DENVER WILDLIFE RESEARCH CENTER

INTERNATIONAL PROGRAMS RESEARCH SECTION

VERTEBRATE PEST MANAGEMENT IN AGRICULTURE

OUTREACH PROGRAM—FY 1993

PROBLEM SOLVING RESEARCH TECHNOLOGY TRANSFER EXTENSION
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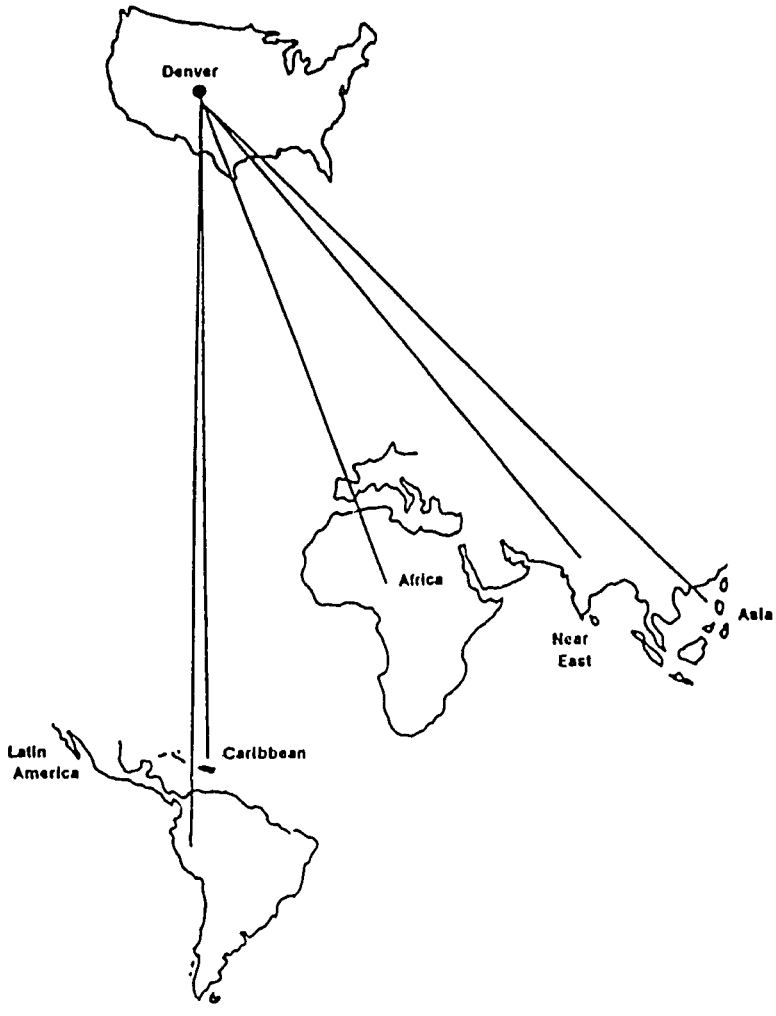

U.S. DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
ANIMAL DAMAGE CONTROL

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

United States
Department of
Agriculture

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Animal Damage
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OUTREACH ACTIVITIES

International Programs Research Section

November 1993

This document is a compilation of trip reports resulting from international requests for Denver Wildlife Research Center (DWRC) technical assistance in vertebrate pest management. Between October 1, 1992, and September 30, 1993, DWRC staff facilitated 12 consultancies by 8 different individuals to the following countries in Africa, Asia, Europe, and South America to assess vertebrate pest problems and environmental issues; to conduct, review, evaluate, and coordinate present and future activities; to participate in training workshops; and to present technical seminars.

Argentina	Egypt	Philippines
Bangladesh	Italy	Pribilof Islands
Chad	Niger	Uruguay

These consultancies were at the request of the Food and Agriculture Organization (FAO) of the United Nations, National Institute of Agricultural Technology (INTA), U.S. Agency for International Development (USAID), U.S. Department of the Interior/Fish and Wildlife Service, and foreign governments. The consultancies had a diverse range of topics including problem assessment and project planning of pest birds, rodent control research and training, and project research and institutionalization.

Richard L. Bruggers, Chief
International Programs Research Section

FY-93 TRIP REPORTS*

CONTENTS

Fiedler, L. A., and W. B. Jackson. 1992. Vertebrate pest management in Egypt. Trip Report--Egypt. 6 pp. and 1 appendix.

McConnell, J. E. 1992. Chad rodent research and rodenticide field trials. Trip Report--Chad. 12 pp. and 3 annexes.

Tobin, M. E. 1992. Review of vertebrate pest research: Bangladesh. Trip Report--Bangladesh. 7 pp. and 4 appendices.

Bruggers, R. L. 1993. Final Report on FY-93 Sabbatical Program (November 15, 1992-May 1, 1993), National Institute of Agricultural Technology (INTA), Parana, Argentina. Unpublished Report to Denver Wildlife Research Center, Denver, Colorado. 5 pp. and 4 appendices.

Brooks, J. E. 1992. Trip Report--Chad rodent control research and closeout of the project. 5 pp. plus 4 annexes and attachment.

Jaeger, M. M. 1993. Review of preharvest rodent control in Bangladesh. Trip Report--Bangladesh. 11 pp.

Fiedler, L. A. 1993. Assessment of the 1992 Bangladesh National Rodent Control Campaign. Trip Report--Bangladesh. 9 pp. and 3 appendices.

Jackson, W. B. 1993. Assessment of Vertebrate Pest Section at Bangladesh Agricultural Research Institute. Trip Report--Bangladesh. 18 pp. and 1 appendix.

Brooks, J. E. 1993. Closeout of the BARI/USAID/DWRC Vertebrate Pest Research Project in Bangladesh. Trip Report--Bangladesh. 6 pp. and 2 appendices.

Dolbeer, R. A. 1993. Status of rodent populations in Chad, September 1993. Trip Report--Chad. 15 pp. and 2 appendices.

Fiedler, L. A. 1993. An assessment of rodent populations in Niger. Trip Report--Niger. 7 pp. and 1 appendix.

Brooks, J. E. 1993. Surveillance and prevention of rat infestations in the Pibilof Islands, Alaska. Trip Report--Pribilof Islands. 15 pp.

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* Trip reports are on file at the International and Special Programs Unit, DWRC.

Trip Report*

VERTEBRATE PEST MANAGEMENT IN EGYPT

September 29-October 3, 1992

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Unpublished Report

December 16, 1992

* This activity was conducted with funds provided by the U.S. Department of Agriculture (USDA)/ Animal and Plant Health Inspection Service (APHIS)/Animal Damage Control (ADC) and with funds contributed to the APHIS/ADC/Denver Wildlife Research Center (DWRC) by the U.S. Agency for International Development under the Project "Vertebrate Pest Management Systems R&D," PASA Dan 4173-X-AG-6001.

ITINERARY

Date	Location	Activity
Sep 29	New Delhi, India, to Cairo, Egypt	Travel
Sep 29-Oct 1	Cairo, Egypt	Met with personnel of U.S. Agency for International Development, Ministry of Agriculture/National Agricultural Research Project, Plant Protection Research Institute, and Egyptian/ German Rodent Control Project, and staff at the Universities of Cairo, Ain Shams, Zagazig, and Alexandria.
Oct 2-3	Cairo to Denver, Colorado, and Bowling Green, Ohio, via Rome, Italy	Travel

* In conjunction with the August 26-September 29, 1992, Asian consultancy, this trip was a stopover en route home.

SUMMARY

We briefly visited Cairo, Egypt, on our way home from an extended Asian trip to evaluate vertebrate pest management programs in selected Asian countries. Egyptian vertebrate pest problems are sufficiently different from those experienced in Asia; thus, a separate report was prepared.

From September 29 to October 1, 1992, we met and discussed the vertebrate pest problems in Egypt with the U.S. Agency for International Development (USAID)/ Agricultural Development Office and the Ministry of Agriculture/National Agricultural Research Project (NARP). We also had discussions with vertebrate pest control specialists at the Plant Protection Research Institute (PPRI), the Egyptian/German Rodent Control Project, and the staff of the Cairo, Ain Shams, Zagazig, and Alexandria Universities.

