POPULATION MANAGEMENT of RODENT PESTS through INTENSIVE TRAPPING inside RURAL HOUSEHOLDS in MOZAMBIQUE

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Abstract Field trials involving seventy rural households from three villages in Mozambique were established to test whether intensive daily trapping inside household-level food stores could effectively reduce rodent pest populations. The main species caught inside dwellings where food was stored were *Rattus rattus* [*alexandrinus*], comprising 74.3% of rodents caught over the year, followed by *Mastomys natalensis* (20.1%) and *Saccostomus campestris* (5.6%). Baseline surveys showed that households using 10 break-back traps caught an average of 1.2 ± 0.37 rats/day (mean ± sem). Annual trials whereby half of the selected dwellings in each village continuously trapped every day with 10 traps were able to reduce the number of rodents in their houses by 50–70% compared to the non-treatment group of farmers who only trapped for three days every eight weeks. The population reduction caused by intensive trapping was maintained over the remaining duration of the trial. Farmers who intensively trapped rodents (treatment group) caught an average 1.27 ± 0.43 rats/day, whereas non-treatment group farmers caught an average of 2.95 ± 0.71 rats/day. The number of rats and the ratio of species caught by treatment farmers varied over an annual cycle related to seasonal and anthropogenic factors. Variation in the number of rats caught among farmers intensively trapping within a village and variation among villages was significant, showing Morrumbala to have the highest rodent population density (2.7 ± 0.15 rats/day, mean ± sem) followed by Gurué (1.0 ± 0.14 rats/day) and Namacurra (0.3 ± 0.07 rats/day). Average daily trap catch initially increased in Morrumbala, then decreased as the storage season progressed, whereas populations continually decreased in Namacurra and Gurué. The average weight of rodents caught by treatment farmers was reduced by more than 30% compared to the non-treatment, falling from 69.5 ± 3.26 g to 41.9 ± 2.02 g. We conclude that intensive trapping can constrain rodent populations that utilise stored grain stocks within rural African households, thereby reducing grain losses. The implications of these results are discussed in the context of implementing ecologically-based rodent management strategies for poor rural communities in Africa.

Key Words pest management *Mastomys natalensis* population dynamics *Rattus rattus* [*alexandrinus*] *Saccostomus campestris*

INTRODUCTION

Rodents are among the most important pests affecting human food security and public health in the developing world. Their significance has increased for a number of reasons such as expanding urbanisation and the corresponding growth of peri-urban areas. Consequentially, factors such as the proximity of agricultural areas to human populations and the concentration of open sewage and human refuse are exacerbating rodent problems. Despite this, research on rodent management strategies has been relatively stagnant for several decades. Most of the ecology and control of rodent pests in rural agricultural settings concerns rodenticide use (Makundi et al., 1999; MacDonald and Fenn, 1994). However, especially in rural parts of Africa, there are several constraints to their use. Primarily, rodenticides are not affordable for the rural poor who are most affected by rodent pests. Even when rodenticides are widely available, they are often used inappropriately, leading to low efficacy and to health and environmental risks. Recently, there has

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been an increased effort to apply our understanding of rodent population dynamics to develop more ecologically-based methods of rodent management (Singleton et al., 1999).

Most households in Mozambique traditionally store their food inside their dwelling for security and spiritual reasons. However, this storage practice makes it difficult to exclude rodents from the food store, exacerbating food losses and contamination caused by rodents. Food losses based on the number of rodents caught in our research (50 to 1150 rats/year/dwelling) and estimates of the number of rats living in the roof at any one time (50-100) would conservatively indicate losses of stored food in the region of 200 to 500 kg/year/dwelling. In addition to food losses, annually recurrent outbreaks of plague (*Yersinia pestis*) occur in parts of Mozambique; however, the impact of other rodent-borne diseases such as leptospirosis (*Leptospira icterohaemorrhagiae*) remain undocumented (Hugh-Jones et al., 1995).

