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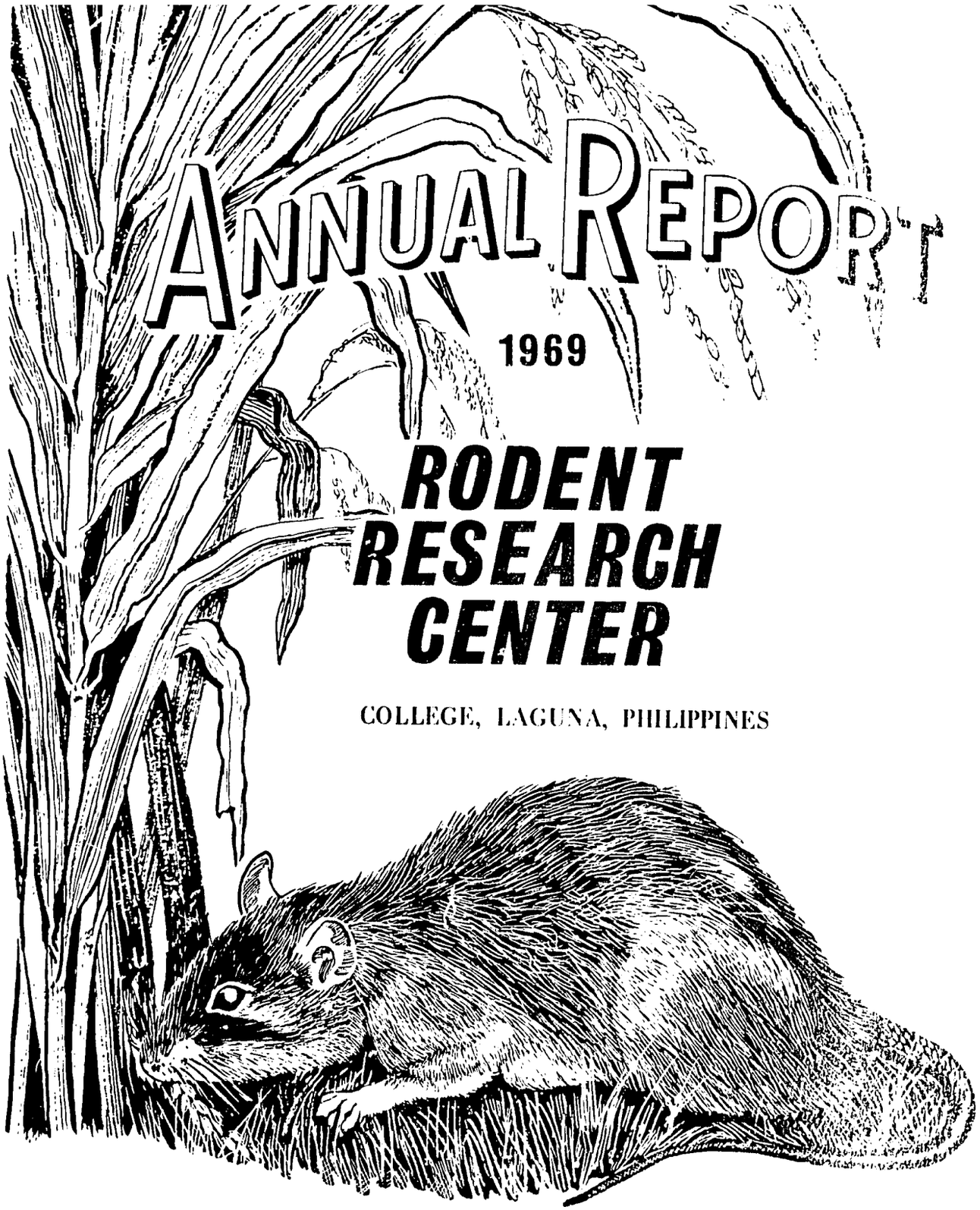

ANNUAL REPORT

1969

RODENT RESEARCH CENTER

COLLEGE, LAGUNA, PHILIPPINES

COOPERATING AGENCIES

REPUBLIC OF THE PHILIPPINES:

- National Economic Council
- Bureau of Plant Industry
- University of the Philippines, College of Agriculture

UNITED STATES:

- Agency for International Development
- Denver Wildlife Research Center
- Bureau of Sports Fisheries and Wildlife

RODENT RESEARCH CENTER

1969 ANNUAL PROGRESS REPORT*

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COOPERATING AGENCIES:

Republic of the Philippines –

- National Economic Council
- Bureau of Plant Industry
- University of the Philippines, College of Agriculture

United States –

- Agency for International Development
- Denver Wildlife Research Center
- Bureau of Sports Fisheries and Wildlife

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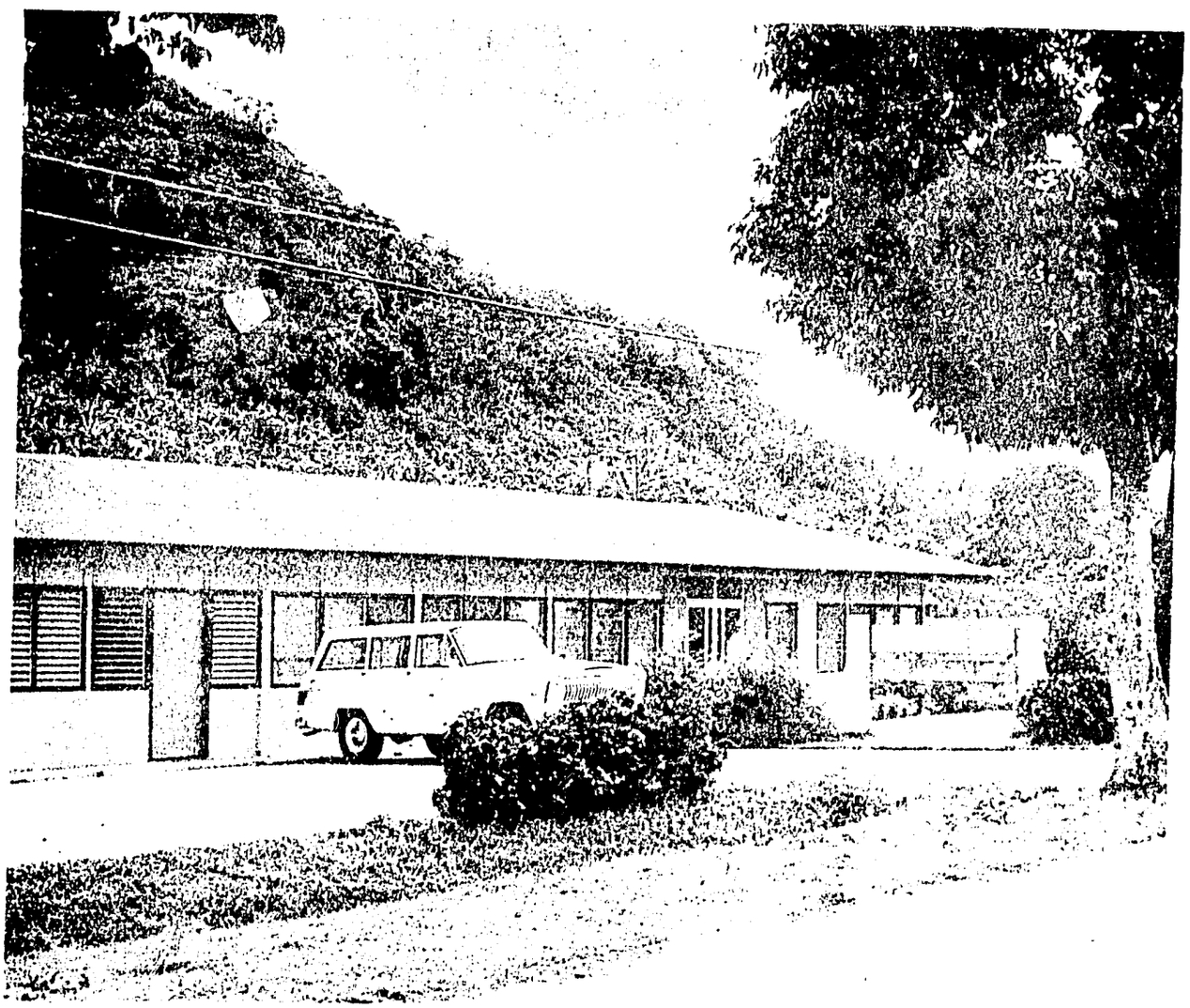

