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# THE BREEDING PATTERNS OF AGRICULTURAL PEST RODENTS OF THE KISHE SETTLEMENT AREA, SOUTHWEST ETHIOPIA

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## ABSTRACT

*A study on the breeding patterns of pest rodents was carried out for 18 consecutive months (April, 2009 to October, 20010) at Kishe settlement area, southwest Ethiopia. Both capture mark recapture (CMR) and snap trapping studies were carried out to investigate the breeding patterns of pest rodents. A total of 801 and 484 captures of rodents was made by live trapping and snap trapping methods respectively. Four rodent species were identified: Rattus rattus, Mastomys erythroleucus, Arvicanthis dembeensis and Mus mahomet from CMR study. From snap trapped rodents, all the above rodent species were identified except Mus mahomet. In both types of studies, the proportion of males and females was not different from a 1:1 sex ratio. Scrotal males and perforate females were captured throughout the study period though reproduction was seasonal. Breeding started in the later part of the rainy season and declined at the beginning of the dry season and ceased in the later part of the dry season. The average number of embryos counted per pregnant females was 6.14±1.06, 7.96±1.84 and 5.25±1.76 for R. rattus, M. erythroleucus and A. dembeensis respectively.*

***Keywords:*** Breeding, Pest rodents, Kishe settlement area, southwest Ethiopia

## INTRODUCTION

Breeding is the main reason why population size increases. Many rodent species are capable of rapid population growth when conditions are favorable. A high reproductive potential and short period to reach sexual maturity are the two main reasons of rapid population growth. Length of the gestation period, litter size, length of time between delivery and the next conception and the reproductive life of females are the main factors that affect the reproductive potential of rodents (Alpin *et al.* 2003). The fecundity of many rodents is further enhanced by postpartum or lactational estrus, which enables females to be continuously pregnant (Kay and Hoekstra, 2008).

A seasonal pattern of reproduction has been observed in rodents from widely separated parts of Africa. In eastern Africa, changes in temperature and day length are minimal. Thus, seasonal distribution and quantity of rain are considered the most important factors in determining reproduction of rodents in the region (Delany and Monro, 1986). Neal (1986) regarded water and food as the dominant factors controlling reproductive cycles throughout Africa. Taylor and Green (1976) reported that breeding often appears to reach peak during the latter part of the rainy season and to decline during the dry season. A notable exception for this conclusion is the breeding pattern of *Arvicanthis abyssinicus* on the Semien Mountains, Ethiopia. This species stop breeding during the rainy season (Muller, 1977). Studies on the major pest species in Ethiopia and Tanzania have also showed that breeding activity is highly influenced by climatic factors, especially the amount and distribution of rainfall (Makundi *et al.* 2007, Afework Bekele and Leirs, 1997, Massawe *et al.* 2007, Leirs *et al*. 1994).

Most rodents have high litter size and they have the ability to become pregnant within a few days after delivery. Afework Bekele and Leirs (1997) reported an average litter size of 5.74 ±2.65 and 7.42±2.63 for *Arvicanthis dembeensis* and 10.21±4.32 and 12.84±3.26 for *Mastomys erythroleucus* in grassland and maize fields respectively. The litter size of *Mastomys natalensis* is even higher. Studies from different localities in Kenya showed average litter size of 11-13 with a maximum of 24 young per litter (Stenseth *et al*. 2003). This high litter size is one of the major reasons why the population size increases rapidly in many pest species.

Knowledge on the breeding patterns of rodent pests is one of the basic information needed for the development of sound management strategies that can alleviate problems of rodent pests. Despite their diversity and pest status, limited work has been carried out on the breeding patterns and other ecological aspects of Ethiopian rodents (Afework Bekele, 1996a, b; Afework Bekele, *et al*., 1993; Afework Bekele, *et al*., 2003; Afework Bekele and Leirs, 1997; Tsegaye Gadisa and Afework Bekele, 2006; Manyingerew Shenkut *et al*., 2006).). In addition, most of these studies concentrated around central Ethiopia. In this study an attempt was made to gather information about the breeding patterns of pest rodents around the Kishe settlement area, southwest Ethiopia.

