeensis*. Most of our data support this assumption. However, since the number of trapping sessions we have employed was very limited, some observed apparent inconsistencies between catch records and vegetation structure in some of the sites could result from chance. From there, it becomes apparent that detailed micro-habitat studies are required to better understand the habitat selection of *Arvicanthis*.

References

AFEWORK BEKELE and LEIRS H., 1997 — Population ecology of rodents of maize fields and grassland in Central Ethiopia. *Belgium Journal Zoology*, 127: 39-48.

BOND W., FERGUSON M. and FORSYTH G., 1980 — Small mammals and habitat structure along altitudinal gradients in the southern Cape Mountains. *South African Journal of Zoology*, 15: 34-43.

CAPANNA E., AFEWORK BEKELE, CAPULA M., CASTIGLIA R., CIVITELLI M., CORTI M. and FADDA C., 1996 — A multidisciplinary approach to the systematics of *Arvicanthis* Lesson, 1842 (Rodentia, Muridae). *Mammalia*, 60: 677-696

CHAPMAN B., CHAPMAN R. and ROBERTSON I., 1959 — The growth and breeding of the multimammate rat, *Rattus (Mastomys) natalensis* (Smith) in Tanganyika territory. *Proceedings of the Zoological Society, London*, 133: 1-9.

CHEESEMAN C.L., 1977 — Activity patterns of rodents in Ruwenzori National Park Uganda. *East African Wildlife Journal*, 15: 281-287.

CHIDUMAYO E.M., 1980 — Ecology of rodents in an old quarry in Zambia. *South African Journal of Zoology*, 15 (1): 44-49.

COETZEE C.G., 1965 — The breeding season of the multimammate mouse *Praomys (Mastomys) natalensis* (A. Smith) in the Transvaal. *Zoologica Africana*, 1 (1): 29-39.

CORBET G.B. and HILL J., 1991 — *A world list of mammalian species*. 3rd ed. Oxford, Oxford University Press, 243 p.

CORTI M., CIVITELLI M., CASTIGLIA R. and AFEWORK BEKELE CAPANNA E., 1996 — Cytogenetics of the genus *Arvicanthis* (Rodentia, Muridae) 2. The chromosomes of three species from Ethiopia: *A. abyssinicus, A. dembeensis* and *A. blicki*. *Zeitschrift für Säugetierkunde*, 61: 339-351.

CORTI M. and FADDA C., 1996 — Systematics of *Arvicanthis* (Rodentia Muridae) from the Horn of Africa: a geomorphometric evaluation. *Italian Journal of Zoolology*, 63: 185-192.

DELANY M.J., 1964a — A study of the ecological and breeding of small mammals in Uganda. *Proceedings of the Zoological Society, London*, 142: 347-370.

DELANY M.J., 1964b — An ecological study of the small mammals in the Queen Elizabeth National Park, Uganda. *Revue de Zoologie et de Botanique africaine*, 70: 129-147.

DELANY M.J. and MONRO R.H., 1985 — Movement and spatial distribution of the Nile rat (*Arvicanthis niloticus*) in Kenya. *Journal of Tropical Ecology*, 1: 111-130.

DELANY M.J. and MONRO R.H., 1986 — Population dynamics of *Arvicanthis niloticus* (Rodentia Muridae) in Kenya. *Journal of Zoology, London*, 209: 85-103.

FISHER M., 1991 — A reappraisal of the reproductive ecology of *Arvicanthis* in Africa. *African Journal of Ecology*, 29: 17-27.

GHOBRIEL I. and HODIEB A.S.K., 1982 — Seasonal variations in the breeding of the Nile rat (*Arvicanthis niloticus*). *Mammalia*, 46: 320-333.

HAPPOLD D.C.D., 1974 — The small rodents of the forest savanna farmland association near Ibadan, Nigeria, with observation on reproductive biology. *Revue de Zoologie africaine*, 88: 814-835.

HONACKI J.H., KINMAN K.E. and KOEPPL J.W., 1982 — *Mammal species of the world. A taxonomic and geographic reference*. Lawrence, Kansas, 694 p.

