*Pak. J. Agri. Sci., Vol. 21 (1-2), 1984*

# REPRODUCTION AND STRUCTURE OF A BANDICOTA BENGALENSIS POPULATION IN AN AGRO-ECOSYSTEM*

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## ABSTRACT

The females of the bandicoot rat (*Bandicota bengalensis*) living in the croplands of the central Punjab remained reproductively quiescent from November through February. The smallest sexually mature males weighed 100.0 gm and measured 14.7 cm long, whereas the smallest visibly pregnant females weighed and measured 120.1 gm and 16.2 cm, respectively. The annual rate of pregnancy varied greatly; the average for three years being 47.36%. The mean embryonic litter size was 7.40 (3-11) $\pm$ .512 (27). The annual production rate was 75.18 young/female. The proportion of adults, subadults, and juvenilesin the pooled samples of three years averaged 76.80, 16.02, and 7.18%; the annual variations being the least with respect to the adults and maximum with respect to the juveniles. The ratio of the two sexes was in favour of the males (1 : 0.69 (181) : $x^2$ = 6.016; $p < .05$).

## INTRODUCTION

The bandicoot rat (*Bandicota bengalensis*) is endemic to the Oriental Region and is found virtually throughout the Indo-Pakistan subcontinent. It is known to inflict heavy damage to the rice crop in lower Sind since long (Wagle, 1927). But, its ecology as a pest of agriculture has been investigated only recently. Sagar and Bindra (1971), Greaves *et al.* (1975), Bindra and Sagar (1977), Chakraborty (1977), Durairaj and Guruprasad (1977), Smiet *et al.* (1980) Fulk *et al.* (1981) and Beg *et al.* (1977, 1979, 1980, 1981, 1983) have studied the reproduction, population structure, and food habits of outdoor populations of the rat inhabiting the agricultural fields. But the principal studies of the species, Spillett (1968) and Frantz (1973),deal with the reproduction and behavi-

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our of indoor populations. In Pakistan, *B. bengalensis* is an entirely outdoor species. All the outdoor investigations referred to above were either of short duration or were made in context with a single crop. The present study, which is based on three years data, describes some important reproductive and demographic parameters of the bandicoot population living in a high intensity agriculture of irrigated croplands of the central Punjab.

## MATERIALS AND METHODS

The bandicoot rats were snap-trrapped from irrigated farmlands of the central Punjab, at least, once a month from December, 1977 through November, 1980. The captured specimens were weighed, measured, and autopsied for the reproductive data which included the condition of vagina (perforate/imperforate), condition of uterus (embryo count/scar count/nulliparous),development of nipples (large/protuberances/distinct), position of testes (scrotal/abdominal), condition of cauda epididymis (tubules visible/not visible) and the size of seminal vesicle. The rate of reproduction was estimated by calculating the number of young produced/female/year following Southwick's (1966) procedure. Body length, body weight and the reproductive condition of the specimens were used to define three age categories, namely, juvenile, subadult, and adult.

## RESULTS

### REPRODUCTION

*Breeding Season :* A male with enlarged and distinctly visible tubules in cauda epididymis of the testes was taken as reproductively active and fertile. Females with embryos or visible uterine swellings were considered as breeding.

Reproductively active males were found in all the bimonthly periods excepting December-January and their proportion in the bimonthly samples from February through November varied from 78 to 87%.

The first pregnant females of the season appeared on February 27 in 1978, on March 3 in 1979, and on March 7 in 1980, whereas the last gravid females of the season were recorded not later than August 22 in 1978, August 8 in 1979, and October 30 in 1980. Thus, the period of reproductive quiescence in the females of the bandicoot rat varied annually and minimally it lasted from November till late February.

*Sexual Maturity :* The timing of puberty relative to the life span of a species governs the total number of young produced by the female and is thus relevant to demographic investigations. In the present study, body weight and body length have been used as indices of age of the bandicoot rat.

The smallest sexually mature male bandicoot rat weighed 100.0 gm and measured 14.7 cm long. The smallest visibly pregnant female weighed 120.1 gm and had a body length of 16.2 cm. The smallest post-parturient female weighed 120.8 gm and had a body length of 14.8 cm. The smallest sexually active males were generally captured in early summer, whereas the smallest sexually active females were taken in late February and March. Perhaps, these females were born just before the onset of winter reproductive quiescence.

*Rate of Pregnancy :* For estimating the rate of pregnancy only adult females were considered. As the size of the bimonthly samples for each of the three years and especially for 1977-78 was relatively small, only the annual and the combined bimonthly rates of pregnancy were considered. In the 1977-78 and 1978-79 samples, the rates were 37.50 and 33.33%, respectively. These rates were low as compared to 58.06% of 1979-80. Although the pooled bimonthly data of three years revealed only one peak occurring in April-May, yet the pregnany rate may also accelerate under favourable conditions, during late summer or early fall. The average rate of pregnancy for the three years was 47.36% (Table 1).

