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POPULATION STUDIES OF THE MALAYSIAN WOOD RAT (*RATTUS TIOMANICUS* MILLER) IN A COCOA-COCONUT PLANTATION

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RINGKASAN

Populasi tikus *Rattus tiomanicus* (Miller) yang dianggap stabil di ladang koko-kelapa telah dianggarkan bilangannya di antara 151 hingga 216 ekor/ha (anggaran yang telah di 'extrapolated' dari 0.74 hektar). Tikus-tikus ini dianggap mudah terperangkap (trap prone) dan ini mungkin mengakibatkan anggaran bilangannya yang rendah. Kadar hidup terus (survival rate) antara tangkapan adalah tinggi (0.5–1.0). Pembiakan populasi banyak bergantung pada kelahiran, di mana perbezaan jantina adalah sama banyak. Di dalam populasi tikus tersebut, kumpulan pembiak adalah 65%–100%, kumpulan bunting dan ibu penyusu ialah 5%–57 peratus. Jumlah tangkapan yang telah dibuat pada keseluruhan masa kajian adalah 1 086 jantan dan 741 betina. Kadar purata pertambahan bilangan berubah-ubah dengan nilai *r* antara 0.2655 hingga −0.3643 (kecuali selepas teracun pada minggu 63).

INTRODUCTION

The Malaysian wood rat, *Rattus tiomanicus* (Miller) is the dominant rodent species found in cocoa plantings (HAN and BOSE, 1980; KAMARUDIN, BAHARI and MAULUD, 1983). Although a number of studies concerning the species have been reported (KAMARUDIN and LEE, 1981; KAMARUDIN, 1983a; 1983b; 1984a; 1984b), data on population dynamics, survival rates, recruitments and reproduction have not been much investigated. WOOD and LIAU (1984a; 1984b; 1984c), however, have reported on these aspects on the same rat species population but for oil palm.

This paper attempts to relate such activities of *R. tiomanicus* in the cocoa-coconut ecosystem. These are matters of interest which will contribute to the animal attaining pest status.

MATERIALS AND METHODS

The study was carried out at Kuala Bernam Estate, near Teluk Intan, Perak. An 18-hectare plot of cocoa interplanted with MAWA coconut variety which had not been baited with rat-poison for the past 1.5 years, was selected as the study site. The cocoa trees were about seven years old, bearing and 3–5 m tall. The coconut palms measured 5–8 m in height. Ground vegetation was absent except for some grasses around the irrigation drains. Dead leaves, coconut fronds and piles of coconut husks littered the floor of the study area *(Plate 1)*.

Plate 1. Field condition of the study plot at Kuala Bernam Estate, Teluk Intan, Perak.

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A 10 x 20 rectangular trapping grid was marked based on the cocoa planting distance of 3.05 m x 3.05 metres. Each trap point was a cocoa tree spaced with a tree in between before the next trap point (distance between traps was 6 m apart). The trapping area, thus, covered an area of approximately 0.74 hectare. Four hundred locally made live-traps were used, and each trap measured 30 x 15 x 12 centimetres. Two traps were placed at each trap point; one at the base of the cocoa tree and the other tied to a branch between 1 m and 2 m above ground. Fresh coconut meat was used as baits.

The duration of each trapping round was three nights with daily inspection each morning. The interval between trappings was 17–19 days. All animals captured were ear-tagged with numbered Monel metal No. 1 fingerling tags. Each animal was identified to species, weighed [animal was classified as adult if it weighed $\geqslant$ 90 g, sub-adult 60–89 g, and juvenile $\leqslant$ 59 g (KAMARUDIN, 1983a)] and sexed. Reproductive condition (male: testis scrotal or abdominal; female: vagina perforated or unperforated, pregnant or lactating) and the number of youngs born in traps were also recorded. Animals were then released at the point of captures.

Computer programs developed by KREBS (1972) to analyse the population estimates and demographic information gathered on small mammal populations were used to interpret the data collected from the field. Statistical analysis was carried out using the SPSS computer program (NIE, HULL, JENKINS, STEINBRENNER and BENT, 1975).