LEIRS H., STUYCK J., VERHAGEN R. and VERHEYEN W., 1990 — Seasonal variation in growth of *Mastomys natalensis* (Rodentia, Muridae) in Morogoro, Tanzania. *African Journal of Ecology*, 28: 298-306.

LEIRS H., VERHAGEN R. and VERHEYEN W., 1993 — Productivity of different generations in a population of *Mastomys natalensis* rats in Tanzania. *Oikos*, 68: 53-60.

MISONNE X., 1971 — "Order Rodentia". *In* MEESTER J.A.J, SETZER H.W. (eds.): *The Mammals of Africa: An identification manual*. Washington, D.C., Smithsonian Institution Press: 38-39.

MULLER J.P., 1977 — Population ökologie von *Arvicanthis abyssinicus* in der grassteppe des Simien Mountains National Park (Athiopien). *Zeitschrift für Säugetierkunde*, 42: 145-172.

MUSSER G.G. and CARLETON M.D., 1993 — "Family Muridae". In Wilson D.E., Reeder D.H. (eds.): *Mammal species of the world. A taxonomic and geographic reference:* Washington, D.C., Smithsonian Inst. Press: 501-755.

NEAL B.R., 1970 —
The habitat, distribution and activity of a rodent population in Western Uganda, with particular reference to the effects of burning. *Revue de Zoologie africaine*, 81: 29-49.

NEAL B.R., 1977 —
Reproduction of the multimammate rats, *Praomys (Mastomys) natalensis* (Smith), in Uganda. *Zeitschrift für Säugetierkunde*, 42: 221-231.

NEAL B.R., 1981 —
Reproductive biology of the unstriped grass rat, *Arvicanthis*, in East Africa. *Zeitschrift für Säugetierkunde*, 46: 174-189.

NEAL B.R., 1986 —
Reproductive characteristics of African small mammals. *Cimbebasia*, 14: 113-127.

OKIA N.O., 1973 —
The breeding pattern of the soft-furred rat, *Praomys morio*, in an evergreen forest in southern Uganda. *Journal of Zoology, London*, 170: 501-504.

PERRIN M.R., SLOTOW R.H. and MENDEL J.H., 1992 —
The population dynamics of rodents at settlers, Transvaal, South Africa. *Zeitschrift für Säugetierkunde*, 57: 238-247.

RABIU S. and FISHER M., 1989 —
The breeding season and diet of *Arvicanthis* in northern Nigeria. *Journal of Tropical Ecology*, 5: 375-386.

SENZOTA R.B.M., 1982 —
The habitat and food habits of the grass rats (*Arvicanthis niloticus*) in the Serengeti National Park, Tanzania. *African of Tropical Ecology*, 20: 241-252.

SICARD B., MAUREL D., FUMINIER F. and BOISSIN J., 1994 —
Climate, trophic factors and breeding patterns of the Nile grass rat (*Arvicanthis niloticus solatus*): a 5 year study in the Sahelian region of Burkina Faso (formerly Upper Volta). *Canadian Journal of Zoology*, 72: 201-214.

SOUTHERN H.N. and OLIVER H., 1963 —
Notes on breeding of small mammals in Uganda and Kenya. *Journal of Mammalogy*, 44: 126-129.

SWANEPOEL C.M., 1980 —
Some factors influencing the breeding season of *Praomys natalensis*. *Southe African Journal of Zoology*, 15: 95-98.

TAYLOR K.D. and GREEN M.G., 1976 —
The influence of rainfall on diet and reproduction in four African rodent species. *Journal of Zoology, London*, 180: 367-389.

VOLOBOUEV V., VIEGAS-PEQUIGNOT E., LOMBARD M., PETTER, F., DUPLANTIER J.M. and DUTRILLAUX B. 1988 —
Chromosomal evidence for a polytypic structure of *Arvicanthis niloticus* (Rodentia, Muridae). *Zeitschrift für Zooloie, Systematische*