SMALL MAMMAL COMMUNITIES IN DOI SUTHEP NATIONAL PARK AND PHU KHIEO WILDLIFE SANCTUARY

SOMYOT UA-APISITWONG

BIOLOGY DEPARTMENT, FACULTY OF SCIENCE
CHIANGMAI UNIVERSITY

1988

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BACHELOR OF SCIENCE

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DATE 21st FEBUARY 1989

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Abstract

A survey of small mammals was carried out to compare the species composition of small mammal communities in evergreen and deciduous forest types. Four trap grids were established in Doi Suthep National Park : behind Chiang Mai Zoo (430 m.), Palad (570 m), Suan Son (970 m), and Doi Suthep Summit (1610 m) and two grids in Phu Khieo wildlife Sanctuary : Salapom (590 m) and Thung Ka Mung (840 m). The grids behind Chiang Mai Zoo and at Palad were in deciduous dipterocarp savanna whilst the others were all in various kinds of evergreen forest. Each grid covered an area of 90m x 90m and contained 49 traps at 15 m intervals. Bait was banana mixed with sticky rice and crushed roasted peanuts. Animals were marked by the hair clipping method and released at the site of capture. In evergreen forest Rattus surifer, R. rattus, R. bukit, R. sabanus, R. bowersi, Menetes berdmorei, and Tupaia glis were trapped and Tamiops mcclenllandi, Callosciurus finlaysoni bocourti and C. flavimanus thai were directly observed. In diciduous dipterocarp savanna Menetes berdmorei and Melogale personata were captured. Using total number of individuals of all species caught per trap night as an index of relative abundance, indicated that evergreen forest sites supported a greater abundance of small mammals than deciduous forest sites, except on Doi Suthep Summit which had the lowest abundance. Using estimates of population density (by mark-recapture method) as a measure of absolute abundance of

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R. rattus, *R. bukit*, *R. surifer* at 2 evergreen forest sites indicated that *R. bukit* was the commonest species at Thung Ka Mung whilst *R. rattus* was the commonest at Suan Son. Distance between successive recaptures increased with the body size of rat species, indicating that larger rat species forage more widely that smaller ones. The home ranges of all 3 species overlapped considerably indicating an absence of space partioning as a means of avoiding interspecific competition.

บทคัดย่อ

การสำรวจสัตว์เลี้ยงลูกด้วยนมขนาดเล็กมีวัตถุประสงค์ เพื่อเปรียบเทียบองค์ประกอบของชุมชนของสัตว์เลี้ยงลูกด้วยนมขนาดเล็กในป่าไม่ผลัดใบและป่าผลัดใบ โดยเลือกสำรวจใน 2 สถานที่คือ อุทยานแห่งชาติดอยสุเทพ ทำในพื้นที่ตัวอย่าง 4 แห่งคือ บริเวณด้านหลังสวนสัตว์เชียงใหม่ (430 เมตร), ผาลาด (570 เมตร), สวนสน (970 เมตร) และยอดดอยสุเทพ (1610 เมตร) และที่เขตรักษาพันธุ์สัตว์ป่าภูเขียว ทำในพื้นที่ตัวอย่าง 2 แห่งคือ ศาลาพรม (590 เมตร) และทุ่งกะมัง (840 เมตร) พื้นที่ตัวอย่างบริเวณด้านหลังสวนสัตว์เชียงใหม่ และ ผาลาด เป็นป่าผลัดใบ ส่วนพื้นที่ตัวอย่างอื่นเป็นป่าไม่ผลัดใบ แต่ละพื้นที่ถูกกำหนดให้มีขนาดเท่ากับ 90X90 เมตร ใช้กับดัก 49 อัน วางห่างกัน 15 เมตร เหยื่อที่ใช้ประกอบด้วย กล้วยหอมคลุกกับข้าวเหนียวนึ่ง และถั่วลิสงป่น วางกับดักเวลาประมาณ 14.00-17.00 น. และตรวจในเวลา 9.00-12.00 ของวันถัดมา สัตว์ที่ถูกจับได้ทำเครื่องหมายโดยวิธีตัดขน แล้วปล่อยกลับที่ตำแหน่งเดิม ผลการสำรวจพบว่า ในป่าไม่ผลัดใบ สัตว์เลี้ยงลูกด้วยนมขนาดเล็กที่ถูกจับได้ประกอบด้วย หนูพ่านเหลือง (Rattus surifer), หนูท้องขาว (R. rattus), หนูขนเสี้ยนดอย (R. bukit), หนูหวาย (R. sabunus), หนูฟันขาวใหญ่ (R. bowersi), กระจ้อน ((Menetes berdmorei) และ กระแตธรรมดา (Tupaia glis) นอกจากนี้ยังพบเห็น กระเล็น (กระถิก) ขนปลายหูสั้น (Tamiops mcclenllandi), กระรอกหลากสี (Callosciurus finlaysoni bocourti) และ กระรอกท้องแดง (C. flavimanusi Thai) สำหรับป่าผลัดใบ สัตว์เลี้ยงลูกด้วยนมขนาดเล็กที่ถูกจับ ได้แก่ กระจ้อน Menetes berdmorei) และ หมาหริ่ง (Melogale personata) เมื่อใช้จำนวนตัวของสัตว์ที่จับได้ต่อจำนวนครั้งที่วางกับดักเป็นค่าดัชนีของความหนาแน่นสัมพัทธ์ของประชากร พบว่า ที่ป่าไม่ผลัดใบมีจำนวนตัวของสัตว์เลี้ยงลูกด้วยนมขนาดเล็กมากกว่าป่าที่ผลัดใบ ยกเว้น บนยอดดอยสุเทพ ซึ่งมีจำนวนตัวน้อยที่สุด และ เมื่อใช้การประมาณความหนาแน่นของประชากรโดยวิธีทำเครื่องหมายแล้ว

ปล่อย เป็นค่าของความหนาแน่นที่แท้จริงของหนู 3 ชนิด คือ หนูท้องขาว, หนูขนเสี้ยนดอย และ หนูฟานเหลือง ในป่าไม่ผลัดใบ 2 แห่ง พบว่า ที่ทุ่งกะมัง หนูขนเสี้ยนดอยมีจำนวนมากที่สุด ในขณะที่สวนสน หนูท้องขาวจำนวนมากที่สุด สำหรับระยะทางที่หนูเดินทางใน 1 คืน พบว่า จะเพิ่มขึ้นตามขนาดของตัวหนู นอกจากนี้อาณาเขตของหนูทั้ง 3 ชนิดมีการซ้อนทับกัน

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Introduction

There have been few published studies of small mammals in Thailand. Most previous studies have concentrated on the taxonomy of small mammals (Marshall 1977). With the exception of Wiles' (1981) study in Southwestern Thailand, there is no information about the ecology of ground-dwelling small mammals in natural habitats, such as population density and home range size etc. Such information could be of economic importance, since rats are the vectors of several diseases e.g. scrub typhus. The aim of this study was to survey the small mammal communities of Doi Suthep National Park in Northern Thailand and Phu Khieo Wildlife Sanctuary in Northeast Thailand. Nabhitabhata (1987) presented preliminary information on the species precent at Doi Suthep, but no data on population densities or habitat preferences were provided. Phu Khieo has never been surveyed for small mammals before.

In this study, trapping was carried out to compare the species composition of the small mammal communities in evergreen and deciduous forest types, to observe the species abundance at different elevations and to estimate population density and home range size for some of the species.

Literature Review

In Thailand, previous studies of small mammals have tended to concentrate on their taxonomy. Information about the ecology of small mammals in Thailand is sparse. The most important book on the subject is "Mammals of Thailand" written by B. Lekegul and J.F. McNeely, published in 1977, which provides descriptions of all mammal species occuring in Thailand. In this volumn J. Marshall reviews the taxonomy of the Muridae and R. Askins reviews the Sciuridae.

A report on the fauna of Doi Suthep was complied by Nabhitabhata and published in 1987. In his study, Nabhitabhata determined the presence or absence of animal species on the mountain mostly by interviewing people living in or near the mountain. Some trapping of small mammals was also carried out but no details are provided of the methods used, % capture rate, the degree of trapping effort or the habitats covered. Nabhitabhata also uses synonyms of scientific names of the Muridae which predate those provided by Marshall (1977). Nabhitabhata recorded 4 non-flying squirrel species Menetes berdmorei, Callosciurus flavimanus, Tamiops macclellandi and Dremomys rufigenis and 9 rat species, the name used by Nabhitabhata is followed by the synonym in brackets provided by Marshall (1977) Berylmys berdmorei (= Rattus berdmorei), B. bowersi (= R. bowersi), Maxomys surifer (= R. surifer), Niviventer niviventer (= R. bukit), N. flavescens (= ?), R. sikkimensis (= R. koratensis), R. exulans, R. rattus

and Leopoldymys sabanus (= R. sabanus). The presence of Melogale personata and Tupaia glis was also recorded. Which records were obtained from interviews and which by trapping is not clear in the report. Nabhitabhata provided some information on habitat preference. He noted that Rattus bowersi lives near streams and ponds at the top of the mountain. R. surifer is abundant in the ecotone between deciduous and evergreen forest with dense undergrowth especially near streams. R. bukit is found in "hill evergreen forest (ป่าดงดิบเขา)" and "pine evergreen forest(ป่าสนเขา)", whilst R. rattus is found near houses. Menetes berdmorei forages on the ground in evergreen forest (ป่าดงดิบ) whilst Callosciurus flavimanus is confined to the upper canopy in evergreen forest. Nabhitabhata noted that Melogale personata is a rare species found "far from houses".

Wiles (1981) in his study of small mammals in Salak Phra Wildlife Sanctuary also provided some information on habitat preference. Heavy cover for escape appears to be the most important factor for the occurrence of Tupaia glis. Menetes berdmorei was observed to be abundant in lowland bamboo forest. The highest captures of R. rattus occurred in dry dipterocarp forest. Wiles also noted that where R. surifer was absent, R. rattus increased in abundance.

In a study of large rat species in Malaysia, Lim (1970) recorded that R. sabanus is common in disturbed lowland primary forests and secondary forests but rare in highland primary forest. It can climb trees and prefers the drier parts of the forest floor.

Lim found that R. bowersii is abundant in disturbed lowland primary forests, but is less common in secondary forest

Davis (1956) provided a comprehensive review of trapping methods for small mammals in temperate ecosystems including methods of estimating population density and range of movements. Two trapping systems have been used in tropical forest : the trap line and the trap grid. The trap line system, in which traps are placed in a single line up to 30 m apart, usually along footpaths, is adequate for collecting specimens for identification or for relating species present with habitat structure (Kemper and Bell 1985). However if an estimate of population density is required, the grid system must be used. At Salak Phra, Wiles (1981) used grids of 20-25 traps placed in 3-5 rows spaced 15-20 m aparts. To study the range of movement of Malayan rat, Harrison (1958) employed rectangular grids with 20 metre intervals between traps.