The development of ecologically-based rodent management strategies that are affordable and easily implemented by the rural poor of Africa could substantially improve public health and local economies. The objectives of our research have been to test management strategies that attempt to reduce rodent pest populations in rural areas. Intensive trapping has often been argued to be an ineffective management tool (Sullivan and Sullivan, 1986; Stenseth, 1981; Krebs, 1966). However, in this paper we test whether it can significantly reduce local populations under certain circumstances, particularly under the high density populations found in household level food stores.

MATERIALS and METHODS

Three villages in different districts of Zambezia Province, Mozambique, were selected for involvement in the trials, based on reports from farmers indicating rodents were a significant pest problem, particularly after harvest when crops are stored within the dwelling. The village of Zimbi in Namacurra District lies within a flat lowland rice-growing area, the village of Cozombo in Morrumbala District is found in a highland plateau maize-growing area, and the village of Insurupe in Gurué District is in a mountainous mixed forest-cropland area. Each village has approximately 200 domestic dwellings, which typically consist of a mudded timber-frame rectangle (about 4 x 5 meters) with a grass or palm-leaf thatched roof. The open-plan interior contains a raised platform where food is stored, a cooking fire, and a sleeping area for up to 8 people.

Baseline population data of rodents inside houses were obtained during April to May 1999 when farmers in each village were approached to participate in the study. This period coincided with the start of the food-storage season when their main commodities of maize and rice are harvested. Thirty farmers in Cozombo and twenty farmers in each of the other villages were asked a series of questions to determine potential anthropogenic factors influencing rodent population dynamics. At the same time, 10 break-back traps (big snap-e-trap®, Kness Manufacturing Ltd., USA) were placed in each of the dwellings along interior walls and walkways, especially in places where food is usually stored. Farmers were given individual training on the operation of the traps and instructions to set them each evening. Dwellings were visited each morning for three days to record the number of rodents caught including their sex, weight, and species type. Representative samples of species types were collected for later taxonomic identification.

After obtaining these baseline data, dwellings were randomly assigned to either the treatment or non-treatment group. Dwellings in the treatment group continued to trap with ten traps every day for the duration of the trial and were instructed to set the traps each evening as before. Treatment dwellings continued to be visited each morning to collect data on the number, sex, weight, and species type of rodents caught. All traps were collected from dwellings allocated to the non-treatment group. Every eight weeks, ten traps were redistributed to the non-treatment dwellings, and data were collected as indicated for the treatment group. After a period of three

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Susan C. Jones, Jing Zhai, and Wm H. Robinson editors. (2002)

trapping nights, the traps were re-collected from the non-treatment dwellings, with the process repeated for an entire year.

RESULTS

Taxonomic identification of the rodents trapped from all three areas showed that the main species was the house rat, *Rattus rattus* [*alexandrinus*] (74.3% of total caught). As commonly found in other rural areas in the tropics, *R. rattus* nested in the thatching of the roof. Two other species were also trapped, *Mastomys natalensis* (20.1%) and *Saccostomus campestris* (5.6%), both of which are known to make burrows in grassland areas. The numbers of each species caught varied over the year (Friedman x^2 = 84.1, df = 2, P < 0.01). Anthropogenic factors are largely responsible for the increase in the proportion of *Mastomys natalensis* caught during the months of August and September (Figure 1).

Results of the questionnaire showed that several anthropogenic factors influenced rodent populations within dwellings. The main control strategy adopted in all three areas involved removing the thatching from the roof and killing as many of the nesting rats as possible before replacing the thatch. Farmers replaced the roof thatching anytime between every six months and two years, and the frequency of roof replacement for the house was weakly correlated with the number of rats caught within the house during the baseline survey (Spearman's p = -0.45, n = 60, P < 0.05). Less than 5% of the dwellings had 1 or 2 locally-made traps for rodent control, and less than 2% of the dwellings had one or more cats. No other forms of physical or chemical control

