EFFECTIVE PERIOD FOR CONTROL OF THE BROWN SPINY FIELD MOUSE (*MUS PLANTYTHRIX*) IN DRY LAND CROPS

G. GOVINDA RAJ, All India Coordinated Research Project on Rodent Control, Department of Vertebrate Biology, University of Agricultural Sciences, GKVK Campus, Bangalore - 560 065, India.

ABSTRACT: Information on breeding aspects of rodents is important to ensure control program timing necessary for effective pest management. Hence, studies on breeding aspects of the brown spiny field mouse (*Mus platythrix)*, a known rodent pest in dry land crops were investigated including environmental factors influencing reproduction, from regular monthly collections made during the years 1990 and 1991. Field trapped rodents were classified to derive their population structure--percent juvenile, pre-pubertal and adult including prevalence of pregnancy--based on body weights and sexual conditions. The stage of pregnancy and sperm motility were confirmed by autopsy studies. The data were also analyzed to calculate the annual breeding productivity. The results indicate that the brown spiny field mouse experiences a seasonal reproductive cycle of active breeding during the period June to February followed by sexual quiescence during the period March to May. The peak reproductive activity seen during September (55%), October (79%) and November (62%) coincides with peak abundance of heavier males and females in the population. A litter size of two (during June) to eight (during October) also coincides with peak prevalence of pregnancy. The adult male to female ratio is 1.0:1.1, respectively. The annual breeding productivity is calculated .o be 54 young/female/breeding season. Further prevalence of rainfall, low temperature, short day length, and higher relative humidity seen during July onwards promoting green vegetation are conducive to reproduction. Hence, it is inferred that the period March to May is suitable for timing the rodent control programs in dry land crops against the brown spiny field mouse, when the field population is at base considering the cost-benefit ratio and operational aspects.

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INTRODUCTION

Studies on breeding aspects and the reproductive cycle of rodents are important in understanding rodent breeding potential and in timing rodent control programs to achieve more cost effective management. Among the rodent pest species of economic importance, the members of the genus Mus are relatively less understood in relation to crop loss (Rao 1992). In India, Ellerman (1961) recognized six species under the genus Mus. Both *Mus platythrix* and *Mus booduga* have been recognized as rodent pests in agricultural crop fields of ragi, maize, groundnut, tomato, cucumber, and also occur in paddy in irrigated fields of Karnataka, South India (Prakash and Mathur 1987, UAS 1990).

The brown spiny field mouse (*Mus platythrix*) is distributed throughout the country and occurs mostly in the borders of cultivated fields, preferably in the rain fed agricultural fields.

Chandrahas (1974) outlined the ecology of the brown spiny mouse together with breeding aspects in connection with studies on the wild rodent plague reservoirs in and around Kolar. Rao (1981) also conducted similar studies on the reproductive biology of the brown spiny field mouse around Tirupati, falling under the semi arid zone. With this backdrop, the present studies were conducted under the national rodent control program, mainly to understand the reproductive cycle of the brown spiny field mouse so as to provide definite information and recommendations to the farming community to time/focus the rodent control programs for effective field-scale operations.

METHODS

Brown spiny field mice were collected from the dryland agricultural fields in the area of Bangalore. Usually one crop was harvested in these dry lands under rain fed cultivation. Vegetables, such as tomatoes, cucumbers, etc., were grown in some areas under protective irrigation. The brown spiny field mice were collected every month by live trapping, and sometimes a few burrows were dug up to collect the juvenile mice. They were removed live from the traps and immediately killed with ether in the laboratory. They were classified using the following criteria.

1. Juvenile/Immature: smaller body weight (5-10 gm); mammary teats not visible, vaginal orifice imperforate.
2. Sub Adults/Pre-pubertal: body weight (10-20 gm); at autopsy juvenile conditions of the gonads and reproductive sex accessories, vagina imperforate and mammary teats undeveloped.
3. Mature/Adults: larger body weight (20 gm and above); at autopsy ovary conspicuous with follicles, uterus edematous in females, scrotal testes and presence of motile sperm in the cauda epididymis in males.
4. Pregnant: body weight 20 gm and above; swollen abdomen and conspicuous mammary teats (glands), embryos detected by palpitating the abdomen, vagina imperforate.
5. Quiescent: reduced body weight (19-22 gm); mammary teats regressed, vagina imperforate; at autopsy uterus shows placental scars and sex accessories in male and female regressed.

