BIOLOGY AND CONTROL OF *RATTUS RATTUS WROUGHTONI* HINTON, A PEST OF COCONUT IN INDIA

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ABSTRACT

The biology and control aspects of *Rattus rattus wroughtoni* were studied in coconut gardens around Kasaragod. Among the eight different species of rodents that harboured in the plantations, *R.r. wroughtoni* was the most predominant (45 per cent) one. This rat caused 14 to 20 per cent damage to tender coconuts. The intensity of damage was more during summer and early monsoon (April to June) and less during post-monsoon (August to October). The mean persistence of individuals in the population was four months. Poison baiting with warfarin, fumarin or bromadiolone gave good control of the pest.

R.r. wroughtoni is the most predominant rodent pest in the coconut and cocoa plantations of Kerala and Karnataka and also of Maharashtra. Detailed studies were initiated at the Central Plantation Crops Research Institute, Kasaragod on the biology and control of this pest as the information available was scanty. The present paper summarises the results obtained in the past one decade.

1. Species Composition

In coconut plantations eight different species of rodents were observed to coexist (Advani, 1984). Among them *R.r. wroughtoni* was the most predominant one (45 per cent) followed by the field mouse *Mus booduga* (31 per cent). Other rodents found in association with these animals were the tree mouse, *Vandeleuria oleracea* (12 per cent); the Western Ghats squirrel, *Funambulus tristriatus* (7 per cent); *R.r. rufescens* (4 per cent) and the Indian gerbil, *Tatera indica* (1 per cent). The burrows of the lesser bandicoot *Bandicota bengalensis* and the larger bandicoot, *Bandicota indica* were also found in certain gardens (Table 71.1). The *R.r. wroughtoni* lived mostly on the tree canopy whereas *M. booduga* remained on the ground, thus minimising competition for food and shelter.

Table 71.1: Relative abundance and spatial preferences of rodents* in coconut gardens (N = 465)

Species	*Number trapped*	*Spatial preferences of individuals*	
		Ground	*Above ground*
R.r. wroughtoni	214(46.0)	37(17.3)	177(82.7)
M. booduga	145(31.2)	145(100.0)	0
R.r. rufescens	17(3.7)	4(23.5)	13(76.5)
F. tristriatus	32(6.9)	3(9.4)	29(90.6)
V. oleracea	55(11.8)	1(1.8)	54(98.2)
T. indica	2(0.4)	2(100.0)	0

Figures in parentheses are per cent values.
*Burrows of *B. bengalensis* and *B. indica* were observed in certain gardens.

2. Damage Intensity

Monthly observations carried out for three years in a coconut plantation of 165 yielding palms revealed considerable variation in damage from month to month. The intensity of damage was more during summer and early monsoon (April to June) and less during post-monsoon (August to October) periods (Fig. 71.1). The damage intensity varied from 14.3 per cent during 1988 to 20.4 per cent during 1990. Advani (1984) has reported that the damage intensity to coconut was more in coconut-cocoa mixed cropping systems (28.5 per cent) than in coconut monocrop system (21 per cent).

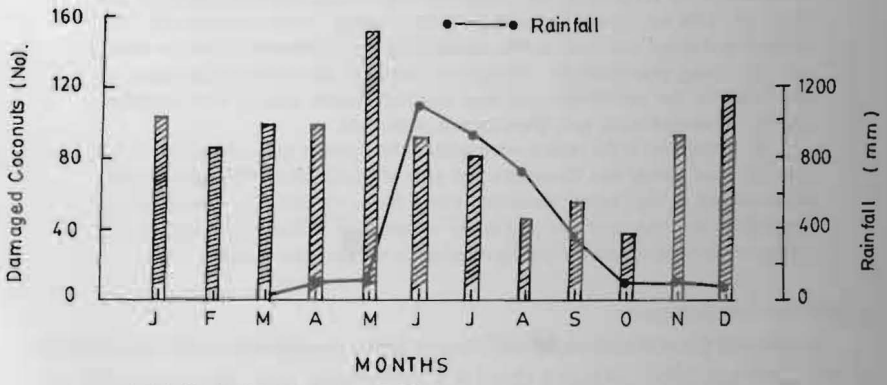

Fig. 71.1: Number of tender coconuts damaged by rats in 165 palms in different months (Mean of three years).

3. Population Structure and Movement Patterns

3.1. Sex ratio: In the natural population of *R.r. wroughtoni* the female rats significantly ($P < 0.001$) outnumbered male rats by 1.0: 0.87 (Bhat *et al.*, 1987). However, during the months of March, July and August, the number of male rats trapped was more than the females. This was attributed to the presence of more number of pregnant females during these months which restricts their movement.

