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Body weights, sex ratio and population structure of the Western ghat squirrel, *Funambulus tristriatus*

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Abstract. Studies were made on 516 specimens of Western ghat squirrel, *Funambulus tristriatus* collected from cocoa—coconut cropping systems in Western ghat biome of South India. Sex ratios, body weights and age structure factors of *F. tristriatus* are compared with sciurid species in India and other countries.

Keywords. *Funambulus tristriatus*; population structure; sex ratios.

1. Introduction

The Western ghat squirrel, *Funambulus tristriatus* (Rodentia: Sciuridae) is a diurnal and arboreal rodent. It is a major pest of cocoa (*Theobroma cocoa*) and other fruit crops like mango, grapes, guava and sapota in the Western ghat biome of Kerala and Karnataka. Next to the black rat, *Rattus rattus*, it is the second most predominant rodent pest in order of relative abundance (Advani 1983). Although 75% of cocoa crop is being damaged by *F. tristriatus* and *R. rattus* combinely in South India (Advani 1983), very little information is available on the ecology, biology, behaviour and control of *F. tristriatus* (Prakash 1977). The present paper deals with body weights, sex ratios and age structure of *F. tristriatus* in general, and seasonal variations in these parameters in particular.

2. Materials and methods

The squirrels were collected from June 1982 to May 1983 from the coconut and cocoa plantations in and around Kasaragod (12·30° N lat; 75° E long). Wooden 'live' traps (35·5 × 10·5 × 11·55 cm) baited with banana or coconut were operated for about 25 days in each month. Traps were placed in a grid manner on cocoa or coconut trees following removal 'trap line method' (Barnett and Prakash 1975). The trapped squirrels were killed with chloroform. Following Prakash and Kametkar (1969), general and seasonal patterns in the body weights, sex ratios and age structure were obtained by examining their external and internal genital parts and recording their body weights. To find out inter-sex variations, male and female populations of *F. tristriatus*, were segregated accordingly in each month. Squirrels weighing above 100 g (sexually active), were classified as adults, while animals with body weights below 100 g were considered as subadults, on the basis of their genital organs (Purohit 1963).

3. Results and discussion

516 specimens of *Funambulus tristriatus* were studied and the monthwise break-up of the sample size is given in table 1. The average trap index (rodents/100 traps/24 hr) was 23·78, indicating higher level of infestation. Abundance of protective nesting sites (coconut, *Ficus* and fruit trees) and additional food source in the form of cocoa (in addition to fruit crops), which is a perennial crop, are two important factors for survival and multiplication of squirrels in higher densities.

3.1 *Body weights*

The individual body weights of squirrels varied from 45 g (minimum) to 215 g (maximum) in general population, whereas, among males and females, minimum and maximum body weights fluctuated from 45–215 g and 50–175 g respectively. On an annual basis, males (127·52 ± 1.47 g) were heavier than females (124·71 ± 1·78 g) though the difference was not statistically significant ($t = 0{\cdot}525$, $N = 516$). However during July, August and November, the body weights of males were significantly ($P < 0{\cdot}05$) higher than females (table 1). Though the females collected in March, September, October and December were heavier than males, the difference was negligible (1·91–6·43 g in mean body weights). Peak in male body weights was observed during the monsoon period of June (135·10 ± 6·15 g), July (143·84 ± 3·50 g) and August (133·47 ± 4·023 g) as in males of Northern palm squirrels, *Funambulus pennanti* (Prakash and Kametkar 1969). Females were heaviest during October (138·9 ± 3·634 g) when the reproductive rates are fairly high (15 % prevalence of pregnancy) resulting in deposition of fat (Advani and Sujatha 1984).

Total body weights of males and females collected during a month, exhibited peak

Table 1. Monthly variations in the body weights of male and female populations of *F. tristriatus*.