## MATERIALS AND METHODS

### Study area

The study was conducted in maize cultivated fields around the Kishe settlement area, Jimma Zone, southwest Ethiopia (Fig.1). Two permanent live trapping grids were established for CMR studies. Snap trapping surveys were also carried out in areas at least 200m away from the live trapping grids. The coordinates of the two live trapping grids were 07$^0$27’06.7”N, 036$^0$ 23’10.0” E for grid 1 and 070 27’19.1”N, 36$^0$ 22’.2”E for grid 2. The average altitude of the study area where the two grids were established is 1772m above sea level. The mean annual rainfall is 1719.39 mm (n=10). The mean monthly minimum temperature ranged between 12.64$^o$C in January, 2009 and 15.93 $^0$C in May, 2010 and mean maximum temperature ranged between 22.92$^o$C in June, 2010 and 27.68$^o$C in January, 2010.

## Methods

### Capture mark recapture study

Two 60mx60m permanent live trapping grids were established for CMR studies. The grids consisted of 7 parallel lines, 10m apart, with a trap station at every 10 m. Each trap station was identified with coordinates; A to G and 1 to 7. Trapping was carried out in one month interval for three consecutive days using Sherman live traps. Peanut butter was used as bait. One Sherman live trap was placed at each trapping station. During every trapping session, traps were left open once they were set though out the trapping session and checked twice a day, early in the morning (usually from 7 to 9 am) and late in the afternoon (usually from 4 to 6 pm) to avoid death of animals in the traps. Bait was replenished as necessary. Handling of rodents was carried out following techniques described in Alpin, *et al*. (2003). Captured rodents were identified following 'Ecorat Key to problem rodents in agricultural lands (www.nri.org/projects/ecorat/docs) and taxonomic characteristics described in Alpin, *et al* (2003), Yalden et *al.* (1996), Kingdon (1997) and the identification process was also supplemented by comparing voucher specimens of the captured rodents with those that are identified and preserved in Zoological Natural History Museum, Addis Ababa University, Ethiopia. The captured animals were marked by toe-clipping code before they were released at the point of their capture. Species type, sex, the date of capture, grid number, the coordinate of trap station, toe-clipping code (identification mark), sexual condition and body weight (using Pesola spring balance ) were recorded. When animals were recaptured, no new code was given.

### Snap trapping

Monthly Snap trapping was carried out using Victor rat traps. Traps were set up in lines at least 200m far from the live trapping grids. Peanut butter was used as bait. Traps were set 5-10m distance and the number of traps in a line varied depending on the size of the field to be surveyed. To increase the trap success, the traps were set along the edges of cultivated fields or in cultivated fields where possible rodent refugia are available or where there were visible runways as rodents use specific paths (Kingdon, 1974: Alpin et al. 2003).

### Assessing reproductive activities

After collecting the captured animals, reproductive activities were assessed both from external and internal characteristics of reproductive organs. In CMR studies, reproductive activities were assessed from external signs of reproductive organs (Alpin *et al.* 2003). In males sexual maturity or immaturity was assessed from the conditions of the testes and the scrotal sacs. Captured animals were considered juveniles if their testes were non-descended or had undeveloped scrotal sacs and they were considered sub-adults, if testes were partially descended (the scrotal sac is visible but not to the full extent, general). Rodents that possessed fully descended testes were considered as adults. In female rodents, the external signs of sexual maturity or immaturity were assessed from the condition of the vagina and the teats. Females that were with an open vagina and enlarged teats were considered as adults. A female rodent was considered as currently lactating if the teats were enlarged and the mammary glands were active (produce milk).