*Embryonic Litter Size :* The number of embryos in the gravid females of the bandicoot rat ranged from 3-11 and the mean litter size was $7.40 \pm .512$ (27). The overall mean of the placental scar counts per post-parturient female was $8.67 \pm 1.094$ (28) (Table 1). The poolled bimonthly embryonic litters varied significantly ($F = 4.8556$; d. f. $= 4, 22$; $p < .01$). The February-March and April-May litters were larger than those of the following bimonthly periods during which they tended to be successively smaller. There was no relationship, at a significant level, between the maternal body weight and the number of embryos carried by them ($r = .37014$; d. f. $= 25$; $P > .05$).

Table I. *Prevalence of pregnancy and embryonic litter size in Bandicota bengalensis*

| Biomonthly period | Sample size | Preval. of preg. (%) | Emb./female (N) |
|---|---|---|---|
| | 1977-78 | | |
| D-J | – | – | – |
| F-M | 2 | 50.00 | 9.00 (1) |
| A-M | 1 | 0.00 | – |
| J-J | – | – | – |
| A-S | 4 | 50.00 | 5.00 (2) |
| O-N | 1 | 0.00 | – |
| Annual | 8 | 37.50 | 6.33±1.7609 (3) |
| | 1978-79 | | |
| D-J | – | – | – |
| F-M | 8 | 37.50 | 8.00 (3) |
| A-M | 1 | 100.00 | 11.00 (1) |
| J-J | 6 | 16.67 | 7.00 (1) |
| A-S | 2 | 50.00 | 4.00 (1) |
| O-N | 1 | 0.00 | – |
| Annual | 18 | 33.33 | 7.66±1.5962 (6) |

*Rate of Reproduction* : The production rate in 1979-80 had remarkably improved after remaining low during the preceding two years. The immediate causes of this acceleration were mainly the higher rate and incidence of pregnancy (Table 2).

The bandicoot rat had only one peak in its rate of reproduction and that occurred in April-May. Past this peak, the production rate continually declined. Peak production was attained, through improvement in all the three reproductive parameters, namely, rate of pregnancy, litter size and indicence of pregnancy (Table 2).

Table 1. (Contd.)

| Biomonthly period | Sample size | Preval. of preg.(%) | Emb./female (N) |
|---|---|---|---|
| | | 1979-80 | |
| D-J | 1 | 0.00 | – |
| F-M | 15 | 53.33 | 9.00 (8) |
| A-M | 3 | 100.00 | 8.33 (3) |
| J-J | 4 | 75.00 | 6.00 (3) |
| A-S | 3 | 33.33 | 8.00 (1) |
| O-N | 5 | 60.00 | 4.00 (3) |
| Annual | 21 | 58.06 | 7.50±.6058 (18) |
| | | 1977-80 | |
| D-J | 1 | 0.00 | – |
| F-M | 25 | 48.00 | 8.75± .6149 (12) |
| A-M | 5 | 80.00 | 8.99±1.2250 (4) |
| J-J | 10 | 40.00 | 6.25± .75 (4) |
| A-S | 9 | 44.44 | 5.50±1.19 (4) |
| O-N | 7 | 42.85 | 4.00± .5774 (3) |
| Combined | 57 | 47.36 | 7.40± .5119 (27) |

POPULATION STRUCTURE

*Age Composition* : The proportion of adult *B. bengalensis* in the yearly samples varied from 73.08 to 78.30% and the average for the three years was 76.80%. The proportion of subadults and juveniles during the three years ranged between 13.21 and 26.92%, and between 0.00% and 8.49% and the respective average being 16.02% and 7.18%.

In the pooled bimonthly samples, the proportion of adults peaked in February-March, declined rather sharply in April-May and then stabilized before declining further in October-November. The subadults were largely concentrated in three bimonthly periods, namely, December-January, June-July and October-November. No subadult was captured during August-September in