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ABSTRACT*

Distribution studies showed Rattus r. mindanensis to be the principal agricultural rodent pest on most of the larger islands of the Philippines. Rattus argentiventer assumed this role on Mindoro and Mindanao.

Laboratory evaluations of four standard and five experimental chemical lethal agents were conducted on R. r. mindanensis. Two standard lethal agents were also evaluated on R. argentiventer.

Studies in Mindanao in 1969 showed rice damage by rats to be about half of 1968's average of 10 percent. First year damage estimates in Central Luzon averaged three percent.

Current control methods, using zinc phosphide bait at two kg/hectare during the dry season, were compared with a modified technique using 0.25 kg/hectare during the growing season. Both methods gave good results in reducing rice-field rats. Bait acceptance was high during the modified baiting despite the apparent abundance of natural foods.

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*This research was conducted with funds provided by the Republic of the Philippines and the Bureau of Technical Assistance, Agency for International Development, United States Department of State.

Livetrapping data, involving 1,111 individually marked and released rats, indicated an average movement of 51 meters between observations. Adults moved an average of 47 meters while young animals averaged 72. The rat population on the Central Luzon study area during the latter part of the dry season was estimated at 20/hectare (8/acre).

Rats, utilizing an extensive rain-fed paddy system overgrown with weeds, were marked with a bone labeling chemical. A week after flooding and plowing, traps were placed in adjacent paddies of growing rice. Three-quarters of the marked rats trapped in these paddies were within 100 meters of the disturbed area.

INTRODUCTION

The primary goals of the Rodent Research Center are: (1) to conduct research on rodents that damage agricultural crops and, (2) to assist in the training of Filipino scientists in rodent research. Research efforts have been directed toward identification of important agricultural rodent species, evaluation of current control methods, the study of rodent movements and populations, measurement of rat damage to rice crops, and the testing of lethal agents on field rats in the laboratory.

PROGRAM

The Rodent Research Center Board voted to increase the number of member agencies and added the National Science Development Board, the Rice and Corn Production Coordinating Council and the Armed Forces of the Philippines to Board membership. The additions were made by an amendment to the Memorandum of Understanding dated June 26, 1968.

The Rodent Research Center Board appointed a Technical Committee to assist with the guidance of research programs. The Technical Committee is responsible for

the review of all research proposals submitted by government agencies and for making recommendations on these proposals. The Committee has spent considerable time discussing proposals and preparing comments on the projects submitted.

Several people were added to the staff during the year. Mr. Gerry Atwell, a wildlife ecologist from the Denver Wildlife Research Center arrived in late March. The Bureau of Plant Industry assigned a biologist, Mr. Agapito dela Paz, to assist with laboratory studies. Mr. Justiniano L. Libay was hired as a field technician under a USAID contract.

TRAINING

The graduate training program was initiated during the year with the appointment of three students to undertake studies through the Center and the University of the Philippines College of Agriculture. One each was appointed from the Bureau of Plant Industry, University of the Philippines College of Agriculture, and Central Mindanao State University. Each student receives a stipened from the National Economic Council.

In September a study was initiated at the newly constructed RRC inclosure-exclosure to identify and measure rat damage and to determine what effect it has on yield (Figure 1). This study is being carried out as part of the graduate training program and is expected to be completed in May 1970.