Reproductive activities from internal characteristics were assessed for snap trapped rodents. A male rodent was considered as sexually mature if it possessed large testes, each with a prominent blood supply and enlarged epididymis with highly convoluted sperm filled tubules. Female rodents were considered as reproductively active if they possessed perforate vagina, were pregnant or lactating. The number of embryos in each uterine horn were counted and recorded for pregnant females. After assessing reproductive characteristics both internally and externally, commencement and cessation of the breeding season were assessed from percentage of pregnant females and percentage of reproductively active individuals at different seasons.

## RESULTS

### Sex Ratio and Reproductive Seasons

Among 250 rodents captured in grid 1 during the first cropping season, 119(47.6%) were males and 131(52.4%) were females. This proportion was not significantly different from 1: 1 sex ratio ($X^2$= 0.576, DF= 1, P (0.448) > 0.05). Similarly, out of 340 rodents captured in the live trapping grids during the second cropping season, 160 (47.06%) were males and 180 (52.94%) were females which was also not statistically different from a 1:1 sex ratio ($X^2$ = 1.176, DF=1, P (0.278) >0.05).

Scrotal males and perforate females were captured throughout the study period. However, there were variations in the percentage of scrotal males and perforate females in different trapping sessions (table 1). Generally, the percentages of scrotal males and perforate females were high before September and after December.

During snap trapping surveys, a total of 96 R. rattus, 41 A. dembeensis and 107 M .erythroleucus females were captured. Among these, 21 R. rattus, 12 A. dembeensis and 25 M. erythroleucus were pregnant. Although the percentages of scrotal males and perforate females captured were very high throughout the study period, pregnant females were captured in June for R. rattus and A. dembeensis and few pregnant females of M. erythroleucus in May (Figures 2 and 3). The highest percentage of pregnancy was recorded in August for all the three species. No pregnant females were captured after November for R. rattus and M. erythroleucus and after October for A. dembeensis until pregnant females of R. rattus and A. dembeensis were captured in June, 2010 of the second cropping season (Figures 4 and 5).

### Litter size

The average number of embryos counted for R. rattus was 6.14 ± 1.06. The number of embryos counted per pregnant female ranged between four and eight. Embryo counts of six and seven were the most frequently encountered while that of eight was the least encountered embryo count (Figure 6). For M. erythroleucus the average litter size recorded was 7.96 ± 1.84. The maximum and minimum numbers of embryos counted per pregnant female were twelve and four respectively (Figure 7). Embryo counts of seven and eight were the most frequently occurring and embryo counts of four, five and 12 were the least frequently encountered. For A. dembeensis the mean number of embryos counted per pregnant female was 5.25 ± 1.76. The maximum number of embryos counted per pregnant female was eight and the minimum was two

## DISCUSSION

Detection of pregnancy using palpable embryos requires experience and even the highly experienced worker fail to detect pregnancy at early stage (trimester 1) of pregnancy (Alpin *et al*., 2003). Thus, to avoid biases in calculating pregnancy rates, discussions of reproductive activity from the results of CMR study were made based on the proportion of reproductively active individuals in different trapping sessions. Generally, scrotal males and perforate females were captured throughout the study period. But, the proportion of scrotal males and perforate females was lowered in some trapping sessions during both cropping seasons (Table 1). For *R. rattus* and *A. dembeensis*, the proportion of scrotal males was lowered from September to December due to the addition of young individuals into the population and in the remaining months the proportion remained high. For *M. erythroleucus the* reduction in the proportion of scrotal males started in the month of July during the first cropping season and September during the second cropping season. A similar pattern of fluctuation in the proportion of perforate females was observed for the above three species. From the variation in the proportion of scrotal males and perforate females observed, one could say that these species must have started breeding before the months when reduction in proportion of reproductively active individuals was observed and the new born individuals of both sexes have reached a trappable size at this month. The high proportion of scrotal males and perforate females after December suggests that all the new born individuals that entered to the population have become adults and breeding has ceased. If breeding has continued, the addition of juveniles into the population continues but this did not happen. In general, it is possible to say that breeding for these three species is restricted to the wet season, especially to the later part of the rainy season and ceases in the dry season. This finding is in agreement with many research results obtained in many rodent pest species in other areas (Afework Bekele and Leirs, 1997; Tsegaye Gadisa and Afework Bekele, 2006; Odhiambo *et al*., 2005; Leirs *et al*., 1994; Makundi *et al*., 2007; Lima *et al.*, 2003). The variation in the proportion of scrotal males and perforate females was not clear for *M. mahomet*. Low proportion of scrotal males and perforate females was observed in different months (table 1). Juveniles were added to the population at different months indicating that breeding in this species might be year round.

