ECOLOGICAL STUDIES ON THE FAT MOUSE *STEATOMYS PARVUS CUPPEDIUS* (RODENTIA: MURIDAE) IN GHANA: POPULATION AND REPRODUCTIVE BIOLOGY

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Summary

A population of *Steatomys parvus cuppedius* (Coetzee), recently reported south of the Guinea Savanna of West Africa for the first time, was studied on an abandoned farmland in the forest region of Ghana over a period of 1 year. The population size showed single peak which was mainly caused by an influx of immigrants. Population density ranged from 9.5 to 44.3 animals per ha. Males and females had mean minimum longevities of 3.2 and 3.8 months, respectively, but true longevities may have been in excess of 8 months. Females and males matured at about the same body weight (26.1g and 27 g respectively). Females were in breeding condition in most months of the year with a peak at the beginning of the rainy season: males were, however, in breeding condition throughout the year without any evidence of seasonality. Mean litter size was 4.0 ± 0.85 (S.E.) and the mean number of litters per female per year was 3.4.

Introduction

The first report of *Steatomys parvus cuppedius* in Ghana and its invasion of the forest region south of the Guinea Savanna has been reported by Yeboah (1988). In West Africa *Steatomys parvus cuppedius* has previously been reported only north of the forest zone at Kano in the Sudan Savanna Zone of Nigeria and at Gangara in the Niger Republic, within the Sahel Savanna Woodland (Rosevear, 1969). Rosevear examined the scanty information available on the species and concluded that nothing definite has been recorded of its habits.

The present paper describes the population and reproductive biology of *Steatomys parvus cuppedius* occurring on an abandoned farmland at Suhum in the forest region of Eastern Ghana (latitude 6° 10' N, longitude 0° 25' W) over a period of 1 year.

Experimental

Steatomys parvus cuppedius (Coetzee) were trapped with live-traps (Sherman's type traps manufactured in Aberdeen) and break-back traps in a similar habitat about 300 m away. In the live-trapping area a grid of 190 trap sites was laid out in 19 rows of 10 traps at a spacing of 8 m; 30 break-back traps were distributed randomly in the habitat. Traps were baited with a combination of dried maize, a slice of banana, and a small slice of cassava (*Manihot utilisima*). The traps were inspected twice daily at 0600-0800 h and 1700-1830 h. Trapping lasted for one year with twelve trapping sessions, each session covering the first 3 weeks of the month (the first week for live-trapping and the second and third weeks for break-back trapping).

Reproductive organs obtained from break-back trapping were stored in Bouin's solution and, thereafter, washed several times in 70 per cent ethanol. The uteri were then dissected out and the foeti removed, counted, blotted dry and weighed. Since post-partum oestrus was observed in some females, placental scars were not counted.

Histological sections were made from the testes and 'tails' of the epididymes to monitor sexual activity. The testes were examined for the pres-

ence or absence of mature spermatozoa. The weight of the smallest male that had mature spermatozoa in its testes was taken as the lowest maturity weight.

For the epididymis a subjective assessment of the relative quantities of stored spermatozoa in cauda epididymis was made. Individuals with the entire lumen of a majority of the cauda epididymis tubules filled with spermatozoa were classified as Grade 1. Those with between 50-100 per cent of the lumen of a majority of the epididymis tubules filled were placed in Grade 2, and those with less than 50 per cent filled classified as Grade 3.

In females the least body weight of sexually mature animals was determined by deducting the weight of the embryos carried by a pregnant individual from its pregnant body weight.

The monthly proportion of pregnant adult female was used as a measure of the number of litters produced per female. For example, if in a particular month 50 per cent of the adult females were pregnant it was taken that every adult female produced or contributed half a litter (0.5) that month. The sum of all estimated monthly litters produced per female was assumed to be equivalent to the number of litters produced during the breeding season.

An alternative method, using the number of times marked females trapped more than once became pregnant over the study period was also used for comparison. The latter method is, however, a function of how often the individual female is caught.

Results

Population estimates were made from live-trapping recapture data using Jolly's stochastic method (Jolly, 1965). Because of the nature of the method, no population size estimates were possible for the first and last trapping sessions. Whenever necessary references were made to the actual numbers captured during these months (Table 1).