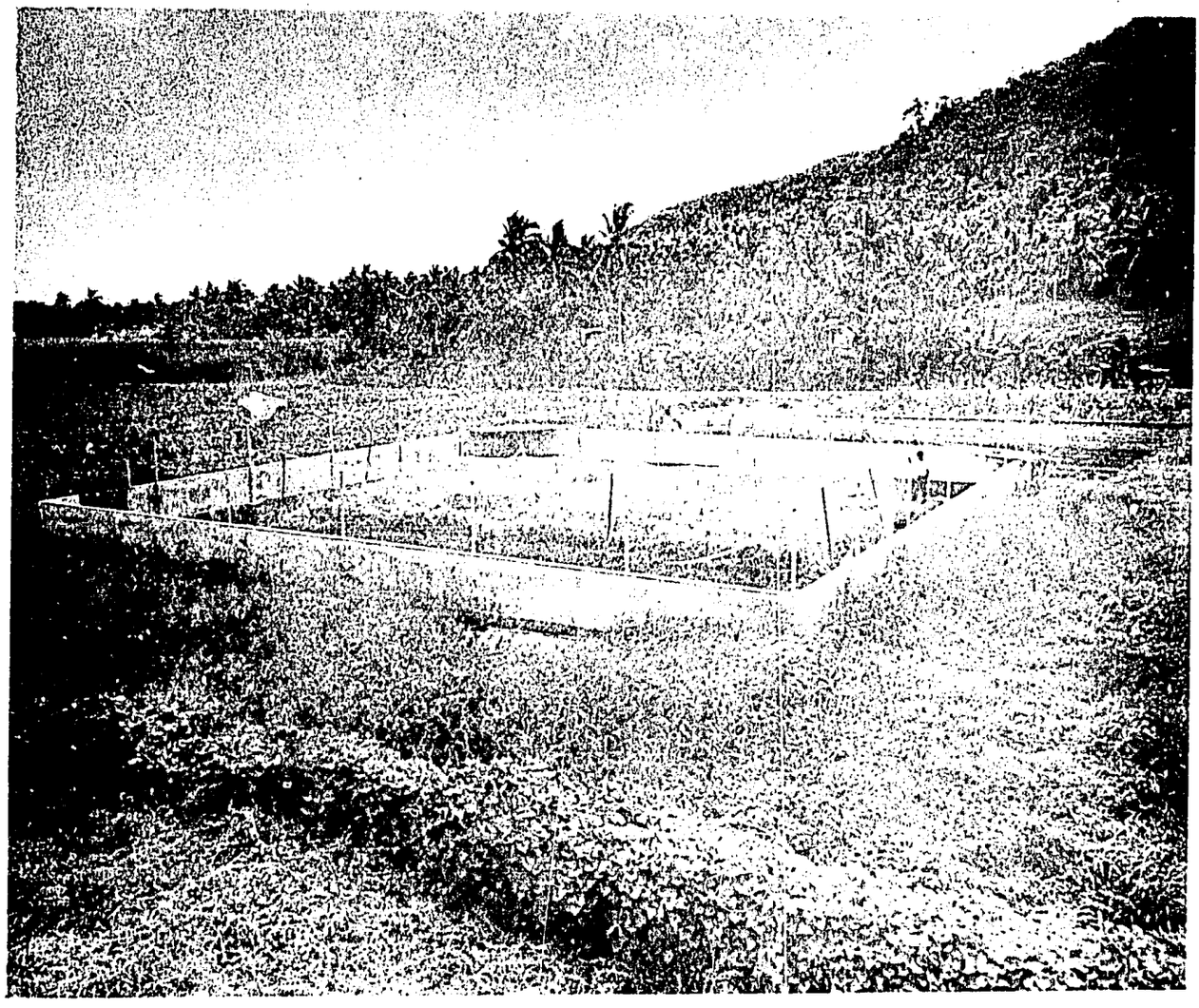

Fig. 1. Exclosure at Rodent Research Center with rice protected from birds by netting.

The RRC provided training in damage appraisal techniques for approximately 90 Bureau of Plant Industry staff and field personnel. Many of these people assisted with the Central Luzon and Cotabato damage trend studies.

ACKNOWLEDGMENTS

The RRC staff wishes to extend its appreciation to the many Bureau of Plant Industry field personnel who participated in the Central Luzon, Visayas, and Central Cotabato studies. The contributions of Regional Directors Domingo Panganiban, Arturo Sarmiento, Pedro Asico, and Messrs. Alberto M. Macanas, Felicito R. Tidon, and Maximo Parra are worthy of special mention.

RESEARCH ACTIVITIES

DISTRIBUTION OF AGRICULTURALLY IMPORTANT PHILIPPINE RODENTS

INTRODUCTION

The distribution of a species is an important aspect of the animal's ecology and provides a stable basis for control-oriented research. Until recently, little research had been conducted on the ranges of agricultural rodents of the Philippines. Because of the lack of knowledge in this respect a distribution study was initiated early in 1969.

PROCEDURES

All cereal-producing islands and provinces having any current or previous history of chronic rat infestations were covered in the collections. These included 18 provinces in Luzon and 12 in Mindanao. The major islands of the Visayan group along with those of Mindoro, Palawan, and Siargao were also sampled.

Most collecting was done on cropland areas at various elevations. The crops consisted of: rice, corn, coconut, sugar cane,

and tubers. Occasionally, fallow lands, backyard gardens and rural buildings were also sampled.

RESULTS AND DISCUSSION

A total of 3,309 specimens were collected for study. Most of the 450 study skins prepared as reference materials were temporarily deposited at the Smithsonian Institute, Washington, D.C. A small number were sent to the Rice Protection Research Center, Bangkok, Thailand. The remainder were presented to various schools and Bureau of Plant Industry Offices.

Three species were found to be of major importance. Rattus rattus mindanensis Mearns was collected in 98 percent of the localities studied; its distribution was much wider than the other species. This rat was found in association with rice, corn, coconut and other crops on Luzon and the Visayan Islands. Rattus r. mindanensis, was more commensal in its distribution in the presence of Rattus argentiventer Robinson and Kloss. Rattus argentiventer was found in ricefields and other croplands in Mindanao and Mindoro, the two islands to which this species, surprisingly, was restricted.

The Polynesian rat, Rattus exulans Peale, was found primarily in the uplands. It was distributed throughout all the islands and was associated with upland rice, corn, vegetables and root crops. It was found in

small numbers in the presence of either R. r. mindanensis or R. argentiventer in lowland habitats.

Rattus norvegicus Berkenhaut, mainly a cosmopolitan species, was found in rural environments in Central Luzon and Laguna provinces; specimens were occasionally trapped in sugar cane and ricefields.

Several species collected in the study were more important as museum specimens than as agricultural pests. Among the more notable were: Rattus everetti Gunther, Rattus tiomanicus Miller, and Rattus panglima Robinson. Other rodent forms such as Chrotomys whiteheadi Thomas, Phleomys cumingi Waterhouse and Mus musculus castaneous Waterhouse were also caught. The insectivore Suncus luzoniensis Peters was found in all the collecting areas.

LABORATORY EVALUATION OF LETHAL AGENTS

INTRODUCTION

Two types of chemical lethal agents were tested at the Rodent Research Center: standard lethal agents currently employed for reductional rodent control and experimental chemicals from the Denver Wildlife Research Center.

PROCEDURES

Standard evaluation procedures, developed at the Denver Center, were used. The basic procedures consisted of an LD_{50} determination by gavage for each rat species. Chemicals were then evaluated for acceptance and mortality by bioassay. The chemical concentration was formulated to yield one LD_{50} on each 1/10 of the average daily consumption of polished rice (Figure 2). This was offered to ten individually-caged rats (Figures 3 and 4) weighing within 20 percent of the mean weight for that species (Table 1). Consumption was recorded for three days, followed by a four-day observation period. From these data a rating index was constructed consisting of the LD_{50}, the average acceptance for the first day of feeding (expressed in LD_{50}'s consumed) and the resulting percent mortality. Promising standard or experimental chemicals were further evaluated in concentration effect

Fig. 2. Formulation of lethal agents for bioassay.

Fig. 3. Technician placing bait formulation in bank of cages for bioassay.

Fig. 4. Individually caged rats are used in the bioassay of standard and experimental lethal agents.

bioassays. These tests were similar to the acceptance bioassay except that four or more groups of ten individually caged rats were used. Each group was offered a different concentration based on the LD_{50}. From these data the optimum chemical concentration was established.

TABLE 1. Mean animal weight and average daily consumption of polished rice

Species	Sample Size*	Mean Weight (g)	Average Daily Consumption** (g)
R. r. mindanensis	363	119	10.3
R. argentiventer	185	107	10.4

*For mean weight data only.
**Consumption of C-4 polished rice.

RESULTS AND DISCUSSION

LD_{50}'s were determined for four standard lethal agents and five experimental chemicals for *Rattus rattus mindanensis*. Two LD_{50} determinations of standard lethal agents were also completed for *Rattus argentiventer* (Table 2).

TABLE 2. LD_{50} data for two species by gavage (mg/kg)

Compound	*R.r. mindanensis* LD_{50}	*R.r. mindanensis* Range1/	*R. argentiventer* LD_{50}	*R. argentiventer* Range
•DRC 714	19.8	23.2-16.9		
DRC 2474	7.4	9.5- 5.8		
DRC 2978	63.0	94.5-42.0		
DRC 3201	4.4	7.8- 2.5		
DRC 3492	9.8	10.7- 9.0		
DRC 3608	77.2	137.2-43.4		
•DRC 3745	28.5	33.1-24.6	35.0	43.1-28.5
•DRC 4007	57.5	62.1-53.2		
•DRC 4008	4.2	5.4- 3.3	3.4	4.5- 2.6

1/ .05 confidence level.
• Indicates standard lethal agents.