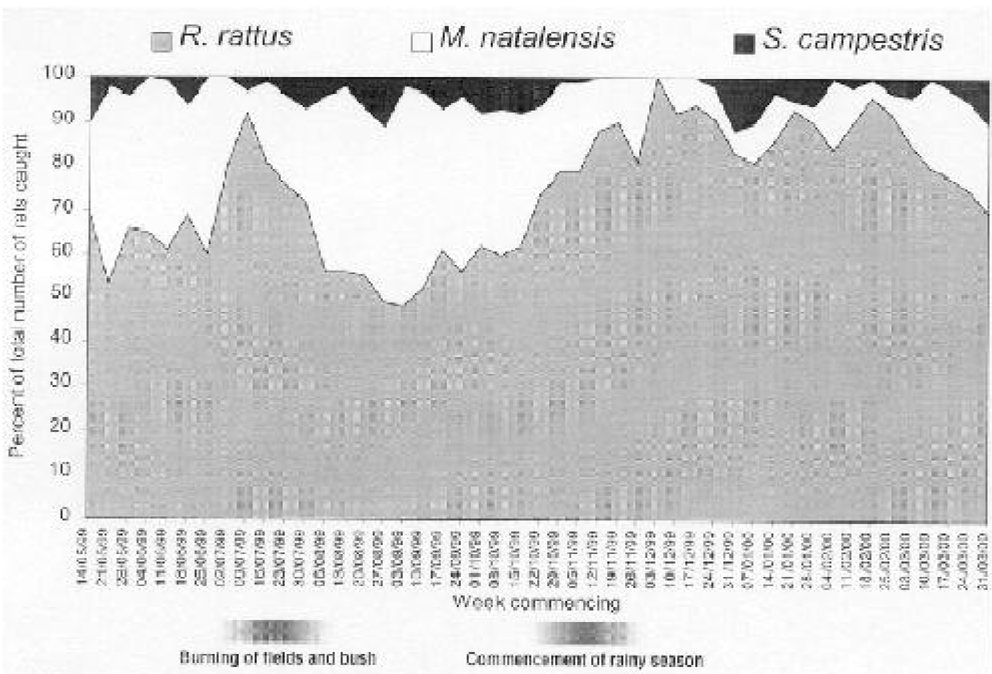

Figure 1. Species composition of rodents trapped by dwellings intensively trapping with 10 break-back traps inside their house in Morrumbala. The increase in the proportion of Mastomys natalensis *caught within dwellings during August and September is due to anthropogenic factors, mainly farmers setting fires to clear the land.*

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were used by the dwellings. Farmers consistently indicated that anywhere from 50 to 100 rats would nest in their roof at any given time, that 50-200 kg of stored food was lost to rodents, and that more than 10% of the population had been bitten by a rat in the last six months. The main anthropogenic factors influencing rodent population dynamics were considered to be the storage of all harvested food within the dwelling, the location of refuse and vegetation near to the house, the provision of open water supplies within dwellings, and the preparation and burning of fields in advance of the planting season. The cyclical effects of food storage practice and field preparation were noted to correlate with rodent populations inside dwellings in Morrumbala (Figure 2).

The number of rodents caught during the initial baseline survey did not significantly vary among dwellings within villages or among the three villages (Kruskal-Wallis, $P > 0.05$), and an average of 1.2 ± 0.37 rats/day (mean ± sem) were caught per dwelling over the three days when using 10 break-back traps. Likewise, the sex ratio and mean weight of rodents caught did not vary significantly among dwellings or villages, showing a 1 to 1.06, male to female, sex ratio and a mean weight of 69.2 ± 6.51 g.

The number of rats caught by dwellings that trapped intensively trapping (treatment group) varied temporally and spatially over the course of the trial (Figure 2). Variation in the number of rats caught among farmers within a village was significant (Table 1). Variation was also significant among villages (Kruskal-Wallis, $\chi^2 = 119.6$, df = 2, $P < 0.01$), showing Morrumbala to have the highest rodent population density (2.7 ± 0.15 rats/day, mean ± sem), followed by Gurué (1.0 ± 0.14 rats/day) and Namacurra (0.3 ± 0.07 rats/day). Regression analysis showed that rodent