The mark-recapture method is one of the most useful for estimating population density and has been the subject of detailed reviews by Nichols and Pollock (1983), Krebs and Boonstra (1984) and Jolly(1965).The simplest mark-recapture method uses the Petersen estimator (Jolly 1965):-

$$N = \frac{nM}{m}$$

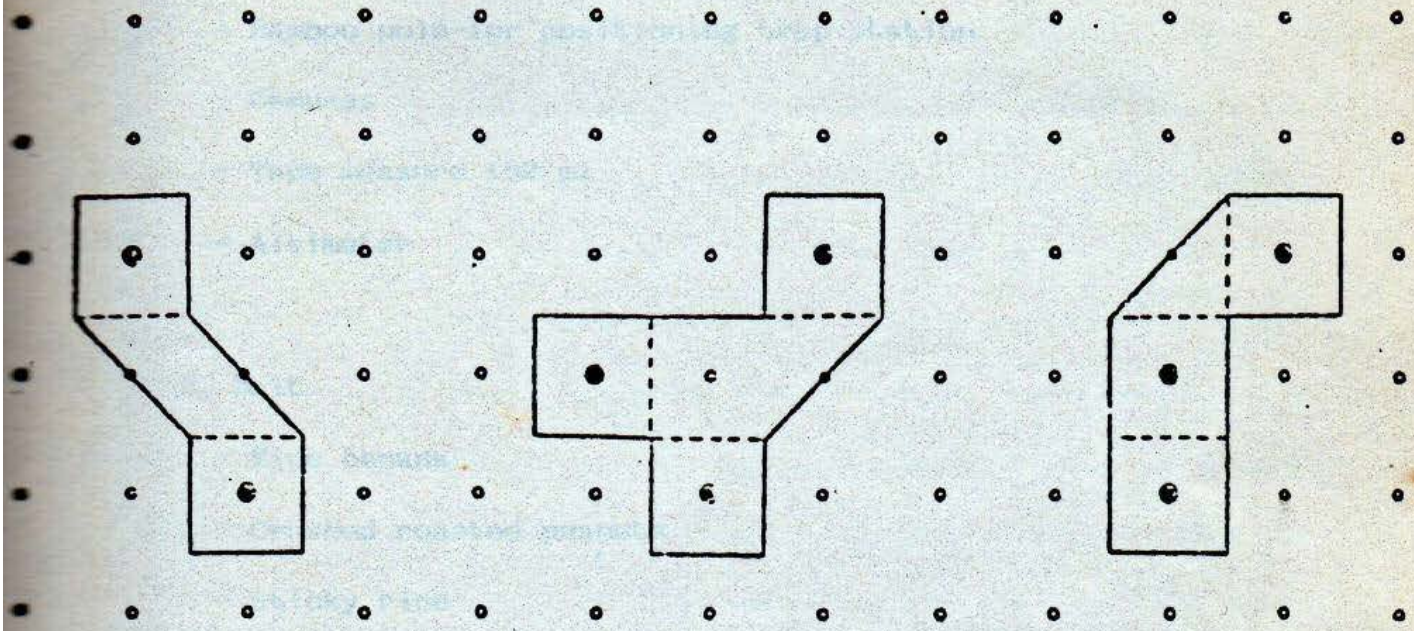
where "N" is an estimate of population size,"M"is the number of animals marked in the first sample,"n"is the total number of

animals recaptured in the second sample and "m"is the number of marked animals caught in the second sample. The model makes the following assumptions (Nichols and Pollock 1983) 1) every animal in the population (marked or unmarked) has the same probability of being caught, 2) every animal has the same probability of surviving from the first to the second sample, 3) marked animals do not loose their marks and all marks are reported on recapture and 4) actual time spent sampling occupies a short period.

Dickman and Doncaster (1987) used the boundary strip method to calculate the population density of small mammals in urban habitats in Oxford, England. The total population size estimated by the Petersen estimator is divided by the area of the trap grid plus a strip around the perimeter of the grid of width equal to half the average distance moved by individuals of each species between successive captures (D). This method assumes that if an animal is 1/2 D m away from the trap grid at the beginning of the trap period it has an equal chance of entering the trap grid or moving away from the trap grid.

The method of calculating home range area from trap grids were reviewed by Stickel (1954). By using various models of rodent movements, Stickel determined that the "exclusive boundary strip" method was the most accurate method of calculating home range area. In this method 15m x 15m squares are drawn around each trap station where the same individual is recaptured over a fairly long period. The corners of the squares are then joined with straight lines so as to enclose the smallest possible area (Fig. 1).

Fig. 1 Exclusive boundary strip method (Stickel, 1954)



Meterials

1. Setting Traps

   - Wire mesh trap (12 x 12 x 30 cm)
   - Collapsable havahart trap (8 x 9 x 25 cm)
   - Bamboo pole-for positioning trap station
   - Campass
   - Tape measure (50 m)
   - Altimeter

2. Bait

   - Ripe banana
   - Crushed roasted peanuts
   - Sticky rice

3. Handling Animals

   - Gloves
   - Black clothe bag (35 x 50 cm) - for weighing animals
   - Plastic bags (65 x 90 cm)
   - Spring balance (300 g and 1000 g)
   - Ruler
   - Scissors
   - Forceps
   - Camera Nikon FM-2
   - Glass-fronted box (collapsable) for photography

Methods

1. Preparation of Trapping Grids

Four trap grids were established in Doi Suthep National Park (อุทยานแห่งชาติดอยสุเทพ อ. เมือง จ. เชียงใหม่) ; two in deciduous forest at 430 m and 570 m, one in evergreen forest at 970 m and one in evergreen forest at the summit 1610 m above sea level. Two grids were established in evergreen forest at Phu Khieo Wildlife Sanctuary (เขตรักษาพันธุ์สัตว์ป่าภูเขียว จ. ชัยภูมิ) at 590 m and 840 m above sea level. At each grid, permanent trap stations were marked with bamboo poles 15 metres apart. The grids were 90m x 90m and contained 49 traps (7 rows x 7 columns). Columns were lebelled A, B, C, D, E, F and G and rows perpendicular to the columns were numbered 1-7. Trap stations were accurately positioned in straight lines using a tape measure and campass.

2. Preparation of Bait.

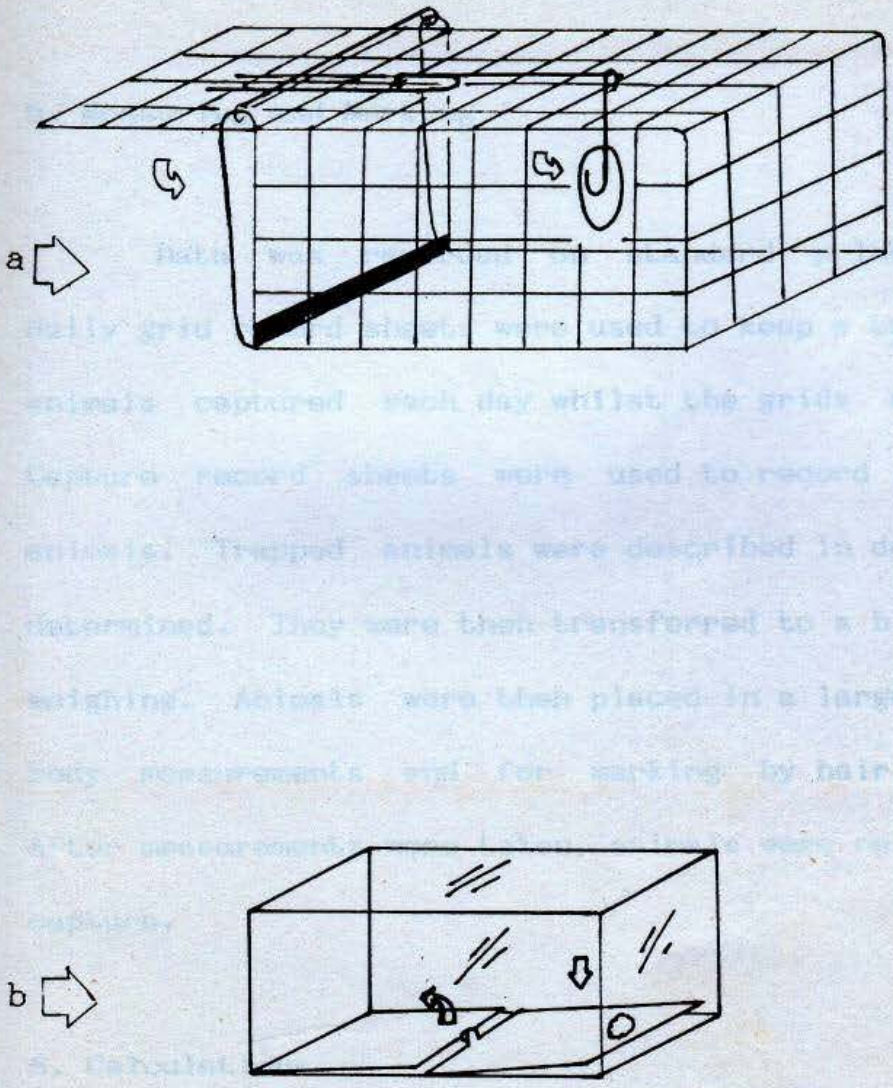
Sticky rice, ripe banana and crushed roasted peanuts were used as bait. First, hot sticky rice (300-400 g) was mashed with 1-2 ripe bananas (for 10-12 portions). The mixture was moulded into balls about 3x5 cm and rolled in crushed roasted peanuts. Bait was renewed every other night.

3. Setting traps

A total of 49 traps were used; 40 wire mesh traps and 9 collapsable havahart traps (Fig. 2). In havahart traps a small piece of bait was placed on a sprung pressure plate (Fig. 3b). The advantage of these traps is the ease with which they can be transported. However they are too small to catch some of the larger species such as ground squirrels and the larger rats. Costing 200 baht each, they are nearly ten times more expensive than wire mesh traps. Furthermore the pressure plate mechanism is easily jammed by pieces of bait becoming trapped underneath. For wire mesh traps, bait was placed securely on a hook. Wire mesh traps are triggered when an animal moves the hook to which bait is attached releasing a sprung door (Fig. 3a). They are cheap, readily available and large enough to catch any rat or squirrel species. However they are quite bulky, requiring at reast 3 people to carry 40 traps. Traps were placed in suitable microhabitats 1-2 m from the trap station. Any obstructions in front of the trap entrances were cleared away to enable ease of access for small mammals and the traps were covered with leaves. Covering the traps with leaves served three purposes : it made the traps appear to be a natural part of the habitat; it helped to protect animals in wire mesh traps from sun and rain and it camouflaged the traps to reduce the risk of them being stolen by local people.

Fig. 2 Type of traps

Fig. 3 Mechanism of traps



4. Trapping program

On the first day of trapping at each site, traps were laid out and baited at 14.00-17.00. On subsequent days, traps were checked and if necessary, rebaited at 9.00-12.00. Dates of trapping at each study site are shown in Table 1.

5. Measuring and Marking

Data was recorded on standard printed sheets (Fig. 4). Daily grid record sheets were used to keep a tally on the number of animals captured each day whilst the grids were being checked. Capture record sheets were used to record data on individual animals. Trapped animals were described in detail and their sex determined. They were then transferred to a black clothe bag for weighing. Animals were then placed in a large polythene bag for body measurements and for marking by hair clipping (Table 2). After measurements were taken, animals were relased at the side of capture.

6. Calculations

a) Weight and body measurements

Mean body weight and size measurements for each species and sex were calculated for sexually mature specimens as follows :-

$$\text{Mean } (X) = \frac{\Sigma X (I)}{N} \quad ; \; I = 1\text{-}N$$

Table 1. Trapping program

Location	Grids	Attitude(m)	Dates
Doi Suthep	Behind Chiang Mai Zoo	430	23-29/3/1988
Phu Khieo	Salapom	590	2-8/4/1988
Phu Khieo	Thung Ka Mung	840	22-28/4/1988
Doi Suthep	Suan Son	970	11-17/5/1988,
			8-10/7/1988
			21-23/9/1988
Doi Suthep	Doi Suthep Summit	1610	19-25/5/1988
Doi Suthep	Palad	570	31/5/1988-6/6/1988,
			11-14/8/1988

Fig. 4 Standard printed sheets

Capture Record

Species:

Date. Grid I.D./Trap No. Mark. Re-/First Capture

Body Measurements

Weight gm HB mm T mm E mm HF mm

Reproduction

Male/Female

Testis Position: Scrotal/Abdominal

Vaginal Orefice: Open/Closed by membrane

Mammary Nipples: Visible/Not visible

Samples

Hair Faeces Ectoparasites

Dates/Grid I.D./Trap Nos. of Previous Captures

Notes

Recorder:

Daily Grid Record

Grid I.D.