The results of snap trapping surveys were also not different from that of CMR studies. Although the percentage of scrotal males and perforate females was very high in most of the months, pregnancy for the three snapped species was detected only from May to November. The first pregnant females were captured in May for *M. erythroleucus* and June for *A. dembeensis* and *R. rattus during* the first cropping season. For all the three species pregnancy was detected in June during the second cropping season for the first time. Rate of pregnancy has reached peak in August and declined towards the dry season and the last pregnant females were captured in November. From this it is possible to say that breeding commences from the middle of the rainy season and continues up to the early dry season. Such restrictions of breeding to the wet season for many rodent species have been reported by different workers in many different areas (Afework Bekele and Leirs, 1997; Tsegaye Gadisa and Afework Bekele, 2006; Odhiambo *et al*., 2005; Leirs *et al*., 1994; Makundi *et al*., 2007; Lima *et al.*, 2003).

The results of the snap trapping surveys could also explain why the proportion of scrotal males and perforate females varied in different trapping sessions. The high percentage of scrotal males and perforate females before September and after December can be explained differently. The high percentages obtained before September were because breeding has started in June and the highest percentage of pregnant females was captured in August, and thus, the number of juveniles that could enter the population before September would be very small so that the percentage of scrotal males and perforate females in the population would be very high. But, the high percentage after December would have a different reason. In a month before December, the percentage of scrotal males and perforate females was relatively lower because of the presence of juveniles an sub-adults in the population. The high percentage after December could be because the juveniles that were present in the population had become adults and no juveniles could enter the population as breeding has ceased in the early dry season.

The average number of embryos counted (7.96 ±1.84) in this study for *M. erythroleucus* was lower than the average number of embryos obtained (10.21 ± 4.32 for grassland and 12.84 ± 3.26 for maize field) by Afework Bekele and Leirs ( 1997) at Koka ( central Ethiopia). It was also lower than the average number of embryos obtained (11.8 ± 3.4) for the same species by Duplantier *et al.* (1996) in Senegal. On the other hand the average number of embryos counted for *A. dembeensis* in this study (5.25 ±1.76) is higher than those (4.2± 2.2) obtained by Tsegaye Gadisa and Afework Bekele (2006) at Bilalo (southeast Ethiopia) for the same species but comparable with the ones obtained ( 5.74±2.65) by Afework Bekele and Leirs (1997) for grassland at Koka. But in the same study Afework Bekele and Leirs (1997) obtained a higher number of embryos (7.42± 2.63) for maize field. The average litter size (5.85±0.34) obtained by Massawe *et al*. (2007) for *A. neumanni* (a related species) in central Tanzania is comparable with the average litter of *A. dembeensis* in this study. The average number of embryos (6.14 ± 1.06) obtained for *R. rattus* was higher than the average number of embryos (5.2) recorded by Tamarin and Malecha (1972) for Rattus rattus in Hawaii and average litter size of 4.95 obtained for ship rats in northern Tavaruas by Innes (1979).