RESULTS

Four rodent species; *Rattus tiomanicus* (Miller), *R. exulans* (Peale), *Callosciurus notatus* (Boddaert) and *Chiropodomys gliroides* (Blyth) were trapped in the area (KAMARUDIN *et al.*, 1983) Since the other three species were relatively small in numbers, attention was focused on *R. tiomanicus*, the dominant species trapped.

Estimates on the population density of the Malaysian wood rat using the Jolly technique (JOLLY, 1965) in the 0.74-hectare trapping grid tended to fluctuate between 102±6 and 160±9 animals *(Figure 1;* estimates after April 1981 were not taken into account). While there appeared to be more males than females in the population, the difference was not significant (Chi-square test, $P>0.05$).

The rates of survival between each trapping period (17–19 days interval) were relatively high throughout the study, varying between 0.5 and 1.0. Both male and female rats exhibited similar survival rate patterns *(Figure 1)*.

The proportion of marked animals in the population at each capture ranges from 62% to 93% of the minimum number known to be alive *(Table 1)*. Tests on their equal catchability for both the males and females indicated that the animals tended to be trap prone.

The number of untagged animals captured per trapping period varied from one to 50 animals and constituted about 5%–35% of the total population *(Figure 2)*. The number of new juveniles joining the population seemed to exhibit small cyclical trends every three or four trapping periods. These new additions to the population did not favour any one sex, except for those animals trapped in May 1980 where more males joined the population ($P<0.05$) and in September 1981 when more females were recruited ($P<0.05$). These new additions to the population by age-weight classes also did not show trends of domination by any one class although intermittently adults and juveniles appeared prominent. This was true before December 1980, but for later trappings, juveniles were more frequently caught *(Figure 2)*.