Months	Body weights (g ± SE) Male N = (g ± SE)		Female N = (g ± SE)		t value between males and females	Total of body weights (male + female) /month/60 trap/ha
January	24	130·2 ± 4·8	10	127·0 ± 6·8	0·418 NS	4394·8
February	27	118·0 ± 4·0	24	111·6 ± 4·9	0·997 NS	5864·4
March	28	126·8 ± 4·2	10	128·8 ± 5·3	0·281 NS	4838·4
April	24	116·0 ± 6·2	18	115·1 ± 7·5	0·091 NS	4855·8
May	19	128·4 ± 8·1	20	128·2 ± 5·3	0·023 NS	5003·6
June	24	135·1 ± 6·1	11	126·8 ± 6·2	0·943 NS	4637·2
July	19	143·8 ± 3·5	19	128·2 ± 5·2	2·470 *	5168·0
August	18	133·4 ± 4·0	10	110·5 ± 8·1	2·515 *	3506·2
September	18	122·1 ± 5·1	14	126·6 ± 6·2	0·560 NS	3970·2
October	35	132·3 ± 5·0	40	138·9 ± 3·6	1·044 NS	10186·5
November	29	135·2 ± 3·4	10	114·7 ± 7·8	2·401 *	5067·8
December	41	117·0 ± 4·0	24	120·8 ± 6·1	0·520 NS	7696·2

*-Significant at 5% level; NS-not significant.

during October–December (table 1) coinciding with peak production of the cocoa crop in the Western ghat biome of India (Anonymous 1981).

3.2 *Sex ratios*

Males ($N = 306$) were captured in preponderance (59·30 %) over females ($N = 210$) on an yearly basis (table 2). Except for May (48·71 % males) and October (46·56 % males), males were collected in preponderance over females during the remaining ten months. Relatively more trap success for males may be due to their higher exploratory behaviour and food and home ranges as in *F. pennanti* (Prakash *et al* 1968) where males explore more ($P < 0·05$) than females. Females, which were represented equally in the subadult stage (61–100 g; 38:37; table 3), are expected to confine their food and home ranges at adult stage and are restricted to their nests (for rearing young ones) which are maintained mostly on fruit/*Ficus* trees away from plantation crops. However, parallel to the present results, Prakash and Kametkar (1969) also observed preponderance of males (69 %) over females in *Funambulus pennanti* populations in Rajasthan. On the other hand, among Fox squirrels, *Sciurus niger rufiventer*, Allen (1942) noted a

Table 2. Sex ratio in the free living populations of *Funambulus tristriatus.*

Month	$N =$	Male	Female	% Male
January	34	24	10	70·58
February	51	27	24	52·94
March	38	28	10	73·68
April	42	24	18	57·14
May	39	19	20	48·71
June	35	24	11	68·57
July	38	19	19	50·00
August	28	18	10	64·28
September	32	18	14	56·25
October	75	35	40	46·66
November	39	29	10	74·35
December	65	41	24	63·07
Total	516	306	210	59·30

Table 3. Sex ratio variations among different weight classes of *F. tristriatus.*

Age class (g)	$N =$	Male	Female	% Male
Subadults				
40–60	11	7	4	63·63
61–100	75	38	37	50·66
Adults				
101–140	286	181	105	63·28
141–220	144	80	64	55·55

preponderance of females (66%) at Michigan as was also found by Fitch (1948) and Evans and Heldenried (1943) in Beechy Ground Squirrel, *Citellus beechevi* in California. An equal proportion of male to female ratio (102:100) has been reported in Red Squirrel, *Tamiasciurus hudsenicus loecuax* (Layne 1954) in Central New York. The χ^2 test revealed that seasons do not influence sex ratio in the *F. tristriatus* populations inhabiting Western ghats ($\chi^2 = 0{\cdot}9085$ (NS)).

3.3 *Age structure*

In general, 16·66% squirrels trapped represented the subadult population (up to 100 g body weight), whereas, about 83·33% squirrels were sexually mature adults (table 3). The weight class belonging to 121–140 g predominated (35·85%) the squirrel population followed by the 141–160 g class (22·87%), with the minimum relative occurrence of 181–200 and 201–220 g groups (0·19% each) (figure 1). Relatively more