A severe rodent outbreak occurred in 1980-81 that attracted the attention of crop protection officials in Egypt and international donor assistance agencies from the United States and Germany. A technical assistance project emphasizing rodent pests was initiated in 1982 by the German Society for Technical Cooperation (Deutsche Gesellschaft für Technische Zusammenarbeit [GTZ]). This project, currently operated by Egyptian personnel, is now being supported with temporary duty assignments from German experts until the assistance program ends in 1993.

The rodent problem appears to have been successfully dealt with. Surveillance programs in primary crops have shown a gradual decline since 1987 in both rodenticide use and crop losses to rodents. Farmer participation in control programs averages anywhere from 20-80%, depending on the agricultural area surveyed. However, resistance to first-generation anticoagulants in rodents, particularly by *Arvicanthis niloticus*, has been reported. Current efforts are in progress to further define the problem, both biochemically and operationally.

The potential for initiating a cooperative international training workshop by Cairo University and an American university (e.g., Bowling Green State University) was considered favorably. A detailed proposal needs to be prepared and external funding (e.g., AID/Egypt) sought.

OBJECTIVES

After completing a six-country Asian visit to evaluate regional rodent pest management programs, we planned a brief stop over in Cairo to assess Egyptian rodent and other vertebrate pest research and training needs.

ACTIVITIES

AID/Cairo

The Acting Director of the Agricultural Development Office of USAID made arrangements for us to meet with various Egyptian crop protection counterparts working in fields of interest related to vertebrate pest control.

National Agricultural Research Project (NARP), Cairo

USAID has funded a 5-year agricultural development project (NARP) that includes crop protection components. There is currently no vertebrate pest component, since a German technical assistance project (described below) has emphasized rodent pest management in the primary affected crops. Birds and rodents are recognized as causing significant losses in cereal grains such as wheat, maize, barley, rice, and sorghum as well as sunflowers, grapes, and tomatoes. Also, fruit bats cause losses in several kinds of fruits. Although progress has been made in researching rodent problems and organizing rodent pest management programs, including systematically monitoring rodent damage, experience is needed in researching and developing control methods to manage bird and other vertebrate losses. There are about 2 years remaining in the NARP project, and opportunities are possible for some short-term DWRC technical assistance to investigate specific Egyptian bird problems.

Agricultural Research Center

Plant Protection Research Institute, Cairo

The Egyptian/German Rodent Control Project is ending, but it will continue to exist for another year with short-term assignments of GTZ technical experts to complete a few remaining objectives. Outstanding success has apparently been achieved with farmer participation as high as 80%. Graphic presentations indicated striking reductions of rodent damage in program areas at the same time that total rodenticide use was also decreasing. This illustrates the value of proper use of chemicals in an integrated pest management approach. Also, excellent graphic instruction materials have been prepared and distributed. Detailed reports are not generally available; much of the work needs to be written up and published in recognized journals for use by personnel in other countries with similar problems.

Egyptian geese are a problem in northeastern Egypt and along the Nile River where forage crops are being depredated by large flocks. Birds (primarily sparrows) in grain crops are also a problem.

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Cairo University

Dr. M. A. Kandil, toxicologist with the Faculty of Agriculture at Cairo University, has been actively researching toxicological aspects of rodenticides. Graduate students are involved in research on anticoagulant rodenticide resistance mechanisms in rodents. Course work on vertebrate pests was indicated at several of the universities, but time did not permit examination of curricula or further investigation of academic programs.

DISCUSSION AND RECOMMENDATIONS

Egyptian officials in pest management programs requested assistance in developing and conducting a pest management workshop that would be held in the late summer or early fall of 1993. The workshop would consist of practical lectures and demonstrations by Egyptian experts and supplemented by a few specialists from Bowling Green State University and the Denver Wildlife Research Center.

Several months ago a rodent outbreak involving mice (species unknown) was noticed in a newly settled, northern coastal area where agricultural expansion schemes are being established. Apparently the outbreak is still ongoing; thus, it should be documented and a management strategy developed for mitigating the problems that large mice populations are causing.

In the same manner that rodent problems have been dealt with, there is a need to outline and implement management approaches for Egyptian bird pest problems. Bird problems have not been adequately researched, nor have bird damage control methods been developed.

The First International Development and Wildlife Conference will be held in Egypt in September 1993. Participation by DWRC would provide an opportunity to present results from the DWRC/Chad Rodent Control Research Project and to meet with Egyptian experts to discuss their vertebrate pest problems in detail.

CONTACTS AND ACKNOWLEDGMENTS

Egypt

Mr. Bob Resseguie, Acting Director, Agricultural Development Office, USAID

Dr. Md. Said Tewfik, Research Coordinator, RSP, National Agricultural Research Project, Cairo

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Dr. G. M. Moawad, Director, Plant Protection Research Institute, Cairo

Dr. Hassan Ibrahim El Deeb, Plant Protection Research Institute, Cairo

Dr. Mohamed A. Kandil, Toxicologist, Faculty of Agriculture, Cairo University

APPENDIX

RODENT PEST MANAGEMENT MEETING ATTENDEES
October 1, 1992, 9:00 a.m.

Dr. M. S. El-Zemaity	Faculty of Agriculture, Ain Shams University, Plant Protection Department
Dr. Mahmoud E. Tharwat	Ain Shams University, Faculty of Agriculture, Plant Protection Department
Dr. Abdalla E. Abdelmonem	Faculty of Agriculture, Al-Azhar University, Plant Protection Department
Dr. Mohamed A. Desheesh	Faculty of Agriculture, Cairo University
Dr. Kawtise El Kamwith	Faculty of Agriculture, Cairo University
Dr. Essam A. Ewes	Assistant to the Faculty of Agriculture, Cairo University
Dr. Mohamed A. Kandil	Faculty of Agriculture, Cairo University
Mr. Hamed Khirallah Said (M. Sc.)	Faculty of Agriculture, Cairo University
Dr. Sohail S. Soliman	Department of Zoology, Cairo University
Eng. Mustafa Mohamed Ali	Egyptian Field Rat Control Project
Dr. Abdel Rawgaud Abdella Asran	Egyptian Field Rat Control Project
Dr. Aly H. El-Sherbiny	National Agricultural Research Project
Dr. Zeimula El Tobshy	CID, National Agricultural Research Project
Dr. M. Said Tewfik	Research Coordinator, RSP, National Agricultural Research Project
Dr. Hassan Ibrahim El Deeb	Plant Protection Research Institute
Dr. Nadia El Hwashy	Plant Protection Research Institute
Dr. Mohammed Farlag El Sayed	Plant Protection Research Institute, Pest Physiology Department
Dr. Hamdy I. Hussein	Plant Protection Research Institute
Dr. Joseph M. Nabhla	Plant Protection Research Institute
Dr. Abdel-Hamid Omal	Plant Protection Research Institute
Dr. Gamal Abdel El Sattar El Kody	Suez Canal University
Dr. Mohamed Bassem Ashour	Faculty of Agriculture, Zagazig University
Dr. El-Adarosy A. Gomao	Professor, Plant Protection Department, Zagazig University
Dr. Wahied M. Gabr	Agriculture Engineer

Trip Report*

CHAD RODENT RESEARCH AND RODENTICIDE FIELD TRIALS

October 11-November 11, 1992

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Unpublished Report

November 19, 1992

* This work was conducted with funds contributed to the U.S. Department of Agriculture (USDA)/ Animal and Plant Health Inspection Service/Animal Damage Control/Denver Wildlife Research Center by the U.S. Agency for International Development under the "Africa Emergency Locust/Grasshopper Assistance Project," PASA AFR-0517-P-AG-9042-01.

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ITINERARY

Date	Location	Activity
Oct 11-13	Philadelphia, Pennsylvania, to N'Djamena, Chad, Africa	Travel
Oct 13-19	N'Djamena	Attended briefing with officials of the U.S. Agency for International Development (USAID).
Oct 19-29	N'Gouri	Conducted field work: rodent monitoring, initiated pitfall traps, continued rodenticide trials, and trapped animals for population studies.
Oct 29-Nov 2	N'Djamena	Briefed USAID, the Office for Rehabilitation Through Training (ORT), and the Ministry of Agriculture (MOA)/Crop Protection Service (CPS).
Nov 2-5	Karal; Guite	Conducted rodent population studies.
Nov 5-10	N'Djamena	Prepared trip report and briefed USAID officials.
Nov 10-11	N'Djamena, Chad, to Philadelphia, Pennsylvania	Travel

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INTRODUCTION

The Chad Rodent Control Research Project (RCRP) was initiated, in part, as a result of the 1986-87 rodent population irruption in the Sahelian area of Chad. This Project is a cooperative program among the Chad MOA/CPS; AID/N'Djamena; and the USDA/Animal Plant Health Inspection Service/Animal Damage Control/DWRC. The project is organized to conduct applied research and to provide training to MOA personnel so that safe, effective, and economical rodent control techniques can be implemented when needed in the future.