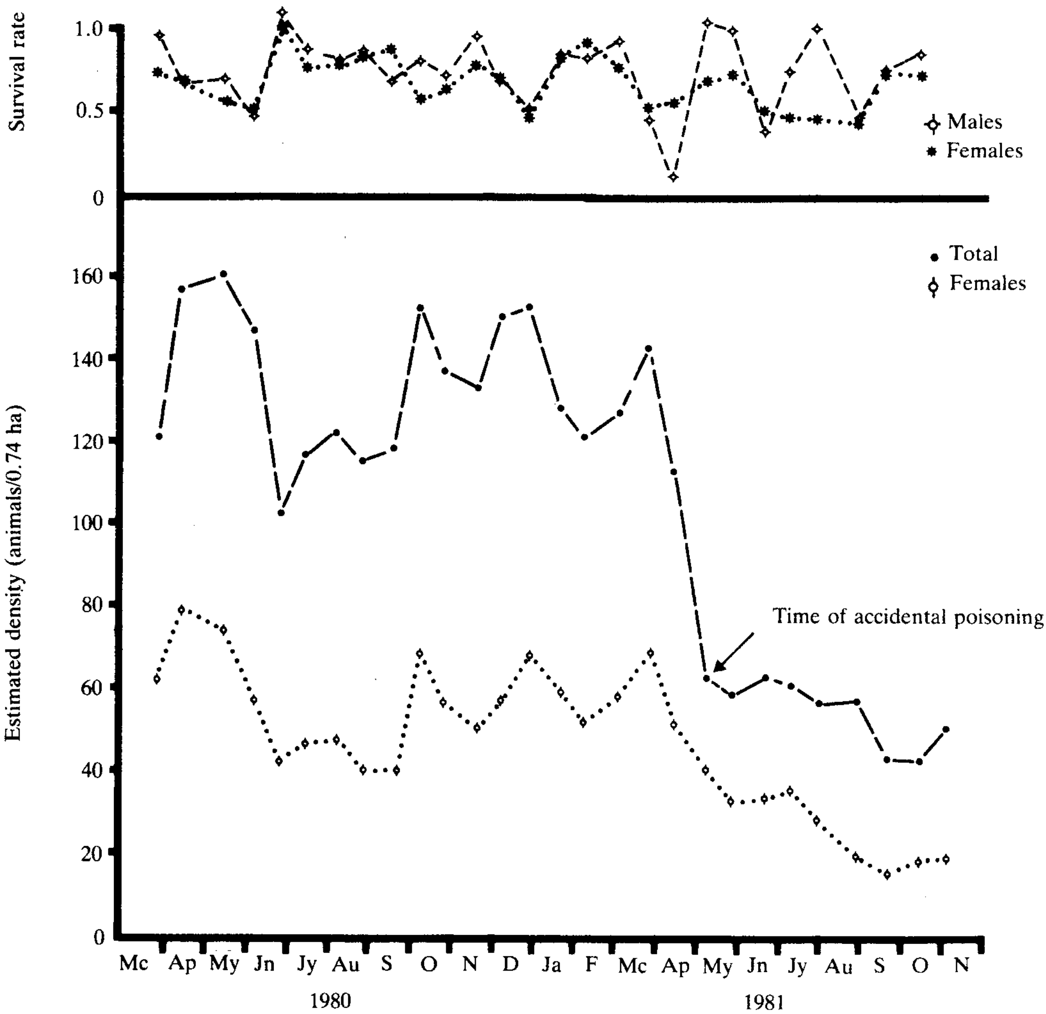

Figure 1. Survival rates and estimated animal densities between Mar. 1980 and Nov. 1981 in 0.74-hectare trapping grid.

Though rats weighing 16–178 g were trapped throughout the entire study period, a large proportion of the animals were adults (males 64.5%, females 53.9%). The rest comprised sub-adults (which consisted of 20.4% males and 28.3% females) and juveniles (males 15.1% and females 17.8%). The total number of male and female rats captured throughout the study were 1 086 and 741 respectively, of which pregnant females were excluded from the analysis to avoid false reporting of the age-weight classes.

There was a high proportion of 'potential breeders' in the population *(Figure 3)*. The proportion of scrotal males to total number of males captured ranged from 65% to 95%, and the proportion of females with perforated vaginas to total females was 80% to 100 per cent. The proportion of visibly pregnant and lactating females varied between 5% and 57 per cent. Four females gave birth while in traps, and the mean number of youngs at birth was 4.5 (range: 3–6 youngs).

To calculate the mean growth rate of the population at each trapping period, the formula used by HALL (1964) was adopted:

$$r = \frac{\ln N_t - \ln N_{t-1}}{T}$$

Table 1. Proportions of marked animals in traps, minimum number known to be alive and growth rates at each trapping sequence (Mar. 1980 – Nov. 1981)

Week	Proportion of marked animals	No. known to be alive	Mean rate of population growth
1	0	64	–
5	0.48	103	0
8	0.62	128	0.2655
12	0.69	135	0.0220
15	0.81	112	−0.0895
18	0.90	96	−0.3643
21	0.87	105	0.1284
24	0.82	104	0.0562
27	0.87	102	−0.0605
30	0.85	102	0.0270
33	0.62	137	0.2513
36	0.87	120	−0.1029
39	0.82	120	−0.0349
42	0.79	124	0.1214
45	0.75	126	0.0134
48	0.78	107	−0.1673
51	0.85	114	−0.0592
54	0.85	111	0.0513
57	0.77	114	0.1153
60	0.81	98	−0.2460
63*	0.93	58	−0.5845
66	0.93	55	−0.0752
69	0.82	59	0.0844
72	0.68	50	−0.0196
75	0.74	46	−0.0889
79	0.75	43	−0.0016
82	0.80	34	−0.2693
86	0.77	34	−0.0279
89	0.67	41	0.1758
92	0.71	34	0

*Accidental poisoning with one round of brodifacoum baits.

Where:

ln = natural log,

r = instantaneous rate of increase,

N_t = population size at time t,

N_{t-1} = population size at time t-1,

T = time span between two consecutive sampling periods (17–19 days interval).

It was noted that the population growth of the rat fluctuated between r values 0.2655 and −0.3643 during the trapping intervals before the marked reduction in the population during week 63 ($r = -0.5845$) when the field was accidently poisoned *(Table 1)*.