TABLE 1

Number of individuals caught each month on the live-trapping grid on the farmland and Jolly's estimates of population sizes of Steatomys parvus cuppedius

Month	*No. of individuals caught*	*Jolly's estimates S.E*
1986		
M	7	
A	14	24 (10.8)
M	16	14.4 (1.%)
J	20	17.6 (1.3)
J	26	24.8 (1.0)
A	28	28.2 (1.0)
S	28	54 (10..3)
O	26	28.8 (3.9)
N	22	26.8 (1.0)
D	20	18.8 (1.1)
1987		
J	12	11.6 (0.6)
F	8	-

Monthly variations in population size. The population density of *Steatomys parvus cuppedius* occurring in the live-trapping grid on the farmland was low throughout the year and varied from 9.5 animals per ha in March 1986 to 44.3 animals per ha in September 1987. The seasonal pattern of the estimated population size showed a single peak in September (Fig. 1), the minor rainy season.

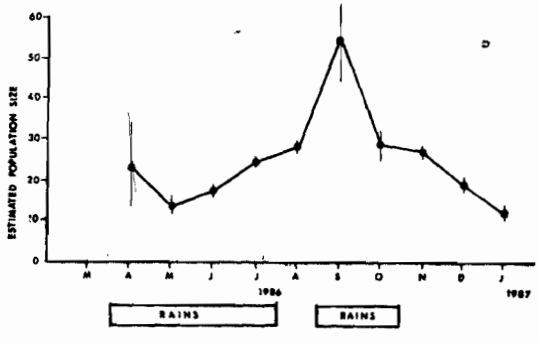

Fig. 1. Monthly changes in the estimated population size of *Steatomys parvus cuppedius* based on Jolly's (1965) method, Vertical lines represent standard error (one on each side) associated with the estimates.

Except in March when juveniles formed 33 per cent of the sample, the proportion of juveniles in the population was generally low throughout the year ranging from 0-15 per cent. No juveniles were obtained in July to September, and January to February, the main dry season.

Monthly changes in biomass. The monthly changes in the estimated biomass are shown in Fig. 2. The biomass varied from a minimum of 319 g/ha in January to a maximum of 1650 g/ha in September. The monthly mean over the period was 629.6 g/ha. Biomass was generally low for most of the year. A single peak in biomass occurred in September and was immediately followed by a decline in October.

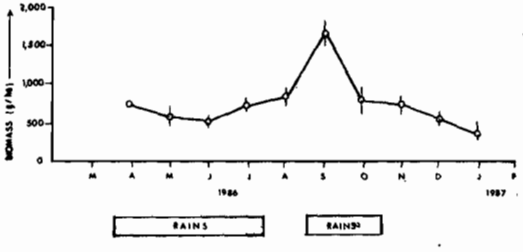

Fig. 2. Monthly changes in standing crop biomass of *Steatomys parvus cuppedius* on the farmland based on the population estimates by Jolly's (1965) method. Vertical lines represent standard errors (one on each side) associated with the estimates.

Minimum longevity. Minimum longevity was calculated as the length of time in months between first and last captures of individual animals. Males and females of the 'resident' population (individuals caught in more than one trapping session) had mean longevities of 3.2 and 3.8 months, respectively. The difference between these values was not significant (t -test, $P > 0.1$). Mean longevity estimates for both sexes including 'nonresidents' was 3 months. One female, pregnant when first caught, had the greatest longevity of eight months and was still alive at the end of the last trapping session. Resident mice formed 51 per cent of the trappable population.

Reproductive biology

The relationship between the proportion of spermatozoa stored in the tubules of the epididymis (classified as Grade 1, 2 and 3), and testes weight of individuals were plotted (Fig. 3) to determine whether the animals in category 2 (no category 3 males were found) were young adults, or alternatively mature adults in breeding condition but whose epididymis tubules were not completely filled with spermatozoa because

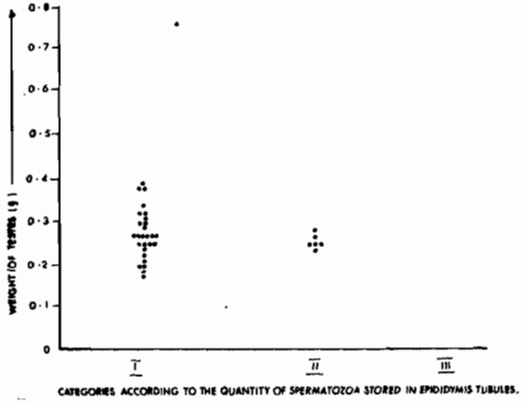

Fig. 3. The relationship between testes weight and the amount of spermatozoa stored in the epididymis of *Steatomys parvus cuppedius*. I = Epipidymis tubules filled with spermatozoa; II = Epipidymis tubules at least half- filled but not completely filled with spermatozoa; III = Epipidymis tubules less than half - filled with spermatozoa.

of their high level of sexual activity prior to capture.