Location

Habitat Description

Altitude

Weather

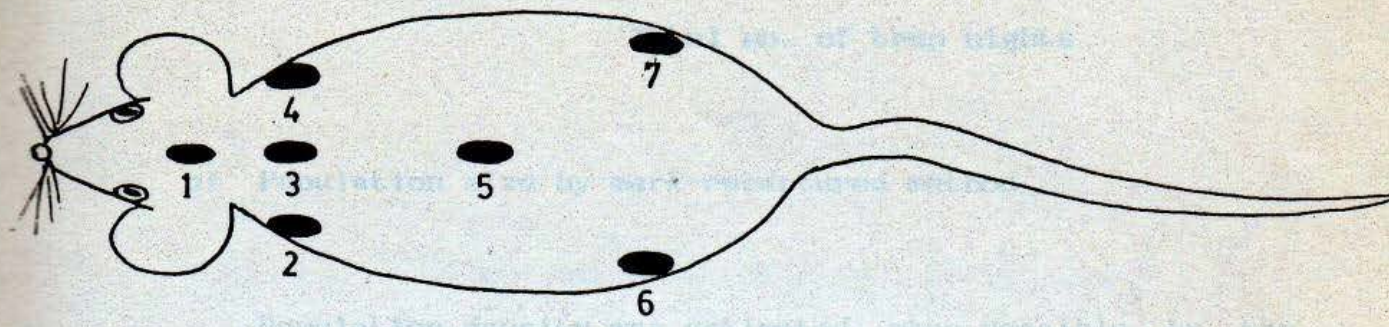
Traps Set Date: time:

Traps Checked Date: time:

Recorders Name

Trap No.	Type	Empty	Accidently Sprung	Dead Capture	Live Capture	Mark Recapture	Mark New Capture
TOTALS							

Table 2. Hair clipping method



Mark	Number
1	1
2	2
21	3
3	4
31	5
32	6
321	7
4	8
41	9
42	10
43	11
421	12
431	13
432	14
4321	15
5	16

Mark	Number
51	17
52	18
53	19
54	20
521	21
531	22
532	23
541	24
542	25
543	26
:	:
765321	123
765421	124
765431	125
765432	126
7654321	127

b) Percentage capture rate

$$\% \text{ capture rate} = \frac{\text{Total number of captures}}{\text{Total no. of trap nights}} \times 100$$

c) Population size by mark-recaptured method

Population density was estimated, when possible, by the mark-recapture method. Trapping periods usually lasted 6 nights. The first 3 nights were considered as the "marking peroid" and the last 3 nights as the "recapture period" (Davis, 1962). Total population size was calculated using the following equation...

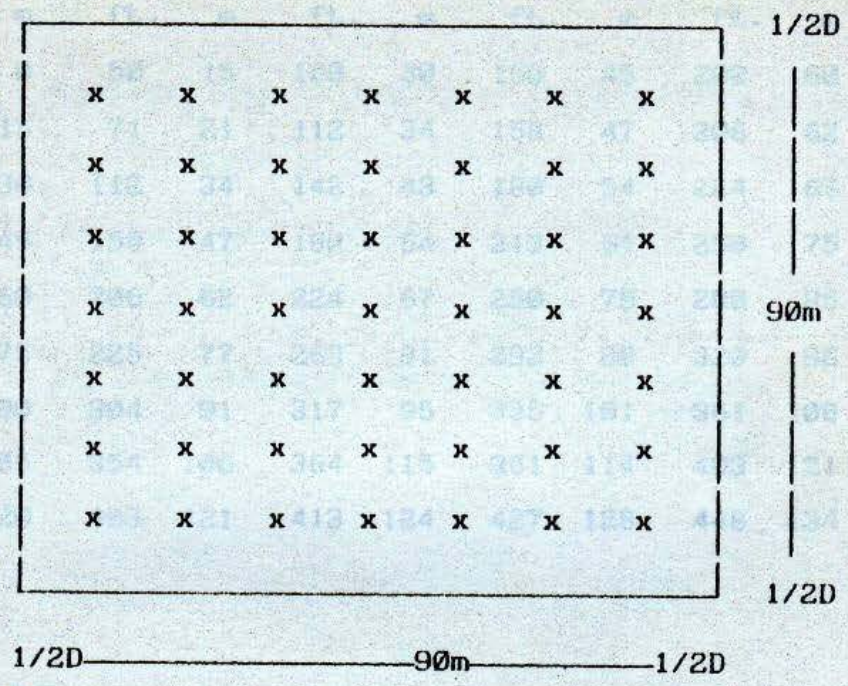
$$N = \frac{nM}{m}$$

Where "M" is the number of animals marked in the first 3 nights, "n" is the total number caught in the second 3 nights , "m" is the number caught in the second 3 night that were marked in the first 3 nights and "N" is the total population estimate.

d) Equivalent area

Population density was estimated by dividing the total population estimate by the "equivalent area".

Equivalent area was calculated by adding a boundary strip equal to 1/2 the mean distance between consecutive recaptures, to the grid area.



where D = mean distance between consecutive recaptures.

e) Distance between recaptures

The approximate distance travelled by individuals in 24 hours was calculated by recording the trap numbers, when the same individual capture 2 nights in succession, and using table 3.

Table 3 Distance between grid stakes (Davis, 1962)

stake in other direction	Stakes in one direction												
	0		1		2		3		4		5		
	ft.	m	ft.	m	ft.	m	ft.	m	ft.	m	ft.	m	
0	0	0	50	15	100	30	150	45	200	60	250	75	1
1	50	15	71	21	112	34	158	47	206	62	225	77	2
2	100	30	112	34	142	43	180	54	224	67	269	81	3
3	150	45	158	47	180	54	213	64	250	75	292	88	4
4	200	60	206	62	224	67	250	75	280	85	320	96	5
5	250	75	225	77	269	81	292	88	320	96	354	106	6
6	300	90	304	91	317	95	335	101	361	108	391	117	7
7	350	105	354	106	364	115	381	114	403	121	431	129	8
8	400	120	403	121	413	124	427	128	448	134	427	142	9

Suppose a rat is caught at C3 and then at E6. Form C3, E6 is 2 stakes in one direction (C to E) and 3 stakes in the other (3 to 6). the distance is 54 m (Davis, 1962).

f) Biomass

Biomass was estimated by calculating 95 % confidence limits for mean weight of individuals (including both sexually mature and immature individuals)

$$95\ \%\ \text{confidence limits} = X + t\frac{s}{\sqrt{N-1}}$$

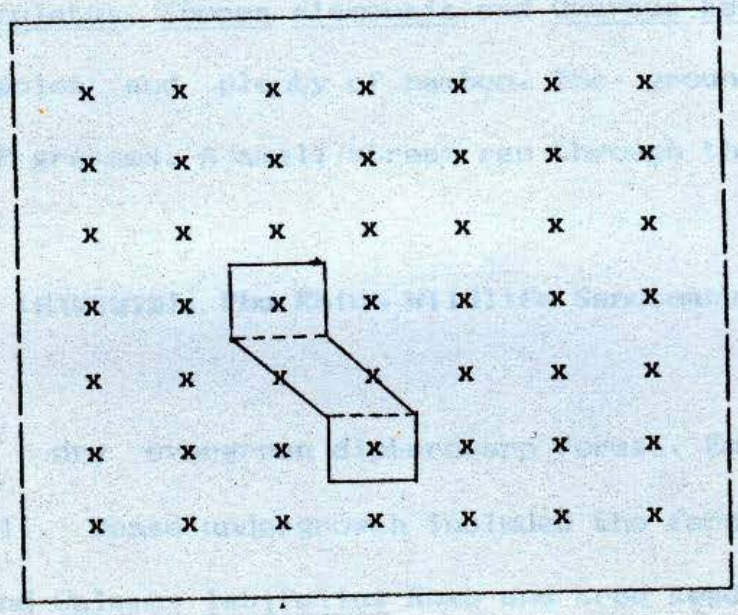
$$\text{Standard deviation } (s) = \sqrt{\frac{\Sigma(Xi - X)^2}{N-1}}$$

Using t distribution for degrees of freedom (ν) = N-1 and α = 0.05 and multiplying the values thus obtained by the population density.

Population biomass(g per ha) = Population density(per ha) X Upper or lower 95% c.l. of individual weights (g)

g) Home range

The exclusive boundary strip method (Stickel 1954) was used to calculate the home range. A square of 15 x15 m was drawn around all trap stations were an individual was captured. The squares were then joined by the shortest possible lines, thus providing a minimum estimate of total home range area.



from the diagram the home range is 3 x 225 square metres equal 675 square metres.

Study Site Descriptions

Plant names in the following habitat descriptions were provided by J. F. Maxwell, Pharmacy Faculty, Chaing Mai University.

Behind Chiang Mai Zoo, Doi Suthep National Park (430 m above sea level)

A dipterocarp savanna with Dipterocarpus obtusifolius, D. tuberculatus, Shorea siamensis and Quercus kerrii the commonest tree species and plenty of bamboo. The ground layer consisted mostly of grasses. A small stream ran through the study site.

Salapom (ศาลาพวม), Phu Khieo Wildlife Sanctuary (590 m above sea level)

A dry evergreen dipterocarp forest. Emergent trees up to 35 m tall. Dense undergrowth included the ferns, Calamus rotang Linn., and Calamus latifolius Roxb and tree seedlings. The Nam Pom river ran near the area.

Thung Ka Mung (ทุ่งกะมัง), Phu Khieo Wildlife Sanctuary (840 m above sea level)

A hill evergreen forest with some pine and a few bamboo and dense undergrowth. Common tree species included Pinus kessiya Royle ex Gordon, Castanopsis acuminatissima Rehd, Quercus dussaudii Hick, A. Camus, and Quercus kerrii Craib. A narrow track ran nearby and there was a small pond near the study area.

Palad (ปาลาด), Doi Suthep National Park (570 m above sea level)

A trap grid was situated about 0.5 km west of Palad temple. The basic forest structure was that of a deciduous dipterocarp-oak savanna with more evergreen species in the area of intermittent streams which criss-crossed the area. There had been some disturbance near the entrance to the area and many of the species there were secondary. In addition to a profusion of seedling and saplings of canopy species, there was a dense ground cover which often burns during the dry season (November-April). Most of the trees and shrubs were deciduous and began to develop leaves from about April-May. The more common plants in this are included the herbs Scutellaria glandulosa, Clobba nuda, Drynaria rigidula, Breynia glauca , the vines Streptocaulon juventas, Argyreia kerrii, the lianas Millettia extensa, the treelets Pavetta petiolaris and the trees Shorea siamensis, Quercus kerrii, Dipterocarpus obtusifolia, Dipterocarpus tuberculatus, etc.

Suan Son (สวนสน) Doi Suthep National Park (970 m above sea level)

The trap grid was placed to the west of the Mahidol Waterfall road about 2 km from the forestry station. The forest in this area was primary and evergreen. There was a canopy of massive trees from C. 20-40 m above the ground with other tree species providing a lower stratum below the canopy, these smaller trees ranged in size from C.15-25 m in height. There was an abundance of woody climbers which reached the canopy, and vines in the understorey. The ground flora was dense and included some minute to

massive herbs, shrubs, and treelets (i.e. single-stemmed woody species that have a mature height of up to C. 5 m). There were epiphytes also, some of which were found in the shaded understorey; most of the flowering epiphytes were in the conopy and included many species of Orchidaceae. Examples of plant species included the herbs Lasia spinosa, Phrynium capitatum, the vines Jasminum nervosum, the lianas Calamus kerrii, the treelets Psychotria ophioxyloides, Amoora chittagonga and the trees Garcinia xanthochymus, Xanthophyllum flavescens, Baccaurea ramiflora, Carallia brachiata, Schoepfia acuminata, Kuema corticosa, Nyssa javanica, etc.

Doi Suthep Summit, Doi Suthep National Park(1610 m above sea level)

The area had suffered a ground fire just before trapping in May. The vegetation was basically evergreen, mostly primary and scrubby i.e. single storey canopy with trees up to C. 10 m tall. There was a general lack of lianas (i.e. woody climbers) , but an abundance of epiphytic lichens, mosses, ferns and many orchids. There were only a few species of deciduous tree and these were deciduous for a short period. Examples of plant species included the herbs Dianella ensifolia, Hypoxis aurea, Costus speciosus, the ferns Pteridium aquilinum, Humata repens, the treelets and shrubs Vernonia volkameriifolia, Euodia triphylla, the vines polygonum chinense, the orchids Pholidota articulata, Otochilus alba and the trees Anneslea fragrans, Helicia nilagirica, Pinus kesiya, etc.

Results

During 1983 trap nights at 6 locations, a total of 126 individuals of 8 species of small mammals were captured. On average animals were caught in 12.2 % of traps set each night. A detailed account of work carried out is given in the appendix and summarized in table 4, which shows trapping effort and percentage capture rate at the six grids.

Evergreen forest sites supported more species of small mammals than deciduous forest sites except the lower montane evergreen forest near the summit of Doi Suthep where only one species (R. bukit) was captured.

