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Some observations on reproduction in *Rattus rattus* (L.) in Rangoon, Burma[1]

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Abstract

Observations on the reproduction of *Rattus rattus khyensis*, a white-bellied commensal roof rat common in Rangoon, are described. Breeding activity is seen in all months of the year with no marked seasonal fluctuations. Female *R. r. khyensis* become sexually active at approximately 130 mm head and body length and at 60 g body weight. Prevalence of pregnancy in adult females averaged 33.3 % for the entire 2-years sampling period. Breeding activity as judged by both pregnancy and lactation averaged 52.8 % of all adult females. Litter size was found to be 5.03 ± .21 with very little evidence of intrauterine embryo loss. The mammary pattern was determined to be 3 + 3 = 12, caused by a twinning of the postaxial mammae. The 50 % point for scrotal testes in males occured at a head and body length of 124 mm and an approximate body weight of 50 g, with sexual activity evident year round.

The high rate of breeding activity is indicative of a population subject to heavy population pressure, predation and stress and a consequent high mortality rate. Similar observations have been noted for *Rattus exulans*, *Bandicota bengalensis* and *Suncus murinus* in Rangoon. Recruitment of young is almost continuous and populations are maintained only by a high degree of breeding activity with little seasonal fluctuation.

Introduction

In Burma, the commensal *Rattus rattus* complex is represented by white-bellied rats (subspecies *khyensis*, *brunneus*, etc.) which are typically found in such places as bamboo clumps, and are secondarily house rats (Harrison and Woodville 1948;

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Harrison 1961). The commensal *R. rattus* in Rangoon, Burma, is a form with a bright brown dorsum, a clear white venter and a uniformly dark-coloured tail. Harrison and Woodville (1950) call this rat *R. rattus* var. near *khyensis* Hinton. During a survey of urban small mammals in Rangoon we have captured over 400 specimens of this rat from houses, shops, bazaars, hospitals, factories and from trees and shrubs outdoors. Almost all have been the bright brown-backed form with the clear white belly and with a usual mammary pattern of $3 + 3 = 12$. The few exceptions were typically grey-bellied commensals trapped in the Port Area and one township immediately adjacent to the Port. These are likely to be rats introduced by ships calling at the Port of Rangoon. This paper describes observations on the reproduction of the white-bellied commensal *R. rattus* in Rangoon.

Materials and methods

Animals were captured in locally-made wooden live traps, usually baited with dried fish. Collections covered most every month from September 1975 to August 1977. Captured animals were brought alive to the laboratory while still in the traps. There they were anaesthetized, bled by cardiac puncture and combed for ectoparasites. Individual *R. rattus* were sexed, measured and weighed. All measurements are given in millimetres. Body weight was obtained by means of either a Pesola or Ohaus spring scale and all weights are expressed in grams. Reproductive condition was noted on all females: perforation of the vaginal orifice, location and number of visible mammaries, lactation, visible pregnancy and number and size of embryos. A sample was examined for placental scars and corpora lutea. The position of the testes in the males was noted. The points in body length at which 50 % of the animals showed the several sexual maturity criteria (such as scrotal testes or perforated vaginal orifices) were determined by plotting the proportion showing the character in each length class on arithmetic-probability paper and fitting a line to the data points by eye (Davis 1964).

Table 1

Head and body length, body weight and sex ratio of *Rattus rattus* from Rangoon, Burma (Means ± S.E.)

Non pregnant females only were used for computation of body weight

Head and body length classes (mm)	Males		Females			P
	No. animals	Body weight (g)	No. animals	No. nonpregnant	Body weight (g)	
80— 89	3	19.3 ± 1.3	0		—	
90— 99	3	21.3 ± 1.7	5	5	25.5 ± 1.5	N.S.
100—109	2	30.0 ± 3.9	11	11	27.5 ± 2.0	N.S.
110—119	11	35.6 ± 2.2	18	18	40.3 ± 2.4	N.S.
120—129	14	43.4 ± 1.5	9	9	51.3 ± 6.0	N.S.
130—139	20	61.2 ± 3.9	20	15	59.3 ± 3.1	N.S.
140—149	21	74.1 ± 2.4	37	24	79.7 ± 2.4	N.S.
150—159	27	89.7 ± 3.2	55	34	91.5 ± 2.6	N.S.
160—169	29	111.1 ± 3.8	64	39	103.9 ± 2.2	N.S.
170—179	31	125.9 ± 3.5	19	13	112.2 ± 3.6	.01
180—189	12	138.8 ± 6.3	4	4	112.5 ± 9.1	.05
190—199	4	147.0 ± 7.8	1	1	132.0	
Totals	177		243	173		
Mean wgt., g		89.2 ± 2.9			78.9 ± 2.3	
Mean lgth., mm		122.6 ± 6.8			148.2 ± 1.3	
Sex Ratio	.421		.579			

Results

Characteristics of the sample and sex ratio

The characteristics of the sample in terms of head and body length, body weight and sex ratio are given in Table 1. A total of 420 rats was examined; 177 males and 243 females. Males grew to a greater body weight than females but not to a longer head and body length. There was no significant difference in mean body weight at equivalent head and body lengths between sexes until 170 mm and beyond, at which point males became significantly heavier ($P = .01 - .05$). Males predominated in the largest length classes. The proportion of males in the 420 rats sexed was .421. This proportion differs significantly from a 1:1 sex ratio ($X^2 = 10.4$, $P = .01$).