3.2. Body weight distribution: In general, the male rats were significantly ($P < 0.001$) heavier and bigger than the female rats (Bhat *et al.*, 1987). The body weight in male rats varied from 20 to 190 g and in female rats 20 to 176 g. Nearly 46 per cent of male rats weighed > 100 g whereas only 29 per cent of the female rats attained that weight (Table 71.2).

Table 71.2: Body weight distribution in *R.r. wroughtoni*

Weight group(g)	*Sample size*	*Number*		*Females %*	$X^2(1)$	*P value*
		Males	*Females*			
<41	189	61	128	67.7	23.7	0.001
41–60	420	158	262	62.4	25.7	0.001
61–80	428	160	268	62.6	27.2	0.001
81–100	625	283	342	54.7	5.6	0.05
101–120	495	263	232	47.0	1.9	NS
121–140	273	166	107	39.2	13.6	0.001
>140	209	140	69	33.0	24.1	0.001

3.3. Home ranges: The movement of *R.r. wroughtoni* in coconut plantations was observed by capture, mark, release and recapture technique (Blair, 1940). The home ranges of four male and three female rats, recaptured for 10 or more times within the study area were plotted in the map and the area covered calculated. It was found that the male rats covered an area of 1160 sq m (787.5 to 1687.5 sq m) whereas the female rats covered only 932.8 sq m (843.7 to 998.5 sq m). The home ranges were highly overlapping and up to seven individuals were observed to visit one trap point. In coconut-cocoa mixed cropping system the home ranges of *R.r. wroughtoni* were observed to be smaller (661.6 sq m for males and 557.8 sq m for females) than in coconut pure crop.

4. Breeding Behaviour

4.1. Breeding season: In the natural population, *R.r. wroughtoni* was observed to breed throughout the year but with two peaks. One peak during February–March (early summer) and the other during July–August (monsoon). The breeding was lowest during summer (April to early part of June).

4.2. Ovulation rate and litter size: In *R.r. wroughtoni* the ovulation rate based on *corpora lutea* count varied from one to nine (5.26 ± 0.16). However, the litter size based on embryo count varied from one to eight (4.49 ± 0.10).

4.3. Post-natal development: The newly born young ones of *R.r. wroughtoni* weighed 2.5 to 2.9 g and measured 35 to 40 mm. The length of the tail was shorter than the head and the body. During the first week of post-natal development the pinnae unfolded and incisors erupted. Eyes opened during the third week. Tail length surpassed the head and body length during the fifth week. The young ones weaned during the thirty-sixth day of development when they weighed around 15.2 g (Advani, 1984).

4.4. Juvenile emergence and adult persistence: Young ones of *R.r. wroughtoni* came out of their nests when they were 20 to 30 g weight. Such juveniles became

adults within two to three months of their emergence. In nature, nearly 50 per cent of the rats did not persist in the population for more than four months and none after 12 months (Bhat, 1988).

5. Control Methods

5.1. Trapping: Among the two common 'live' traps namely, the wooden and the Sherman, the former was found to capture significantly more number of rats (Bhat and Sujatha, 1987).

5.2. Bait preference: About 25 baits and their combinations were screened in the laboratory to find out the most preferred bait for *R.r. wroughtoni*. It was found that the sweetened (2 per cent) whole grains of rice was ideal to prepare poison baits for the control of this pest. Addition of oils and dried fish decreased the acceptance (Bhat and Sujatha, 1989 a).

5.3. Poison baiting

5.3.1. *Multiple dose anticoagulants*: To begin with, the two common multiple dose anticoagulants, namely, warfarin and fumarin were evaluated against *R.r. wroughtoni* (Bhat and Sujatha, 1989 b). Studies revealed that there was no significant difference in the toxicity between these poisons (LFP_{50} around four days for both) to *R.r. wroughtoni* (Table 71.3) but fumarin mixed baits were accepted significantly more than warfarin mixed ones (Table 71.4).

Table 71.3: Toxicity of warfarin and fumarin (0.025 per cent) to *R.r. wroughtoni*

Days of exposure	*Mortality (%)*		*Lethal dose(mg/kg)*		*Days to death*	
	Warfarin	*Fumarin*	*Warfarin*	*Fumarin*	*Warfarin*	*Fumarin*
3	20.0	20.0	6.7 ± 1.47	5.5 ± 0.73	4.7 ± 0.33	4.3 ± 0.67
4	46.7	53.3	7.7 ± 0.91	8.7 ± 0.67	7.6 ± 1.91	6.1 ± 0.40
6	73.3	73.3	11.1 ± 0.90	9.7 ± 1.18	5.7 ± 0.38	5.2 ± 0.35
8	86.7	80.0	6.7 ± 0.65	8.4 ± 0.92	5.3 ± 0.29	6.9 ± 0.36
10	93.3	93.3	8.1 ± 0.67	11.3 ± 1.63	6.2 ± 0.39	8.5 ± 1.30
12	100.0	93.3	8.5 ± 1.08	11.5 ± 1.47	6.9 ± 0.75	9.0 ± 0.92
14	–	100.0	–	11.6 ± 1.70	–	8.7 ± 1.05

