Belg. J. Zool., 135 (supplement) : 113-118 December 2005

# Community structure and seasonal abundance of rodents of maize farms in Southwestern Tanzania

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ABSTRACT. Community characteristics and seasonal abundance of rodents were investigated in a small-scale maize field-fallow land mosaic in southwestern Tanzania between February 2001 and May 2002. During the study, a total of 2568 rodents were captured in 9150 trapnights giving a 28% trap success. Also shrews of the genus *Crocidura* (Soricidae) were recorded. *Mastomys natalensis* comprised the highest proportion of rodents caught accounting for 82.9% of all captures. Other rodent genera captured included : *Tatera, Saccostomus, Graphiurus,* and *Steatomys*. Relative densities as measured by both trap success and the number of rodents per hectare, and biomass varied between seasons with and without crop in the field but not between habitat types. The work reports seasonality in breeding for the two most commonly trapped species, *Mastomys natalensis* and *Tatera leucogaster.*

KEY WORDS : rodents, community structure, seasonal abundance, refuge habitat, Africa

## INTRODUCTION

Outbreaks of rodents over large areas have been reported in many areas in Africa; however, considerable damage to agriculture has also been reported in non-outbreak years (FIEDLER, 1988, 1994). In eastern Africa, especially in small-scale farms and marginal landscapes, field rodents are a very serious concern after drought and poor soils as a major constraint to improved yield of staple crops. Rodent damage particularly to cereal crops remains a chronic problem among small-scale farmers in this region. However, quantitative information on the type and level of damage remains descriptive. Earlier reports of maize losses due to rodents shows damages of up to 20% annually in Kenya (TAYLOR, 1968; also reviewed in OGUGE et al., 1997) and Ethiopia (GOODYEAR, 1976). TAYLOR (1968) reported that during rodent outbreaks in Kenya, maize losses could be as high as 34 to 100%.

For Tanzania, the average annual yield loss of maize is estimated to be around 5 to 15% (MAKUNDI et al., 1991). This corresponds to more than 400,000 tonnes of maize, equivalent to an amount that could feed 2.3 million people for a whole year (LEIRS, 2003). Besides the usual annual losses in Tanzania, irregular rodent outbreaks occur during which damage to crops can increase to over 80% (LEIRS et al., 1996; MWANJABE & LEIRS, 1997).

In Tanzania, agricultural fields are situated in a matrix of surrounding habitats which in smallholder settings is most often fallow land. These habitats change seasonally leading to a spatial component of the community and population dynamics of organisms living in these fields (LEIRS et al., 1997b). The fallow lands are said to provide a suitable ground for shelter and breeding for rodents while grass and weed seeds provide supplementary food (MWANJABE, 1993). Fallow land matrix has also been assumed to act as refuge for rodents in the maize field during unfavourable conditions. As such it is expected that rodents that inhabit the maize fields will dissipate into the fallow land and return only during the attractive crop stages. This means that during the unfavourable periods, rodent densities will be higher in the surrounding matrix than in the maize field and vice versa during the attractive periods. A sound understanding of community dynamics in the farm lands and the surrounding matrix may allow to predict changes in rodent densities and community structure, which is of prime importance for the development of species and/or community specific management strategies.

In the present paper, we investigate community structure and seasonal abundance of rodents of maize farms and their surrounding matrix in southwestern Tanzania. We hypothesize that, rodents in the maize field move to the surrounding matrix during the unfavourable crop stages and vice versa during the attractive stages leading to a marked difference in densities in the two habitats at the different crop stages.

## MATERIAL AND METHODS

The study took place in Chang'ombe village of Chunya district, which is located in southwestern Tanzania between 07° 58'S – 33° 18'E and 08° 46'S - 33° 18'E. The climate of the area is dry subhumid with annual rainfall of about 900mm. Rainfall is unimodal with peak precipitation between November and March. Although rainfall is variable between years, it is relatively reliable.