In a previous report on *R. r. khyensis* in Rangoon (Harrison and Woodville

Table 2

Size of female *R. rattus* for several sexual maturity criteria

50 % points for body length and body weight

Sexual maturity event	Head and body length (mm)	Body weight (g)
Opening of vaginal orifice	98	24
Visible corpora lutea	125	47
Visible pregnancy	137	65
Placental scars	149	85

Table 3

Presence of visible pregnancy, lactation and placental scars in *R. rattus khyensis* in Rangoon

Body size class (mm)	No. examined	Visibly pregnant %	Lactating %	Pregnant or lactating %	Placental Scars		
					No. examined	% scars	Avg. sets of scars
80— 89	1	0	0	0	1	0	—
90— 99	4	0	0	0	1	0	—
100—109	12	0	0	0	2	0	—
110—119	18	0	0	0	4	0	—
120—129	9	0	0	0	1	0	—
130—139	17	18	0	18	7	29	1.0
140—149	37	35	5	41	16	25	1.0
150—159	52	35	23	58	23	74	1.3
160—169	65	40	23	63	20	75	1.5
170—179	19	26	32	58	7	100	1.4
180—189	4	0	50	50	2	0	—
190—199	1	0	100	100	—	—	—
Number over 130 mm in head and body length and mean per cent	195	33.3	19.5	52.8	75	60.0	1.34

1949), the mean body weight of the sample (n = 154 animals) was noted as 104 g (range 40—190 g) and mean head and body length was 158 mm (range 114—200 mm). Their sample was undoubtedly biased in favor of larger animals since no rats were trapped with a head and body length of less than 114 mm.

Maturation

Males: The 50 % points for size of male rats at sexual maturity (testes scrotal in position) are a head and body length of 124 mm and a body weight of 50 g. In this study, sexually active males are taken to be all those that exceed 120 mm in head and body length and 50.0 g in weight. Sexually active males were seen throughout the year.

Females: The 50 % points for size of female *R. r. khyensis* using several sexual maturity criteria are given in Table 2. The vaginal orifice opens at a head and body length of 98 mm and a body weight of 24 g. A small sample (n = 85) of females was examined for the presence of visible corpora lutea, an indicator of active ovulation, and the 50 % point in body length was determined to be 125 mm. Visible pregnancy was first seen in females of 137 mm head and body length and at a mean weight of 65 g and lactating females were first observed in the 140 to 149 mm body length size class (Table 3) and at a mean weight of 75 g. The point at which 50 % of the females have at least one set of placental scars occurred at a head and body length of 149 mm. Based upon this sequence of events, in this report we have selected the head and body size class of 130—139 mm and the body weight size class of 60—69 g as the arbitrary size for defining actively breeding females.

Prevalence of breeding activity

Using the presence of visible embryos in all females examined that exceeded 130 mm in head and body length, the crude prevalence of pregnancy for the entire sampling period was 33.3 % (Table 3). When visible pregnancy is examined by body weight (Table 4) it is seen that out of 197 females examined whose body weight exceeded 60 g, 65 (33.0 %) were visibly pregnant. The close agreement of these two values confirms the pregnancy rate at about 33.0 % of all adult females.

A better indicator of the total breeding activity among the females is to include all lactating animals in addition to those visibly pregnant. When these animals are added, the proportion of all adult females showing visible evidence of breeding activity is 52.8 %. This rate of activity is fairly high for this species.

Seasonal changes in breeding activity

Over the 24-month period covered by this study we found pregnant females in all months of the year (Table 5). When the prevalence of breeding activity is examined by quarters, there is no significant difference in any part of the year. There is a suggestion, however, that breeding activity slackens during the months of heaviest monsoonal rains, May through August. The prevalence of breeding activity during these four months ran only 44 %, compared to 56 % for the other eight months of the year, but the difference is found to be not significant.