Table 71.4: Relative acceptability of poison baits by *R.r. wroughtoni*

Treatments	*Consumption (g/kg) of baits*			*t value at P <0.01*
	Warfarin	*Fumarin*	*Plain*	
Warfarin versus Fuamrin	12.68 ± 2.34 (12.3%)	90.34 ± 5.43 (87.7%)	–	12.55
Warfarin versus Plain	30.83 ± 6.65 (30.0%)	–	71.96 ± 6.45 (70.0%)	4.91
Fumarin versus Plain	–	28.91 ± 3.22 (38.0%)	47.13 ± 3.92 (62.0%)	3.29

Based on the bait preferences of *R.r. wroughtoni* the following ingredients were suggested to prepare the poison bait in wax cake form:

Broken rice: 12 parts;
Jaggery: 1 part;
Paraffin wax: 6 parts; and
Warfarin/Fumarin (0.5 per cent powder): 1 part.

First, the paraffin wax is melted in a vessel. Rice, jaggery and poison are mixed in a tray of 2.5 cm deep. The molten wax is then poured over that mixture, mixed properly and spread evenly on the tray and pressed well. Once the smooth surface is formed the slightly hardened mixture is cut into blocks of 4.5 × 3.0 × 2.5 cm. The bait is kept overnight for cooling. Next morning the blocks are ready for baiting.

Field trials were conducted using warfarin and fumarin (0.025 per cent) wax blocks to control *R.r. wroughtoni* in coconut gardens (Bhat and Sujatha, 1988). The infestations of *R.r. wroughtoni* were completely controlled by applying warfarin/fumarin wax blocks on the crown of coconut palms three times at an interval of three days at the rate of 105 g, 70 g and 35 g baits per palm on 30 palms per ha (Table 71.5).

Table 71.5: Field evaluation of warfarin and fumarin against *R.r. wroughtoni* in coconut

Times of baiting	*Poisons used*	*Trap index and number of damaged nuts*		*% of reduction*
		Pre-control	*Post-control*	
Once	Warfarin	22.52(63.5)	10.78(29.5)	52.13(53.5)
	Fumarin	24.19(48.0)	11.79(23.0)	51.26(52.1)
	Control	24.72(21.0)	28.57(18.0)	−15.57(14.3)
Twice	Warfarin	23.48(23.5)	6.86(7.0)	70.78(70.2)
	Fumarin	25.72(22.5)	7.44(7.0)	71.07(68.9)
	Control	28.57(18.0)	22.73(20.0)	20.44(−11.1)
Thrice	Warfarin	30.12(21.5)	2.05(Nil)	93.19(100.0)
	Fumarin	34.35(27.5)	2.04(Nil)	94.06(100.0)
	Control	22.73(20.0)	27.27(24.0)	−19.97(−20.0)

Figures in parentheses are number of damaged nuts.

5.3.2. *Single dose anticoagulants:* Among the three promising single dose anticoagulants namely, brodifacoum, bromadiolone and flocoumafen, the first one was found to be more toxic than the other two. However, since only bromadiolone is registered in India, more detailed studies were conducted with that poison to control *R.r. wroughtoni* in coconut gardens.

The rats did not exhibit any bait shyness when exposed to bromadiolone baits (Bhat and Sujatha, 1991). One day exposure to the poison bait (0.005 per cent) resulted in 93 per cent mortality and two days exposure resulted in cent per cent mortality. The days to death varied from three to 13 (Table 71.6).

In the field trial, one time application of bromadiolone (0.005 per cent) wax blocks on the crown of rat infested coconut palm (30 palms per ha) reduced the damage by 79.6 per cent. Two times application of poison baits at an interval of 12 days has completely controlled the damage.

Table 71.6: Toxicity of bromadiolone to *R.r. wroughtoni*

A. No-choice feeding (N = 30)

Exposure (days)	*Poison consumed (mg/kg)*	*Mortality (%)*	*Days to death*
One	6.03(2.0–10.0)	93.3	5.28(3–13)
Two	11.63(3.4–19.1)	100.0	5.80(3–10)

B. Choice feeding (N = 10)

Exposure	*Bait consumption (g/animal/day)*		*Preference*		*Mortality (%)*
	Plain	*Poison*	*Plain*	*Poison*	
One	3.30	2.30	40.0	40.0	60.0
Two	2.75	3.74	50.0	40.0	70.0
Three	3.85	2.05	40.0	40.0	100.0

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