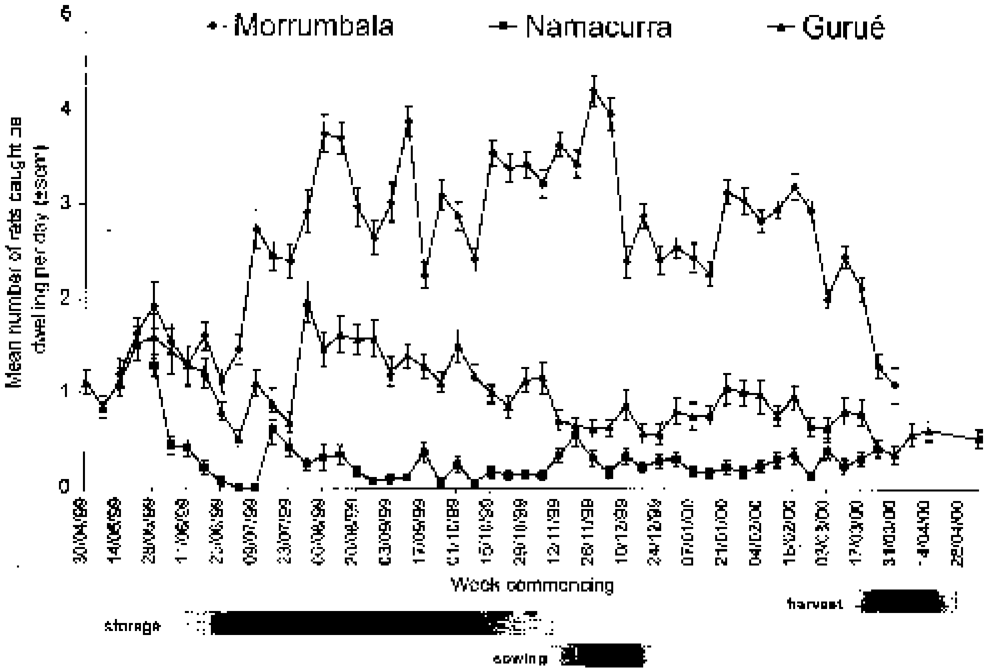

Figure 2. Mean number of rodents caught by dwellings intensively trapping on a daily basis with 10 break-back traps. Regression analysis showed that rodent populations decreased inside houses in Namacurra or Gurué as the trial progressed, whereas in Morrumbala the population increased and decreased following relative food availability patterns inside and outside the house.

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Susan C. Jones, Jing Zhai, and Wm H. Robinson editors. (2002)

Table 1. Analysis of the mean number of rats caught per dwelling per day within each area when intensively trapping with 10 traps every day over one year*

Morrumbala n = 291	Gurué n = 369	Namacurra n = 312
2.58 [a,b,c,d]	1.15 [d]	0.16 [a]
2.65 [b,c,d]	1.07 [c,d]	0.29 [b,c]
2.74 [b,c,d,e]	0.99 [b,c,d]	0.21 [a,b]
2.57 [a,b,c]	0.82 [a,b]	0.33 [c]
2.84 [c,d,e]	0.99 [b,c,d]	0.17 [a]
2.92 [d,e,f]	1.54 [e]	0.32 [c]
2.84 [c,d,e]	0.93 [b,c]	0.36 [c,d]
3.00 [e,f]	0.71 [a]	0.46 [d]
2.75 [b,c,d,e]	1.00 [b,c,d]	0.20 [a,b]
3.16 [f]	1.06 [c,d]	0.14 [a]
2.83 [c,d,e]		
2.27 [a]		
2.71 [b,c,d,e]		
2.69 [b,c,d,e]		
2.46 [a,b]		

[*] Rodents were trapped in 15 dwellings in Morrumbala and in 10 dwellings in the other two villages
N is the number of days over which trapping occurred.
Values within each column preceding the same letter are not significantly different from each other (Duncan's multiple range, P < 0.05).

populations decreased inside houses as the storage season progressed in Namacurra (inverse model, r^2 = 0.533, F = 23.4, P < 0.01) and Gurué (linear model, r^2 = 0.471, F = 29.5, P < 0.01). However, the population initially increased and then decreased in Morrumbala (quadratic model, r^2 = 0.576, F = 29.8, P < 0.01) following relative food availability patterns inside and outside the house (Figure 2).