Litter size

Litter size was obtained by noting the number of grossly visible uterine swellings and embryos. These results are summarized in Table 6. The number of embryos per female ranged from 1 to 10. In the total of 327 embryos, only 3 (0.9 %) were seen

Table 4

Relationship of body weight to visible pregnancy in *R. rattus* in Rangoon

Body weight class (g)	No. examined	% pregnant
50— 59	9	0
60— 69	14	7
70— 79	15	13
80— 89	25	32
90— 99	42	29
100—109	26	42
110—119	37	35
120—129	16	62
130—139	6	33
140—149	4	75
150—159	1	100
160—169	2	100
Totals	197	33.0

Table 5

Seasonal prevalence of breeding activity (pregnancy and lactation) in *R. rattus* in Rangoon

Month	No. adult females examined	Percent breeding activity
January	8	37
February	23	61
March	17	29
April	14	64
May	12	42
June	8	50
July	8	25
August	11	55
September	32	66
October	32	59
November	21	48
December	9	67
Totals	195	53

Table 6

Distribution of litters of various sizes and mean embryo numbers in *R. rattus*

	Number of visible embryos										Totals
	1	2	3	4	5	6	7	8	9	10	
No. Observed	1	3	6	15	17	10	9	3	0	1	65
Mean No. embryos (± S.E.)											5.03 ± 0.21

Table 7

Litter size and head and body length in female *R. rattus*

Head and body size class (mm)	Number observed	Mean number embryos ± S.E.)
130—139	3	4.66 ± .98
140—149	14	5.28 ± .34
150—159	18	4.67 ± .30
160—169	25	5.04 ± .42
170—179	5	5.80 ± .52
Totals	65	5.03 ± .21

Table 8

Comparison of reproductive parameters of *R. rattus* in Rangoon, Burma and Kuala Lumpur, Malaysia

(data from HARRISON 1952, some recalculated)

Character or measurement	Rangoon	Kuala Lumpur
Sex ratio (male:female)	100:137	100:147
Minimal weight first pregnancy (g)	62	50—59
Mean Litter size (crude)	5.03	5.70
Mean Litter size (corrected)	4.99	5.23
Prevalence of pregnancy (adjusted)	33 %	26 %
Embryo rate (all females)	133	87
Embryo rate/100 animals of both sexes (HARRISON's reproduction figure)	77	52

to be resorbing. There was a slight tendency for embryo number to increase with increasing head and body length of the female, although the result is not statistically significant (Table 7). When litter size was examined by embryo size, no evidence of intrauterine loss could be shown.

Mammary pattern

An examination of all females of 140 mm head and body length and greater (the size at which lactating females are first seen) revealed that 86 % had a mammary pattern of 3 + 3 = 12. The usual 2 + 3 = 10 pattern was almost never seen; only 4 out of 182 females had this pattern. The extra pair in *R. r. khyensis* is a twinning of the postaxial mammae, the pair being usually only about 1 cm apart. An examination of the 64 lactating females showed that all had the 3 + 3 = 12 mammary pattern. Harrison and Woodville (1949) noted that of 79 female roof rats they examined from Rangoon, 8 rats (10 %) had 10 mammae, 5 (6 %) had 11 and 66 (84 %) had the 3 + 3 = 12 pattern. Marshall (1977) describes the same for the white-bellied commensal *R. rattus* in Thailand.

Discussion

It is difficult to draw comparisons of reproductive activity in *R. rattus khyensis* with previous studies since most of the latter deal with other subspecific forms of the roof rat, especially the black or ship rat and the grey-bellied commensals as they commonly occur in temperate climate areas.

Perhaps the closest comparison can be made with Harrison's (1952) study of the reproductive activity of *R. rattus diardii* in Kuala Lumpur, a dark-bellied commensal rat common in that city. He found that in rats collected over the period 1948–50, pregnant females were collected in all months, without significant seasonal variation in number. We also found year-round breeding in females but with a suggestion of reduced activity during the early period of heavy monsoon rains.

A comparison of the reproductive parameters of the *R. rattus* subspecies populations from each city is given in Table 8. As can be seen, the similarities are remarkable. Both populations yielded an excess of females. The minimum weight that visible pregnancy occurs is in close agreement. When litter size is corrected for intrauterine loss, both populations show similar sizes at or near parturition. It is only in pevalence of pregnancy in adult females that *R. rattus* in Rangoon demonstrate a higher breeding activity. The consequent embryo rate per female (using Harrison's definition, that is the number of embryos per hundred females, whether pregnant or not) is higher in Rangoon than in Kuala Lumpur.

The reasonably close agreement of breeding rates suggests that *R. rattus* in both cities are existing under similar circumstances of population pressure, predation and longevity. Since we have not detected any unusual fluctuations in roof rat populations in Rangoon during the two-year period of this study, it seems reasonable to assume that the total number of births and deaths are approximately equal. The measure of reproductive activity thus is equally a measure of the average death rate.