OBJECTIVES

The objectives of this consultancy were to (1) evaluate the efficacy and appropriateness of alternate control methods, (2) assist the Chad RCRP in rodent population monitoring studies, (3) conduct rodenticide field trials to obtain information on acceptance, efficacy and potential hazards to nontarget species, and (4) continue collecting data on the status of rodent populations in the Sahel region of Chad. Objectives of mammal surveys were to determine the kinds of species present, test methods for sampling abundance of species, and recommend methods for use in research. Monitoring methods will measure the relative abundance of rodent populations, or relative change in rodent activity. Monitoring methods should be adequate to detect changes in the population, either an increase or decrease. Research will continue on the evaluation of a nonpoisonous removal method (pitfalls).

FIELD RESEARCH

N'GOURI

Field work was conducted near N'Gouri, on the northeast side of Lake Chad, from October 19-29, 1992. We installed pitfall traps, conducted rodenticide trials in cultivated and noncultivated dune areas, and monitored rodent populations. We also conducted roadside censuses by vehicle, excavated burrow systems, performed burrow counts, and autopsied adult rodents for reproductive information.

Pitfalls

We installed eight pitfall traps (clay containers about 60-cm deep and 30-cm in diameter at the mouth, used as water jars). These pitfalls were installed on October 22 in the Goural wadi, which contained one previously installed pitfall. Using a water jar that had been transported from N'Djamena as an example, we purchased pitfalls locally in N'Gouri. The jars were installed into the bed of the wadi about 1 m out from the fencerows and approximately 30 m apart with the lips even with the surface. About

10 cm of water was added to each trap. The pit traps were checked on October 28 and contained 23 beetles (*Coleoptera* sp.). A technician living at N'Gouri has been provided with data sheets (Annex I) to record and recover any animals that have fallen in the pit traps. Pit traps will be checked weekly. All captures such as lizards, toads, beetles, and other insects will be recorded, since this removal alternative may seize nontarget animals.

Monitoring

Rodent population sampling and activity monitoring were conducted in six wadis and six dunes from October 20 to 28. Sampling was done at wadis with live traps, rat snap traps, tracking tiles, and bait piles. Dunes, both cultivated and noncultivated, were sampled using mouse snap traps, bait piles, and tracking tiles. Throughout the sampling period a station could consist of any combination of the preceding methods. Baits included maize on the cob in live traps and peanut oil or peanut butter rolled in millet on both rat and mouse snap traps. Bait stations were set by placing about 15 g or one tablespoon of millet at a trapping station. Activity was recorded as positive if ≥20% of the bait pile was removed overnight. Tracking tiles were recorded positive when footprints were present. In wadis, stations were placed at 10-m intervals along the cultivated margin and the cultivated interior of the wadi. In dunes, stations were placed within 1 m of active burrow systems. Two or three mouse traps were used per station.

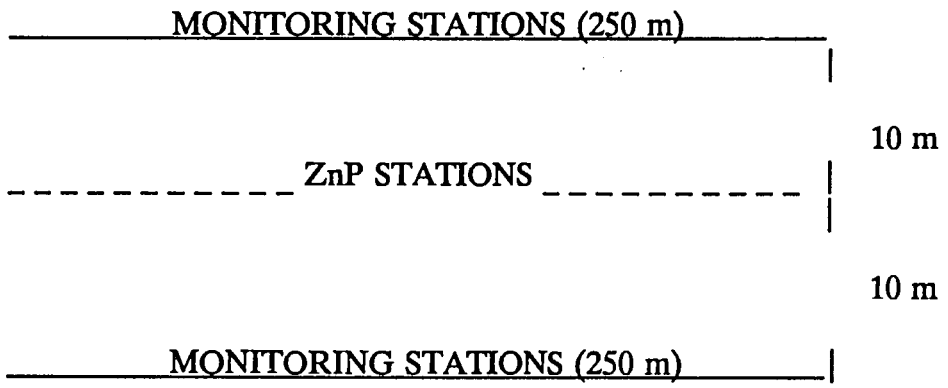
A total of 66 rodents was captured over 410 trap nights in wadis (Table 1). *Arvicanthis niloticus* comprised 66% of the captures; *Mastomys natalensis*, 20%; *Tatera robusta*, 10%; and *Taterillus* sp., 4%, respectively. Rat snap traps had a 10% success rate compared with 41% for live traps, 44% for bait piles, and 46% for tracking tiles. In dunes, 44 rodents were captured over 533 trap nights (Table 2). *Gerbillus* sp. comprised 100% of the captures. Trap success was 8%, even when traps were placed around active burrows. However, this may be explained by not using millet as a bait during early monitoring sessions. When millet was used, capture success increased dramatically. Tracking tiles had a 21% success rate, and bait stations a 41% success rate. No *Jaculus jaculus* were captured in snap traps in the dunes. Given the differences in success rates, it would be well to continue to use several monitoring methods simultaneously rather than relying on only one method.

Rodenticide Trials

A 1%-zinc phosphide (ZnP) bait was formulated (1 g of 94% active ingredient zinc phosphide + 2 g of peanut oil + 97 g of millet) 4 days before using it. The four dunes selected for the trials were within 6 km of N'Gouri. Before the trials began, each dune was inspected for rodent activity (tracks and active burrow systems). In each dune, two transects for monitoring pretreatment activity were established and marked with engineering tape. The transects were 20-m apart and parallel to each other (Fig. 1). Each transect line consisted of 20 live traps, 25 tracking tiles, and 25 bait piles. Monitoring stations were established at 10-m intervals along each 250-m transect line.

Stations were placed within 1 m of signs of rodent activity. Transects incorporated both cultivated and noncultivated exteriors. Tracking tiles were examined for the presence of rodent tracks. Bait piles were recorded as positive if ≥20% of the pile was removed overnight. The observer noted no insects were responsible for the bait removal.

Fig. 1.



After the pretreatment period, baiting with ZnP rodenticide was conducted in the four dunes selected for the trial. Twenty-five ZnP bait stations were placed 10 m apart on a line equidistant between each pretreatment monitoring transect. Baiting with rodenticide was conducted for 3 to 4 nights in the four dunes. About 15 g of ZnP-treated millet was placed on the ground in a pile and monitored daily. All bait stations were covered for the duration of the trial with PVC pipe between 12 and 18 inches long and open at both ends. Bait removal was recorded as positive if ≥20% of the bait pile was removed overnight. The bait pile was replenished to the original amount if ≥50% of the pile was removed. Stations were removed when monitoring ceased. Each dune was searched daily for dead rodents and any nontarget wildlife. Searches were conducted by five people for 20 to 30 minutes each day of the trial. In addition, children were asked to search for any dead animals in the vicinity. No nontarget animals were found on any of the dunes.

A 1-night posttreatment monitoring period using 50 mouse snap traps, 50 tracking tiles, and 50 millet bait piles was then conducted in each dune. Each station consisted of a snap trap, tracking tile, and a bait pile placed along the original pretreatment monitoring transects. Bait acceptance appeared good during both pretreatment and treatment periods (Table 3). Bait consumption showed a decline for all dunes during the treatment period. Bait piles showed the greatest reduction in rodent activity posttreatment. Captures increased slightly in two dunes. However, this may be attributed to the bait (millet) used in mouse snap traps posttreatment vs. corn, potatoes, or cardboard soaked in peanut oil used in live traps pretreatment. Fifteen dead *Gerbillus* were found over the four dunes during the ZnP treatment period and posttreatment monitoring. Autopsies revealed ZnP-treated millet in all stomachs. The

furthest carcass from the ZnP bait line was 17-m. Bait acceptance appeared greater when the 12-inch covers were used vs. the 18-inch covers.