Using total number of individuals of all species caught per trap night as an index of relative abundance, indicated that evergreen forest sites also supported a greater abundance of small mammals than deciduous forest sites, again with the exception of Doi Suthep summit which had the lowest abundance. Weight and body measurements of adults captured are summarized in table 5 and accounts of the different species are presented below. For detailed taxonomic descriptions of the species, the reader is referred to Marshall 1977.

Rattus surifer (Miller, 1900) Yellow Rajah Rat, หนูฟานเหลือง

A medium sized rat; the body has sandy coloured underfur overlaid with black guard hair; pure white underparts; blackish tail which is white underneath with the distal 1/3 white all round

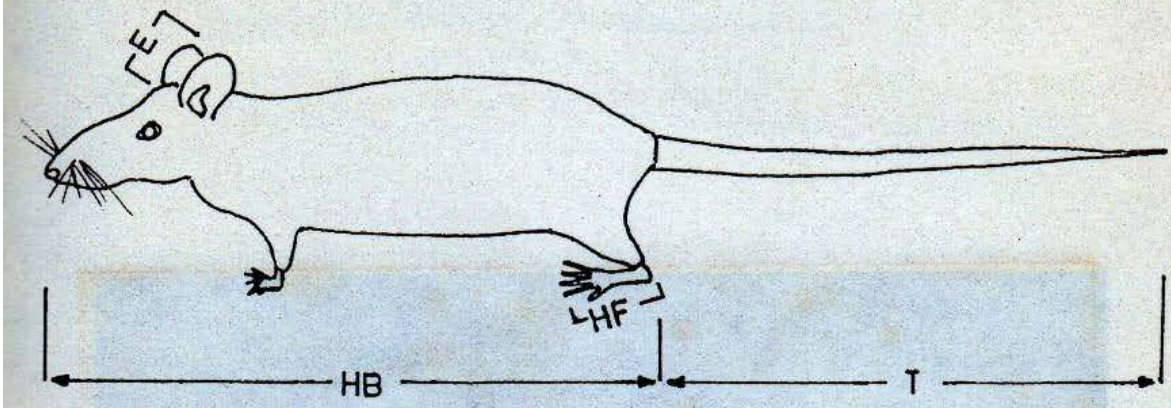
Table 4 Total trapping effort and percentage of capture rates in six gri

Habitat type	Attitude (m)	Grids	Trap nights	Species	Number of individuals captured	% individual capture rate *	Totale number of captures	% capture rate +
Deciduous forest	430	Behind Chiang Mai Zoo	239	M. personata	2	0.8	4	1.7
				M. berdmorei	3	1.3	3	1.2
				Total	5	2.1	7	2.9
Evergreen forest	590	Salapom	262	R. surifer	2	0.8	3	1.1
				R. rattus	1	0.4	1	0.4
				R. sabanus	1	0.4	1	0.4
				M. berdmorei	2	0.8	2	0.8
				T. glis	3	1.1	3	1.1
				Total	9	3.5	10	3.8
Evergreen forest with pine	840	Thung Ka Mung	265	R. surifer	5	1.9	11	4.2
				R. rattus	14	5.3	24	9.1
				R. bukit	24	9.0	60	22.6
				Total	43	16.2	95	35.9
Evergreen forest	970	Suan Son	451	R. surifer	15	3.3	29	6.4
				R. rattus	25	5.5	41	9.1
				R. bukit	12	2.7	26	5.7
				R. bowersi	1	0.3	1	0.3
				Total	53	11.8	97	21.5
Lower montance evergreen forest with pine	1610	Doi Suthep Summit	265	R. bukit	4	1.5	5	1.9
Deciduous forest	570	Palad	381	M. berdmorei	12	3.1	13	3.4
		Total	1863		126	6.8	227	12.2

* no. individuals capture / trap nights

\+ total no. captures / trap nights

Table 5. Weight and body measures small mammal species (sexsually mature individauls only)



Species	Sex	No. of mature animals	Weights			Body measurement both sexes (mm.)											
						HB			T			E			HE		
			Min	M̄	max	Min	M̄	max	Min	M̄	max	Min	M̄	max	Min	M̄	max
Rattus surifer	M	3	156	161	164	165	177	195	180	186	192	19	23	25	23	34	40
	F	7	134	148	168	144	160	170	175	179	185	19	23	26	34	37	40
	SUM	10	134	152	168	144	165	195	175	183	192	19	23	26	23	36	40
Rattus rattus	M	17	64	134	201	138	169	212	146	180	204	14	21	34	30	34	44
	F	6	109	134	195	160	172	183	169	190	220	15	23	32	30	32	35
	SUM	23	64	134	201	138	170	212	146	183	220	14	21	34	30	33	44
Rattus bukit	M	9	78	89	115	135	144	155	158	181	205	13	18	22	27	30	33
	F	12	52	86	134	115	137	155	142	173	195	15	19	22	25	28	31
	SUM	21	52	87	134	115	140	155	142	177	205	13	19	22	25	29	33
Rattus sabanus	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	F	1	-	144	-	-	225	-	-	327	-	-	29	-	-	47	-
Rattus bowersi	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	F	1	-	>270	-	230	-	240	-	33	-	33	-	35	-	52	-
Melogale personata	M	1	-	554	-	-	350	-	-	180	-	-	24	-	-	45	-
	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Menetes berdmorei	M	6	220	223	249	160	171	182	135	162	210	15	18	20	40	41	43
	F	7	188	227	264	170	196	210	140	160	180	15	17	20	34	38	46
	SUM	13	188	225	264	160	179	210	135	161	210	15	17	20	34	40	46
Tupaia glis	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	F	2	164	164	164	160	170	180	175	202	230	13	14	15	43	44	45

Fig. 5 Small mammal species

Rattus surifer, Salapom

Fig. 6 Growth rate of Rattus surifer

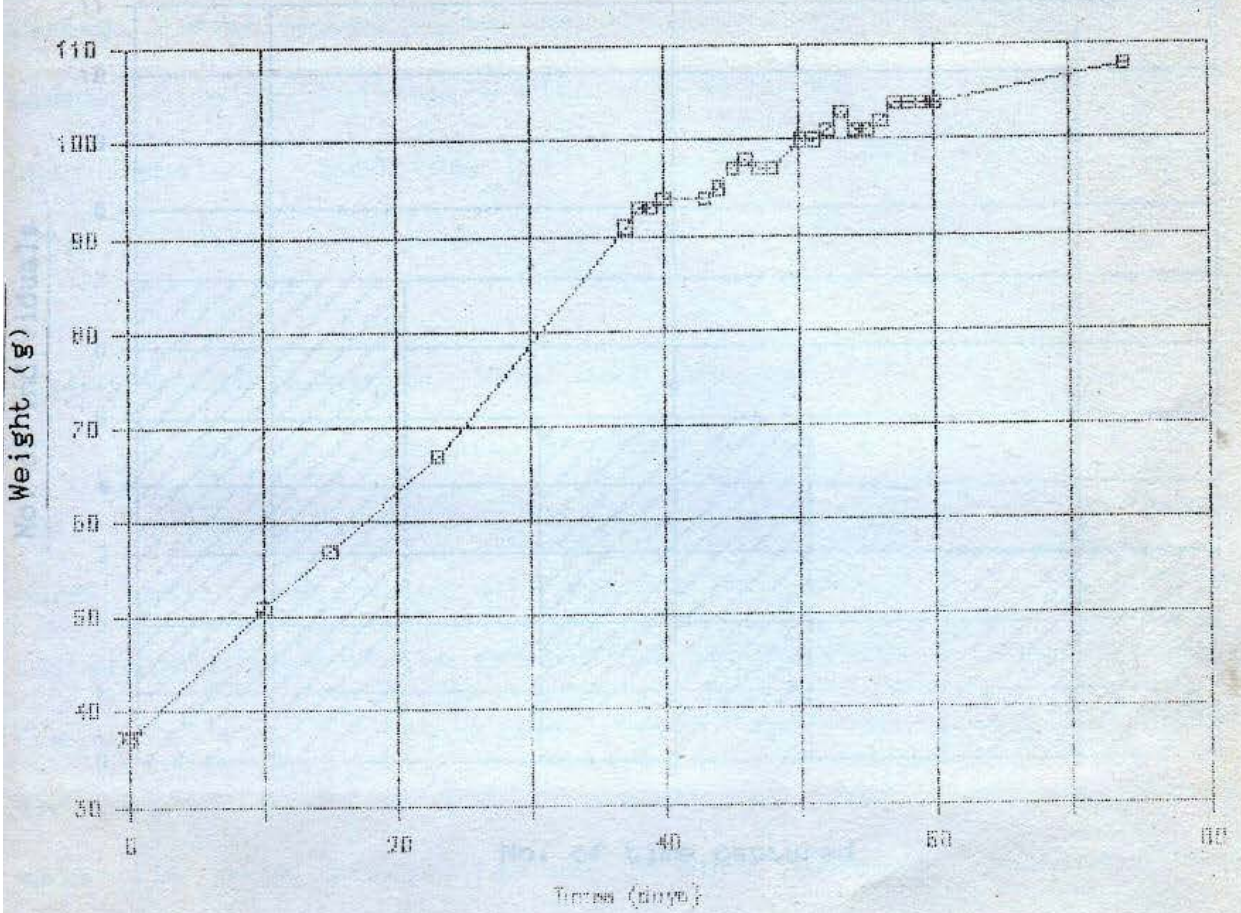
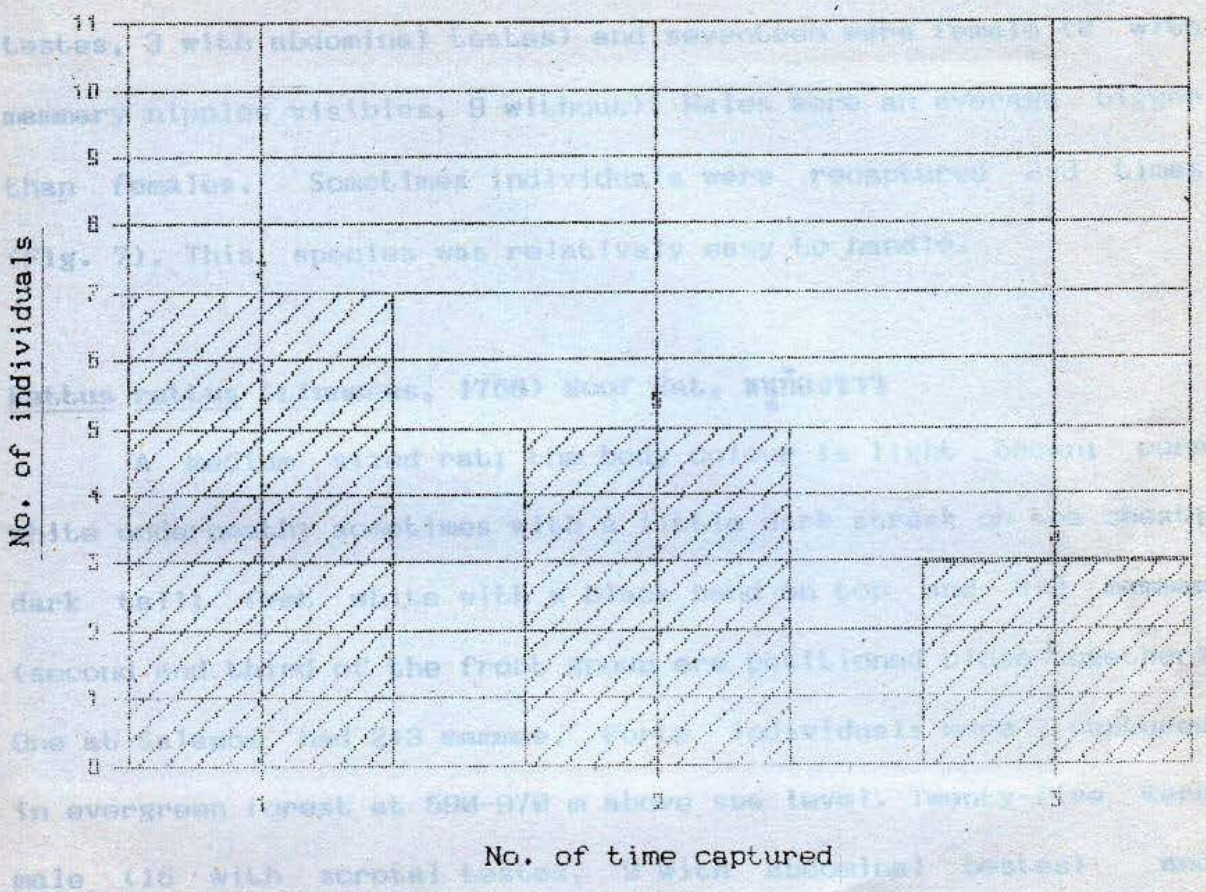


Fig. 7 Recapture rate of Rattus surifer



and with 2+2 mammae. The underparts of a juvenile captured at Suan Son and observed in captivity were at first dark grey with the middle of the back turning a sandy colour which spread to the rest of the body as the animal matured. The growth rate is shown in Fig. 6. Twenty three individuals were captured in evergreen forest at 590-970 m above sea level. Six were male (3 with scrotal testes, 3 with abdominal testes) and seventeen were female (8 with mammary nipples visibles, 9 without). Males were an average bigger than females. Sometimes individuals were recaptured 2-3 times (Fig. 7). This species was relatively easy to handle.