## REFERENCE

1. Aplin, K.P., P. R. Brown, .J. Jacob, C.J. Krebs, and Singleton,G.R. (2003) Field methods for rodent studies in Asia and the Indo-Pacific. Australian center for international agricultural research. Monograph100.ACIAR,Canberra, Australia.223pp
2. Amera, T. and Abate, A. (2008) Assessment of the pesticide use, practice and hazards in the Ethiopian rift valley. Africa stockpiles programme Research paper, 61 pp.
3. Bekele, A., E. Capanna, M. Corti,, L.F. Marcus and Schlitter, D.A. (1993).Systematic and geographic variation of Ethiopian Arvicanthis (Rodentia, Muridae). J. Zool., London. 230: 117-134.
4. Bekele, A. (1996a). Population dynamics of the Ethiopian endemic rodent Praomys albipes in the Menagesha State Forest. J. Zool., London. 238: 1-12.
5. Bekele, A. (1996b). Rodents of the Menagesha State Forest, Ethiopia, with an emphasis on the endemic Praomys albipes (Ruppell 1842). Tropl. Zool. 9: 201- 212.
6. Bekele, A., and Leirs, H. (1997). Population ecology of rodents of maize fields and grassland in central Ethiopia. Belg. J. Zool. 127: 39-48.

7. Bekele, A., H. Leirs and Veshagen, H. (2003). Composition of rodents and damage estimates on maize farms at Ziway, Ethiopia. In: Singleton G.R, Hinds L.A, Krebs

8. C.J and Spratt DM (Eds). Rats, mice and people: rodent biology and management. Canberra, Australia: ACIAR. pp 301–03.

9. Delany, M.J. and Monro,R.H.(1986) Population dynamics of Arvicanthis niloticus (Rodentia, Muridae) in Kenya. J.Zool. London 188: 451-475

10. Duplantier, J.M, L. Granjon and Bougalaly, H. (1996) Reproductive characteristics of three sympatric species of Mastomys in Senegal, as observed in the field and captivity. Mammalia, t. no 4, 629-638.

11. Gadisa, T. and. Bekele, A. (2006) Population dynamics of agricultural rodent pest of the Bilalo area, Arsi Ethiopia. Ethiopian J. Biol. Sciences 5(1): 63-74.

12. Innes, J.( 1979). Diets and reproduction of Ship rats in the Northern Tavaruas. New Zealand J.Ecol. 2: 85-86.

13. Kay, E.H., and Hoekstra, H.E. (2008) Rodents. Current biology. 18(10): R406-R410

14. Kingdon, J. (1974). East African Mammals: An Atlas of Evolution in Africa II (b) Rodents and Hares. Academic Press, London.

15. Kingdon, J. (1997) Field Guide to African Mammals. Harcourt Brace and Company Publishers, London.

16. Leirs, H., Verhagen, R. and Verheyen, W. (1994) The Basis of reproductive seasonality in Mastomys rats (Rodentia: Muridae) in Tanzania. J. Trop. Ecol. 10: 55-66.

17. Lima, M,, N.C.Stenseth, H. Leirs, and F.M. Jaksic,(2003). Population dynamics of small mammals in semi-arid regions: a comparative study of demographic variability in two rodent species. Proc. R.Soc. Lond.(B) 270: 1997-2007.

18. Makundi, R.H., Massawe, A.W., and Mulugu, L.S. (2007) Reproduction and population dynamics of Mastomys natalensis Smith, 1834 in agricultural landscape in the western Usambra Mountains, Tanzania. Integrative zoology.2: 233-236

19. Shenkut,M., Mebratie, A., and Balakrishnan, M. (2006) Distribution and abundance of rodents in farmlands: A case study in Alleltu Woreda, Ethiopia. SINET: Ethiopian Journal of Science 29: 63-70.

20. Massawe, A.W., Mrsso,F.P., Makundi, R.H., and Mulugu, L.S.( 2007) Breeding patterns of Arvicanthis neumani in central Tanzania . Afr.J. Ecol.46: 320-324. New Zealand J. Ecol. 19 (1): 19-27.

21. Muller, J.P. (1977) Population okologie von Arvicanthis abyssinicus in der grassteppe des Semien Mountains National Park (Athopien). Z.Saugetierk., 42 : 145-172.