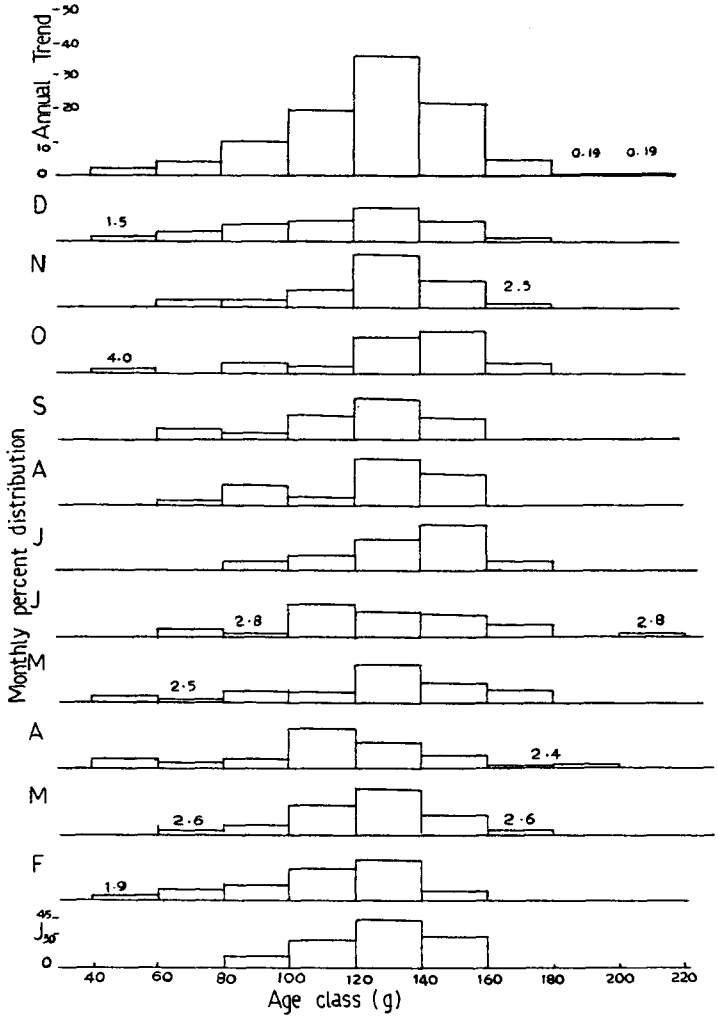

Figure 1. Monthly distribution of various weight classes of *F. tristriatus*.

(more than 20%) subadults were represented during February, April, August and December. As peaks in reproduction of *F. tristriatus* occur during February–March (30–41% pregnancy), August (30% pregnancy) and in October (15% pregnancy), these three periods and subsequent months result in a build up of subadult populations (Advani and Sujatha 1984) in relatively higher numbers. In January, June and July, the relative proportion of subadult population reduced to even less than 10%. The latter two months (June–July) coincide with the highest rainfall period in Kerala when chances of nesting and weaning young ones are relatively less. In *F. pennanti*, Prakash and Kametkar (1969) found a ratio of 8·7:1 for adult to subadult males and 7:1 for adult to subadult females. The present studies show a ratio of 5:1 (adult:subadult) in Western ghat squirrel populations. However, Allen (1942) found variations in subadult to adult ratio during several years in *Sciurus niger rufiventer* populations. In general,