Acceptance bioassays were completed with the standard lethal agents for *R.r. mindanensis* and with DRC 3745 and 4008 for *R. argentiventer*. Acceptance bioassays with two experimental chemicals were also completed for *R.r. mindanensis*. Rating indexes were constructed for the above chemicals and species (Table 3).

Concentration effect bioassays were partially completed with three of the standard lethal agents and one experimental lethal agent for *R.r. mindanensis* (Table 4).

TABLE 3. Rating indexes of lethal agents

Compound	*R.r. mindanensis*			*R. argentiventer*		
	LD_{50}	Accept. Ratio*	% Mortality	LD_{50}	Accept. Ratio	% Mortality
DRC 714	19.8	1.6	100			
DRC 2474	7.4	3.8	100			
DRC 3492	9.8	3.2	100			
DRC 3745	28.5	3.1	100	35.0	0.6	100
DRC 4007	57.5	0.5	40			
DRC 4008	4.2	1.8	10	3.4	0.7	30

*The acceptance ratio is the average number of LD_{50}'s consumed per animal on the first day of the test.

Preparatory to field evaluation of DRC 3745, bioassays of various formulations were conducted to determine the relative bait acceptance for *R.r. mindanensis* (Table 5). Based on the acceptance ratio and mortality, 0.7 percent DRC 3745 on C-4 polished rice (with one percent corn oil as a carrier) was selected for future field testing.

DRC 3776 (a chronic toxicant) was tested at four concentrations on *R.r. mindanensis*. In this test, animals were offered the compound for five consecutive days and observed for 14 days after feeding (Table 6).

TABLE 4. Concentration effect bioassay data on *Rattus rattus mindanensis*

	DRC 714		DRC 3492		DRC 3745		DRC 4008	
Conc.*	Accept. Ratio	% Mort.	Accept. Ratio	% Mort.	Accept. Ratio	% Mort.	Accept. Ratio	% Mort.
.25			1.3	60				
.50			2.0	80				
1.0	1.6	100**	3.2	100	3.1	100	1.8	10
2.0	1.8	100	4.6	100	8.4	100	3.0	60
3.0	3.3	100	10.2	100			8.6	70
4.0	3.8	100			5.4	100	4.7	90
5.0								
6.0	0.2	80					3.8	90
7.0								
8.0					9.2	100		

*Concentration expressed in LD_{50}'s offered on each 1/10 of the mean daily consumption.

**First figure indicates average ingestion in LD_{50}'s. Second figure is percent mortality.

TABLE 5. Results of bioassay of .68% DRC 3745 on *Rattus rattus mindanensis* with various formulations

Variety Of Rice	Formulation Addative		Rating Index LD50 (mg/kg)	Accept. Ratio	% Mortality
C-4	Corn oil	1%	28.5	8.4	100
Raminad	Corn oil	1%	28.5	6.2	100
C-4	Coconut oil	1%	28.5	6.0	100
C-4	Seal oil	1%	28.5	5.2	100
C-4	Lecithin	1%	28.5	4.8	90
C-4	Corn syrup	1%	28.5	2.8	80

TABLE 6. Average consumption of DRC 3776 treated rice by *Rattus rattus mindanensis*

Percent Concentration	Grams Consumed	Percent Mortality
.05	25.8	100
.10	27.8	100
.50	11.5	100
1.00	7.0	100

DAMAGE TRENDS

INTRODUCTION

The objective of this study is to compare the extent of rat damage over a period of several years in selected locations within the two principal rice producing regions of the Philippines, i.e., Central Luzon and Cotabato.

PROCEDURES

Rice paddies in two municipalities of Cotabato (Sultan sa Barongis and Tantangan) were examined for damage, as in 1968.

A prolonged drought had precluded the surveys in Central Luzon in 1968. In 1969 one municipality in each of four provinces was chosen for the damage appraisals. Five barrios were selected from each municipality (random selection was used throughout the studies). Within each barrio 10 paddies of ripening rice were selected and measured for rat damage. The paddies were sampled using the standard method of 10 hills within each of 10 rows, for a total of 1,000 hills per barrio. Cut and uncut tillers were recorded for each hill damaged by rats. If no damage occurred a zero was tallied.

RESULTS AND DISCUSSION

Cotabato

Estimated damage in 1969 for the two Cotabato municipalities was 4.6 percent in Sultan sa Barongis and 3.2 percent in Tantangan, as compared to 10.9 and 8.9 percent respectively, in 1968 (Table 7). In 1969, a difference of 1.4 percent between the two municipalities was not significant ($p = .10$). There was a significant difference in estimated percent damage in the Cotabato surveys between 1968 and 1969.

TABLE 7. Damage by rats to ripening rice in two municipalities of Cotabato - 1969

Municipalities	Barrio	Percent Damage
Sultan sa Barongis	Pidtiguian	2.24
	Pinguiaman	4.62
	Didtaras	1.58
	Lilit	3.77
	Tinomigues	10.63
	$\bar{X}$	4.57
Tantangan	New Iloilo	2.09
	Mangilala	5.92
	Dumadalig	1.71
	San Felipe	1.33
	Bukay Pait - Maibu	4.98
	$\bar{X}$	3.20

Central Luzon

Rodent Research Center staff members trained approximately 60 Bureau of Plant Industry personnel in the methods used to survey rat damage, prior to the actual field measurements. Data were collected from Bulacan, Pampanga, Pangasinan and Nueva Ecija provinces. All provinces sampled had 50 percent or more palay remaining to be harvested at the time of the survey.

Damage estimates in the four Central Luzon provinces ranged between 0.79 and 7.53 percent (Table 8). Nueva Ecija was significantly different ($p = .10$) from the other three provinces.

TABLE 8. Damage by rats to rice in four Central Luzon Provinces - 1969

Province	Municipality	Barrio	Percent Damage
Bulacan	San Miguel	San Agustin	.34
		Mandili	1.57
		Salangan	2.68
		Bagong Silang	.33
		Pulong Kawayan	
		Salakot	.47
		$\bar{X}$	1.08
Pampanga	Arayat	San Juan Bano	1.86
		San Agustin	2.74
		Palinlang	3.17
		Bitas	2.97
		Cutiawin	.26
		$\bar{X}$	2.20
Nueva Ecija	Cabanatuan	Sta. Arcadia	8.75
		Villa Cruz	24.28
		Bangad	2.45
		Matungal Tugal	.75
		San Isidro	1.45
		$\bar{X}$	7.53
Pangasinan	San Manuel	Narra	1.01
		Flores	1.47
		San Juan	.49
		Namangoran	.50
		Gueset	.47
		$\bar{X}$	.79

EVALUATION OF CURRENT CONTROL METHODS

INTRODUCTION

The objectives of this study were: (1) to determine the effectiveness of methods currently used to control rats in lowland ricefields; and (2) to develop and evaluate a modified procedure.