During autopsy, the condition of the ovary, testes and accessory reproductive organs were observed and later weighed nearest to 0.2 mg in a torsion balance before fixing in Bouin's fixative for further histological observations. The data on the number of embryos in each of the uterine horns and the number of corpora lutea in each ovary were observed and recorded in the case of pregnant females. From the monthly collection data, the percentage of fecund males and fertile females was calculated by dividing the total number of adult males and females by the total collected adult sample size and multiplying by 100. Similarly, the prevalence of pregnancy was calculated by dividing the total number of pregnant females by the total number of adult non-pregnant females and their percentage was obtained by multiplying prevalence of pregnancy by 100. The ovarian and testicular weights were pooled to obtain a monthly mean. The study on the reproductive biology of the brown spiny field mouse was made by a monthly collection of either sex during the period from 1990 to 1991. The data were pooled to arrive at the average estimate. Further, the annual productivity of the field mouse (i.e., number of young/female/year or breeding season) was calculated according to Lechleitner (1959) and as detailed in a previous study (Raj and Srihari 1987).

RESULTS

Testicular Weights

The paired testicular weights ranged from 0.9 to 1.8 gm, with the maximum occurring in October and November and the minimum in April and May (Figure 1). Further, the sex accessories--namely, seminal vesicle, coagulating glands and prostate--exhibited well marked secretory activity and appeared hypertrophied in fecund males during August onwards. During the period April to June, fecund males with less conspicuous scrotal sacs were recorded when compared to males with well marked scrotal sacs seen during the period July to March. The sex accessories in males collected during the period April to June were not glandular and regressed.

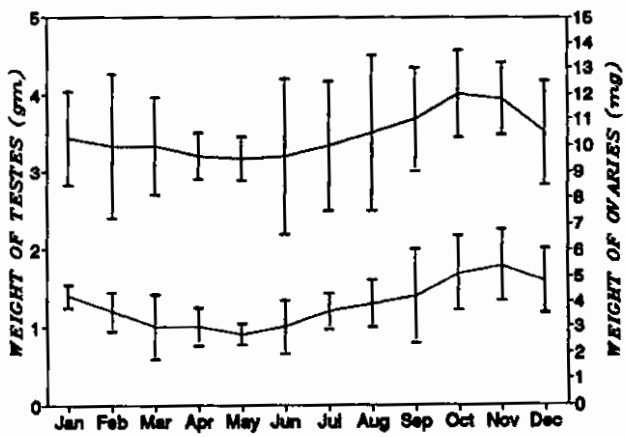

Figure 1. Mean paired testicular and ovarian weights of brown spiny field mice during the reproductive cycle.

Male Fecundity

Brown spiny field mice remained fecund throughout the year, but relatively lesser fecund males were noticed during the period April to June (the range being 20% to 38%). Two peaks of about 60% and 52% fecund males were recorded during October and December (Figure 2).