Differences in the baseline numbers of rodents caught among treatment and non-treatment groups at each site were not significant (Mann-Whitney, P > 0.05). At the first comparison between treatment and non-treatment dwellings conducted eight weeks later, there was a significant difference between the number of rodents caught between treatment and non-treatment dwellings in Gurué (Table 2). Non-treatment dwellings caught more rats than treatment dwellings in all three areas by the time of the second comparison, and the difference in the number of rats caught between treatment and non-treatment dwellings was maintained over the duration of the trial (Table 2). The pattern of increasing difference in the mean number of rodents caught between treatment and non-treatment was similarly noted with respect to the mean weight of rodents caught. On average, rodents caught among non-treatment dwellings were significantly bigger than those caught at treatment dwellings, and this difference increased during the course of the trial (Table 3). No significant differences were noted with respect to changes in the sex ratio of rodents caught between treatment and non-treatment dwellings (Mann-Whitney, P > 0.05).

DISCUSSION

Our study showed that intensive trapping of rodents can effectively reduce their localised population densities within rural African dwellings. Although trapping is relatively labour intensive, the relatively low cost of inputs could favour the technique. At the commencement of the

Table 2. Comparison between the mean (±sem) daily number of rodents caught at treatment and non-treatment dwellings in each area when assessed over three trapping nights every two months

Assessment time	Group	Morrumbala n = 45	Gurué n = 30	Namacurra n = 30
0	Non-treatment	1.30±0.18	0.96±0.17	1.26±0.24
	Treatment	1.37±0.18	1.00±0.22	1.34±0.26
1	Non-treatment	2.43±.020*	4.00±0.33**	2.00±0.30
	Treatment	1.38±0.30	1.90±0.36	0.58±0.23
2	Non-treatment	3.90±0.26*	4.43±0.26***	2.00±0.19**
	Treatment	2.81±0.19	1.43±0.22	0.66±0.11
3	Non-treatment	5.35±0.17**	4.13±0.40***	1.95±0.20**
	Treatment	3.51±0.17	1.64±0.30	0.26±0.09
4	Non-treatment	5.75±0.22***	2.30±0.36**	1.87±0.19***
	Treatment	3.28±0.20	0.96±0.24	0.54±0.12
5	Non-treatment	4.56±0.27***	3.21±0.21***	1.78±0.21**
	Treatment	2.15±0.15	0.93±0.25	0.32±0.13

Mann-Whitney, *P < 0.05, **P < 0.01, ***P < 0.001.
N is the number of dwellings multiplied by the number of trapping nights.

intensive trapping trial, it was not known whether rodent population densities would vary among dwellings or areas. However, it was considered likely that density would be generally dependent upon food availability (Krebs, 1999; Boutin, 1990; Prakash, 1988). Thus, rodent populations should have been at their lowest inside dwellings during the harvest season when food is just beginning to be stored, and this moment was chosen for the commencement of the intensive trapping experiment. This trend was most apparent in the intensive trapping data obtained in Morrumbala, whereby a quadratic regression best represented the fluctuation in average trap catch over the year. However, it is not known to what degree populations would have increased or decreased in the absence of intensive trapping, and another less intrusive method of population monitoring would be required to obtain such data (Thomas, 1999).

Table 3. Comparison between the mean (±sem) weight of rodents caught at treatment and non-treatment dwellings in each area when assessed over three trapping nights every two months

Assessment time	Group	Morrumbala	Gurué	Namacurra
0	Non-treatment	65.3±4.86	68.2±5.21	66.7±3.54
	Treatment	67.2±3.04	66.3±4.45	67.2±3.30
1	Non-treatment	68.4±6.51*	70.5±5.00*	66.9±2.45**
	Treatment	48.5±2.34	50.7±3.89	44.3±3.21
2	Non-treatment	69.5±3.33**	69.9±2.55**	68.0±4.36***
	Treatment	41.9±1.95	42.0±2.15	42.1±3.67
3	Non-treatment	72.7±4.00**	70.6±3.67***	71.5±3.33***
	Treatment	41.6±2.36	41.2±3.40	40.0±2.85
4	Non-treatment	70.1±3.87***	68.1±3.27***	69.2±3.06**
	Treatment	37.4±2.55	40.5±2.87	48.5±2.76
5	Non-treatment	70.9±4.01***	66.4±4.06***	70.3±3.51***
	Treatment	38.4±3.55	38.8±3.63	39.4±3.86

Mann-Whitney, *P < 0.05, **P < 0.01, ***P < 0.001.