We selected two sites for the placement of our removal grids. These sites were denoted as Chunya1 and Chunya2. At each of the two removal grids, 75 snap traps and 75 Sherman traps were used, giving a total of 150 trap stations. Of the 150 trap stations per grid, 50 trap stations were placed within the target crop (maize) while the other 100 trap stations were placed in the matrix habitat. The traps were placed in lines on which traps were spaced 10m apart. Within the target crop each of the 5 trap lines (10 traps/line) were spaced 10m apart while the 5 trap lines outside the target crop (20 traps/line) were spaced 40m apart up to 200 m from the edge of the crop. During trapping sessions, snap traps and Sherman traps were placed alternating in each trap line. The trap positions were marked with painted bricks so that the locations could be used during subsequent trapping. The traps were baited with a mixture of peanut butter and maize scrap. The two grids were about 3km apart. Animals were trapped during the different crop stages : a) at least one month before planting b) planting/after planting c) seedling stage d) vegetative/middle of growth stage e) before harvesting/ripe stage and f) at least one month after harvest. During these sessions, trapping was carried out for three consecutive days.

Trapped animals were identified, weighed, sexed and measured. The body condition (visible injury, ectoparasites) and reproductive condition were also noted. In addition, the point of capture, date and weather conditions were recorded. Processed specimens were preserved in 10% buffered formalin. Live-trapped animals were sacrificed under diethyl ether before processing.

For purposes of description and analysis, rodent community is defined as all trappable rodent species occurring in the study sites. Description of seasonal abundance and community composition is based on trapped individuals. Rodent abundance is expressed as 1) percent trapping success i.e. the proportion of captures relative to the number of traps set over a given period (TELFORD, 1989) and, 2) density estimates; rodent captures per given area. A chi-square ($\chi^2$) test was used to inspect any differences in sex ratios. Biomass is based on the total weights of the different rodents captured and is expressed in relation to the studied area.

## RESULTS

### *Rodent species composition*

A total of 2568 captures of five species of rodents were made in 9150 trap nights. Also shrews of the genus *Crocidura* were caught during this study. The five species of rodents recorded were *Mastomys natalensis* (82.9%), *Tatera leucogaster* (15.9%), *Saccostomus campestris* (0.8%), *Graphiurus murinus* (0.2%) and *Steatomys* sp. (0.2%) (Table 1).

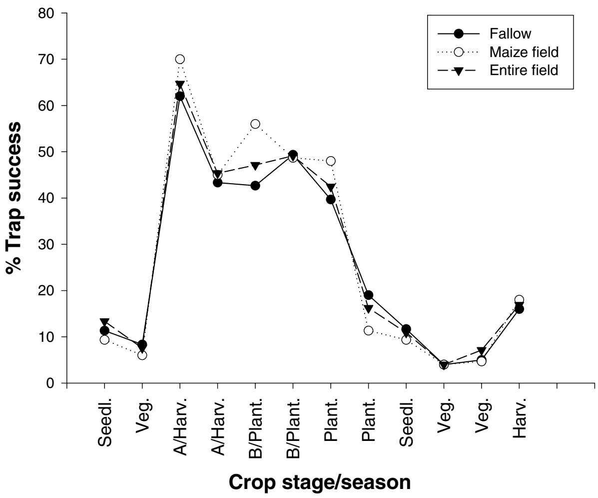



Fig. 1. – Trap success for the different crop stages/seasons in southwestern Tanzania.

TABLE 1

Rodent species composition in Chunya, southwestern Tanzania

| Species | Chunya1 | Chunya2 | Totals | % contribution |
|---|---|---|---|---|
| *Mastomys natalensis* | 946 | 1176 | 2122 | 82.9 |
| *Tatera leucogaster* | 300 | 103 | 403 | 15.9 |
| *Steatomys* sp. | 6 | 0 | 6 | 0.2 |
| *Graphiurus murinus* | 4 | 2 | 6 | 0.2 |
| *Saccostomus campestris* | 1 | 20 | 21 | 0.8 |
| Totals | 1257 | 1301 | 2558 | 100 |