DISCUSSION

The population of *R. tiomanicus* in the experimental area (extrapolated to a hectare) was estimated to vary between 138 and 216 animals a hectare. The decline in the population size from April 1981 onwards was attributed to an accidental single round of baiting by the estate management staff during one of their routine field-baiting rounds. As a result, the population was reduced and did not recover to its previous level. HAN and BOSE (1980) from their field studies on animal pests of cocoa at three estates, estimated 100–300 rats/hectare. WOOD and LIAU (1984a) derived a population of 183 rats/ha (minimum) and 537 rats/ha (maximum) for *R. tiomanicus* in oil palm in their long-term studies. Although the two estimates for rats tended to agree, it was believed that the population size of this study was an under-estimation. This conclusion was made based on the finding that some individuals were trap prone. Thus estimates based on retrapping tended to be low, measuring only a portion of the available population.

The tendency for *R. tiomanicus* to be highly trap prone has been mentioned by WOOD and LIAU (1978; 1984a). CAUGHLEY (1977) proposed changes in the trapping design to make chances of capture less dependent on a decision made by the animal. This is by devising a model to cope with capture proneness or a trapping plan that reduces the time of recapturing occasions so that the animals have no time to learn much about getting caught. He also suggested that traps should be rotated randomly during each trap night. The latter proposal was not followed in this study since a fixed trap point was required for the estimation of movements and home ranges (KAMARUDIN, 1984b). The reasons for the phenomena of trap proneness have been discussed by EBERHARDT (1965) and CORMACK (1966).

The survival rates of the Malaysian wood rat for the periods between trappings

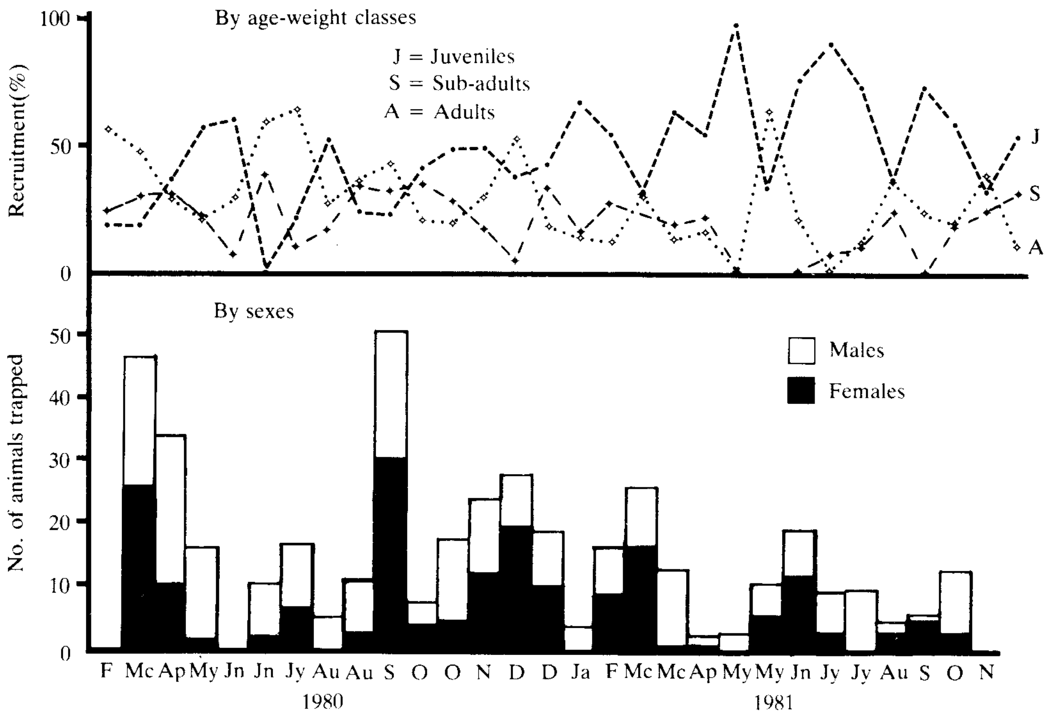

Figure 2. Recruitment at varying trapping periods between Mar. 1980 and Nov. 1981 by age-weight classes and sexes.