Table 2. *Estimates of the number of young produced per female of Bandicota bengalensis per year and per bimonthly period (pool of three years)*

| Year | Preval. of preg. (%) | Emb./female | Incid. of preg. | Young/female/yr (F x Emb./female) |
|---|---|---|---|---|
| | | Annual | | |
| 1977-78 | 37.50 | 6.33 | 8.05 | 50.96 |
| 1978-79 | 33.33 | 7.66 | 7.15 | 54.77 |
| 1979-80 | 58.06 | 7.50 | 12.46 | 93.45 |
| Average | 47.36 | 7.40 | 10.16 | 75.18 |
| | | Bimonthly | | |
| D.J | – | – | – | – |
| F-M | 48.00 | 8.75 | 1.66 | 14.47 |
| A-M | 80.00 | 8.99 | 2.87 | 25.80 |
| J-J | 40.00 | 6.25 | 1.43 | 8.97 |
| A-S | 44.44 | 5.50 | 1.59 | 8.77 |
| O-N | 42.85 | 4.00 | 1.53 | 6.15 |
| Average | 47.36 | 7.40 | 10.16 | 75.18 |

any of the three years. The juveniles, which were entirely lacking from December-January and February-March samples were relatively more abundant in April-May aud August-September, particularly in the latter bimonthly period (Table 3).

*Sex Ratio* : Of the three annual samples of three age categories of *B. bengalensis*, the males significantly outnumbered the females in 1979-80 (1 : 0.60 (83) : $X^2 = 5.313$; $p < .05$). The overall picture remained the same when the data for the three years were pooled age-wise; the ratio of the two sexes in the sample of adults was significantly in favour of the males (1 : 0.70 (139):$X^2 = 4.496$; $p < .05$).

On pooling the age groups and yearly samples on bimonthly basis, it was found that in February-March samples the males outnumbered the females (1 : 0.57 (85) : $X^2 = 6.223$; $p < .05$). In the annual samples (pooled for all ages and bimonthly periods), the sex ratio was in favour of males but at a statistically significant level in only 1979-80 (1 : 0.63 (106) : $X^2 = 5.434$; $p < .05$). The overall ratio of two sexes was (1 : 0.69 (181) : $X^2 = 6.016$; $p < .05$).

Table 3. *Age composition in the annual and bimonthly (pooled) samples of Bandicota bengalensis taken from the croplands of the central Punjab*

| Sampling period | Sample size | Age composition (%) | | |
|---|---|---|---|---|
| | | Adults | Subadults | Juveniles |
| 1977-78 | 26 | 73.08 | 26.92 | – |
| 1978-79 | 49 | 75.51 | 16.33 | 8.16 |
| 1979-80 | 106 | 78.30 | 13.21 | 8.49 |
| 1977-80 | | | | |
| D-J | 3 | 66.67 | 33.33 | – |
| F-M | 85 | 91.76 | 8.24 | – |
| A-M | 24 | 66.67 | 16.67 | 16.67 |
| J-J | 31 | 64.52 | 29.03 | 6.45 |
| A-S | 17 | 70.49 | – | 29.41 |
| O-N | 21 | 52.38 | 38.10 | 9.52 |
| Combined for 3 years | 181 | 76.80 | 16.02 | 7.18 |

Table 4. *Rate of reproduction in some local population of Bandicota bengalensis*

| Habitat & locality | Preval. of preg. | Emb./ female | Incid. of preg. | Young/ female/yr | Source |
|---|---|---|---|---|---|
| Oil cake & rice husk godown, Calcutta | – | 6.0 | 10.6 | 63.6 | Spillett (1968) |
| Grain godown, Calcutta | 55.8 | 6.4 | 12.0 | 76.8 | Spillett (1968) |
| Rangoon | 27.5 | 7.4 | 5.9 | 43.7 | Walton *et al* (1978) |
| Sugarcane field Sind | 44.7 | 6.5 | 6.7 | 43.6 | Smiet *et al* (1980) |
| Rice field, Sind | 14.8 | 8.9 | 1.6 | 28.5 | Fulk *et al.* (1281) |
| Cropland, Punjab | 47.4 | 7.4 | 10.2 | 75.5 | Present study |

## DISCUSSION

### REPRODUCTION

The present data showed that the females ceased to reproduce during the colder months of the year. The males, however, remained fertile for longer periods of time than the females; this phenomenon is common among many mammalian species (Sadleir, 1969).

In the presentagro-ecosystems food is available almost throughout the year. So cessation of breeding during the colder months of the year is apparently related to the low winter temperatures. The rat's populations in Bengal (India) and Rangoon (Burma) breed throughout the year (Spillett, 1968; Chakraborty, 1977; Walton *et al.*, 1978). In lower Sind too, the rat has been reported to breed over most of the year (Smiet *et al.*, 1980; Fulk *et al.*, 1981). But, more northern population in the Indian state of Punjab did not reproduce in January, February and September (Bindra and Sagar, 1977).