### *Trap success*

The mean trap success for Chunya1 and Chunya2 combined was 28%. Trap success varied greatly throughout the study being lowest in February/March during the vegetative stage and highest in July/August, three months after harvesting and before planting (Fig. 1). In most trapping sessions, trap success was higher for rats in the fallow land than for those in the maize field. However, the differences were small, inconsistent and insignificant ($t = -0.166$, $df = 22$, $P = 0.869$). Trap success differed significantly between seasons with and without crops on the field ($F_{5,\,120} = 20.99$, $p < 0.001$), but not between both habitat types and there was no interaction between season and habitat type.

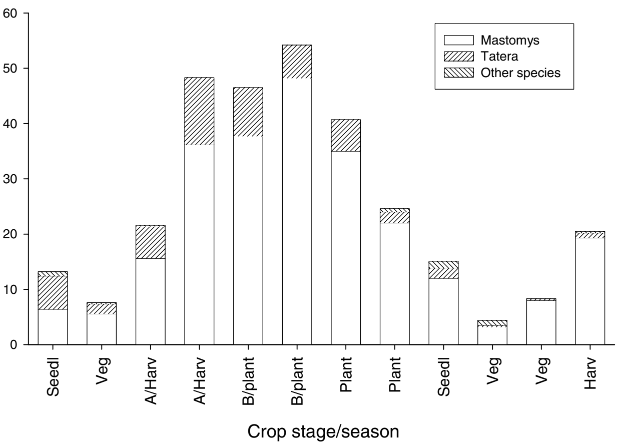



Fig. 2. – Seasonal relative densities of the different rodent taxa in maize fields in southwestern Tanzania.

### *Density patterns*

The total rodent densities varied in the different crop seasons. Densities ranged between 4 animals per hectare during the vegetative period of February/March and 54 animals per hectare just before land preparation and planting in September/October (Fig. 2). This same trend was recorded for animals caught both in the maize field and fallow land. However, relative densities were always higher in maize compared with fallow. Densities in maize ranged between 12 and 156 animals per hectare while those in the fallow area were 3 to 41 animals per hectare. In Chunya1, the overall densities ranged from 4 to 49 animals per hectare. Fallow recorded lower densities (3-37/ha) than in the maize (6-84/ha) (Figs 3a&b). In Chunya2, the overall relative density was 5-59 animals per hectare. Again here fallow recorded lower densities (4-45/ha) than maize (12-162/ha) (Figs 3c&d). Relative densities differed significantly between seasons with and without crop on the field ($F_{5, 120} = 18.03$, $p < 0.001$) but not between both habitat types.