In Namacurra, the rodent population was relatively low and it appears that 10 traps used on a daily basis were able to remove rodents from the environment faster than recruitment did. This result also occurred in Gurué, although to a lesser extent, reflected by the shift to a linear regression model representing the change in the average number of rodents caught rather than the inverse regression model representing data obtained in Namacurra. However, intensive trapping was unable to progressively decrease the number of rodents caught in Morrumbala. Increasing the number of traps used per dwelling in Morrumbala might be necessary to achieve the same impact observed at the other two sites. It is likely that the overall differences among the three sites in the number of rodents caught is related to broad differences in habitat and ecology in the three areas (Ferreira and Aarde, 1999).

Despite the observed differential efficacy achieved among the three areas, intensive trapping with ten traps did constrain population growth when compared to the non-treatment dwellings in the same area. This constraint was reflected in reduced capture rates and reduced rodent weights for treatment dwellings. A reduced average weight would indicate a change in age-structure arising from reduced survival. However, it could be argued that both of these factors are explained by the development of trap-shy animals. Nevertheless, the incidence of traps going off without a rodent being caught was virtually zero over the course of the trial, mainly because the break-back trap design is extremely sensitive, catching rodents as small as 15 g. Thus it is likely that no opportunity existed for the development of trap shyness. As commonly suggested, long-term development of neo-phobia could result from an intensive trapping regime (Mathur, 1997; Barnet, 1988). However, results from the experiment indicated the sex ratio of 1.0 did not change over the trial, and a result that could suggest that neo-phobia would evolve relatively slowly (Ding et al., 1998; Kyelem and Sicard, 1996; Nunney, 1991).

The main species found, *Rattus rattus* and *Mastomys natalensis*, are known to occur in other parts of eastern and southern Africa (Fiedler, 1988). *M. natalensis* is a known carrier of plague (Gratz et al., 1997; Kilonzo et al., 1997), and its foraging inside dwellings could increase the risk of human infection. However, the degree of interactions between *R. rattus* and *M. natalensis* in these environments is unknown, and the pathways of plague transmission could be complex (Mills and Childs, 1998). Villagers in all three areas consumed rats as a significant part of their diet. Plague bacilli are known to survive for several days on dead rodents (Liu, 1991); thus the handling and preparation of rodents for food could result in plague transmission. When farmers cleared their fields by setting fires, *M. natalensis* was increasingly caught inside dwellings, as few food resources remained outside during this time. The increase in the proportion of *M. natalensis* caught roughly coincides with the annual increase in the documented cases of plague. As the trapping programme increases the number of dying rodents within dwellings and the handling of dead rodents, it is possible that such a strategy could increase plague incidence within the locality (Leirs et al., 1997). Further research is planned to determine anthropogenic and interspecific factors that impact upon plague outbreaks.

In conclusion, intensive trapping is likely to be part of any integrated and ecologically-based rodent control strategy for rural dwellings in these areas of Mozambique (Makundi et al., 1999). Further research is required to determine the optimal number of traps needed to effectively modulate rodent populations, given particular habitat and population parameters as well as to accurately measure the impact upon stored food and human health. The traps used in this experiment were highly durable, and each trap caught more than 100 rats/year with no obvious signs of wear, making traps more cost-effective than a comparable value of rodenticide use. Traps are not only more cost-effective, but they are more easily used in a safe way by rural dwellings in Africa. Further studies are planned to incorporate other rodent control strategies that can be cost-effectively and safely implemented by rural communities in Mozambique.

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REFERENCES

Barnet, S.A. 1988. Exploring, sampling, neophobia and feeding. Pp. 459-464 in Rodent pest management, ed. I. Prakash. Boca Raton, Fla.: CRC Press.

Boutin, S. 1990. Food supplementation experiments with terrestrial vertebrates: patterns, problems, and the future. Can. J. Zool. 68, 203-220.