PROCEDURES

This study, was conducted at Barrio Recuerdo, Nampicuan, Nueva Ecija in Central Luzon, a typical rain-fed rice producing area. The 240 hectare study area was arranged on an east-west line with Barrio Recuerdo near its center and was divided into eight plots, 500 by 600 meters each (Figure 5). A 100 meter buffer zone was included within the periphery of each plot, leaving a 300 by 400 meter (12 hectare) interior working area. Every plot was randomly assigned to one of four treatments (Table 9).

The four plots representing the current Bureau of Plant Industry zinc phosphide control procedure (I, III, V & VII) were baited in late-March with binlid (rice flour and broken grain). The binlid was treated with zinc phosphide at approximately 0.75 percent by weight. The farmers baited the paddies at regular intervals of 10 meters (two kg/hectare); in addition, bait was placed at the entrances of active burrows. Each bait site contained about eight grams of binlid.

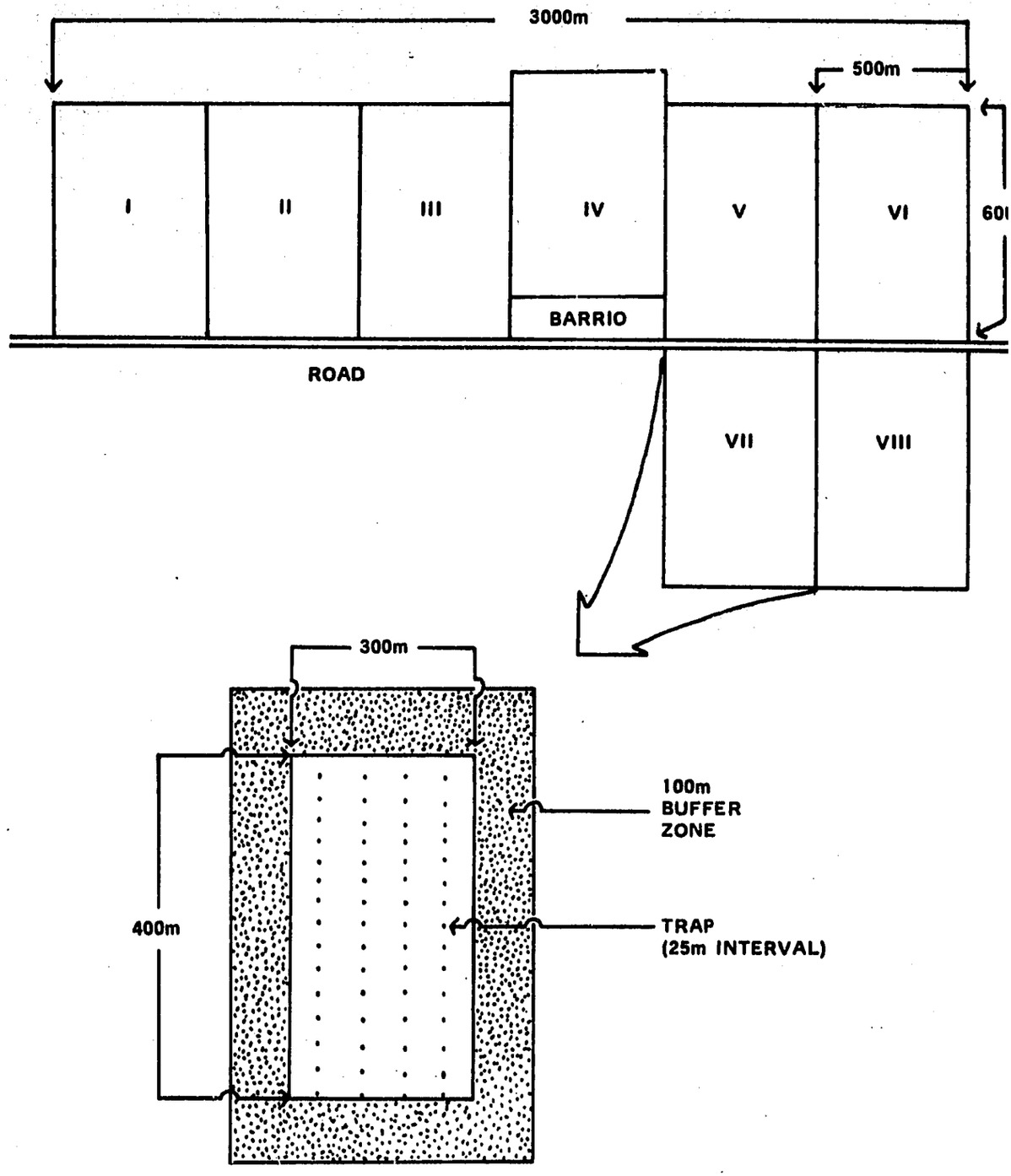

Fig. 5. Barrio Recuerdo study area.

TABLE 9. Locations and dates of treatments at Barrio Recuerdo

Plot Number	Treatment	Date of Treatment
I & VII	Zinc phosphide	3/25/69
III & V	Zinc phosphide Diphacinone	3/25/69 10/22-11/3/69
IV & VI	Modified zinc phosphide	10/5/69
II & VIII	Reference	-

Plots III and V were further treated during booting (flowering) with a preparation of one part (one percent) Diphacinone per 19 parts freshly ground binlid. This treatment was the second of the current control procedures (Table 9). Four hundred 15-inch bamboo bait stations were placed about 15 meters apart on either the top or sides of the dikes in these two plots. The initial introduction of approximately 60 grams of Diphacinone bait, was followed by replenishment every other day for 14 days.

Plots IV and VI were treated with a modified zinc phosphide baiting procedure just prior to booting. Five grams of whole grain,

polished rice (Variety C-4-63) treated at 0.7 percent zinc phosphide (Table 5), were offered in banana leaf "torpedoes" (Figure 6). Baits were placed at five meter intervals on the top of paddy dikes, at approximately .25 kg/hectare.

Treatments were evaluated by live-trapping and radiotracking (Figures 7 & 8). As an additional evaluation method rice damage estimates were made on each plot to relate the percent of rat damage to treatments.

Live-trapping was conducted before and after each baiting. The effectiveness of the treatments was then measured in terms of trap success.

Miniaturized radios were used to determine the effect of control procedures on individual animals within the treated plots. Rats were live-trapped, instrumented and released at the point of capture approximately 24 hours before baiting. Monitoring continued for four days after each application of poison. During the modified zinc phosphide treatment sufficient rats for radiotracking were caught only on Plot VI. Radiotracking was not possible during the exposure of the anticoagulant bait on Plots III and V because so few animals were live-trapped.

Damage estimates were computed from five paddies randomly selected on each of the eight plots. The standard 10 hills within each of 10 rows were measured. Measurements were made

Fig. 6. Banana leaf bait packets (torpedoes).

Fig. 7. Ricefield rat with miniaturized radio transmitter attached by collar-like antenna.

Fig. 8. Radio receiver and loop antenna used to track instrumented rats in the field.

prior to booting, during booting, and immediately before harvest. Because of an early harvest the last measurement could only be accomplished on Plots IV, VII, and VIII.

RESULTS AND DISCUSSION

The effectiveness of zinc phosphide baiting on Plots I, III, V and VII was measured by comparison of the pre- and post-treatment trap success ratios. This baiting resulted in an average reduction of 75 percent of the rat populations; however, a reduction of 20 percent also occurred on plots not treated (Table 10).