On the basis of this analysis which showed that there was no significant difference between the weight of the testes of those in categories I and 2 (t - test, $P > 0.05$; Fig. 3) individuals in categories I and 2 were regarded as adult males in 'effective' breeding condition. As an alter-

nate indication of male breeding seasonality the weights of paired testes, epididymes and seminal vesicles of each adult male were expressed as percentages of body weight and plotted against months of the year (Fig. 4).

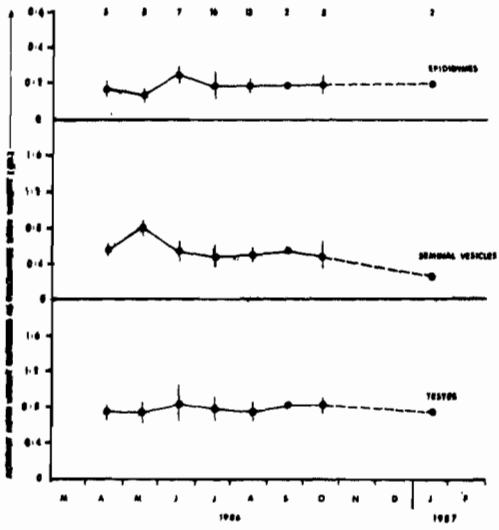

Fig. 4. Monthly changes in the weights of the reproductive organs of adult *Steatomys parvus cuppedius* (≥ 27 g) caught by break-back traps on the farmland. Sample sizes of the adult males are shown above the curves. Vertical lines represent one standard error on each side of the mean.

Sex ratio and maturity size. Although females appeared to outnumber males during the second half of the main dry season (January to March), the overall sex ratio (53.8 : 46.2) did not differ significantly from the expected 50:50 ratio (χ^2=0.8 P>0.05).

Females and males matured at about the same body weight; 26.1g and 27 g, respectively. These weights corresponded to 76.3 and 78.3 per cent. respectively, of the mean female and mean male body weights. One female showed signs of pregnancy for the first time at the age of 3 months.

Monthly changes in the weights of testes, epididymes and seminal vesicles. The available information on the weights of the testes, epididymes and seminal vesicles showed little variation throughout the year (Fig. 4).

Adult males were caught in only eight of the 12 trapping sessions (i.e. from April to October 1986, and January 1987 - covering the beginning to the end of the rains and one month in the dry season), and all of them were in 'effective' breeding condition (i.e. categories 1 and 2). It is probable that the potential breeding season for males lasts throughout the year considering that no adult male was caught in the other four trapping sessions.

Monthly changes in the percentage of pregnant or lactating females. Fig. 5 shows data on the monthly proportion of pregnant and/or lactating females on the farmland. With the exception of January, February and March, the peak of the main dry season, at least 50 per cent of the adult females trapped were pregnant or lactating each month throughout the year. Only non-reproductive and lactating females were caught in January, and the small sample obtained in February and March were not reproductively active.

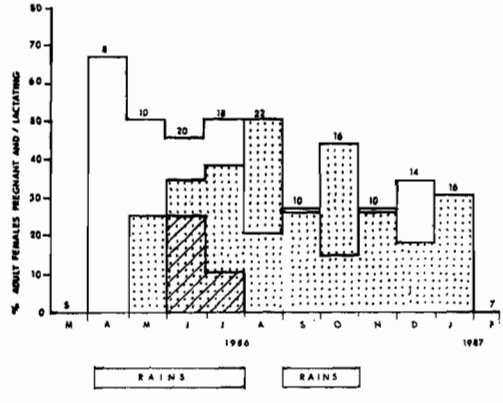

Fig. 5. Monthly changes in percentages of adult females of *Steatomys parvus cuppedius* (> 26 g) pregnant (open histogram) or lactating (hatched histogram). The number of adult females caught(by both break-back and line trapping) are shown above the histogram = both pregnant and lactating.