Burrow Counts

Two burrow count transects were established in the Kiri-Kala dune. The transects were 250-m long in representative habitat. While walking along the transect, fresh open and closed burrows were tabulated. Only burrows within 2 m on either side of the transect were counted. Flagging was used to establish the transect lines for future monitoring. On October 25, the two transects contained 31 and 63 fresh burrows. This represents 31 and 63 burrows/1,000 m^2, or 310 and 630/ha. These same transects will be recounted again in December to note any changes in numbers.

Road Counts

We conducted three roadside counts by vehicle at night near N'Gouri to count rodents. *J. jaculus* was the most abundant species seen at night (Table 4). This species was not captured in any snap or live traps. *Jaculus* was most readily spotted adjacent to millet fields. Ten were captured by hand. We sighted an average of 3.2 rats/km.

Miscellaneous Activities

We excavated three burrow systems of *Gerbillus* sp. in the dunes. We found one juvenile in one of the systems. All burrows had *Tribulus terrestris* seeds stored inside them. All captured animals were measured and adult females autopsied (Annex II). Study skins and skulls of all species were prepared. Table 5 summarizes reproductive data for adult female rodents autopsied. Table 6 compares overall success of snap traps, live traps, tracking tiles, and bait stations for monitoring rodent activity and populations around N'Gouri. Overall, snap traps were the least effective means of monitoring rodent populations. All farmers interviewed expressed concern about crop loss to birds. There was a lot of bird activity in and around all of the dunes.

KARAL

Monitoring

Field work was conducted near Karal and Guite on the southeast side of Lake Chad from November 2 to 5. We placed 25 rat snap traps overnight about 500 m east of Beltram in a noncultivated field, where we caught two *Taterillus* sp. Lake Chad had risen to within 1-km of Beltram, flooded the road, and prohibited any monitoring past this location. We then proceeded to Guite where Lake Chad was also unseasonably high. All sorghum, potato, okra, cassava, and rice fields were either planted and irrigated or being prepared for planting. We monitored only noncultivated exteriors.

No cultivated interiors were available for monitoring. We set one trap line of 50 rat snap traps and 25 mouse snap traps. We also set a trap line of 25 rat snap traps (Table 7). Capture success was 53% for these two transects. This exceptional capture success was caused by the rodents concentrating ahead of the advancing flood waters from the lake. Species composition was *T. robusta* (39%), *Taterillus* sp. (33%), *A. niloticus* (12%), *M. natalensis* (12%), *Gerbillus* sp. (2%), and *Mus* sp. (2%). All rodents were measured and mature females autopsied for reproductive data (Annex III). No pregnant or lactating females were seen, but immature animals comprised 35% of the collection, indicating breeding had taken place 6 weeks or more before. Study skins and skulls of representative species were prepared.

DISCUSSION

Field Trials

The ZnP field trials resulted in between 15 and 73% reduction in rodent activity measures on the four dunes. This is about the normal efficacy for this rodenticide when used in the field. No evidence of poisoning of nontarget animals was found despite diligent searches. No dead *J. jaculus* were found, even though this species frequents the dune areas where the poisoning was done. It might be that *Jaculus* are reluctant to enter the covered bait stations.

Rodent Breeding and Population Structure

Unstriped grass rats (*A. niloticus*) and *Gerbillus* sp. were actively breeding at N'Gouri, with 35% of unstriped grass rats visibly pregnant and another 39% lactating with nursing young (Table 5). The gerbils ran 54% pregnant and another 17% lactating. Immatures comprised 16% of the unstriped grass rats, 71% of the fringe-tailed gerbils, 69% of the multimammate rats, and 18% of the *Gerbillus* sp.. At Beltram and Guite, while no pregnant or lactating female rodents were seen, immatures comprised 35% of the collection (50% of *A. niloticus* were immatures; 29% of *T. robusta*; 35% of *Taterillus* sp.; and 50% of *M. natalensis*).

The presence of multimammate rats in the wadis at N'Gouri is exceptional; only rarely in the last 3 years have they been captured in this habitat. Likewise at Guite, *A. niloticus* was collected where it had not previously been seen. Some unusual events appear to be taking place in the rodent populations this season. Several species, such as *A. niloticus* and *M. natalensis* (the former had been rare at the Karal area in the past and the latter, rare at N'Gouri in the previous 2 years) are present now in considerable numbers. This is indicative of actively breeding and dispersing populations.

Comparison of Rodent Monitoring Methods

Snap traps were the least effective means of monitoring rodent population activity, both in the wadis and on the dunes (Table 6). Live traps (41% success), tracking tiles (35%), and bait stations (43%) all showed reasonable agreement and indicated a fairly high population activity. All activity measures had increased from Dolbeer's (1992) observations made in late September. Actually an overall 9% trapping success at N'Gouri for snap traps was the highest seen during the project since December/January 1989-90.

RECOMMENDATIONS

1. Zinc phosphide, at a 1% concentration on millet bait with an added 1 to 2% peanut oil, is an excellent toxicant to use against *Gerbillus* sp. populations on dunes should there be a need to control these rodents. It is likely that *Gerbillus* and *Jaculus* are involved in gathering and eating millet seeds at the time of sowing, resulting in farmers having to replant a second or third time to achieve an adequate planting.

2. The unusual events occurring in the rodent populations at N'Gouri and Karal should be followed up on the next TDY and perhaps into the next year. It appears that the excellent rains and the abundant harvest of millet may have stimulated rodent populations, virtually dormant for a long time, into increased breeding and dispersal in these areas.

ACKNOWLEDGMENTS

I thank Dr. Maho Angaya for his assistance and leadership. I commend our driver, Mr. Mahamet El-Hadji N'Gaba, for his excellent driving skills and assistance with the field work. I am thankful for the able assistance offered by Mr. Djibo Koulangar. His assistance at N'Gouri and Karal is greatly appreciated. I also note the excellent assistance provided by Mr. Omar Maddu, who served as our guide and helper at N'Gouri. I appreciate the assistance provided by Mr. Dezoumbe Djonret, Assistant to the ADO, and to Dr. Trid Mukherjee, ADO at USAID. Many thanks to ORT personnel Mrs. Wendy Asher and Mr. John Smith, Agricultural Cooperative Development International (ACDI) Guesthouse for their excellent hospitality.

PERSONS CONTACTED

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Mr. Jon Myers, Regional Security Officer

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Mrs. Wendy Asher, Project Leader, N'Djamena

REFERENCES

Dolbeer, R. A. 1992. Rodent control training and rodenticide field trials in Chad. DWRC Unpublished Trip Report, Denver, Colorado. 20 pp.

Table 1. Activity monitoring effort and success for rat snap traps, live traps, tracking tiles, and bait stations in wadis near N'Gouri, Chad, October 21-28, 1992.

	WADI						
	Tomossi	Goural	Guini	Madekouri	Assankadori	Kaya	Total
Live Traps							
No. trap nights	25	25	25	0	0	0	75
No. captures	15[b]	8[c]	8[d]	0	0	0	31
% success	60	32	32	0	0	0	41
Rat Snap Traps							
No. trap nights	75	74	73	39	49	25	335
No. captures	15[b]	17[c]	0	2[e]	1[f]	0	35
% success	20	23	0	5	2	0	10
Tracking Tiles							
No. nights	25	50	25	40	25	25	190
No. marked	15	25	14	13	10	11	88
% success	60	50	48	32	40	44	46
Bait Stations							
No. nights	25	50	50	40	25	10	200
No. piles eaten[a]	13	22	27	8	11	6	87
% success	52	44	54	20	44	60	44

[a] At least 20% of bait pile was eaten overnight.
[b] 20 *A. niloticus*, 9 *M. natalensis*, 1 *Taterillus* sp.
[c] 18 *A. niloticus*, 4 *T. robusta*, 3 *M. natalensis*
[d] 4 *A. niloticus*, 2 *T. robusta*, 1 *M. natalensis*, 1 *Taterillus* sp.
[e] 1 *A. niloticus*, 1 *T. robusta*
[f] 1 *A. niloticus*

Table 2. Activity monitoring effort and success for mouse snap traps, tracking tiles, and bait stations in dunes near N'Gouri, Chad, October 21-28, 1992.