TABLE 10. Rats live-trapped on zinc phosphide treated plots compared with untreated plots

Treatment*	Rats Captured Before Baiting	Rats Captured After Baiting	Percent Change
Zinc phosphide	173	46	-75
None	181	145	-20

*Plots I, III, V & VII treated with zinc phosphide; plots II, IV, VI & VIII not treated at that time.

Baiting of the modified zinc treatment plots (IV and VI) was accomplished during the peak of booting in early October and resulted in a reduction in the rat population of approximately 84 percent (Table 11).

TABLE 11. Rats live-trapped on modified zinc phosphide treated plots compared with reference plots

Treatment*	Rats Captured Before Baiting	Rats Captured After Baiting	Percent Change
Modified zinc phosphide	28	5	-84
None	33	34	+ 3

*Plots IV & VI modified zinc phosphide treatment; Plots II & VIII not treated at that time

The Diphacinone plots (III & V) were baited during the late booting and early heading stages. During the post-treatment trapping no rats were caught (Table 12).

Radiotracking provided an additional measure of the effectiveness of control procedures on individual animals within the population. The results supported the trapping data

TABLE 12. Rats live-trapped on Diphacinone treated plots compared with reference plots

Treatment*	Rats Captured Before Baiting**	Rats Captured After Baiting	Percent Change
Zinc phosphide and Diphacinone	19	0	-100
None	33	40	+ 23

*Plots III & V treated with Diphacinone; plots II & VIII not treated at that time.

**Diphacinone baiting.

obtained during the zinc phosphide treatment and the modified zinc phosphide treatment (Table 13).

Damage appraisal data showed light to moderate tiller destruction for the three examinations (Table 14). There was no significant difference ($p = .10$) between the plots measured just prior to harvest.

Damage by rats was insufficient to establish a relationship with animal density; consequently, no correlation with treatments was possible.

TABLE 13. Effectiveness of zinc phosphide and modified zinc phosphide treatments determined by radiotracking

Plot Number	Radio Equipped Rats Before Treatment	Radio Equipped Rats Surviving Treatment	Percent Change
I & VII	14	3	-79*
VI	8	2	-75**

*Mean of two 30 hectare zinc phosphide treated plots.

**One 30 hectare modified zinc phosphide treated plot.

Based on trapping and radiotracking data, the modified and current zinc phosphide treatments were not significantly different. It is interesting to note that bait acceptance was good during the modified treatment despite the availability of natural foods.

TABLE 14. Damage appraisal measurements at three stages of rice development

Plot Number	Treatment	% Damage Preboot	% Damage Booting	% Damage Pre-harvest
I	Zinc phosphide	0	.31	-
II	Reference	.10	.65	-
III	Zinc phosphide - Diphacinone	0	1.60	-
IV	Modified zinc phosphide	0	0	0
V	Zinc phosphide - Diphacinone	.32	1.69	-
VI	Modified zinc phosphide	.10	.55	-
VII	Zinc phosphide	0	.95	1.13
VIII	Reference	.10	.52	.04

POPULATION AND MOVEMENT STUDIES OF RICEFIELD RATS

INTRODUCTION

The previously described study in Central Luzon entitled, "Evaluation of Current Control Methods," resulted in the accumulation of considerable rat (Rattus rattus mindanensis) population and movement data as by-products of the main research effort. These data are important because a knowledge of the population dynamics and movements of rats is fundamental for the proper application of control measures.

PROCEDURES

For a detailed description of the study area see page 22.

The population and movement information was obtained by the trap-mark-recapture method. Four lines of 15 traps each were placed in every plot. The lines ran lengthwise of the plots with a 25 meter interval between traps. Traps were placed next to dikes on the west side for shade during the dry season (March-June) and on top of the dikes during the growing season (July-December).

There was a total of 10 trapping periods, each of which consisted of three consecutive days of trapping (Table 15). Positioning of

TABLE 15. Trapping periods at Barrio Recuerdo

Period Number	Date*	Length (Days)
1	March 20 - 25	5
2	March 28-April 2	6
3	May 13 - 15	3
4	July 8 - 10	3
5	August 28 - 30	3
6	October 1 - 3	3
7	October 9 - 11	3
8	October 31-November 2	3
9	November 18 - 20	3
10	December 12 - 14	3

*During Periods 1 and 2, three-day trapping schedules were used but not on all plots at the same time. The dates above bracket all trapping.

lines was initially random. During subsequent trapping periods the traps were located in the original positions, plus or minus five meters.

Traps were baited with roasted coconut and inspected at daylight to minimize animal mortality from heat and ants. Rats trapped for the first time were marked with a numbered eartag.

RESULTS AND DISCUSSION

Because a primary objective of the evaluation study was to determine the effectiveness of various control methods, the trapping was designed to that end. Thus, the trapping effort varied slightly between plots (Table 16).

A total of 12,960 trap nights resulted in 1,382 rats being trapped for an overall trap success of 11 percent (Table 17). Of these 1,382 rats, 551 were caught on the two reference plots where the success was 16 percent (details on the plots and treatments are found on page 22). Trap success was next highest on the zinc phosphide plots (13%), with 353 of the rats caught there. The remaining 478 animals were divided almost evenly between the zinc phosphide plus anticoagulant, and the modified plots, with trap success being seven and eight percent, respectively.

TABLE 16. Total number of trap nights for each treatment

Treatment*	Trap Nights Per Treatment
Reference	3,600
Zn_3P_2	2,880
Zn_3P_2 and A	3,240
Modified	3,240
Total	12,960

*Each treatment is represented by two plots (A and B); treatments were:

1. Reference- no poisoning.
2. Zn_3P_2- zinc phosphide.
3. Zn_3P_2 and A- zinc phosphide plus anticoagulant (Diphacinone).
4. Modified- zinc phosphide treatment at booting.

TABLE 17. Trap success at Barrio Recuerdo

Treatment		Number of Rats Trapped*		Percent Trap Success
Reference				
A		252		14
B		299		17
	Total	551	$\bar{X}$	16
Zn_3P_2				
A		180		13
B		173		12
	Total	353	$\bar{X}$	13
Zn_3P_2 & A				
A		118		7
B		107		7
	Total	225	$\bar{X}$	7
Modified				
A		97		6
B		156		10
	Total	253	$\bar{X}$	8
GRAND TOTAL		1,382	$\bar{X}$	11

*Includes all untagged rats plus recaptures from previous tagging periods.

Of the 1,290 untagged rats caught, 114 (9%) died in the traps from the heat or ants (Table 18). Another 65 (5%) escaped before they were tagged. Thus, 1,111 rats were tagged and released.

Over half (64%) of the rats tagged and released were captured during the first three trapping periods (mid-March through mid-May). This coincided with the height of the dry season when food and cover were thought to be at a minimum in the annual cycle. With the onset of the rainy season in July and the appearance of vegetation, fewer animals were captured.

After being tagged and released, 140 rats were recaptured one or more times (Table 19). Almost three-quarters (103) were recaptured only once, 31 twice, 4 three times, and 2 four times. Most of the adults retrapped were females (65%); recaptured young rats had a 50-50 sex ratio.