22. Odhiambo, R., R. Makundi, H.Leirs and Verhagen, R (2005) Community structure and seasonal abundance of rodents of maize fields in southwestern Tanzania. Belg. J. Zool., 135 (supplement): 113-118

23. Stenseth, N.C., H. Leirs, A. Skonhoft, S.A. Davis, P.P. Pech, H.P. Andreassen,

24. G.R. Singleton, M. Lima, R.M. Machangu, R.H. Makundi, Z. Zhang, P.B. Brown, D. Shi and X. Wan. (2003) Mice and rats: the dynamics and bioeconomics of agricultural rodent pests. Ecol. Environ.1 (7)

25. Sutherland, H. M. (1996). Ecological census techniques. Cambridge University Press.

26. Tamarin, R.H. and Malecha, S.R.( 1972) Reproductive parameters in Rattus rattus and Rattus exulans of Hawaii, 1968 to 1970. J. Mamm. 53(3): 513-528.

27. Taylor, K.D. and Green, M.G. (1976) The influence of rainfall on diet and reproduction in four African rodent species. J. Zool. London 180: 367-389.

28. Tubin, M.E., and Fall, M.W. (2004) Pest control: Rodents, in agricultural societies, from encyclopedia of life support systems (EOLSS), developed under the Ausspices of the UNESCO, Eolss publishers, Oxford, UK, [http:/ www.eolss.net]

29. Williams, G.M. (993) Techniques and field work in ecology. Collins Educational. London.

30. Yalden, D.W., M.J.Largen, D.Korck and Hilman,J.C. (1996) Catalogue of the mammals of Ethiopia and Eritrea. 7. revised checklist, zoogeography and conservation. Tropical zoology 9: 73-164.

**Table 1.** Percentage of scrotal males (SM) and perforate females (PF) of each species captured in the live trapping grids (grid 1 and grid 2 combined)

| Trapping session | R. rattus | | M. erythroleucus | | A. dembeensis | | M. mahomet | |
|---|---|---|---|---|---|---|---|---|
| | S M | PF | SM | PF | SM | PF | SM | PF |
| Apr,09 | 100 | 100 | 100 | 100 | 100 | 100 | 80 | 100 |
| May,09 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Jun,09 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Jul,09 | 100 | 100 | 83.33 | 85.71 | 100 | 100 | 66.67 | 66.67 |
| Aug,09 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Sept,09 | 73.33 | 60 | 81.25 | 78.75 | 80 | 80 | 100 | 100 |
| 0ct,09 | 58.33 | 61.54 | 60.86 | 58.33 | 66.67 | 71.43 | 75 | 60 |
| Nov,09 | 75 | 80 | 66.67 | 64.29 | 66.67 | 66.67 | 75 | 75 |
| Dec,09 | 62.50 | 80 | 71.43 | 71.43 | 100 | 100 | 100 | 100 |
| Jan,10 | 100 | 100 | 100 | 100 | 100 | 100 | 50 | 66.67 |
| Feb,10 | 100 | 100 | 100 | 100 | ? | 100 | 100 | 100 |
| Mar,10 | 100 | 100 | 100 | 100 | ? | 100 | 100 | 100 |
| Apr,10 | 100 | 100 | 100 | 100 | 100 | 100 | 80 | 75 |
| May,10 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 83.33 |
| Jun,10 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Jul,10 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Aug,10 | 100 | 100 | 100 | 80 | 100 | 100 | 100 | 100 |
| Sept,10 | 83.33 | 75 | 85.71 | 76.47 | 83.33 | 75 | 80 | 80 |