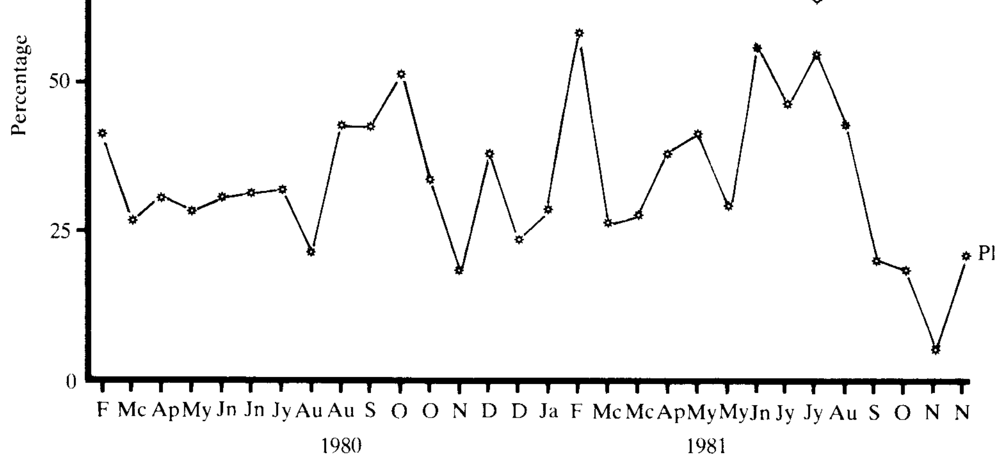

Figure 3. Proportions of scrotal males, females with perforated vaginas, and visibly pregnant and lactating females (Pl) between Feb. 1980 and Nov. 1981.

were similar to those reported by WOOD (1978) which varied between 0.7 and 0.9 for oil palm plantations. HARRISON (1956) also noted similar rates of survival in his studies for similar rat species. There were instances, however, during the study when the estimates on survival rate exceeded 1.0. This could have occurred from a combination of the true survival rate value which indeed be close to 1.0 and a positive error term (BEGON, 1979). The lower survival rate value for April 1981 was obviously attributed to the accidental poisoning, and more males were accidently killed than females during that time. In subsequent census, however, the probability of survival returned to the normal high rate.

HARRISON (1956) believed that in Malaysia where the climate is uniform, breeding in the *Rattus* species is continuous throughout the year. He also postulated that there should not be any seasonal variation in growth rates or in the age distribution of the population. Thus, he considered the population of the Malaysian wood rat as stable. The rate of population growth in this study fluctuated positively and negatively but the latter was low enough to reduce the rate of increase without causing the rapid decline in population size. Violent reduction in growth rate occurred only when the field was accidently poisoned (note the r value dropped drastically).

Untagged animals in the population varied between 5% and 35 per cent. WOOD (1978) estimated that new rats in oil palm constituted about 10%–30% of the population. Birth probably plays an important role in recruitment than does immigration in this instance. Evidences for this assumption are the high proportions of juveniles and of breeding females in the population. Though studies of dispersal (ANDERSON, 1970; DUNFORD, 1977; MICHENER and MICHENER, 1977; HANSEN and BATZLI, 1978) have indicated that most young individuals disperse at about the time of sexual maturation and the immigration of youngs born outside the population is a possibility, it is believed that most of the juveniles are born in the area. The high proportion of pregnant and lactating females preceeding every new addition of juvenile observed earlier evidently support this hypothesis.

ABSTRACT

The estimated population of *Rattus tiomanicus* in cocoa-coconut plantation presumably in a stable condition varied between 151 and 216 animals/ha (extrapolated from population estimates of 0.74-hectare). The rats were believed to be trap prone, and thus the population size was probably an underestimate. Survival rates between trapping intervals were high (0.5–1.0). Recruitment was mostly via birth and equally divided among sexes. The proportion of potential breeders was comparatively high (65%–100%) as was the proportion of pregnant and lactating females. A total of 1 086 males and 741 females were tagged throughout the study. The mean growth rate of the population varied between the r values 0.2655 and −0.3643 (except for week 63 after field was accidently poisoned).

REFERENCES

ANDERSON, P.K. (1970). Ecological structure and gene flow in small mammals. *Symp. Zool. Soc. Lond.* ***26***, 299–325.