Tagged animals were recaptured in large numbers only during the first three trapping periods (Table 20). Of the 161 recaptures made then, 43 percent were of animals retrapped in the same period in which they were initially released.

Of 1,248 rats examined for sex and age data, 46 percent were males and 54 percent were females (Table 21). Using sexual maturity as a criterion, 76 percent were adult.

TABLE 18. Livetrapping results

Trapping Period[1]	Dead In Trap	Escaped Before Tagged	No. Tagged And Released	Total Untagged Rats Trapped	Recaptures[2]	Cumulative Totals Of Tagged And Released Rats[3]
1	52	7	350	409	0	350
2	41	4	132	177	26	482
3	16	7	223	246	32	705
4	1	5	38	44	10	743
5	1	5	96	102	5	839
6	1	10	89	100	8	928
7	2	7	23	32	7	951
8	0	3	19	22	0	970
9	0	5	43	48	3	1,013
10	0	12	98	110	1	1,111
Total	114	65	1,111	1,290	92	

1/ During periods seven and eight only the Reference and Zn_3P_2 plus A plots were trapped.

2/ Marked and released in previous tagging periods.

3/ Since beginning of study.

TABLE 19. Sex and age classification of rats recaptured one or more times

Category	Times Recaptured 1	2	3	4	Total Recaptured One or More Times No.	%
Adult						
Male	28	12	0	0	40	(35)
Female	55	15	2	2	74	(65)
Total	83	27	2	2	114	
Young						
Male	10	3	0	0	13	(50)
Female	10	1	2	0	13	(50)
Total	20	4	2	0	26	
TOTALS	103	31	4	2	140*	

*140 different animals.

TABLE 20. Recaptures by trapping period

Trap-ping Period	Trapping Periods In Which Recaptured										Total No. Retraps	Total No. Tagged & Released Since Be-ginning Of Study
	1	2	3	4	5	6	7	8	9	10		
1	23	29	28	6	-	2	2				90	350
2		12	17	-	2	1					32	482
3			34	4	1						39	705
4				1	2	1	-	-	1		5	743
5					10	3	1				14	839
6						5	2	-	1		8	928
7							1				1	951
8								1	1		2	970
9											0	1,013
10										3	3	1,111
											194	

The ratio of young-to-adult changed with the seasons (Table 22). From the initiation of the study in March through mid-May, the number of young/100 adults averaged 38. With the beginning of the wet season in July, the number of young dropped considerably and averaged 13/100 adults for the two trapping periods in July and August. In October it averaged six and (disregarding a small sample of 19 rats) by mid-November it had climbed to 30. In mid-December it was 62.

Data on sex composition for the 950 adult animals (Table 21) are presented in Table 23. It will be noted that an unusually low number of males was represented in the March samples (an average of 53/100 adult females). If the catch in March is disregarded, along with that of trapping period eight because of a small sample size, the average number of adult males/100 adult females is 112.

In addition to sex and age composition, live-trapping also provided information on rat movements. In Table 24, 186 movement records have been totaled. Disregarding the time element, adult males and females averaged about the same distance between observations while young rats moved farther than adults. Young males moved slightly farther than young females. The average movement when all observations were considered together was 51 meters.

Eighty-three percent of all rats moved 100 meters or less between observations and 25 percent had not changed their locations. Thus, it is not surprising that there was little interchange of animals between plots. Only three rats that had traveled through the 200 meters of buffer

TABLE 21. Sex and age composition

Sex	Age: Adult No.	Adult %	Young No.	Young %	Total Rats No.	Total Rats %
Male	430	(75)	145	(25)	575	(46)
Female	520	(77)	153	(23)	673	(54)
Total	950	(76)	298	(24)	1,248	

TABLE 22. Seasonal changes in the number of young/100 adults

Trapping Period	Date	Sample Size*	Number Young/100 Adults
1	Mar. 20 - 25	401	37
2	Mar. 28-Apr. 2	195	51
3	May 13-15	200	25
4	Jul. 8 - 10	47	12
5	Aug. 28 - 30	106	14
6	Oct. 1 - 3	99	8
7	Oct. 9 - 11	34	3
8	Oct. 31-Nov. 2	19	90
9	Nov. 18 - 20	48	30
10	Dec. 12 - 14	99	62

*Young and adult animals.

TABLE 23. Seasonal changes in the number of adult males/100 adult females

Trap-ping Period	Date	Sample Size*	Number Adult Males/ 100 Adult Females
1	Mar. 20 - 25	293	50
2	Mar. 28-Apr. 2	129	55
3	May 13 - 15	160	116
4	Jul. 8 - 10	42	91
5	Aug. 28 - 30	93	166
6	Oct. 1 - 3	92	100
7	Oct. 9 - 11	33	74
8	Oct. 31-Nov. 2	10	900
9	Nov. 18 - 20	37	118
10	Dec. 12 - 14	61	118

*All adult animals.

TABLE 24. Movement between successive trappings related to sex and age

Category	Sample Size	Average Movement (Meters)
Females:		
Adult	101	45
Young	18	70
Males:		
Adult	49	48
Young	18	74
Totals	186	51

zones separating the central trapping areas of the plots were recaptured during the study. All three were trapped in plots abutting the ones in which they were originally released. One was retrapped 320 meters from its initial tagging location after only one day; another had traveled at least 570 meters in two days. The third had covered 475 meters between trap sites in 54 days. All were adult animals.

When movements are related to time it may be seen that over one half (56%) of the rats were retrapped in the first two days after their initial trapping and release (Table 25). Of these, 38 (36%) were caught at the same location and another 38 had moved to the next trap 25 meters away.

A high population turnover rate is indicated by the data presented in Table 26. There it is shown that 84 percent of all recaptures occurred in the first two months after the animals were released. It is unlikely that a large percentage of tagged rats merely wandered off the study area and were not available for recapture. As was previously shown, the average movement between trappings was 51 meters and only three rats out of the 1,111 tagged and released were documented as having changed plots. If emigration was negligible, it would be expected that the high turnover rate would be observable in the data from the reference plots. Such is the case, and in Table 27, it can be seen that even though the number of tagged rats appears to increase each trapping period, the percent of recaptures does not. This would indicate that many of the tagged animals, and a like proportion of untagged, were being eliminated from the population.

TABLE 25. Distances moved between trappings related to time

No. Of Days Between Trappings	Distance (Meters)							Total Observations	
	0	1-25	26-50	51-75	76-100	101-200	201-325	No.	%
1	26	31	7	5	2	4	2	77	(41)
2	12	7	2	2	2	3	1	29	(15)
3-25	7	14	5	1	1	2	0	30	(16)
26-100	2	3	8	10	5	15	5	48	(25)
101-210	0	2	1	0	1	1	1	6	(3)
	47(25)	57(30)	23(12)	18(9)	11(6)	25(13)	9(5)	190	

TABLE 26. Number of days between initial capture and subsequent recaptures*

	Interval (Days)							Total Observations
	1-10	11-20**	31-40	41-50	51-60	81-100	101-210	
Number Of Observations	28	1	3	23	14	2	12	83
			84%					

*Animals were not counted when recaptured during the same period in which they were initially trapped and released. For trapping interval refer to Table 23.