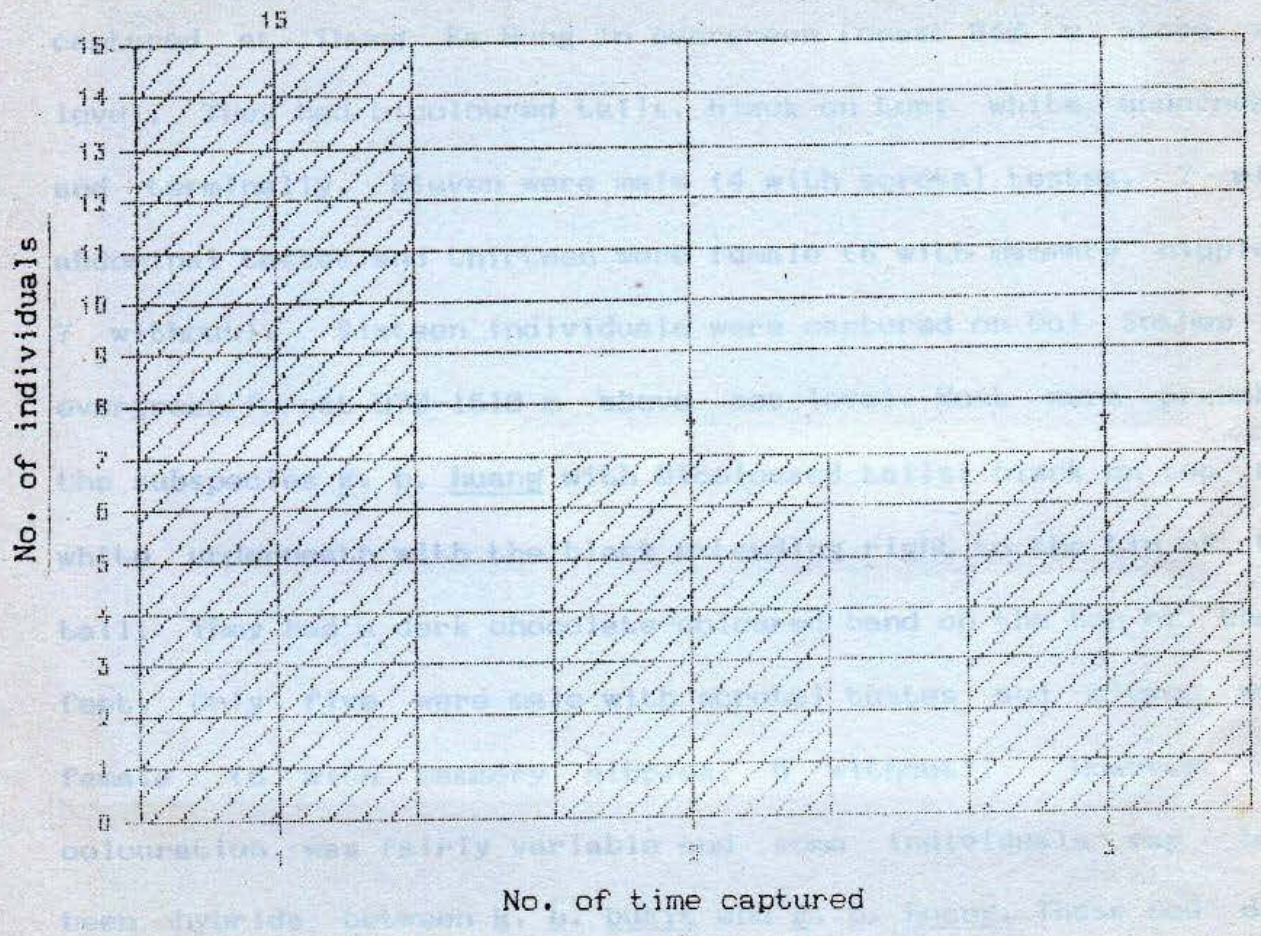
Rattus rattus (Linnaeus, 1758) Roof Rat, หนูท้องขาว

A medium sized rat; the body colour is light brown; pure white underneath; sometimes with a little dark streak on the chest; dark tail; feet white with a black band on top and 3+3 mammae (second and third of the front group are positioned close together). One at Salapom had 2+3 mammae. Forty individuals were captured in evergreen forest at 590-970 m above sea level. Twenty-five were male (16 with scrotal testes, 9 with abdominal testes) and fifteen were female (6 with mammary nipples visible, 9 without). The same individuals were often recaptured 2-3 times (fig. 9). R. rattus was fairly nervous and agressive when trapped and was difficult to handle.

Fig. 8 Small mammal species

Rattus rattus, Salapom

Fig. 9 Recapture rate of Rattus rattus



Rattus bukit (Bonhote, 1903) Chestnut Rat and Bonhote's Rat, หนูท้องเสี้ยนคอย

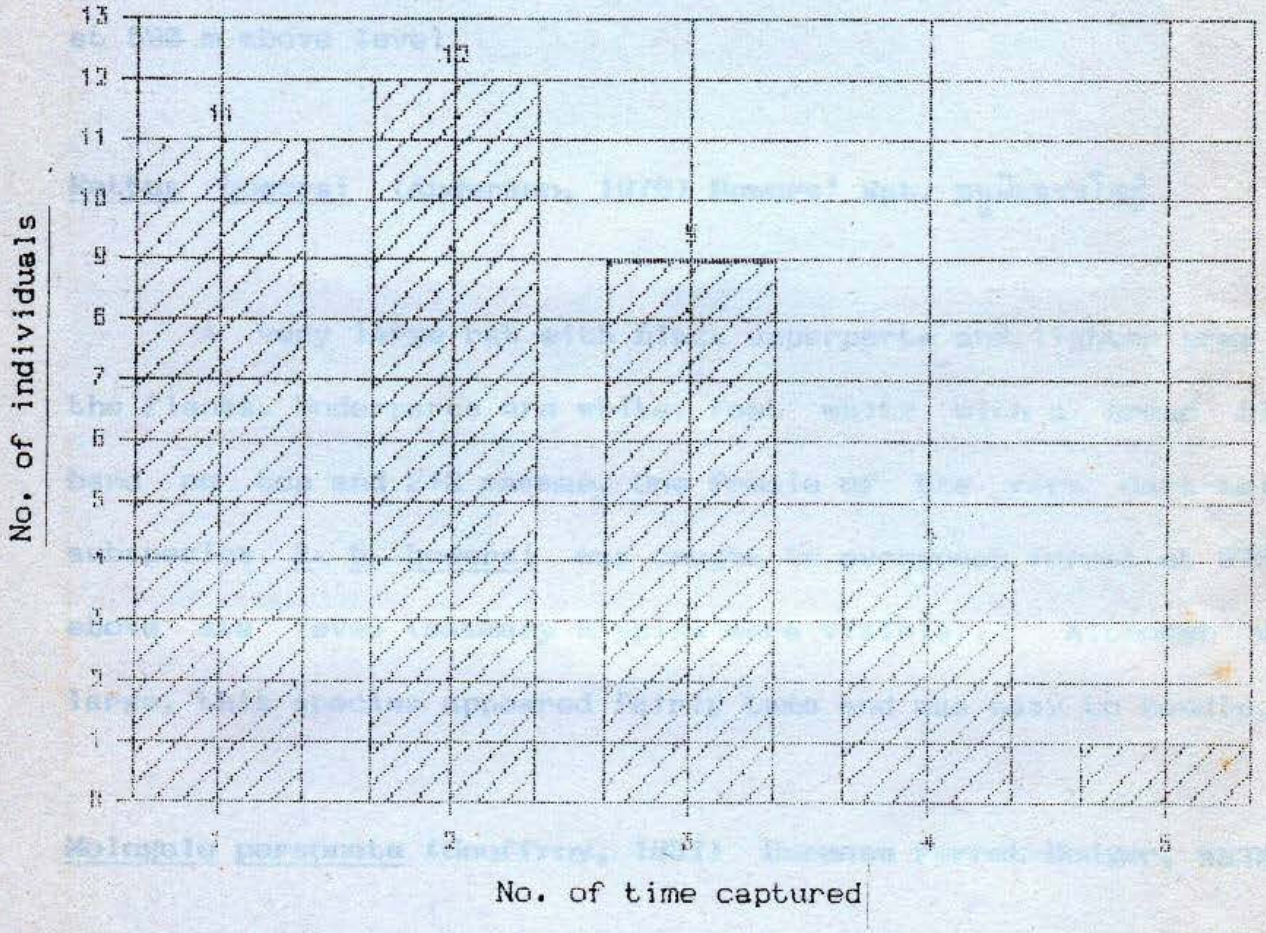
A relatively small rat species; R. bukit is red brown mixed with black hair or dark grey on the back. The side of the face or neck has a lighter buffy colour. Underparts are white. Twenty four individuals of the subspecies R. bukit bukit were captured at Thung Ka Mung in evergreen forest 840 m above sea level. They had bicoloured tails, black on top; white underneath and terminally. Eleven were male (4 with scrotal testes, 7 with abdominal testes)and thirteen were female (6 with mammary nipples, 7 without). Sixteen individuals were captured on Doi Suthep in evergreen forest 970-1610 m above sea level. Most were probably the subspecies R. b. huang with bicoloured tails; black on top and white underneath with the black extending right to the tip of the tail. They had a dark chocolate-coloured band on the top of their feet. Only five were male with scrotal testes and eleven were female (6 with mammary nipples, 5 without). However the colouration was fairly variable and some individuals may have been hybrids between R. b. bukit and R. b. huang. These had dark band on the tops of the feet, a white tip of the tail and variable colour of the upperparts from dull grey to bright red-brown. R. bukit had the highest rate of recapture for the study as a whole (Fig. 11).

Fig. 10 Small mammal species

Rattus bukit, Doi Suthep Summit.

Rattus bukit, Doi Suthep Summit

Fig. 11 Recapture rate of Rattus bukit



R. sabanus (Thomas, 1887) Noisy Rat, หนูหวาย

A large rat species with the longest tail of any rat in Thailand. The upperparts are light brown mixed with black hairs. Underparts are white and there is a dark broad band on the top of the feet. The very long tail is black with white patches, white all around in the distal two thirds. There are 2+2 mammae. Only one female with mammary nipples visible was caught in evergreen forest at 590 m above level.

Rattus bowersi (Anderson, 1879) Bowers' Rat, หนูพันธุ์ใหญ่

A very large rat with black upperparts and lighter grey on the flanks. Underparts are white, feet white with a broad black band on top and 2+2 mammae. One female of the rare dark-tailed subspecies R. b. bowersi was caught in evergreen forest at 970 m above sea level (mammary nipples were visible). Although very large, this species appeared fairly tame and was easy to handle.

Melogale personata (Geoffroy, 1831) Burmese Ferret-Badger, หมาหริ่ง

The body colour is greyish brown. The upper half of the head is black with a white patch across the nose between the eyes; the lower half of head, the throat, and the inner sides of the ears are white, and a white stripe runs from the top of the head over the neck and ends at the middle of back. One male with scrotal testes

Fig. 12 Small mammal species

Rattus sabanus, Salapom

Fig. 13 Small mammal species

Rattus bowersi, Suan son

Fig. 14 Small mammal species

Melogale personata, Behind Chiang Mai Zoo

and one female with mammary nipples not visible in similar habitat at 570 m which suggests they are confined to the very lowest parts of Doi Suthep. In addition they are not infrequently observed around houses in CMU. campus at 360 m above sea level. This animal produces a very strong smelling foetid adour when disturbed.