	DUNE*						
	Madekouri	Yagra	Wolaldji	Boholi	Assankadori	Kiri-Kala	Total
Mouse snap traps							
No. nights	25	124	97	147	94	46	533
No. captures**	0	4	9	17	5	9	44
% success	0	3	9	12	6	19	8
Tracking tiles							
No. nights	25	50	25	25	25	25	175
No. marked	4	9	5	6	5	8	37
% success	16	18	20	24	20	32	21
Bait stations							
No. nights	25	50	0	25	25	0	125
No. eaten***	8	23	0	12	9	0	52
% success	32	46	0	48	36	0	41

* Totals do not include data from ZnP trials.
** *Gerbillus* sp. were the only animals captured.
*** At least 20% of bait pile was removed overnight.

Table 3. Zinc Phosphide (ZnP) field trials at dunes near N'Gouri, Chad, October 1992. Bait piles were fed upon, tracking tiles marked, and rodents captured. (Bait piles are indicated as positive if ≥20% were removed overnight).

Dune Area		Pretreatment activity			Treatment period				Posttreatment activity		
		Bait piles *N*=50	Track tiles *N*=50	No. live trapped *N*=40	Bait piles eaten/day (*N* = 25) 1	2	3	4	Bait piles *N*=50	Track tiles *N*=50	No. snap trapped *N*=50
Wolaldji	No.	29	11	1*	16	12	12	6	10	3	2*
	%	58	22	2.5	64	48	48	24	20	6	4
Boholi	No.	24	8	0	14	9	8	-	11	3	1*
	%	48	16	0	56	36	32	-	22	6	2
Madeklia	No.	13	7	0	8	9	11	8	11	2	0
	%	26	14	0	32	36	44	32	22	4	0
Yagra	No.	27	10	0	14	13	8	8	14	2	0
	%	54	20	0	56	52	32	32	28	4	0

* *Gerbillus* sp. were the only animals captured.

Table 4. Nightime Rodent Census

Date	Start time	Distance	No. Observed			
			J. jaculus	*Gerbillus* sp.	Total	No./km
10/21/92	1930	5 km	24	1	25	5
10/24/92	1915	5 km	12	0	12	2.4
10/27/92	1900	5 km	15	1	16	3.2

Note: Ten *Jaculus jaculus* were captured by hand.

Table 5. Reproductive data for adult female rodents captured and autopsied at N'Gouri, Chad, October 21-28, 1992.

Species	No. females autopsied	No. pregnant	No. lactating	Avg. litter size	Percent immatures
Arvicanthis niloticus	23	8	9	5.0	16
Tatera robusta	2	0	2	-	71
Mastomys natalensis	2	0	1	-	69
Gerbillus sp.	24	13	4	3.8	18
Jaculus jaculus	1	0	1	-	

Table 6. Overall comparison of snap traps, live traps, tracking tiles, and bait stations for monitoring rodent populations in N'Gouri, Chad, October 1992.*

Monitoring method	No. of trap, baiting or tracking nights	No. of captures, or positive tracks or piles eaten	Percent success
Snap traps	868	79	9
Live traps	75	31	41
Tracking tiles	365	125	35
Bait stations	325	139	43

* Data does not include results from ZnP rodenticide trials.

Table 7. Activity monitoring effort and success for rat and mouse snap traps in noncultivated areas near Beltram and Guite, Chad, November 3-5, 1992.

	GUITE	BELTRAM
Rat snap traps		
No. trap nights	75	25
No. captures	48[a]	2[b]
% success	64	8
Mouse snap traps		
No. trap nights	25	0
No. captures	5[c]	0
% success	20	0

[a] 21 *Tatera robusta*, 15 *Taterillus* sp., 6 *Arvicanthis niloticus*, 5 *Mastomys natalensis*, 1 *Mus* sp.

[b] 2 *Taterillus* sp.

[c] 3 *Taterillus* sp., 1 *Gerbillus* sp., 1 *M. natalensis*

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Annex I.

PITFALL TRAP DATA

		Animals Captured					
Date	Wadi	*A. nil.*	*T. rob.*	Other rodents	Toad	Lizard	Ins.
10/28/92	Goural	0	0	0	0	0	23*

* *Coleoptera* sp.

Annex II. Measurements of Rodents from N'Gouri, Chad

Species	Sex	Wt.	HBL	Tail	H. foot	Ear	Remarks
WADIS:							
Arvicanthis niloticus	M	U	U	130	30	U	-
" "	F	100	150	125	30	15	lactating
" "	F	100	165	125	25	16	-
" "	F	106	175	135	20	16	lactating
" "	F	74	125	120	30	16	-
" "	F	80	140	U	30	15	-
" "	F	72	135	110	30	16	Preg. 6 emb.
" "	F	42	105	100	26	12	Immature
" "	M	118	170	130	30	14	-
" "	F	84	135	115	30	16	lactating
" "	M	162	190	140	31	16	-
" "	F	116	170	110	27	16	-
" "	M	18	95	80	22	12	Immature
" "	F	18	80	75	22	13	Immature
" "	F	130	160	130	27	16	Preg. 5 emb.
" "	F	110	160	125	30	14	-
" "	F	112	160	130	30	15	lactating
" "	M	138	170	135	34	16	-
" "	M	140	170	125	31	17	-
" "	F	88	150	115	30	14	Preg. 5 emb.
" "	M	112	170	125	26	14	-
" "	M	70	130	120	30	14	Immature
" "	F	40	105	105	30	14	Immature
" "	F	112	150	130	30	17	lactating
" "	F	104	140	105	32	13	Preg. 4 emb.
" "	F	80	125	125	30	12	Preg. 4 emb.
" "	F	116	145	130	31	12	Preg. 7 emb.
" "	F	80	135	110	30	13	Preg. 5 emb.
" "	M	U	125	125	31	13	-
" "	M	118	150	130	32	16	-
" "	M	134	160	150	33	16	-
" "	F	102	150	130	33	15	Preg. 4 emb.
" "	M	100	150	125	33	14	-
" "	F	102	150	130	32	12	lactating
" "	M	58	130	115	30	14	Immature
" "	U	U	U	U	U	U	
" "	U	U	U	U	U	U	
" "	M	131	170	132	31	18	-
" "	F	58	132	111	30	16	lactating
" "	F	114	160	135	31	18	lactating
" "	U	U	U	U	U	U	-
" "	F	125	160	130	27	16	lactating
" "	M	105	150	125	30	15	-
" "	F	50	120	110	27	16	Immature

Annex II. (Continued)

Species	Sex	Wt.	HBL	Tail	H. foot	Ear	Remarks
WADIS:							
Mastomys natalensis	U	U	U	U	U	U	Immature
" "	F	U	105	U	22	U	Immature
" "	F	16	80	95	22	14	Immature
" "	F	U	U	100	22	U	Immature
" "	U	U	U	100	24	U	-
" "	U	U	U	U	23	U	-
" "	U	U	U	U	U	U	Immature
" "	F	18	90	100	22	16	Immature
" "	F	56	130	130	25	16	lactating
" "	F	34	110	125	22	16	Immature
" "	M	26	115	145	21	14	Immature
" "	F	32	100	125	24	16	-
" "	F	20	90	105	22	13	Immature
Taterillus sp.	M	38	110	140	32	17	-
" "	U	U	U	U	U	U	-
Tatera robusta	M	132	175	180	37	16	-
" "	M	56	130	150	35	16	Immature
" "	M	50	130	U	37	U	Immature
" "	M	50	115	145	34	18	Immature
" "	F	126	165	185	40	20	lactating
" "	M	22	95	100	31	14	Immature
" "	F	125	150	180	37	17	lactating
DUNES:							
Gerbillus sp.	F	26	90	110	24	12	Preg. 3 emb.
" "	M	18	85	115	24	12	-
" "	F	16	80	100	24	12	-
" "	F	8	70	85	23	11	Immature
" "	F	6	60	80	23	11	Immature
" "	M	22	85	100	25	U	-
" "	M	22	90	105	25	U	-
" "	M	14	75	95	24	12	-
" "	M	18	80	110	26	14	-
" "	M	16	80	100	23	U	-
" "	F	26	90	110	24	12	Preg. 3 emb.
" "	F	20	90	120	24	U	-
" "	F	20	85	105	22	12	-
" "	M	28	100	115	25	13	-
" "	F	28	90	110	23	13	Preg. 4 emb.
" "	F	20	85	110	23	12	Preg. 2 emb.
" "	F	18	80	110	22	12	-
" "	F	18	85	110	24	13	lactating

Annex II. (Continued)