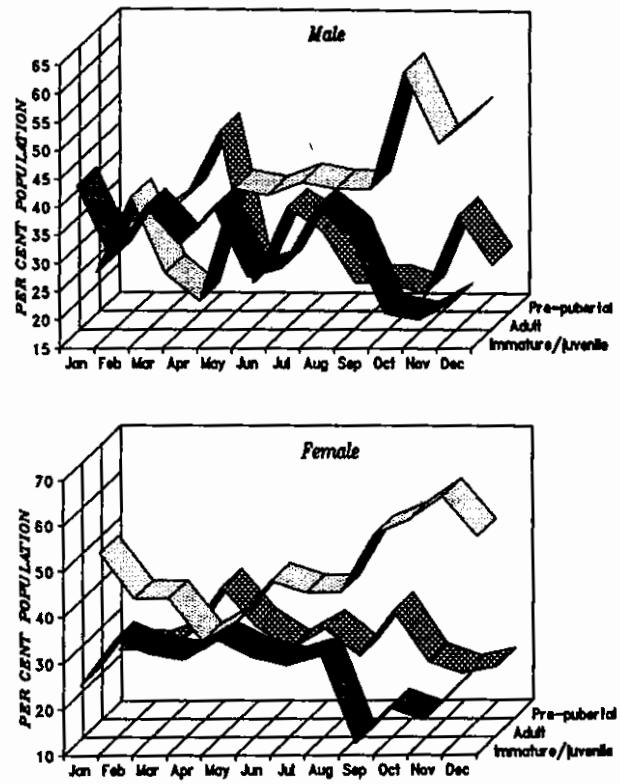

Figure 2. The population structure of the brown spiny field mouse in and around Bangalore, Karnataka.

Ovarian Weights

Female brown spiny field mice maintained a fairly constant ovarian weight of 10 mg throughout the year, except during the months of April, May and June when a slight reduction 9.5 and 9.6 mg in their weights were recorded (Figure 1). During these months, the ovary was compact without visible follicles and showed lesser weights. Similarly, the uterus in females collected during July onwards was edematous and became thin and slender during the months of April, May and June showing placental scars and regeressed conditions.

The percentage population of fertile brown spiny field mice increased commencing from June onwards and reached a peak during the months of November (62%) and December (53%) (Figure 2). Pregnant females were encountered only during the period June through February, with a maximum of 79% in October and a minimum of 12.5% in February (Table 1, Figure 3). Further, pregnancy was not seen during the months of March, April and May (Figure 3). The peak reproductive

activity was recorded during the months of September (55%), October (75%), and November (62%).

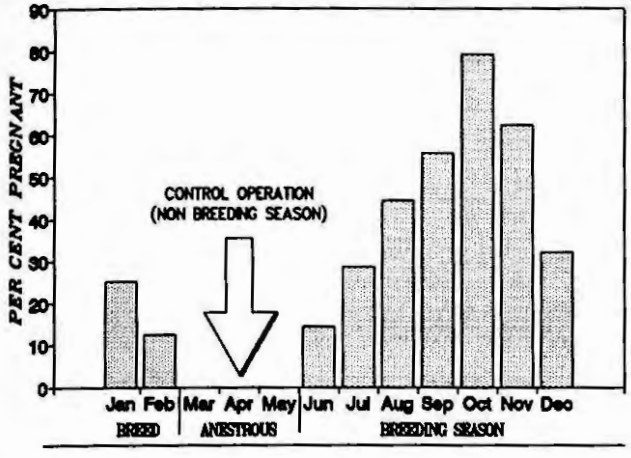

Figure 3. The peak reproductive activity of the brown spiny field mouse--effective period for its control in dryland crops.

Litter Size

A litter size of implanted embryos ranged from 2 (during June) to 8 (during October), with an average of 5.33 (Table 1). The corpora lutea in the ovaries were conspicuous, their number corresponded to the visible embryos seen in the respective uterine horns. The unilateral implantation was not uncommon and in no case was embryonic motility noticed. Further, there was no preferential distribution of embryos between the uterine horns. The annual productivity of the brown spiny field mouse was calculated to be 54 young/female/breeding season or year.

Body Weight

A body weight of less than 5 gm comprised the very young mice and the range of 5 to 10 gm comprised immature mice. The body weight range for sub-adults or pre-pubertal mice was 10 to 20 gm. Adult brown spiny field mice weighed 20 gm and above. The smallest body weight recorded was 4 gm and the largest was 38 gm. The body weight of adult males ranged from 20 to 36 gm, and the adult females 20 to 38 gm. The annual average body weight of the males was 24.74 gm and females 24.16 gm (i.e., males were almost equal to females in body weight) (Table 2). The adult brown spiny mice caught during the months of April, May and June had body weights ranging from 19.5 to 21 gm, while those collected during the peak breeding months of September, October and November had body weights ranging from 25 to 36 gm for males and 22 to 38 gm for females. The male to female ratio was 1.0:1.1, respectively (Table 2). The smallest pregnant brown spiny field mice weighed 22 gm in the month of June.