Menetes berdmorei (Blyth, 1859) Indochinese Ground Squirrel, กระจ้อน หรือ กระแต

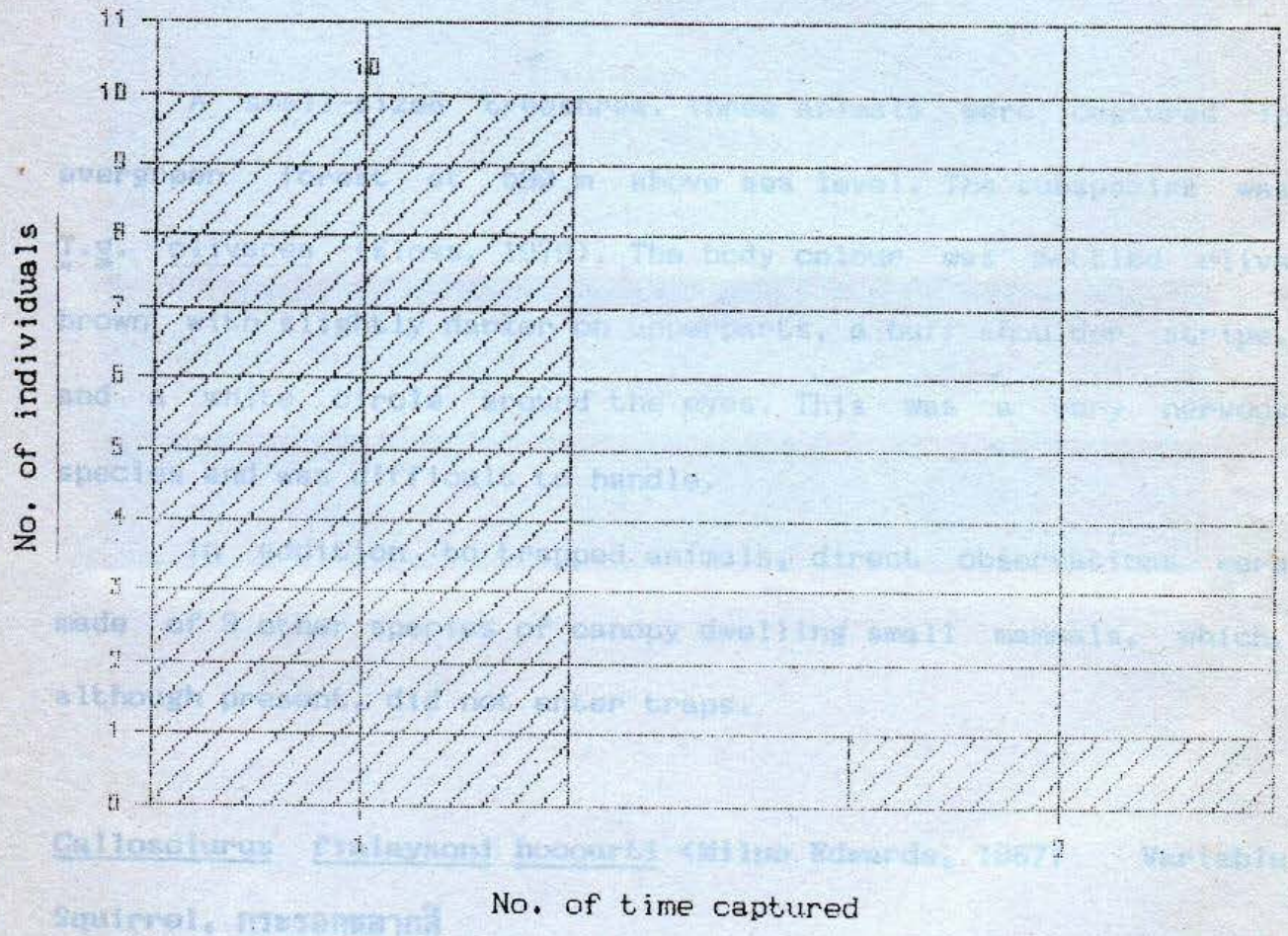
A large squirrel. Most individuals captured were the subspecies M.b. consularis. In the rainy season, the body colour is dark grey with reddish black or reddish fur on the back and pure white underparts. There is one black or reddish black stripe between 2 white stripes on the flanks and a faint dark grey or grey olive stripe under the lowest white stripe. Sometimes this species is a richer brown on the back with one black stripe between 2 cream stripes on the flanks. In summer, the body is dark grey with reddish fur on the back and slightly black middorsal stripe, pure white underparts, and two black stripes alternating with two white stripes on the side. At Salapom one individual of the subspecies M. b. mouhotei (Gray, 1861) was caught at 590 m above sea level in evergreen forest (female with mammary nipples visible). The body colour was grey with one black stripe between the two white stripes on the flanks and slightly reddish fur on the back with a faint black middorsal stripe. Sixteen individuals were captured in deciduous and forest at 430-570 m above sea level on

Fig. 15 Small mammal species

Menetes berdmorei consularis, Salapom

Menetes berdmorei mouhotei, Salapom

Fig. 16 Recapture rate of Menetes berdmorei



Doi Suthep. The subspecies was M.b. consularis. Seven were male (6 with scrotal testes, 1 with abdominal testes) and seven were female with mammary nipples visible and two escaped before sex determination. They were highly nervous and difficult to handle. They often suffered cuts to the nose in their attempt to escape from the trap. They were rarely recaptured (Fig. 16).

Tupaia glis (Diard, 1820) Common Treeshrew, กระแตธรรมดา

A small-sized treeshrew. Three animals were captured in evergreen forest at 590 m above sea level. The subspecies was T.g. olivacea (Kloss, 1979). The body colour was mottled olive brown with slightly darker on upperparts, a buff shoulder stripe, and a white circle around the eyes. This was a very nervous species and was difficult to handle.

In addition to trapped animals, direct observations were made of 3 other species of canopy dwelling small mammals, which, although present, did not enter traps.

Callosciurus finlaysoni bocourti (Milne Edwards, 1867) Variable Squirrel, กระรอกหลากสี

Two animals were observed in evergreen forest at 590 m above sea level. One had a pure black back and white underparts with white tail. The other was pure black on the upper side of tail and white underneath. Both were observed climbing in trees about 15-20 m above the ground.

Fig. 17 Small mammal species

Tupaia glis, Salapom

Tamiops mcclellandi (Horsfield, 1839) Striped Tree Squirrel, กระเล็น (กระถิก) ขนปลายหูสั้น

Five observation were made at Thung Ka Mung and one was made at Doi Suthep in evergreen forest at 800-840 m above sea level. They were all highly active and were observed climbing on the trunk and branches of pine trees and eating seed from pine cones.

Callosciurus flavimanus Thai (Kloss, 1917) Belly-Banded Squirrel, กระรอกท้องแดง

One individual, which had apparently injured itself by falling from a tree, was collected at the Suan Son trapping grid in evergreen forest. The animal died within 12 hours of collection. The upperparts were olive brown with a distinct black patch on the posterior two-thirds of the back. The belly was bright auburn, and the tail bushy with indistinct strips.

Population density and home range

Population estimates, and home range size of 3 rat species : R. surifer, R. rattus and R. bukit are presented in table 6 at 2 evergreen forest sites. Using estimates of population density (by mark-recapture method) as a measure of absolute abundance indicated that R. bukit was the commonest species followed by R. rattus and R. surifer at Thung Ka Mung, while R. rattus was the commonest

species followed by R. surifer and R. bukit at Suan Son.

Distance between successive recaptures increased with the body size of rat species (Fig. 18) indicating that the larger rat species foraged more widely than small ones. At Thung Ka Mung all 3 rat species moved much longer distance than at Suan Son.

The home ranges of all 3 species (Fig. 19, 20) overlaped to a high degree.

Table 6 Estimated population of mark animals and home range

Grids	Species	Number of individuals from capture -recapture equation	Mean distance between recaptures (metre)	Equivalent area (Hectare)	Population density (per hectare)	Number of individuals from trapping	95% confidence limit for mean weight (grams)			Biomass (grams per hectare)			Home range (square meters)		
							Min	M	max	Min	M	max	Min	M	max
Thung Ka Mung	R. surifer	5	56.3	2.14	2.3	5	78	125	172	179	288	396	296.7	759.4	1222.1
	R. rattus	17	31.2	1.47	11.6	14	82	95	108	951	1102	1253	105.5	594.6	1083.8
	R. bukit	26	21.2	1.24	21.0	24	60	67	73	1260	1407	1533	218.7	716.4	1214.2
Suan Son	R. surifer	14	15.0	1.10	12.7	9	89	124	159	1130	1575	2019	403.3	618.8	834.2
	R. rattus	18	7.5	0.95	18.9	16	110	128	145	2079	2419	2740	486.1	1135.2	1784.3
	R. bukit	10	5.0	0.90	11.1	9	67	96	125	744	1066	1388	340.2	642.9	945.5

Fig. 18 Distance between recaptures rates related to mean weight of mature animals