Species	Sex	Wt.	HBL	Tail	H. foot	Ear	Remarks
DUNES:							
Gerbillus sp. "	F	20	85	105	23	12	Preg. 3 emb.
" "	F	28	90	120	24	12	Preg. 4 emb.
" "	F	28	95	120	23	12	Preg. 4 emb.
" "	F	24	85	120	24	12	Preg. 4 emb.
" "	F	20	85	105	23	12	Preg. 3 emb.
" "	F	26	90	120	25	12	lactating
" "	M	18	85	110	24	U	-
" "	M	20	90	110	25	13	-
" "	M	18	80	105	24	13	-
" "	F	U	U	90	22	U	Immature
" "	F	36	90	125	25	12	-
" "	F	8	60	80	22	12	Immature
" "	F	30	95	120	25	13	Preg. 5 emb.
" "	F	28	95	115	24	12	Preg. 6 emb.
" "	M	18	85	110	23	12	-
" "	M	16	80	110	24	U	-
" "	F	18	90	110	24	13	-
" "	M	24	90	120	25	12	-
" "	F	28	100	125	25	13	lactating
" "	F	30	95	120	25	13	lactating
" "	M	18	80	115	25	U	-
" "	F	26	90	120	25	13	Preg. 4 emb.
" "	F	12	75	100	25	U	Immature
" "	M	12	75	90	24	U	Immature
" "	M	9	75	92	25	11	Immature
" "	U	U	U	U	U	U	-
" "	M	32	95	125	25	13	-
" "	F	26	95	115	24	13	Prg. 4 emb.
" "	M	20	80	110	23	12	-
" "	F	20	80	110	23	12	-
" "	F	12	75	95	23	12	Immature
" "	F	5	60	60	18	8	Immature

Annex III. Measurements of rodents captured in Beltram and Guite, Chad.

Species	Sex	Wt.	HBL	Tail	H. foot	Ear	Remarks
Taterillus sp.	M	34	110	125	30	16	-
" "	F	60	120	150	30	18	-
" "	F	U	105	140	25	16	-
" "	F	U	U	125	30	U	-
" "	F	U	U	155	30	U	-
" "	F	U	90	95	25	16	Immature
" "	U	U	105	125	30	U	-
" "	M	64	135	150	30	17	-
" "	M	62	130	170	30	17	-
" "	F	32	120	130	30	18	Immature
" "	M	40	115	140	30	17	Immature
" "	F	32	100	130	30	16	Immature
" "	M	60	130	140	30	17	-
" "	F	56	125	U	30	17	-
" "	F	46	120	145	30	16	-
" "	F	26	100	125	30	16	Immature
" "	F	30	100	130	30	18	Immature
" "	F	U	90	U	30	16	Immature
" "	F	44	115	150	30	17	-
" "	U	U	U	140	30	17	-
Tatera robusta	M	130	165	170	36	20	-
" "	M	126	165	180	32	20	-
" "	F	132	160	165	33	20	-
" "	M	112	155	170	36	20	-
" "	M	94	150	155	36	20	-
" "	M	86	159	170	35	18	-
" "	M	108	145	165	31	18	-
" "	M	108	150	160	35	20	-
" "	M	104	150	170	35	20	-
" "	F	62	130	150	35	18	-
" "	M	120	155	U	35	20	-
" "	M	140	150	140	34	17	-
" "	M	98	130	140	34	17	-
" "	M	86	145	160	35	17	-
" "	M	60	130	140	33	18	-
" "	F	50	125	140	33	17	Immature
" "	M	U	140	165	33	18	-
" "	M	90	150	160	32	16	-
" "	F	60	130	135	33	17	Immature
" "	F	30	100	110	30	17	Immature
" "	M	32	100	115	25	17	Immature

Annex III. (Continued)

Species	Sex	Wt.	HBL	Tail	H. foot	Ear	Remarks
Mastomys natalensis	F	18	90	85	22	18	Immature
" "	F	26	100	105	22	16	Immature
" "	U	18	90	95	21	15	Immature
" "	U	U	U	95	25	15	-
" "	M	76	130	120	27	16	-
" "	F	64	130	110	25	17	-
Arvicanthis niloticus	M	170	170	135	35	15	-
" "	F	72	135	105	28	15	-
" "	F	68	135	105	26	14	-
" "	M	78	130	110	30	16	Immature
" "	F	140	150	125	32	12	-
" "	F	106	145	110	30	15	-
Gerbillus sp.	M	26	100	110	25	13	-
Mus sp.	M	U	U	105	30	U	-

Trip Report*

REVIEW OF VERTEBRATE PEST RESEARCH

BANGLADESH

October 28-November 24, 1992

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SUMMARY

The Bangladesh Agricultural Research Institute (BARI)/Vertebrate Pest Section (VPS) was visited to review 1992 bird research and help plan bird control studies for 1993, to assess technical aspects of the 1992 Rodent Control Campaign, and to provide technical assistance for rodent and predator research. Guidance was given in defining research objectives, designing study protocols, and collecting and analyzing research data. The scientific officer responsible for conducting bird damage control research should be given additional training in techniques for observing and studying birds, estimating avian populations, and assessing damage to crops, as well as in hypothesis testing, basic statistics, sampling, and experimental design.

OBJECTIVES

The objectives of this TDY were to (1) review 1992 bird research conducted by the BARI/VPS and help plan and initiate bird control studies for 1993, (2) assess technical aspects of the 1992 Rodent Control Program, and (3) provide technical assistance as requested for rodent and predator research.

ACTIVITIES

Bird Research

Mr. Habibur Rahman, the BARI scientific officer responsible for conducting bird damage control research, has limited experience with birds and had previously requested additional training in this area. We reviewed the results of the 1991-92 bird research, discussed studies outlined in the BARI 1992-93 Annual Research Programme, and reviewed basic scientific principles and techniques for conducting bird/crop damage research, including basic experimental designs and sampling. I showed Mr. Rahman how to use a random number table to assign treatments and sample crops for damage.

Bird Damage to Maize

A 1991-92 study indicated that rose-winged parakeets (*Psittacula krameri*) and large-billed crows or jungle crows (*Corvus macrorhynchos*) damaged as much as 80% of the maize crop at the BARI Regional Agricultural Research Station in Joydebpur. A field study was proposed for 1992-93 to determine the extent of damage in selected farmers' fields in Joydebpur, Kashimpur, Gazipur, and Chuadanga districts and to identify environmental factors associated with damage. The proposal did not stipulate how fields were to be selected, and it was vague about sampling methods. Both Messrs. Rahman and Emdadul Haque stated that most farmers experience only minor bird damage because they harvest their maize prior to the milk stage, before birds are attracted to the

crop. After discussion, the study was redesigned to determine the extent of bird damage at Joydebpur and also at two other BARI Regional Agricultural Research Stations: Jessore and Ishurdi (Appendix I). We reviewed several published techniques for assessing bird damage to maize and discussed sampling designs for selecting fields, plants within fields, and ears on plants. We practiced estimating percent damage on individual ears of corn. I stressed the importance of documenting the species and numbers of birds causing damage.

A second study described in the 1992-93 Annual Research Programme proposed to "develop a reliable quantitative method for assessing bird damage to maize." The labor-intensive study called for collecting, drying, sorting, and weighing 500 undamaged cobs from each of several maize fields, apparently to develop a regression between cob size and kernel weight. The proposal did not specify how the data were to be analyzed. I suggested that in view of the apparently low levels of bird damage incurred by most maize farmers, a preliminary study to estimate the overall extent of bird depredations might be more appropriate. If warranted, a followup study can be conducted to assess the economic impact of bird damage.

Evaluation of Seed Repellents

Myna (*Acridotheres* spp. and *Sturnus* spp.), crow (*Corvus* spp.), and sparrow (*Passer* spp.) feeding on sprouting seeds is a major problem in Bangladesh. During 1991-92 four insecticides were evaluated as bird repellents for protecting sprouting maize from bird damage. Laboratory and field tests were conducted to evaluate germination and survival of seeds treated with Sevin®[1] 85% WP, Mipcin® 75% WP, Lebaycid® 50% EC, and Chemocarb® 50% EC.