Legend

= Kishe settlement area

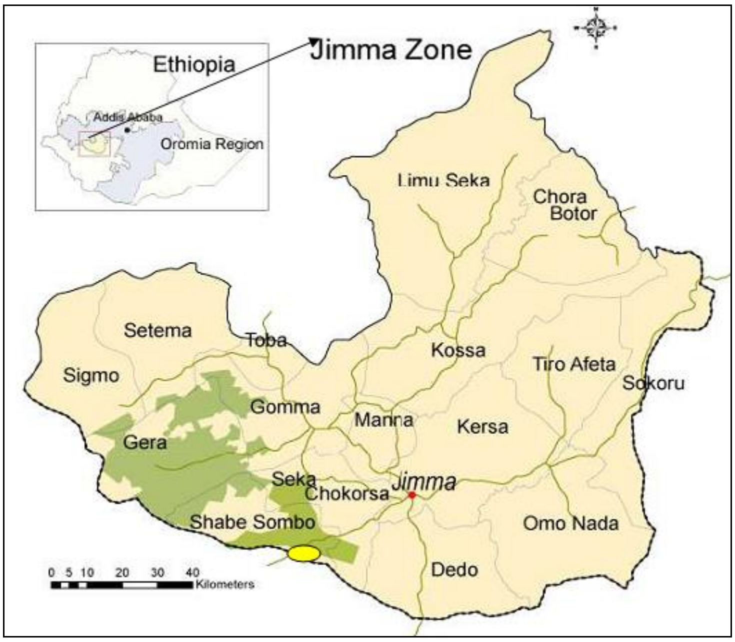


**Figure 1.** Map of Ethiopia, Oromia regional state and Jimma zone with the study area indicated

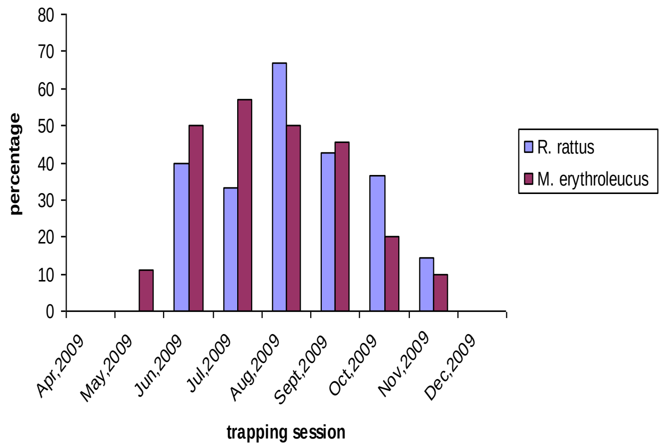


**Figure 2.** Percentage of pregnant females of *Rattus* and *Mastomys* captured by trapping during the first cropping season

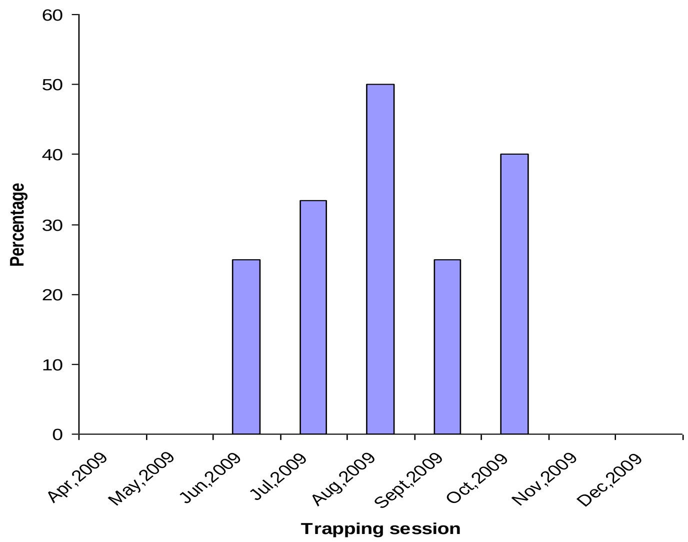


**Figure 3.** Percentage of pregnant females of *A. dembeensis* captured by snap trapping during the first cropping season