The age of sexual maturity in mammals depends on a number of factors, namely, season of birth, state of nutrition, and sociological factors, (Sadleir, 1969). In seasonally breeding species living in a temperate climate, sexual maturity in the young born in late fall might be delayed. Delayed sexual maturity in the over wintering young of *B. bengalensis* has been noted by Bindra and Sagar (1968) and Fulk *et al.* (1981). The data of the present study seem to suggest that sexual maturity in the young of *B. bengalensis* born in late fall is greatly delayed, but the factor (s) responsible for this delay is not known. Possibly, low winter temperature is responsible for this.

The range of body weight and body length of *B. bengalensis* at sexual maturity is generally consistent with the observation recorded for this species in Bengal by Chakraborty (1977). But, the bandicoot rats of lower Sind seem to attain sexual maturity at somewhat lesser body weight (Fulk *et al.*, 1981). On the other hand, the female bandicoot rats in Rangoon become gravid at greater body lengths (Walton *et al.*, 1978) than those of this study area.

In the smallest sexually mature rats of this study, the body length ranged from 14.6 to 16.0 cm. Caged specimens of the bandicoot rat in Calcutta attained a body length of 15.5 cm in 140 days (Spillett, 1968). The assumption that growth rate for cage-reared specimens of *B. b. bengalensis* from Calcutta was directly comparable to those of trapped specimens of *B. b. wardi* from the present study area would be erroneous, but it may be used, at least, for a rough estimation of the age of trapped specimens. If the smallest sexually mature bandicoot rats taken in late February and early March and in early June attained sexual maturity in 140 days, they must had been born in October, and late January. respectively. Since no pregnancy in the bandicoot rat of this study area was observed earlier than March 3, it seemed that the young ones born in early March attained sexual maturity at about three months age.

The major peak in pregnancy occurred during the ripening and harvesting of wheat crop. Thus, the bandicoot rat seemed to respond to the sudden abundance of food. Bandicoot rats in the rice fields of the lower Sind exhibited great fluctuations in the prevalence of pregnancy related with the availability of food (Fulk *et al.*, 1981), whereas those affecting the sugarcane crop did not show any sharp peak in pregnancy rate (Smiet *et al.*, 1980). The overall prevalence of pregnancy was higher in the cane population than in the rice population. Similar increase in the prevalence of pregnancy related to the energy rich food has also been observed by Chakraborty (1977) in India. He reported pregnancy peaks in *B. bengalensis* at rice harvest or shortly after.

The data of this study indicate that the size of the litter in *B. bengalensis* was the largest at the beginning of the breeding season and then gradually decreased. The seasonal variations in the litter size could be due to a variety of factors but the observed variations were largely related to deteriorating food conditions.

The bandicoot rat confined its maximum reproductive efforts to the period extending from February to May during which the wheat crop provided rich and abundant food to it. Fulk *et al.* (1981) found that in the rice fields of the lower Sind, the rat heavily depended on maturing rice grains and responded to this surfeit of energy rich food by producing many large litters. In the present study area the rat seemed to depend greatly on the wheat crop during the spring season.

Table 4 shows that different local populations of the rat are considerably variable with respect to their reproductivity. The annual production of the present population of *B. bengalensis* compared well with production of bandicoot rats affecting the grain godowns of Calcutta (Spillett, 1968). Inspite of low preva lence and incidence of pregnancies, the bandicoot rats of this study approximated the productivity of the Calcutta population by producing somewhat larger litters.

## POPULATION STRUCTURE

A comparison of age composition in the yearly samples of *B. bengalensis* showed that the proportion of juveniles was generally small in spite of a high rate of reproduction. Wheth er the observed low proportion of juvenile bandicoot rats was simply due to differential trappability or due to some other factor (s) is not known. Representation of the young in trapped samples lower than their true proportions in the population has been noted for this species by Spillett (1968) and for several species of *Rattus* by Harrison (1956). As the bandicoot rat hoards food in its burrows (Fulk, 1977), the weaned young possibly tended to feed on the underground cache and did not forage outside the matunal burrow for sometime. Low representation of young bandicoots may also result from a trapping bias, a higher mortality in the young, or a combination of these factors.

The proportion of sex ratio in most rodent population is expected to be about 0.52 in favour of males at birth (Asdell, 1964). However, differential mortality can alter the ra tio which often results in equal or higher percentage of females. But, this may not always be ev ident from the trapping data since males have larger home ranges and or more active than the females and, therefore, have better trappability (Burt, 1940; Davis, 1953). Thus, a slight excess of males may be taken as an indication of equality of sexes in wild populations.

As for *B. bengalensis*, Chakraborty (1977) and Spillett (1968) observed excess of males in the trapped samples. The data of the present study showed that ratio of males was significantly skewed in favour of males. This deviation from the expected 1 : 1 ratio was mainly due to the preponderance of males in the adult age category.

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