The 1992-93 Annual Research Programme called for a replication of the 1991-92 seed repellent study. Because Lebaycid 50% EC and Chemocarb 50% EC were not effective in 1991-92, they can be dropped from the 1992-93 study. Sevin 85% WP and Mipcin 75% WP resulted in lower damage in 1991-92, but they also were associated with reduced seedling survival. I suggested evaluating whether lower concentrations of these two insecticides would result in improved germination while still repelling birds. Mr. Rahman and I reviewed the use of a random number table for assigning treatments and discussed possible experimental designs for laying out seed treatments in the field. I stressed the importance of observing birds and recording the numbers and species causing damage. Mr. Rahman revised the 1992-93 seed repellent proposal (Appendix I), and I reviewed it.

[1] Reference to trade names does not imply endorsement by the U.S. Government.

Recommendations

Mr. Rahman could use training in standard techniques for observing and studying birds, estimating avian populations, and assessing damage to crops, as well as in hypothesis testing, basic statistics, sampling, and experimental design. I gave Mr. Rahman selected literature reprints on behavioral observations of birds, the use of mist nets, avian radiotelemetry, measurement of bird populations, and bird repellents. Traveling to another country and seeing how other research institutes conduct research with birds would broaden Mr. Rahman's experience and help him to think more critically about bird problems in Bangladesh and how they should be addressed.

National Rodent Control Campaign

The Bangladesh Department of Agricultural Extension (DAE) coordinates an annual national rodent control program that relies upon a hierarchy of agricultural extension officials to disseminate rodent control technologies to farmers and villagers. During 1992 the DAE conducted a survey to determine how effective the campaign was in motivating farmers to apply the rodent control technologies recommended by the DAE and to evaluate farmers' perceptions of the success of the campaign.

During November 1992, BARI/VPS scientists were contacting a subsample of farmers surveyed by the DAE to further evaluate the effectiveness of the National Rodent Control Campaign. Both the DAE and BARI/VPS surveys examined farmers' perceptions of the rodent control campaign, but neither actually assessed rodent populations nor measured damage. The survey results were not available before my departure.

I reviewed a draft Ph.D. dissertation entitled "Evaluation of rodent control strategies in Bangladesh," by Mr. Santosh Sarker, and made numerous suggestions for condensing and clarifying the text. The dissertation analyzed the effectiveness of the National Rodent Control Campaign for disseminating information to farmers.

Recommendations

I recommended that BARI scientists assess rodent populations, crop damage, and crop yields in contact and noncontact farmers' fields to determine the accuracy of farmers' perceptions and verify the effectiveness of current rodent control practices during the next National Campaign.

Rodent Research

Assessing Damage in Transplanted Aman Rice

I reviewed a proposal by Mr. Mian to compare the accuracy and precision of three sampling schemes for estimating rodent damage in transplanted aman rice (Appendix II). The objective was to identify a simple, easy-to-use, and statistically valid method for evaluating the efficacy of the National Rodent Control Campaign. We discussed the advantages and disadvantages of different schemes with respect to sample size, labor requirements, and accuracy of estimates. Mr. Mian plans to use computer models to evaluate each of three methods for estimating various levels and distributions of damage. Based on the accuracy and precision of the three methods, he will recommend one for comparing rodent damage in "contact" and "noncontact" farmers' fields during the 1993 transplanted aman rice season. Mr. Mian requested that I send the literature and computer program for a similar study conducted at the DWRC Hawaii Field Station.

Rodent Identification

Scientists at the VPS have recently initiated a study to determine the reliability of various cranial and morphological features for differentiating species of rodents. Discriminate function analyses will be used to determine which features most reliably separate the species. Mr. Mian and I discussed possible variables to measure, and I suggested analyzing previously published data from a south Asia mammal guide to get a preliminary idea of which variables are most important. Mr. Mian and I discussed the structure of the data file, and I helped him import a Lotus data file into SAS for analysis. Mr. Mian requested more information about multivariate statistical analyses and an appropriate SAS model to conduct the analyses.

Swimming Ability of Rodents

I reviewed a proposal by Messrs. Pandit and Mian to determine the swimming ability of each of three species of rodents (*Bandicota bengalensis*, *B. indica*, and *Rattus rattus*) (Appendix III). Rodents will be released in the middle of the BARI Lake at Joydebpur, Gazipur; and the time and distance traveled until they tire and stop swimming will be recorded. The findings could lead to the development of more effective techniques for controlling rodent damage to deepwater rice. Knowledge of how far rodents can swim from surrounding fields could lead to improved rodenticide baiting strategies. Mr. Pandit and I discussed methods for conducting the study and specified data to be collected.

Rodent Glue

Mr. Pandit and I discussed a proposal to develop a rodent glue from materials available in local markets. The objective was to develop a safe, economical

alternative to rodenticides for controlling rodents. Mr. Pandit proposed boiling mixtures of rosin or "Dhup powder" and different oils until they become sticky, spreading the mixtures on cardboard, allowing them to dry at room temperature, and recording the number of days that the mixtures hold their adhesive properties. Followup studies will be conducted to evaluate promising materials in laboratory rodent control trials.

Maintenance of Rodent Facilities

The room used to conduct rodent feeding trials was cluttered with miscellaneous equipment and supplies and was maintained in poor condition. The rodent chow was stored in open containers. Mr. Mian and I prepared a schedule of duties for maintaining the laboratory in a clean, safe condition. I promised to send them copies of DWRC Standard Operating Procedures for maintaining captive rodents (see Appendix IV).

Predator Research

Jackal Damage to Sugarcane

Researchers from BARI/VPS assessed jackal and rodent damage to sugarcane in the Sripur area of Gazipur District during the early 1980's and reported that jackals were the more significant pest in this crop. However, a more recent study indicated that economic losses caused by rodents has increased and may be more than 10 times those caused by jackals. More study is needed to clarify the impact of these two pests. Mr. Pandit and I inspected some sugarcane fields in the Sripur area and talked to farmers about their pest problems. We also discussed methods for assessing damage to sugarcane, and I described the Point-distance Nearest-neighbor (PDNN) assessment technique developed at the DWRC Hawaii Field Station. Mr. Pandit requested that I send them the PDNN computer program and documentation.

Computer

Mr. Mian and I deleted unnecessary data from the 80286 IBM PS/2 50 computer at the VPS to allow sufficient space for running software applications, and we set up separate subdirectories for each researcher so that each might be responsible for his own files. Meanwhile, USAID has approved funding for BARI to purchase a new computer and laser printer for the VPS.

Mr. Mian requested updated versions, along with documentation, for Freelance Graphics, dBASE, Procite, Quattro Pro, and Derive. I showed Dr. Karim, Mr. Mian, and Mr. Pandit how to use Procite 2.0 Personal Bibliographic Software to store and retrieve literature reprints. They inquired about funding for purchasing a copy of Procite for BARI.

Dr. Karim explained that BARI relies on DWRC for renewing the SAS licensing agreement each year. He expressed doubts about whether this will be possible after the USAID project ends in June 1993 and inquired as to whether BARI can receive its own SAS software licensing agreement. Mr. Mian requested a copy of the SAS files that Dr. Saltz used for the data analysis he ran when he visited BARI in April 1992. Mr. Mian also requested a SAS Programming Guide.

VPS Facilities

USAID funding is available for constructing a rodent holding facility adjacent to the BARI/VPS building. The computer room at BARI/VPS has been enlarged and repainted, and the termite-infested door jams have been replaced throughout the building. Remodeling of the conference room was almost complete.

ITINERARY

Date	Location	Activity
Oct 28-30	Hilo, Hawaii, to Dhaka, Bangladesh	Travel
Oct 30-Nov 22	Dhaka	On duty
Nov 22-24	Dhaka, Bangladesh, to Hilo, Hawaii	Travel

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PERSONS CONTACTED

USAID

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Dr. Md. Abdul Karim, Head, Entomology Division
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Private Individuals

Dr. Sayed Ahmed
Dr. Parvin Sultana
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RESEARCH PLAN FOR THE YEAR 1992-93

MD. HABIBUR RAHMAN, SCIENTIFIC OFFICER, BARI.

Experiment 1. BIRD DAMAGE ASSESSMENT TO MAIZE

Objectives: (1) To determine the extent of bird damage to maize at three BARI field stations.

(2) To determine the species of birds causing damage.