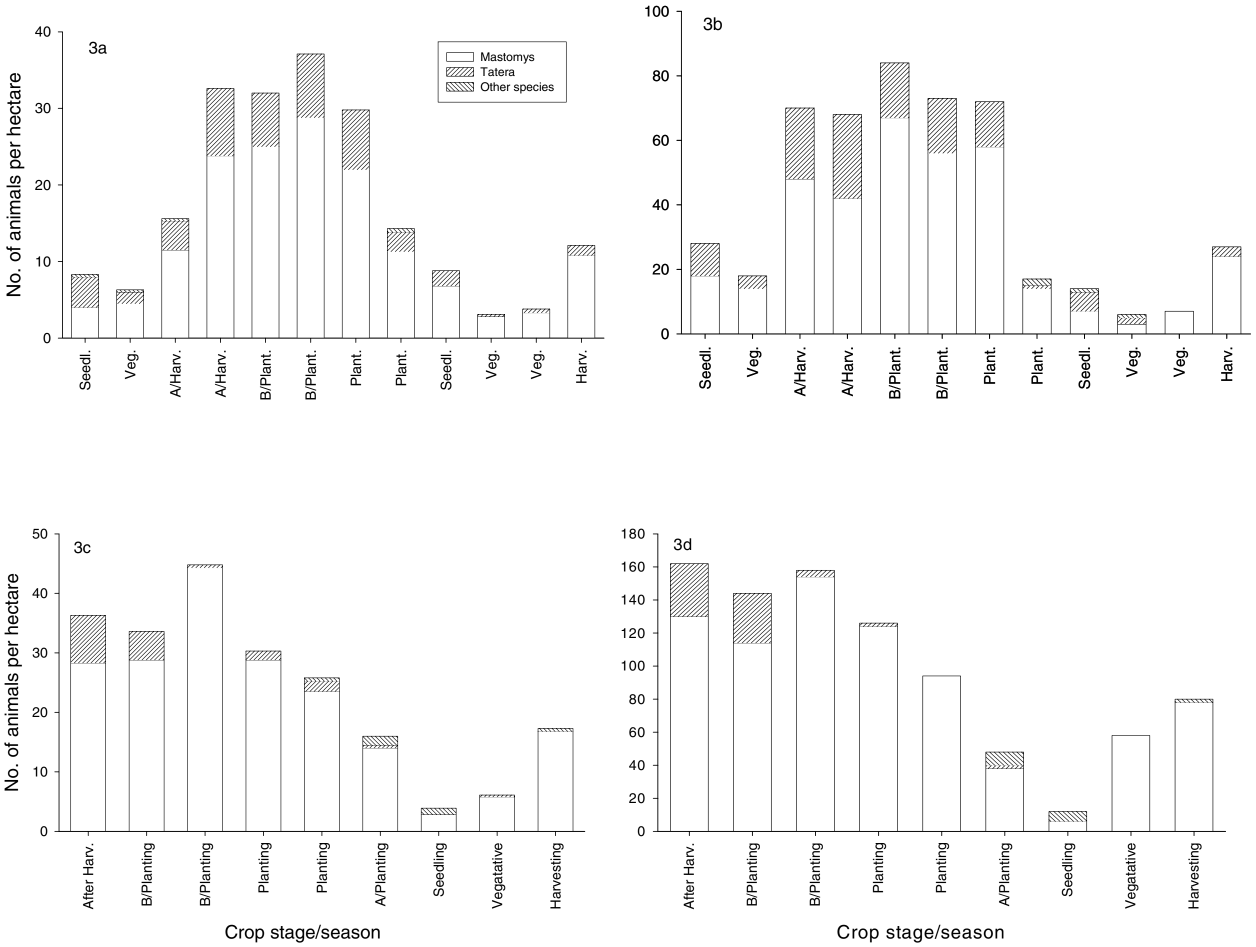



Fig. 3. – Seasonal relative densities of rodents
a) in Chunya 1 fallow land; b) in Chunya 1 maize farm; c) in Chunya 2 fallow land; d) in Chunya 2 maize farm

### *Biomass*

The seasonal weight of the total number of rodents captured in the 4.5 ha grids varied from 923 to 9246g (205-2055g/ha). Except for February 2001 (vegetative stage) when *Tatera* recorded equal biomass with that of *Mastomys*, *Mastomys natalensis* formed the largest biomass on all trapping occasions accounting for as high as 86.2% of the total biomass in April (Table 2). In most seasons, biomass was higher for rodents in the fallow land than those in the maize crop. However, again here as with trap success the differences were small, inconsistent and insignificant ($t = -1.13$, $df = 32$, $P = 0.26$). Biomass differed significantly between seasons with and without crops on the field ($F_{4, 120} = 24.98$, $p < 0.001$), but not between both habitat types and there was no interaction between season and habitat type.