Ding, L.S., Zhang, W.G., and Han, T.H. 1998. The relationship between population size of Myospalax baileyi and its reproductive characteristics. Acta Prataculturae Sinica 7(4), 49-54.

Ferreira, S.M., and Aarde, R.J. van. 1999. Habitat associations and competition in Mastomys-Saccostomus-Aethomys assemblages on coastal dune forests. African J. Ecol. 37(2), 121-136.

Fiedler, L.A. 1988. Rodent problems in Africa. Pp. 35-65 in Rodent pest management, ed. I. Prakash. Boca Raton, Fla.: CRC Press.

Gratz, N.G., Leirs, H., and Schockaert, E. 1997. The burden of rodent-borne diseases in Africa south of the Sahara. Belgian J. Zool. 127(1): 71-84.

Hugh-Jones, M.E., Hubbert, W.T., and Hagstad, H.V. 1995. Zoonoses: recognition, control, and prevention. Ames: Iowa State University Press. 369 pp.

Kilonzo, B.S., Mvena, Z.S.K., Machangu, R.S., and Mbise, R.J. 1997. Preliminary observations on factors responsible for long persistence and continued outbreaks of plague in Lushoto district, Tanzania. Acta Tropica 68(2): 215-227.

Krebs, C.J. 1999. Current paradigms of rodent population dynamics — what are we missing? Pp. 33-48 in Ecologically-based management of rodent pests, ed. G.R. Singleton, L.A. Hinds, H. Leirs, and Z. Zhang. Canberra, Ausralia: ACIAR Monograph.

Krebs, C.J. 1966. Demographic changes in fluctuating populations of Microtus californicus. Ecol. Monogr. 36: 239-273.

Kyelem, M., and Sicard, B. 1996. Population heterogeneity in regulation of reproduction in *Mastomys erythroleucus* (Rodentia, Muridae). Mammalia 60: 796.

Leirs, H., Verhagen, R., Sabuni, C.A., Mwanjabe, P., and Verheyen, W.N. 1997. Spatial dynamics of *Mastomys natalensis* in a field-fallow mosaic in Tanzania. Belgian J. Zool. 127 (1): 29-38.

Liu, H.W. 1991. Study on the survival of plague bacillus in rodent pelts. Chinese J. Vector Biology and Control 2(2): 114-117.

MacDonald, D.W., and Fenn, M.G.P. 1994. The natural history of rodents: pre-adaptations to pestilence. Pp. 1-22 in Rodent Pests and their Control, ed. Buckle, A.P., and Smith, R.H. Wallingford, UK: CAB International.

Makundi, R.H., Oguge, N.O., and Mwanjabe, P.S. 1999. Rodent pest management in East Africa — an ecological approach. Pp. 460-476 in Ecologically-Based Management of Rodent Pests, ed. Singleton, G.R., Hinds, L.A., Leirs, H., and Zhang, Z. Canberra, Australia: ACIAR Monograph.

Mathur, R.P. 1997. Effectiveness of various rodent control measures in cereal crops and plantations in India. Belgian J. Zool. 127: 137-144.

Mills, J.N., and Childs, J.E. 1998. Ecologic studies of rodent reservoirs: their relevance for human health. Emerging Infectious Diseases 4: 529-537.

Nunney, L. 1991. The influence of age structure and fecundity on effective population size. Proceedings of the Royal Society of London. Series B, Biological Sciences 246(1315): 71-76.

Prakash, I., ed. 1988. Rodent Pest Management. Boca Raton, Fla.: CRC Press.

Singleton, G.R., Hinds, L.A., Leirs, H., and Zhang, Z., eds. 1999. Ecologically-Based Management of Rodent Pests. Canberra, Australia: ACIAR Monograph.

Stenseth, N.C. 1981. How to control pest species: application of models from the theory of island biogeography in formulating pest control strategies. J. Appl. Ecol. 18: 773-794.

Sullivan, T.P., and Sullivan, D.S. 1986. Resiliency of snowshoe hares to population reduction. J. Appl. Ecol. 23: 795-807.

Thomas, M.D. 1999. Feasibility of using wax-blocks to measure rodent and possum abundance and changes in population size. Science for Conservation 127: 39-48.