It is possible, therefore, that breeding contin-

ues from April (when only pregnant females were caught) through to January. The proportion of pregnant or lactating females was high from April to August, the major rainy season (Fig. 5).

Three female specimens were found to be both pregnant and lactating indicating postpartum oestrus. More than half of the females which were caught and found to be pregnant more than once in the breeding season appeared to be pregnant from month to month without signs of lactation. This probably indicated that a high proportion of the pregnancies or litters were unsuccessful.

Litter size and number of litters per female. The corrected number of embryos (after 6% reduction to take account of resorption; Neal, 1967) found in the uteri of females (regarded as estimates of litter size (Neal, 1967; Delany, 1971) ranged from 4 to 6 with a mean of 4 ± 0.85 (S.E.). The number of litters per female per year based on the proportion of adult females pregnant each month was 3.4; the equivalent value based on the mean number of times marked females caught more than once were found to be pregnant during the breeding season was 2.5. ± 1.9 (S.E.). One female was found to be pregnant in eight of the 12 trapping sessions.

Discussion

Steatomys parvus cuppedius attain maximum population size in September but it is difficult to relate juvenile captures to trends in population size since very few juveniles were caught. This low catch of juveniles may be related to the low mechanical efficiency of the live-traps in trapping individuals less than 10 g body weight; most juveniles weighed less than 10 g. In view of the fact that juveniles were absent in the September catch, the peak numbers at this time may be due primarily to immigration into the study area. The reason for such an influx cannot be easily explained since the quality and quantity of the bait remained the same throughout the study period. The pattern of the changes in the biomass was similar to that of the population size. This is because adults formed a greater part of the catch each month of the year.

Breeding in female *S. parvus cuppedius* was possible in most months of the year but with peak reproductive activity at the beginning of the major rainy season in April. There have been very few studies on *S. parvus cuppedius* and, therefore, it is very difficult to make comparisons. Nothing definite has been recorded of habits but three of the five specimens collected by Buchanan (Rosevear, 1969) at Kano in late December were juveniles. On the basis of this Rosevear (1969) assumed that the dry season is a favoured breeding time.

Rosevear also suggested that since the solitary specimen Buchanan collected from Gangara in the middle of May was also juvenile, there may be two litters in the dry season. This is contrary to the present findings which suggest that the beginning of the rainy season is the much favoured peak breeding time. However, this difference need not be emphasized because Rosevear (1969) made his suggestions on the basis of the random collection made by Buchanan.

The present study suggests that with the possible exception of March and April, when no lactating individual was trapped, juveniles are to be found throughout the year and, therefore, the December and May collections by Buchanan were not unexpected although they did not necessarily reflect periods of peak breeding.

Since the gestation period in *S. parvus cuppedius* was approximately 1 month it follows that most of the females would litter between the peak of the major rainy season and the start of the minor rainy season. In mammals an adequate supply of food for both the lactating mother and young is essential for successful breeding, and the natural provision of this resource is to a greater extent dependent on rainfall. During the end of the dry season and the beginning of the major rainy season random sam-

pling indicated that there was less food in the habitat, especially insects which formed a greater proportion of the diet of *S. parvus cuppedius*. This coincided with the lowest occurrence of lactating females. At the peak of the rains insects were abundant and this coincided with the peak breeding season. Males were in breeding condition throughout the year without any clear-cut evidence of seasonality, suggesting that males were probably not involved in the regulation of timing of reproduction.

The mean litter size in *S. parvus cuppedius* was 4. Each female was capable of producing an average of 3.4 litters per year. All these suggest a fairly high reproductive potential in the species. But the fact that some females were repeatedly found to be pregnant without any signs of lactation suggests that many pregnancies or litters were unsuccessful in the habitat.

Although this study has highlighted various aspects of the population and reproductive biology of *S. parvus cuppedius* in Ghana, several areas need further investigation that will help to elucidate the present findings. More quantitative information is required on the food and feeding habits and the seasonal availability of this resource. Factors affecting pregnancy success must also be investigated. Confined populations of the species should be studied to provide a more reliable information on litter size.

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