Population Structure

The number of young brown spiny field mice increased during the period July to January as a result of breeding activity; whereas the pre-pubertal population was maximum during March and April (35% to 46%). In the case of adults, the peak population was recorded during October (60%) for males and during November (62%) for females (Figure 2). This increase of fecund and fertile population coincided with the maturity of crops in fields and, consequently, the harvest period. Further, this increased trend in the occurrence of brown spiny field mice declined during the period February through May. Thus, the observed peak in the population density coincided with the peak breeding season when food availability in the environment is assured.

DISCUSSION

From the analysis of the data, it is evident that brown spiny field mice experience a period of breeding activity from June through February and remain reproductively inactive during the period March through May. The peak reproductive activity noticed during the period September through November (Figure 3) synchronizes with the availability of food in the fields. These observations of seasonal reproductive activity are in agreement with Chandrahas (1974) and Rao (1981). Prakash (1971) reported two peak periods of breeding activity in the case of desert rodents--one in the spring and the other during monsoon--and, further, that the quality of food available in post-monsoon months triggers the breeding activity. Additionally, in brown spiny field mice the seasonal variations in the weight of the ovaries and testes also coincide with the variations in the sexual activity of fecund male and fertile females.

The seasonal breeding pattern in brown spiny field mice is related to environment factors (Figure 4). Availability of surplus food seemed to enhance breeding activity in the majority of rodents (Prakash 1971, Rao 1981). Bimodal patterns of breeding with two peaks--one in post-monsoon and the second during March--has been attributed to severe winter weather conditions such as in the Northern states (Bindra and Sagar 1975). It has also been reported that in the majority of rodents the reproductive activity is enhanced during the late summer months with the onset of rainfall, and an increase in breeding activity continues when green vegetation is available (Jain 1980, Prakash and Ghosh 1992). The data presented here confirm that the breeding activity was evident at the onset of rainfall during July onwards (Figure 4). Further, the prevalence of high temperatures recorded in the environment does affect the breeding activity. The maximum temperature recorded was 30° to 31°C during the period March through May. During the period June through September, the environs of Bangalore experience high rainfall of 60 to 220 mm and, as a result, the temperature is lowered thus favoring the optimum conditions for breeding which coincides with the maturing of the crops in the fields. Therefore, the variations in the breeding activity of brown spiny field mice could be correlated with rainfall and the availability of food in the environment.

Table 1. Percentage pregnancy and the mean litter size of the brown spiny field mouse (*Mus platythrix*) during various months of the year.

Month	Average No. of Live Fetus/Female in Uterus		Total	Avg. No. of corpora lutea/female	% pregnancy
	Right	Left			
January	2	2	4	4	25.00
February	1	2	3	3	12.50
March	-	-	-	-	-
April	-	-	-	-	-
May	-	-	-	-	-
June	-	2	2	2	14.28
July	3	3	6	6	28.57
August	3	3	6	6	44.44
September	2	5	7	7	55.60
October	5	3	8	8	79.00
November	4	3	7	7	62.50
December	3	2	5	5	32.14

Table 2. Absolute body weight (gm) and the total number of brown spiny field mice (*Mus platythrix*) collected during the year with number of pregnant females shown in parentheses.

Month	Male		Female		Total Number Collected	
	Minimum	Maximum	Minimum	Maximum	Male	Female
January	5	21	4	28	16	12(5)
February	5	23	5	25	13	20(4)
March	8	30	10	20	20	15
April	7	25	6	20	15	13
May	5	20	6	21	25	20
June	10	19.5	9	22	25	18(3)
July	8	19.5	7	20	17	17(5)
August	5	25	6	22	25	19(6)
September	5	25	5	24	20	24(8)
October	4	28	4	26	33	54(24)
November	4	36	4	38	25	51(20)
December	11	25	5	24	51	52(9)
Annual Average	5.83	24.74	5.91	24.16	285	315