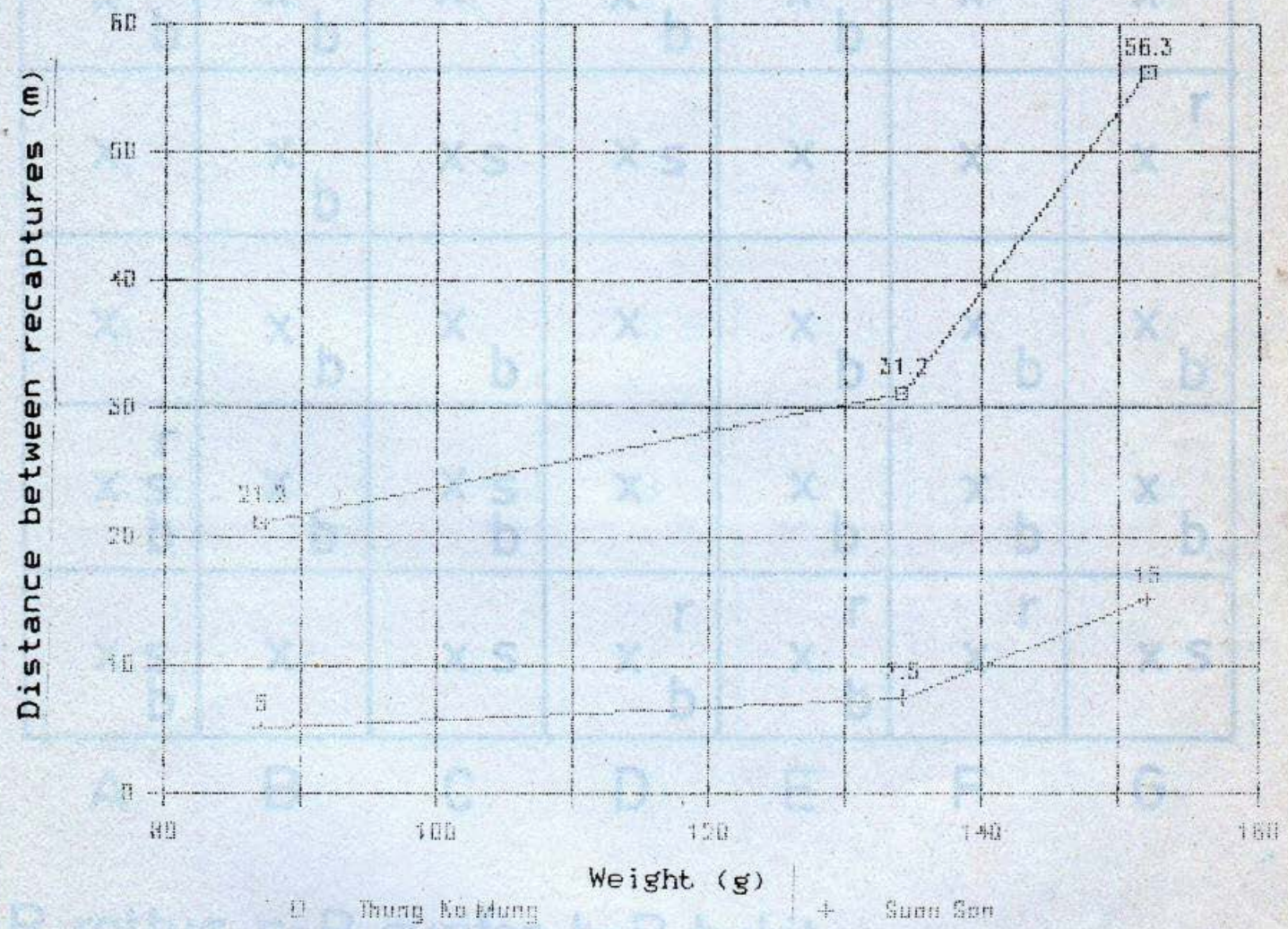
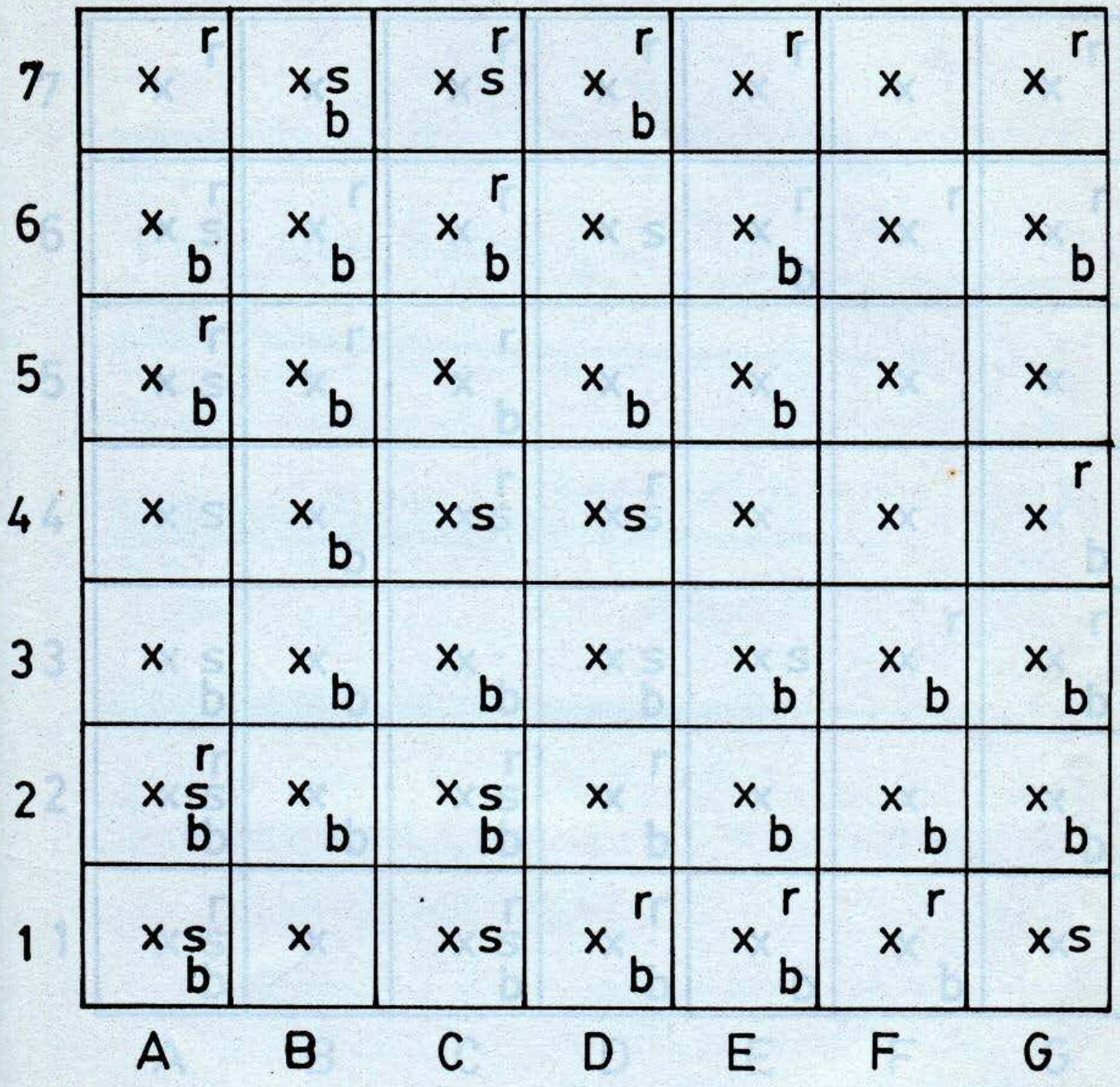


Fig. 19 Home range of small mammals in Thung Ka Mung



r=R. rattus, s=R. surifer, b=R. bukit

Fig. 20 Home range of small mammals in Suan Son

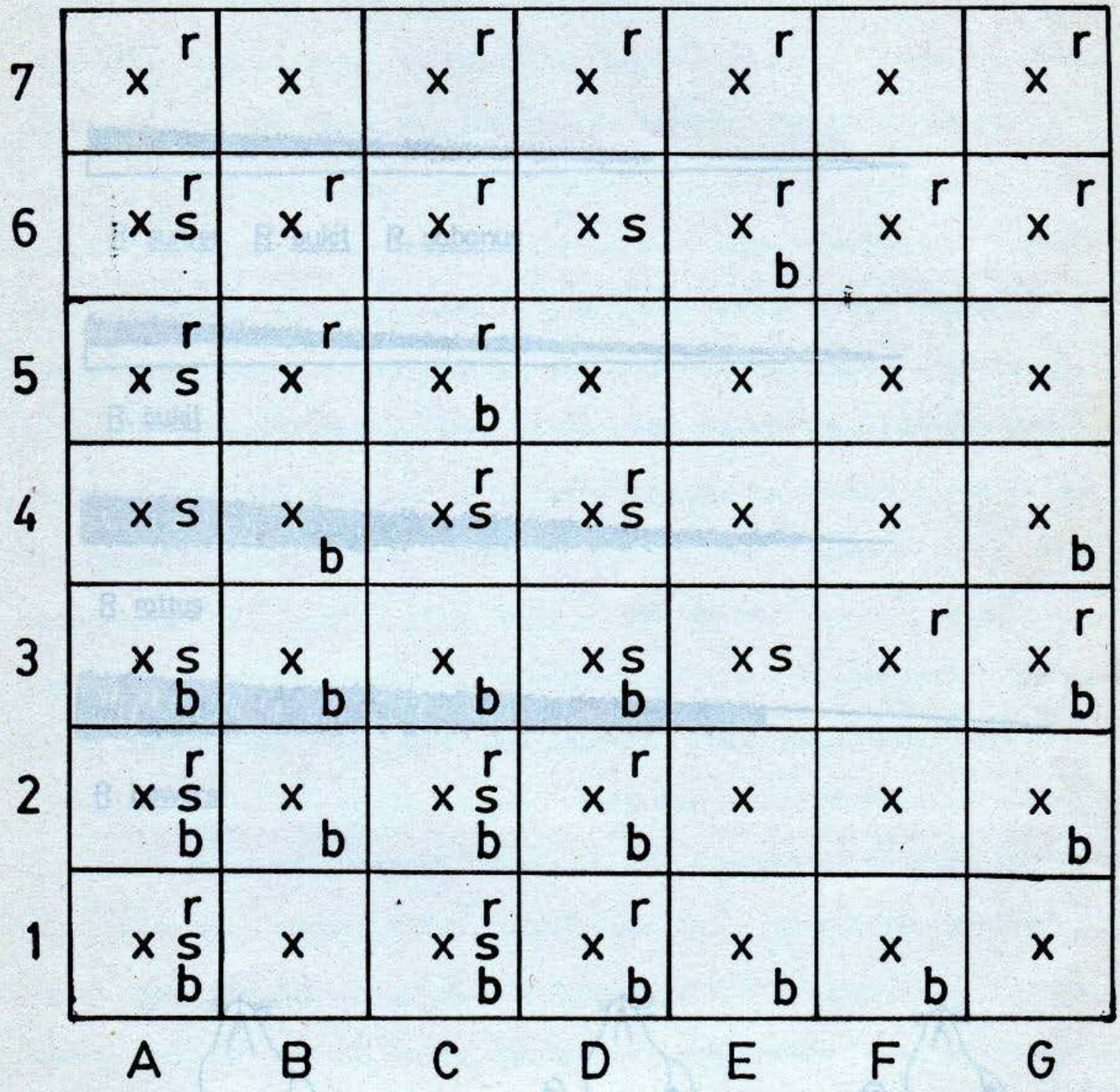
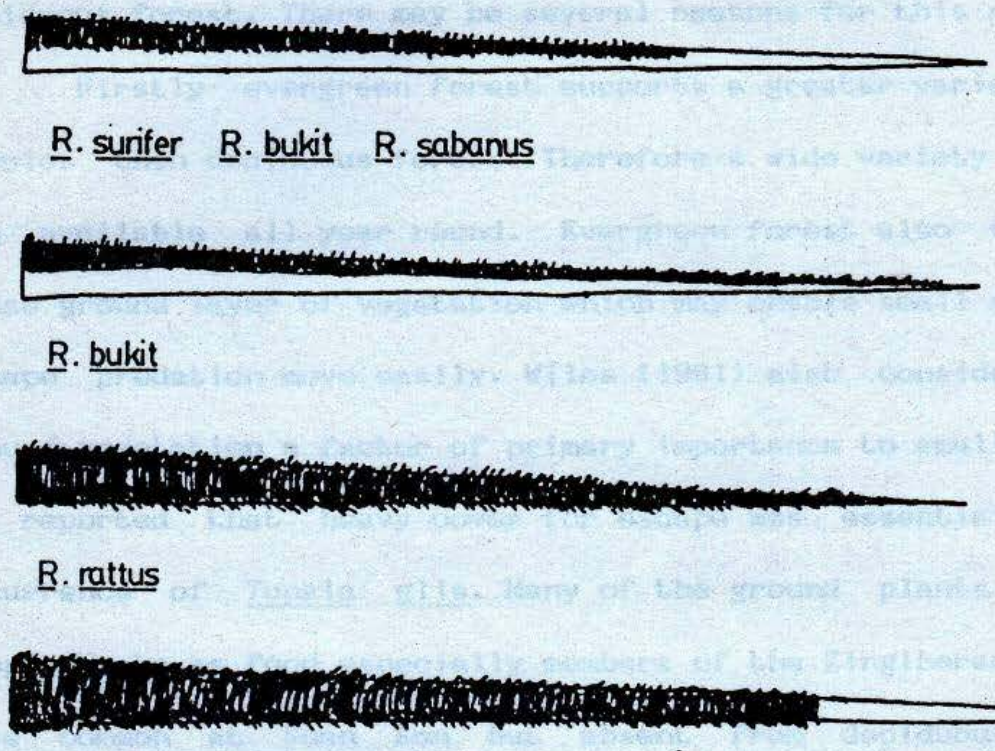
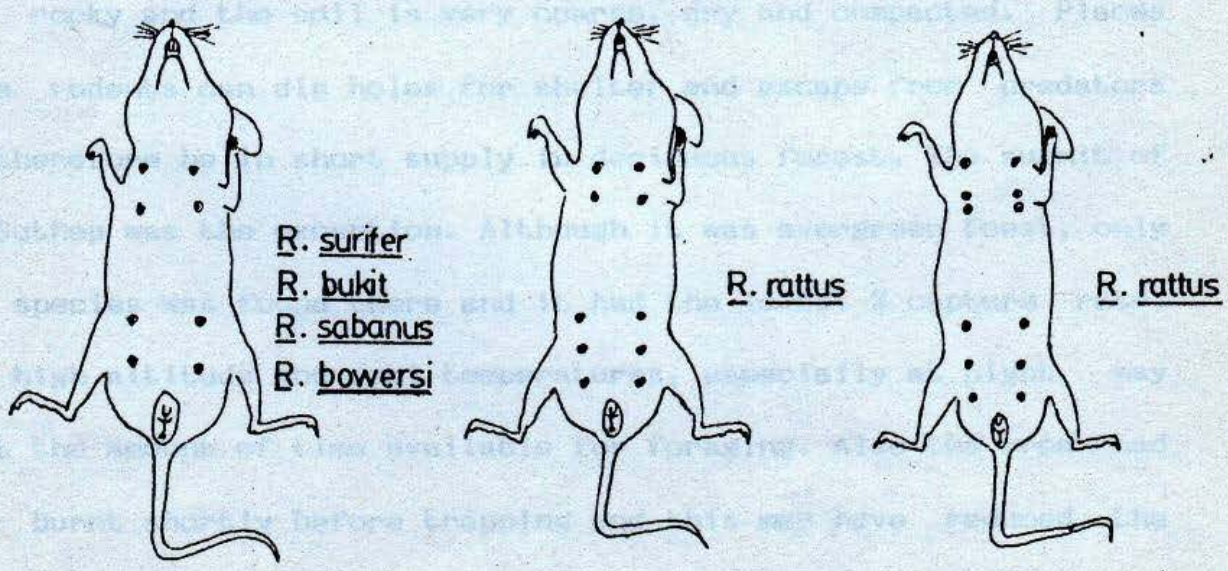


Fig. 21 Characteristics of rat species





Discussion

This study shows that evergreen forest supported a greater diversity and higher numbers of ground-dwelling mammals than deciduous forest. There may be several reasons for this result.