TABLE 2

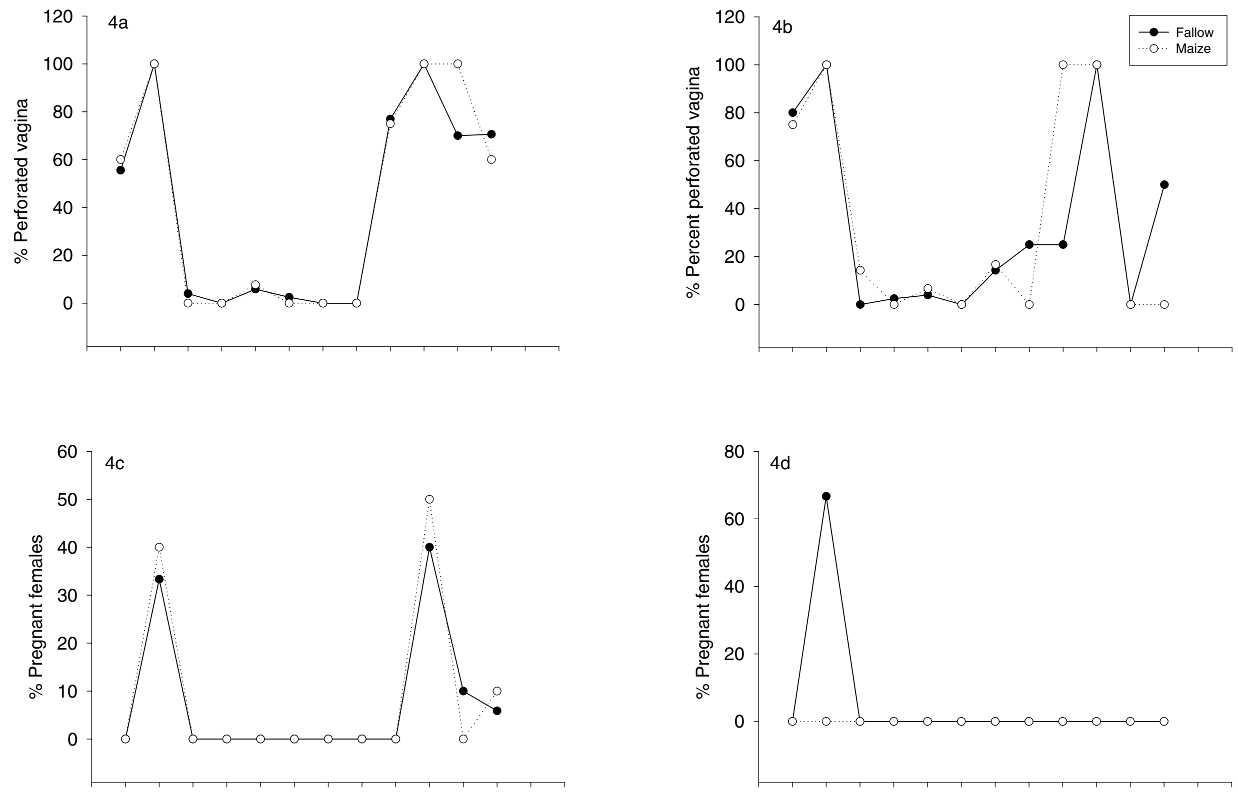
Total biomass (g/4.5ha) of rodents and other small mammals in Chunya (% contribution are given in parentheses).