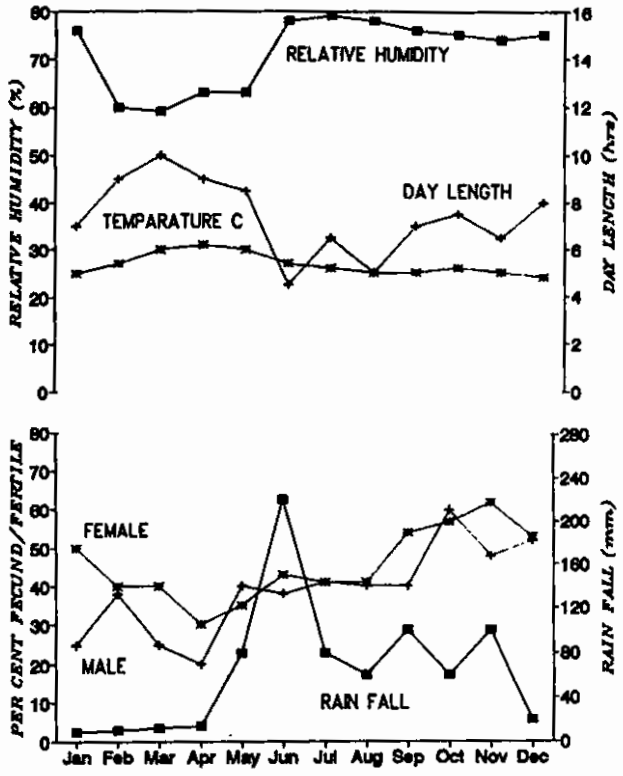

Figure 4. Composite graph showing the relation of environmental changes with seasonal sexual activity of the male and female brown spiny field mouse. The curves at the bottom show the monthly percentage of males with spermatozoa in the epididymis and the females with estrous cycle.

The litter size in brown spiny field mice ranged from 1 to 8 with a mean of 5.33, and unilateral implantations were not uncommon in the field mice reported. Ellerman (1961) reported 6, and later Prakash (1971) recorded 3 to 10 brown spiny field mice in the Rajasthan desert, but Chandrahas recorded 8.3 average, with a range of 4 to 14. In Andhra Pradesh, Rao (1981) reported 2 to 8 with a mean of 4.54. Thus, the observed variations recorded may be due to the different locations and climatic zones (Asdell 1964). The increase in litter size in brown spiny field mice during the peak breeding period is in agreement with Rao (1981). Considering the total number of female (325) and male (285) field mice collected, the male:female ratio was 1.0:1.1, respectively. This confirms the previous observations of Chandrahas (1974) who recorded the male:female ratio of 1.0:1.12, respectively.

The comparison of body weight between adult field mice collected during the months of April, May and June with those during peak breeding months of September, October, and November, indicates less growth in body weight during the months of April, May and June. Further, the percentage of field mice in the body weight class range of 23 to 30 gm decreased during these months (Table 2). One possible explanation could be the non-availability of food during these months; while the possibility of the photoperiod and temperature controlling growth (Salender 1966, Iverson and Turner 1974, Petterberg 1978) cannot be ruled out. Considering the breeding period (270 days), gestation period (21 days) (Southwick 1966), the observed prevalence of pregnancy (0.79) and the litter size (5.33), the annual productivity in brown spiny field mice is calculated to be 54 young/female/breeding period or year. Chandrahas (1974) recorded annual productivity of 39.5 young/female/year and Rao (1981) recorded a low annual productivity of 17.78 young/female/year due to prenatal mortality in the loss of ova during both pre-implantation as well as during post-implantation periods inspite of the 10.09 pregnancies/female with an average litter size of 4.54. However, in the present studies involving 81 pregnancies, there have been no embryonic mortalities noticed, which may be due to intrinsic physiological response towards stress and habital removal.

In light of these observations on the breeding habits of brown spiny field mice and considering the economic aspect of rodent pest management in dryland crop fields, it is suggested that rodent control strategies/programs be initiated to achieve effective results during non-breeding months of April, May and June when the field mice population is at base level (Figure 3), rather than during the months of September, October and November when the population is at its peak due to intense breeding activity and the immigration of new populations in search of food and habital selection. Killing one field mouse during the months of April, May and June would be equivalent to killing 54 during the peak breeding season. Furthermore, that is the time when most of the farmers are free from other operational activities.

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