Firstly evergreen forest supports a greater variety of tree species than deciduous forest. Therefore a wide variety of foods are available all year round. Evergreen forest also supports a dense ground layer of vegetation which may enable small mammals to escape predation move easily. Wiles (1981) also considered dense ground vegetation a factor of primary importance to small mammals. He reported that heavy cover for escape was essential for the occurrence of Tupaia glis. Many of the ground plants may also supply roots as food especially members of the Zingiberaceae which were common at Suan Son but absent from deciduous forest. Differences in the soils between evergreen and deciduous forests may also be a significant factor. In evergreen forest it is relatively easy to dig holes, but in deciduous forest the ground is very rocky and the soil is very coarse, dry and compacted. Places where rodents can dig holes for shelter and escape from predators may therefore be in short supply in deciduous forest. The summit of Doi Suthep was the exception. Although it was evergreen foest, only one species was found there and it had the lowest % capture rate. The high altitude and cool temperatures, especially at night, may limit the amount of time available for foraging. Also the area had been burnt shortly before trapping and this may have reduced the

population density. It is interesting to note that pine trees were present on the summit of Doi Suthep and that the only species captured was R. bukit. R. bukit was commonest at Thung Ka Mung where there was also of pine. Jarujin (1987) and Marshall (1977) also noted that R. bukit prefers forests which include pine tree.

All species recorded on Doi Suthep in this study were also found by Nabhitabhata (1987). In addition Nabhitabhata (1987) recorded one squirrel species, Dremomys rufigenis which was not found in the present study, probably because it prefers forest habitat more that 900 m above sea level. Nabhitabhata also recorded R. sabanus, R. berdmorei, N. flavescens, R. koratensis and R. exulans which were not found in the present study. This study confirms Nabhitabhata's result that R. surifer prefers evergreen forest with dense undergrowth especially near streams but contradicts Nabhitabhata's finding that R. rattus occurs only near houses. In this study R. rattus was common in evergreen forest at Suan Son at least 2 km from the nearest houses. Nabhitabhata also stated that on Doi Suthep Melogale personata is found only in primary evergreen forest far from hoses. This study failed to find Melogale personata in evergreen forest but showed that the species occured at low altitudes in deciduous dipterocarp savanna close to houses.

The population densities of rat species determined in this study were much higher than those recorded in previous studies in other countries. At Tangkoko Batungus Reserve in lowland evergreen forest in Salawesi it wat estimated that the density of all rat

species considered together is about 20/ha (Whitten et al. 1987 p 409) whereas total rat populations at Thung Ka Mung and Suan Son found in this study were 35/ha and 43/ha respectively. Harrison (1969) reported polulation a density of R. surifer of 2.9/ha in disturbed rain forest in Malaysia at about 50-100 m above sea level. This is comparable to the figure of 2.3/ha recorded at Thung Ka Mung but is much less than the 12.7/ha at Suan Son.

Measurements of weight in the present study contrasted greatly with those of the same species in Malaysia (Rudd 1965). The mean weights of sexually mature R. surifer this study (Males 161 g females 148 g) were 21 % lower for males and females than that recorded by Rudd (1965) for R. surifer specimens collected in Malaysia. Tupaia glis at Salapom (females 164 g) were 33 % larger on average than Malaysian specimens. The single specimen of R. sabanus captured at Salapom was similar in weight to the average weight recorded by Rudd (1965) for Malaysian specimens.

The home range of all 3 rat species overlapped considerably indicating on absence of space partitioning as a means of avoiding interspecific competition. It is suggested that the different rat species consume different foods or are active at different times of the day to avoid competition.

This study has demonstrated the suitability of the trap grid method with 15 m intervals between traps for population studies of small mammals in forest habitats in Thailand. However due to the limited time available, the results presented here are only rudimentary. There was no detailed attempt to determine precisely

which components of the habitats were important for small mammal species. Further research of the type carried out by Kemper and Bell (1985), who related the species composition of small mammal communities in Malaysia to habitat components, needs to be done in Thailand. In addition further research could also be carried out on food preferences, using captive animals and the activity times of different species, by inpecting traps at dawn and dusk instead of the 24 hours intervals used in this study. Such studies would enable us to understand how very similar rat species (eg. R. surifer and R. rattus) can co-exist in the same habitat. Such work is needed as rats are the vectors of several diseases and are also pests or crops. Attempts to control rat populations can only be improved through a greater understanding of their ecology in their natural habitats. In addition they are part of the whole forest ecosystem and their activities may be essential to the survival of the forest as a whole.

Summary

1. In evergreen forest the small mammal species present included Rattus surifer, R. rattus, R. bukit, R. sabanus, R. bowersi, Tupaia glis, Menetes berdmorei, Callosciurus finlaysoni bocourti, C. flavimanus thai, and Tamiops mcclellandi.

2. In deciduous forest the small mammal species present included Menetes berdmorei and Melogale personata.

3. An index of relative abundance indicated that evergreen forest sites supported a greater abundance of small mammals than deciduous forest sites, except the lower montance evergreen forest near the summit of Doi Suthep.

4. Measuring absolute population density by the mark-recapture method at 2 evergreen forest sites indicated that at Thung Ka Mung R. bukit was the commonest species followed by R. rattus and R. surifer, while at Suan Son R. rattus was the commonest species followed by R. surifer and R. bukit.

5. Distance between successive recapture increased with body size of rat species.

6. The home range of all 3 species (R. surifer, R. bukit, R. rattus) overlapped to a high degree.

References

Davis, D.E. 1962. Manual for Analysis of Rodent Populations. Pennsylvania state University. 82 pp.

Dickman, C.R. and C.P. Doncaster. 1987. The ecology of small mammals in urban habitats. I. populations in patchy enviroment. Journal of Animal Ecology. 56 : 629-640.

Harrison, J.L. 1958. Range of movement of some Malayan rats. Journal of Mammalogy. 39 : 190-206.

Harrison, J.L. 1969. The abundance and population density of mammals in Malayan lowland forest. Malayan Nature Journal. 22: 174-178.

Jolly, G.M. 1965. Explicit estimates from c.pture-recapture data with both death and immigration-stochastic model . Biometrika. 52 : 225-247.

Kemper, C. and D.T. Bell. 1985. Small mammals and Habitat structure in lowland rain forest of Peninsular Malaysia. Journal of Tropical Ecology. 1: 5-22

Krebs, C.J. and Boonstra. 1984. Trappability estimates for mark-recapture data. Can J. Zool. 62 : 2440-2444.

Lekagul, B. and J.A. McNeely. 1977. Mammals of Thailand. Kurusapha Ladprao Press. Bangkok. 758 pp.

Lim, B.L. 1970. Distribution, relative abundance, food habits and parasite patterns of giant rats (Rattus) in West Malaysia. Journal of Mammalogy. 51: 730-740.

Marshall, J. 1977. Family Muridae. In Lekagul, B and J.A. McNeely. Mammals of. Thailand Kurusapha Ladprao Press. Bangkok.

Nabhitabhata, J. 1987. Wildlife in Doi Suthep-Pui National Park. Kog-Ma Watershed Research Bulletion. 48: 42 pp

Nichols, J.D. and K.H. Pollock. 1983. Estimation methodology in contemporary small mammal capture-recapture studies. Journal of Mammalogy. 62:253-260.

Rudd, R.L. 1965. Weight and growth in Malaysian rian forest mammals. Journal of Mammalogy. 46: 588-594.

Stickel, L.F. 1954. A comparision of certain methods of measuring ranges of small mammals. Journal of Mammalogy. 35: 1-15.

Whitten, A. J., Mustafa. M. and G.S. Henderson. 1987. The Ecology of Sulawesi. Gudjah Mada University Press.

Wiles, G. J. 1981. Abundance and habitat preferences of small mammals in southwestern Thailand. Nat. Hist.. Bull. Siam Soc. 29 : 43-54.

Appendix

Behind Chiang Mai Zoo, Doi Suthep National Park

Date	No. of traps	Species caught	No. of captures
24/3/88	32	Melogale personata	1
25/3/88	43	-	0
26/3/88	41	Melogale personata	1
27/3/88	45	Melogale personata	1
28/3/88	39	Menetes berdmorei	3
29/3/88	39	Melogale personata	1

Salapom, Phu Khieo Wildlife Sanctuary

3/4/88	27	Rattus surifer	1
4/4/88	47	-	0
5/4/88	48	Rattus surifer	1
		Menetes berdmorei	2
		Tapaia glis	2
6/4/88	45	-	0
7/4/88	48	Rattus surifer	1
		Rattus sabanus	1
8/4/88	47	Tupaia glis	1
		Rattus rattus	1

Thung Ka Mung. Phu Khieo Wildlife Sanctuary

23/4/88	47	Rattus bukit	10
		Rattus rattus	1
		Rattus surifer	3
24/4/88	36	Rattus bukit	5
		Rattus rattus	3
		Rattus surifer	2
25/4/88	49	Rattus bukit	12
		Rattus rattus	5
		Rattus surifer	2
26/4/88	43	Rattus bukit	12
		Rattus rattus	4
		Rattus surifer	2
27/4/88	46	Rattus bukit	14
		Rattus rattus	5
		Rattus surifer	2
28/4/88	44	Rattus bukit	7
		Rattus rattus	6

Suan Son, Doi Suthep National Park

12/5/88	46	Rattus bukit	1
		Rattus rattus	5
		Rattus surifer	5
13/5/88	46	Rattus bukit	3
		Rattus rattus	1
		Rattus surifer	1

14/5/88	44	Rattus bukit	2
		Rattus rattus	7
		Rattus surifer	1
15/5/88	44	Rattus bukit	4
		Rattus rattus	4
		Rattus surifer	3
16/5/88	44	Rattus bukit	5
		Rattus rattus	7
		Rattus surifer	4
17/5/88	44	Rattus bukit	3
		Rattus rattus	3
		Rattus surifer	1
9/7/88	47	Rattus bukit	4
		Rattus rattus	9
		Rattus surifer	2
		Rattus bowersi	1
10/7/88	48	Rattus bukit	6
		Rattus rattus	3
		Rattus surifer	2
22/9/88	43	Rattus bukit	2
		Rattus rattus	5
		Rattus surifer	1
23/9/88	43	Rattus bukit	1
		Rattus rattus	1
		Rattus surifer	1

Doi Suthep Summit, Doi Suthep National Park

20/5/88	42	-	0
21/5/88	46	-	0
22/5/88	49	Rattus bukit	1
23/5/88	47	-	0
24/5/88	41	Rattus bukit	2
25/5/88	40	Rattus bukit	2

Palad, Doi Suthep National Park

1/6/88	45	-	0
2/6/88	41	Menetes berdmorei	2
3/6/88	39	-	0
4/6/88	35	Menetes berdmorei	4
5/6/88	39	Menetes berdmorei	2
6/6/88	40	Menetes berdmorei	2
12/8/88	46	Menetes berdmorei	1
13/8/88	46	Menetes berdmorei	2
14/8/88	46	-	0

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