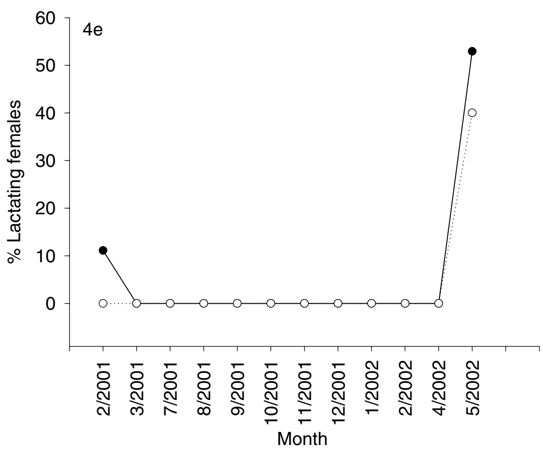
| Month | Mastomys | Tatera | Steatomys | Graphiurus | Saccostomus | Crocidura | All species |
|---|---|---|---|---|---|---|---|
| February 2001 | 1612 (43.5) | 1970 (53.1) | 63 (1.7) | 38 (1.0) | 0 | 24 (0.6) | 3709 |
| March 2001 | 1257 (62.9) | 710 (35.5) | 0 | 28 (1.4) | 0 | 0 | 1999 |
| July 2001 | 2945 (60.6) | 1854 (38.1) | 0 | 24 (0.5) | 0 | 41 (0.8) | 4862 |
| August 2001 | 4915 (53.1) | 4331 (46.8) | 0 | 0 | 0 | 0 | 9246 |
| September 2001 | 4887 (62.2) | 2964 (37.7) | 0 | 0 | 0 | 0 | 7851 |
| October 2001 | 5637 (65.0) | 3038 (35.0) | 0 | 0 | 0 | 0 | 8675 |
| November 2001 | 3975 (58.7) | 2796 (41.3) | 0 | 0 | 0 | 0 | 6771 |
| December 2001 | 1959 (69.0) | 799 (28.1) | 62 (2.2) | 0 | 0 | 19 (0.7) | 2839 |
| January 2002 | 1606 (58.5) | 1141 (41.5) | 0 | 0 | 32 (1.2) | 0 | 2747 |
| February 2002 | 951 (78.5) | 238 (19.6) | 0 | 0 | 0 | 0 | 1211 |
| April 2002 | 796 (86.2) | 127 (13.7) | 0 | 0 | 0 | 0 | 923 |
| May 2002 | 2804 (82.8) | 539 (15.9) | 0 | 0 | 0 | 42 (1.2) | 3385 |

### *Reproduction*

Of the rodents trapped, 1177 (46.0%) were males, 1063 (41.6%) were females while 318 (12.4%) were unsexed. The sex ratios (male :female) of *Tatera leucogaster* (170 :191), *Saccostomus campestris* (12 :9), *Graphiurus murinus* (2 :4) and *Steatomys* sp. (2 :4) were all of the expected one-to-one (1 :1) ratio. In overall more males of *Mastomys natalensis* (991 :855) were caught than females ($\chi^2 = 5.0097$, $p < 0.05$) (Table 3). However, the seasonal sex ratio of *M. natalensis* was not significantly different from the expected 1 :1 ratio.

Reproductive activity was highly seasonal in *M. natalensis* and *T. leucogaster*, which were the only species caught in appreciable numbers. This seasonality in breeding was similar in both habitat types. Females of *M. natalensis* had a high proportion of females with perforated vagina around March during the vegetative stage of crop; this is followed by a long period of non-reproductive activity (Fig. 4a). The same reproductive pattern was witnessed in *T. leucogaster* (Fig. 4b). Females of *M. natalensis* and *T. leucogaster* are pregnant (Figs 4c&d) or lactating (Figs 4e&f) around February, March and April thereafter reproduction is suspended.





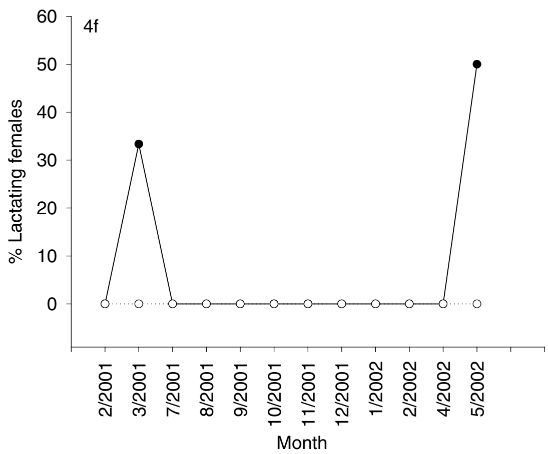




Fig. 4. – Reproductive characteristic of *M. natalensis* and *T. leucogaster* in fallow land and maize field
a) Proportion of female *M. natalensis* with perforated vagina; b) Proportion of *T. leucogaster* with perforated vagina; c) Proportion of visibly pregnant *M. natalensis;* d) Proportion of visibly pregnant *T. leucogaster;* e) Proportion of lactating *M. natalensis;* f) Proportion of lactating *T. leucogaster.*