A measure of the death rate can be made from the reproduction figure (Harrison 1952, 1955). An estimate of this figure (the embryo rate/100 of all animals, males and females) is given in Table 8. The value obtained for Rangoon is markedly higher than that given for *R. r. diardii* in Kuala Lumpur, which is indicative of a population with a very high death rate and short longevity.

The high prevalence of breeding activity seen here in *R. r. khyensis* has been

noted by us in other urban commensal small mammals in Rangoon, *Rattus exulans* (WALTON et al., in press), *Bandicota bengalensis* (WALTON et al., in press) and *Suncus murinus* (unpublished observations). It indicates populations at, or near, saturation densities, with a high degree of competition, predation and stress, and a consequent high death rate. It is more than coincidental that we have now observed this pattern in four urban tropical small mammals, one of which is an insectivore.

These populations are maintained by a high degree of breeding activity with little seasonal fluctuation except during the transition period between dry summer and monsoon and the period of heaviest monsoon rains. Recruitment is almost continuous and hence the large seasonal influx of immature animals, frequently seen in temperate climate rat populations, is not observed in Rangoon. Virtually continuous recruitment of young (rats less than 70 g body weight) was also noted by the Indian Plague Commission (1910) in urban commensal *Rattus rattus* in Belgaum, India and only very minor fluctuations in the pregnancy rate was seen in this same species in Bombay (Indian Plague Commission 1908).

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Zusammenfassung

Einige Beobachtungen zur Fortpflanzung von Rattus rattus (L.) in Rangun, Burma

Einige Beobachtungen zur Fortpflanzung von *Rattus rattus khyensis*, einer weißbäuchigen, synanthropischen Hausratte, die in Rangun verbreitet ist, werden dargelegt. Fortpflanzungsaktivitäten können während des ganzen Jahres beobachtet werden, ohne daß jahreszeitliche Schwankungen erkennbar wären. Weibliche *Rattus rattus khyensis* werden geschlechtsreif, wenn sie etwa 130 mm Gesamtkörperlänge und etwa 60 g Körpergewicht erreicht haben. Erkennbare Trächtigkeit bei ausgewachsenen Weibchen wurde während der gesamten zweijährigen Untersuchungsperiode bei durchschnittlich 33,3 % festgestellt. Fortpflanzungsaktivität war feststellbar bei durchschnittlich 52,8 % aller ausgewachsenen Weibchen; sie wurde gemessen sowohl an Trächtigkeit als auch an Laktation. Die Größe der Würfe betrug 5,03 ± ,21, wobei nur sehr wenige intrauterine Embryo-Resorptionen nachgewiesen werden konnten. Die Anordnung der Zitzen wurde mit 3 + 3 = 12 nachgewiesen; Grund hierfür ist die Verdoppelung der postaxialen Zitzen (Zwillingsanordnung). Sexuelle Reife bei Männchen, gemessen an der Entwicklung der skrotalen Hoden, trat ein bei einer Gesamtkörperlänge von 124 mm und einem Körpergewicht von etwa 50 g; Fortpflanzungsaktivität auch hier während des ganzen Jahres.

Die hohe Fortpflanzungsaktivität ist ein Zeichen für starken Populationsdruck, Verfolgung und Stress und eine hohe Sterberate. Ähnliche Beobachtungen ergaben sich bei *Rattus exulans, Bandicota bengalensis* und *Suncus murinus* in Rangun. Die Produktion von Jungtieren ist nahezu kontinuierlich; die Population kann nur durch hohe Fortpflanzungsaktivität, mit geringen jahreszeitlichen Schwankungen auf dem gleichen Stand gehalten werden.

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On diet, foraging behaviour and interspecific food competition of jackals in the Serengeti National Park, East Africa

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Abstract

Studied the diet, foraging behaviour and interspecific food competition in black-backed and golden jackals (*Canis mesomelas* Schreber and *C. aureus* L.) in the Serengeti National Park, Tanzania. Both species gathered invertebrates and fruits and hunted birds and small mammals up to the size of gazelle fawns. Combined data of both species showed that pairs were more than twice as successful as single individuals in gazelle fawn hunts. The jackals frequently lost prey to scavengers. Behavioural adaptations against losing prey are described and possible reasons for the rarity of pack hunting are discussed.

1 Introduction

Jackals are possible the most common of the larger carnivores in Africa and some parts of Asia, yet they have not attracted the attention of biologists as much as the group hunters, i.e. lions, spotted hyaenas, African wild dogs and wolves. However, jackals live in pairs and family groups and are often seen hunting and foraging in pairs (van der Merwe 1953; Wyman 1967; van Lawick 1970; Hendrichs 1972). Since pair hunting offers opportunities for co-operation, it seemed worthwhile

[1] S.R.I. contribution No. 227.

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