**No observations for days 21-30 and 61-80.

TABLE 27. Percent of tagged rats recaptured on two reference plots

Trapping Period	No. Of Rats Trapped*	Cumulative No. Of Rats Tagged And Released	No. Recaptures From Previous Tagging Periods	Percent Recaptures**
1	125	107	0	0
2	101	163	19	19
3	115	251	18	16
4	20	263	6	30
5	27	287	1	4
6	33	310	3	9
7	34	329	6	18
8	22	348	0	0
9	20	363	2	10
10	54	409	1	2

*Excludes rats retrapped in same period in which initially tagged.

**Percent of recaptures in column two.

Only a meager amount of longevity information was obtained in this study. Three rats originally trapped as young animals on the reference plots were recaptured 191-210 days later. Of the 14 young in the sample (Table 28), 11 were recaptured during the first 60 days. The maximum

TABLE 28. Recapture interval of adult and young rats on reference plots

Age	Interval (Days*) 1-10	11-20	31-40	41-50	51-60	101-110	191-200	201-210	Total Observations
Adult	15	1	1	9	7	4	-	-	37
			89%						
Young	6	-	-	4	1	-	2	1	14
			79%						
Totals	21	1	1	13	8	4	2	1	51**

*No observations for days 21-30, 61-100 and 111-190.

**Age data lacking for five animals.

time interval recorded for adults on the reference plots was three and a half months yet, 89 percent of the recaptures were made in the first two months.

A series of ratios (the Lincoln Index) were used to determine population estimates on four nontreated plots during the dry months of March through May (Table 29). Small sample sizes, involving total numbers as well as retraps, made it impossible to figure estimates at other times. Although many assumptions have to be made when using the Lincoln Index, it was the most feasible method for this study. Estimated populations ranged from 197 to 294 rats per plot and averaged 20 rats/hectare (eight/acre) during the last half of the dry season.

Two additional trapping periods, one in January and the other in March of 1970, will complement the information presented in this report and will complete the study at Barrio Recuerdo.

TABLE 29. Population estimates on non-treated plots using Lincoln Index*

Plot	Trapping Period	Pop. Est. By Trapping Period (Ave.)	Pop. Est. By Plot (Ave.)
Reference A	1	144	197
	2	199	
	3	264	
	4	182	
Reference B	1	245	294
	2	333	
	3	301	
	4	296	
Modified A	2	328	254
	3	179	
Modified B	1	222	221
	2	196	
	3	245	
	Average population	=	242**

*No treatment of modified plots accomplished prior to or during this time; thus, they serve as "reference" plots.

**Twenty rats/hectare.

THE INFLUENCE OF LAND PREPARATION ON THE RICEFIELD RAT

INTRODUCTION

The displacement of ricefield rats by flooding and plowing, prior to planting rice, has not been documented. A knowledge of the subsequent distribution of rats in such a situation would be beneficial to the development of more effective control procedures.

Until recently, methods for long term marking of a large portion of a rodent population were not available; however, the development of techniques employing, demethylchlortetracycline (DMCT) as a bone marking material has made such marking routine (Linhart and Kennelly 1967). DMCT is an antibiotic which combines with calcium ions and produces a golden fluorescence in the bones and teeth.

Laboratory studies (Denver Wildlife Research Center 1968a) on albino rats have shown DMCT induced fluorescence is visible for five to six months after ingestion of the material. Laboratory and field evaluations in Hilo, Hawaii with Rattus exulans, Rattus rattus and Rattus norvegicus indicate that DMCT is well accepted by those species (Denver Wildlife Research Center 1968b).

PROCEDURES

A study site was selected in the province of Nueva Ecija, Central Luzon. The site consisted of two areas: a 50 hectare irrigated ricefield and an adjacent rain-fed ricefield of over 150 hectares. The rain-fed area produced one rice crop annually and was densely vegetated with grasses and forbs when the study was initiated. Each area and the margin between was snaptrapped for one night with 50 traps in each to determine species composition and relative animal density. Seven *Rattus rattus mindanensis* and one shrew (*Suncus luzoniensis*) were trapped in the rain-fed area and three *R. r. mindanensis* and one shrew (*S. luzoniensis*) were trapped in the irrigated rice.

Acceptance and marking bioassays with DMCT at three concentrations were conducted with *R. r. mindanensis*. In each bioassay ten individually caged animals were offered, for one night, five grams of DMCT treated rice each. Untreated vegetables were also available. The 30 test animals were killed four days later and examined for DMCT following the method described by Linhart and Kennelly (1967).

Approximately four weeks before flooding and plowing of the rain-fed area a fifteen hectare central portion adjoining the irrigated land was baited at 0.5 kg/hectare with 0.5 percent DMCT on C-4 polished rice. Bait was dispensed in "packets" consisting of five grams of bait wrapped in banana leaf and tied with

grass to protect it from rain (Figure 6). Five days after baiting two lines of 25 snaptraps each were set in a portion of the baited area to determine bait acceptance and marking success (Figure 9). Ten rats were caught and all proved positive for DMCT, indicating that between 68 and 100 percent ($p = .05$) of the population had accepted the baits and was marked.

Four weeks after baiting, the rain-fed area was flooded and plowed. One week later, four lines of snaptraps were set in the central portion of the irrigated palay at 50, 100, 200 and 400 meters from the baited area. A line of snaptraps was also set on the margin of the baited area.

Fig. 9. A rat population was sampled by snaptrapping to determine DMCT bait acceptance.

RESULTS AND DISCUSSION

The laboratory studies indicate DMCT is well accepted and is an efficient marking agent for *R. r. mindanensis*. Of the three concentrations tested no differences in acceptance were found, each of the 30 animals consumed the five grams of treated rice offered. All animals were found to be recognizably marked with only slight differences between concentrations (Table 30).

TABLE 30. Bioassay data for three concentrations of DMCT on *Rattus rattus mindanensis*

Percent Concentration	Average mg DMCT Consumed	Percent Rats DMCT Positive
0.25	12.5	100
0.50	25.0	100
1.00	50.0	100

A total of 1,204 trap nights resulted in a catch of 108 rats from the five transects of traps. All animals trapped were R. r. mindanensis, except for two Rattus exulans taken at the 0 meters transect. Thirty-two percent of the rats caught in the irrigated area were positive for DMCT and 74 percent of these were trapped within 100 meters of the baited area (Table 31).

TABLE 31. Displacement of ricefield rats by flooding and plowing

Trap Transect*	Sample Size	Percent Rats DMCT Positive	Confidence Limits (p = .05)
0	12	75	57 - 94
50	31	52	34 - 70
100	34	20	8 - 37
200	19	20	6 - 43
400	12	33	10 - 65

*Distances in meters from treated area.

The high percentage of marked animals in the rain-fed area prior to flooding and plowing showed good bait acceptance under those conditions. These data indicated that control programs could be conducted just prior to land

preparation. The distances moved by the displaced rats were in most instances very short. The concentrations of rats in the peripheral zone adjacent to the disturbed area also offered a possibility for control programs.

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Fig. 10. Interested farmer observes live-trapping procedures.