TABLE 3

Sex ratio of rodent species caught in southwestern Tanzania (NS = not significant)

| Species | Males | Females | $\chi^2$ | Significance |
|---|---|---|---|---|
| *Mastomys natalensis* | 991 | 855 | 5.0097 | $P < 0.05$ |
| *Tatera leucogaster* | 170 | 191 | 0.6108 | NS |
| *Steatomys* sp. | 2 | 4 | 0.3333 | NS |
| *Graphiurus murinus* | 2 | 4 | 0.3333 | NS |
| *Saccostomus campestris* | 12 | 9 | 0.2143 | NS |

## DISCUSSION

On a seasonal (crop stage) scale, we found no differences in trap success, relative densities and biomass of rodents in fallow land and maize field. There were animals in the maize fields during the different crop seasons and their relative abundance varied seasonally just like that in the surrounding matrix. Likewise, we did not find any evidence of the fallow land acting as a refuge for rodents during the non-attractive crop stages nor did the data report of animals leaving the fallow land to the maize field during the attractive stages. The same density patterns were recorded for both fallow land and maize field. There is a large turnover in the densities of rodents across time in both the maize field and fallow land. This type of scenario has also been reported in a study of *Mastomys natalensis* in a maize field-fallow mosaic in Morogoro, Tanzania (LEIRS et al., 1997b)

The lowest densities were recorded in February/March during the vegetative period of the crop. Densities start rising steadily in May and peak densities are recorded in September/October, two to three months before planting. This density pattern appeared not to be related with the crop stage rather it could be explained by the fact that the first pregnant females were observed by the end of February (vegetative stage) so that an increase in numbers is not expected before the second half of April. Indeed numbers start increasing by May. Our density estimates are rather low compared to reported densities for Tanzania and elsewhere (LEIRS, 1995 and references therein) where up to a thousand animals per hectare have been reported in outbreak periods, with normal peaks of several hundreds in studies involving *Mastomys* spp. TELFORD (1989) reported a density estimate of 1125 animals/ha while LEIRS (1995) reported densities of 900 animals/ha and CHRISTENSEN (1996) reported densities of 384 animals/ha in Morogoro, Tanzania. Our densities of 3 – 162 animals/ha compare well with those obtained in studies in Kenya (ODHIAMBO & OGUGE, 2003) and Ethiopia (BEKELE & LEIRS, 1997; BEKELE, et al., 2003). These findings are however not surprising given the fact that *M. natalensis* comprised the highest percentage of rodents captured. The population dynamics of this species is known to be influenced by both density dependent and density-independent factors occurring simultaneously (LEIRS et al., 1997a). Moreover, its breeding characteristics are strongly dependent on the amount of rainfall (LEIRS et al., 1989).

Breeding activity was clearly seasonal in *M. natalensis* and *T. leucogaster* in our study with breeding females (visibly pregnant or lactating) occurring in April and May. This is consistent with literature findings from populations of these or related species where reproductive activity appears to be linked in some way to the pattern of rainfall in areas which have well-defined wet and dry seasons. Breeding commences a few months after the onset of the rains and cease during the dry season (e.g. TAYLOR & GREEN, 1976; DELANY & MONRO, 1986; LEIRS et al., 1994; MONADJEM & PERRIN, 1997). In our study, the peaks of pregnancies and lactations followed each other closely with a short time lag.

## ACKNOWLEDGEMENTS

The study was carried out in the framework of the STAPLERAT project financed by the European Union (ICA4-CT-2000-30029). We appreciate the support of Prof. R. S. Machang'u and the staff of Pest Management Centre, Sokoine University of Agriculture. We extend our thanks to Ramadhan Iddi, Khalid Kibwana, Omari Kibwana, Kevin Kessy and Claud Kavishe for their excellent field assistance.

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