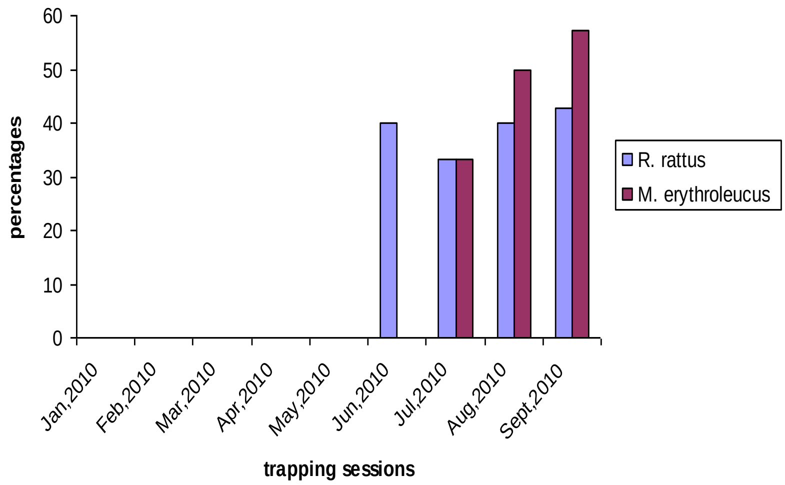


**Figure 4.** Percentage of pregnant females of Rattus and Mastomys captured by snap trapping during the second cropping season

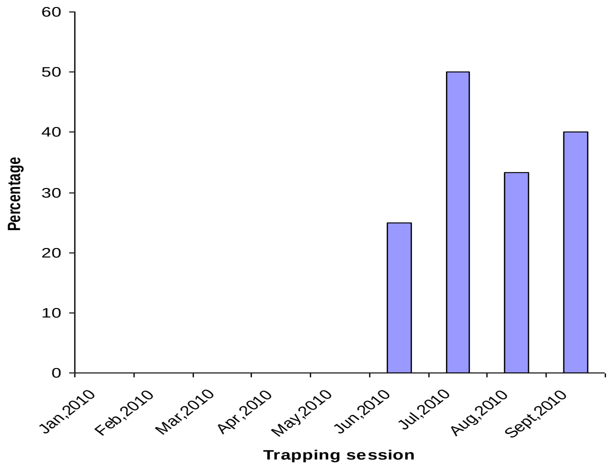


**Figure 5.** Percentages of pregnant females of *A. dembeensis* captured *by* snap trapping during the second cropping season of the study period.

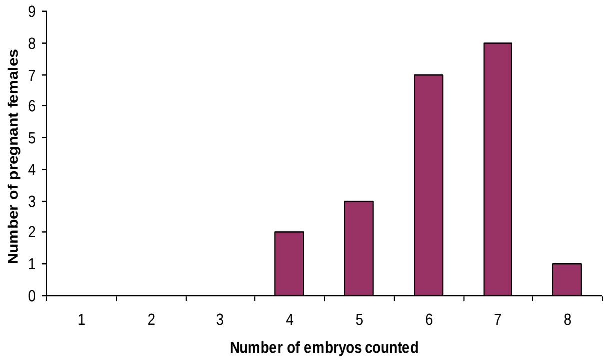


**Figure 6.** Distribution of litter size of pregnant females of *R. rattus*

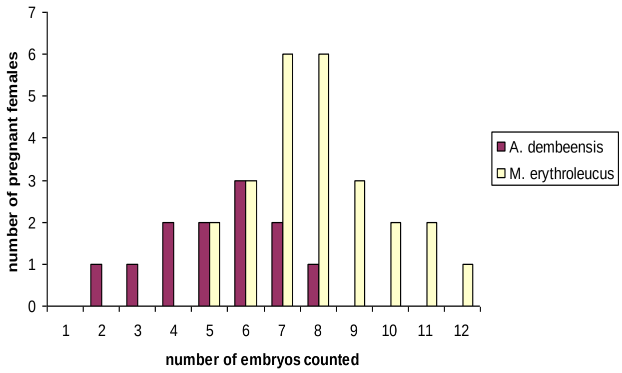


**Figure 7.** Distribution of litter size of pregnant females of *A. dembeensis* and *M. erythroleucus*