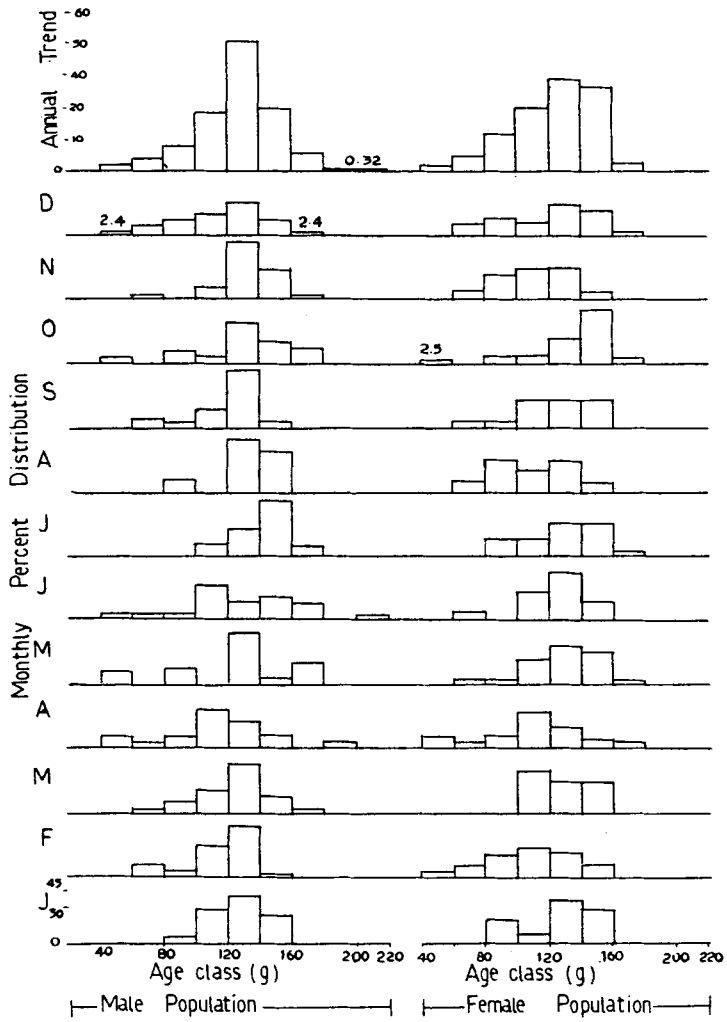

Figure 2. Monthly distribution of various weight classes of male and female populations of *F. tristriatus*.

there is no seasonal variation in the adult:subadult ratio ($\chi^2 = 6{\cdot}65$—not significant) with regard to *F. tristriatus* populations.

Among males, during April, May and December, higher relative numbers of subadults were trapped (figure 2). In January (4·17%) and then in November (3·45%), their relative occurrence decreased drastically. However, in July, not a single subadult male was captured. In females, the two weight classes belonging to 181–200 g and 201–220 g were entirely absent. Subadult female population was higher (more than 20%) in January, February, April, August, November and December. Not a single subadult female was collected in March. Though the female subadults of *F. tristriatus* reduced considerably during May (10%), June (9%) and October (10%), reduction was not as much as in subadult males in January and November.

For effective management of squirrels, the results of the present and future studies may suggest that (a) When adults are in preponderance, trapping operations will be more successful keeping in view the larger home ranges of adults resulting in more chances of rodent-trap contact. (b) When subadult population is relatively higher, traps or poison bait stations should be established closely (on invariably each cocoa tree) as home range of subadults is restricted. (c) The body weights per unit area (ha) will help in estimating population density and requirement of traps and poison baits during control operations.

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References

Advani R 1983 Ecology, status and post-natal development of the Black rat, *Rattus rattus wroughtoni* in plantation crops in Sahyadri tract; *Proc. Plant. Crop. Symp.* Kasaragod (in press)

Advani R and Sujatha A 1984 Reproductive biology of the western ghat squirrel, *Funambulus tristriatus* (Waterhouse) in the western ghat biome of India; *Z. Säugetier Kunde* **49** (in press)

Allen D N 1942 Population and habits of the fox squirrels in Allegan country, Michigan; *Am. Midl. Nat.* **27** 338–379

Anonymous 1981 Annual Report—1981, *Genetics* (Kasaragod: CPCRI) 190–193

Barnett S A and Prakash I 1975 *Rodents of economic importance in India* (New Delhi: Arnold-Hienemann) 175 pp

Evans F C and Heldenried R 1943 A population study of the Beechy ground squirrel in Central California; *J. Mamm.* **24** 231–260

Layne J M 1954 The biology of the red squirrel, *Tamiasciurus hudsenicus lecaux* (Bangs) in Central New York; *Ecol. Monogr.* **24** 227–267

Prakash I 1977 *Rodent pest management. Principles and practises* Monogr. No. 4, 1–28, Central Arid Zone Research Institute, Jodhpur

Prakash I and Kametkar L R 1969 Body weights, sex and age factors in a population of the Northern Palm Squirrel, *Funambulus pennanti* Wroughton: *J. Bombay Nat. Hist. Soc.* **66** 99–115

Prakash I, Kametkar L R and Purohit K G 1968 Home range and territoriality of the Northern Palm Squirrel, *Funambulus pennanti* Wroughton; *Mammalia* **32** 604–611

Purohit K G 1963 Effect of sexual activity on the adrenal gland in the Northern Palm Squirrel, *Funambulus pennanti* Wroughton; *Experientia* **19** 598