BEGON, M. (1979). *Investigating Animal Abundance: Capture Recapture for Biologist* 97 pp. London: Edward Arnold (Publ.) Ltd.

CAUGHLEY, G. (1977). *Analysis of Vertebrate Populations* 234 pp. New York: John Wiley and Sons.

CORMACK, R.M. (1966). A test for equal catchability. *Biometrics* ***22***, 330–42.

DUNFORD, C. (1977). Social system of round-tailed ground squirrels. *Anim. Behav.* ***25***, 885–906.

EBERHARDT, L.L. (1965). Population estimates from recapture frequencies. *J. Wildl. Mgmt.* ***33***, 28–39.

HALL, D.J. (1964). An experimental approach to the dynamics of a natural population of *Daphnia galeata mendotae*. *Ecology* ***45***, 94–112.

HAN, K.J. and BOSE, S. (1980). Some studies on mammalian pests in cocoa planted under coconut. *Planter, Kuala Lumpur* ***56***, 273–83.

HANSEN, L. and BATZLI, G.O. (1978). The influence of food availability on the white-footed mice: Populations in isolated wood lots. *Can. J. Zool.* ***56***, 2530–41.

HARRISON, J.L. (1956). Survival rates of Malayan rats. *Bull. Raffles Mus.* ***27***, 5–25.

JOLLY, G.M. (1965). Explicit estimates from capture-recapture data with both death and immigration-stochastic model. *Biometrika* ***52***, 225–47.

KAMARUDIN, K.A. (1983a). Growth and reproduction of laboratory-bred Malaysian wood rat (*Rattus tiomanicus* Miller). *MARDI Res. Bull.* ***11***(3), 299–304.

——— (1983b). Interrelationships of damage cocoa pods to yield, rat population and harvesting intervals. *Planter, Kuala Lumpur* ***59***, 352–4.

——— (1984a). The nesting habits of the Malaysian wood rat in three cocoa cropping systems. *MARDI Res. Bull.* ***12***(1), 81–5.

——— (1984b). Interrelationship of daily movements and home range sizes to cocoa rat population densities and their implications on control strategies. *Poster presented at Int. Conf. on Cocoa and Coconut*, Kuala Lumpur, 1984.

KAMARUDIN, K.A., BAHARI, T. and MAULUD, A.R. (1983). Komposisi dan tabiat rodensia perosak koko. *Teknol. Pert., MARDI* ***4***(2), 104–7.

KAMARUDIN, K.A. and LEE, C.H. (1981). Modes of cocoa pod depredation by three small mammals. *MARDI Res. Bull.* ***9***(1), 42–8.

KREBS, C.J. (1972). Computer programs for the analysis of demographic data for small mammal populations *(mimeo)*.

MICHENER, G.R. and MICHENER, D.R. (1977). Population structure and dispersal in Richardson's ground squirrel. *Ecology* ***58***, 359–68.

NIE, N.H., HULL, C.H., JENKINS, J.G., STEINBRENNER, K. and BENT, D.H. (1975). *Statistical Package for the Social Science* 2nd ed., 675 pp. New York: McGraw-Hill Book Co.

WOOD, B.J. (1978). *The Dynamics of Rattus tiomanicus (Miller) (Rodentia:Muridae) Populations in Oil Palms* (ed. Turner, P.D.). Kuala Lumpur: Incorporated Soc. of Planter.

WOOD B.J. and LIAU, S.S. (1978). Rats as an agricultural pest in Malaysia and the tropics. *Planter, Kuala Lumpur* ***54***, 580–99.

——— (1984a). A long-term study of *Rattus tiomanicus* populations in an oil palm plantation in Johore, Malaysia. I. *J. appl. Ecol.* ***21***, 445–64.

——— (1984b). A long-term study of *Rattus tiomanicus* populations in an oil palm plantation in Johore, Malaysia. II. *J. appl. Ecol.* ***21***, 465–72.

——— (1984c). A long-term study of *Rattus tiomanicus* populations in an oil palm plantations in Johore, Malaysia. III. *J. appl. Ecol.* ***21***, 473–95.

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