Status: 1st year

Study area: Joydebpur, Jessore, and Ishurdi Regional Agricultural Research Stations

Methodology: Ten maize fields will be selected at random at each of three research stations. Within each field, we will inspect 100 ears of corn for bird damage according to the methods of Bridgeland (1980). We will enter each field at a point about one-fourth of its length from a corner and we will walk across 10 rows in a path perpendicular to the rows. We will stop at the 10th row and inspect 10 consecutive ears for bird damage beginning with the plant where we stopped. After inspecting 10 ears, we will continue into the field for 10 more rows and inspect 10 ears in the 10th row from the edge of the field. We will continue in this manner until we have inspected 50 ears (10 ears in each of 5 rows). We will return to the edge of the field and continue walking toward the far end for a distance about equal to one-half the total length of the field. We will then use the same procedure previously described to examine 10 ears in each of five rows. Thus we will examine a total of 100 ears in each field. We will examine each ear on the stalk and estimate the percentage of kernel loss due to bird damage (Bridgeland, 1980).

For each field we will calculate the percentage of ears with damage by birds and the average damage per ear. Analysis of variance will be used to determine whether the percentage of ears damaged by birds and the average percentage of damage per ear vary at different distances from the edge of the field. We will also record the numbers and species of any birds seen in the field or in the surrounding maize field.

Design: Ten maize fields randomly selected at each of three research stations

Plot dimension: Various sizes

Data to be recorded:

(1) Number of ears damaged by birds at each of five distances along each of two transects in each field.

(2) Percentage of kernels on each ear damaged by birds.

(3) Number and species of birds observed in maize fields.

References:

Bridgeland, W. T. 1980. Assessing blackbird damage in cornfields and timing application of control methods. Cornell University Orgat. Natural Resource. Conservation Circular 18(4). 6 pp.

Experiment 2. EVALUATION OF TWO CARBAMATE INSECTICIDES AS REPELLENTS FOR PROTECTING SPROUTING MAIZE SEEDS FROM BIRD DAMAGE

Objectives: (1) To determine whether the insecticides reduce bird damage to sprouting maize, and

(2) To determine the species of bird causing damage to sprouting maize at the Joydebpur Research Station.

Status: 1st year

Study area: Joydebpur Research Station

Materials and methods:

Materials: Maize - Variety: Barnali
Sevin 85% WP
Mipcin 75% WP

Treatment:
T_1 = Sevin 85% WP @ 0.5% a.i.
T_2 = " " @ 0.25% a.i.
T_3 = Mipcin 75% WP @ 0.5% a.i.
T_4 = " " @ 0.25% a.i.
T_5 = Untreated control

Method of seed treatment:

Sevin and Mipcin will each be applied to maize seeds at concentrations of 0.5% a.i. (w/w) and 0.25% a.i. (w/w). Appropriate quantities of insecticides and seeds will be mixed thoroughly in a polythene bag. Treated seeds will then be dried in the shade for about 1 hour before sowing in the field on the same day.

Spacing: Rows will be 0.75 m and seeds within rows 0.25 m.

Unit plot size: 5.0 m x 6.0 m (8 rows/plot, with 2-m buffer)

Design: Randomized complete block design

Replication: 4 (FOUR)

Date of planting: 30th November 1992

Data to be recorded:

(1) Number of seedlings present/2-m row length in six inner rows/plot 10 to 12 days after sowing.

(2) Percentage of sprouted seeds and seedlings that are damaged by birds.

(3) Number and species of all birds seen in the study plots and surrounding fields.

Experiment 3. EFFECT OF TWO CARBAMATE INSECTICIDES ON GERMINATION OF MAIZE SEEDS

Objective: (1) To determine the effect of two insecticides as seed treating chemicals on the germination of maize seeds.

Status: 1st year

Study area: Joydebpur Research Station

Materials and methods:

Materials: Maize - Variety: Barnali
Sevin 85% WP
Mipcin 75% WP

Treatment:
T_1 = Sevin 85% WP @ 0.5% a.i.
T_2 = " " @ 0.25% a.i.
T_3 = Mipcin 75% WP @ 0.5% a.i.
T_4 = " " @ 0.25% a.i.
T_5 = Untreated control

Method of seed treatment:

Sevin 85% WP and Mipcin 75% WP will be used at concentrations of 0.5% and 0.25% a.i. The appropriate quantities of each insecticide will be added to 25 g of seeds within a polythene bag and mixed thoroughly by shaking. Treated seeds will then be dried in the shade for about 1 hour before sowing in trays on the same day. Clay loam soil will be used, and the seeds will be planted at a depth of 3 cm.

Tray size: 90 cm x 45 cm

Number of trays: 16 (sixteen)

Design - Randomized Complete Block Design. Two insecticides of two concentrations will be replicated four times.

Planting date: 30 November 1992

Data to be recorded:

(1) Number of germinated seedlings/tray/treatment

DAMAGE ASSESSMENT IN TRANSPLANTED AMAN RICE

Md. Yousuf Mian

The Government of Bangladesh conducts a nationwide campaign annually to control rats. In 1991 and 1992, the Department of Agricultural Extension, in conjunction with the Bangladesh Agricultural Research Institute (BARI), surveyed farmers in an attempt to evaluate the effectiveness of the rodent control campaign. The results indicated that farmers believe the National Rodent Control Campaign is effective in reducing damage on their rice farms.

In spite of farmers' favorable impressions, no studies have actually measured the effectiveness of the National Rodent Control Campaign. A perceived reduction in damage does not mean that a reduction actually occurred. To determine this, it is necessary to carry out a controlled study and actually measure damage in the field. Two visiting scientists from the U.S. Department of Agriculture recently reviewed the National Rodent Control Campaign evaluation, pointed out its shortcomings, and recommended such a study.

Although there are methods for estimating rodent damage in wheat and deepwater rice fields (Poché, 1982; Ahmed, 1983), there is no standard method for estimating rodent damage in transplanted aman rice such as is grown in Bangladesh. Methods developed by scientists in the Philippines for estimating damage in transplanted rice (Benigno, 1977) are good, but require the use of a random table or other means to generate random

numbers for surveying fields. The Philippine methods are too complex and time-consuming for wide-scale use in Bangladesh. A simple, easy and statistically valid method could be used by block supervisors of the Bangladesh Directorate of Agricultural Extension (DAE) to compare the efficiency of "contact" and "noncontact" farmers in adopting different rodent control technologies. The proposed study described herein will use computer simulation methods to compare the accuracy and precision of three sampling methods for assessing damage in transplanted aman rice fields.

Descriptions of sampling methods:

Method 1. Count the number of steps along the length and breadth of the field, and select 2 rows (transects) each about one-third of the way from either edge of the field. Select 5 equidistant spots along the length of each transect, and inspect 10 consecutive hills/spot for rodent damage. Where damaged tillers are found, count the number of damaged and undamaged tillers of that hill. Ignore counting tillers on undamaged hills.

Method 2. Count the number of steps along the length and breadth of the field. Select 5 equidistant transects parallel to the rows of rice and select 4 equidistant spots along the length of each transect. At each spot, inspect 5 consecutive hills for rodent damage. Count the number of damaged and undamaged tillers on each hill with damage. Ignore counting tillers on hills without damage.

Method 3. Count the number of steps along the length and breadth of the field. Select 5 equidistant transects along the rows of rice, and select 20 equidistant spots along each transect. In each spot, inspect the closest hill for rodent damage. If damage is found, count the number of damaged and undamaged tillers on that hill. Ignore counting tillers on undamaged hills.

Objective: (1) To compare three methods for assessing rodent damage in transplanted aman rice fields.

Method: Three levels of infestation (low, medium, and high) and three distributions (random, slightly clumped, and clumped) of the damaged tillers will be considered in this experiment. A computer will be used to simulate the nine combinations of distribution and infestation levels.

Three sampling methods will be used to collect samples from all these nine situations. From each field, 100 hills will be sampled for each method and for each distribution-infestation level. The whole experiment will be repeated 50 times. The methods are:

Method 1. 2 transects/field, 5 spots/transect, and 10 hills/spot

Method 2. 5 transects/field, 4 spots/transect, and 5 hills/spot

Method 3. 5 transects/field, 20 spots/transect, and 1 hill/spot

Compute damage per field in terms of percent of the cut tillers, using the following formula:

$$\% \text{ damage} = \frac{\text{(Total number damaged tillers x total number of damaged hills}}{\text{(Total number of tillers in damaged hills)}}$$

Statistical analysis: Mean and variance of percent damage for each method will be computed by using SAS software. Methods having higher accuracy and precision will be recommended as the standard method for comparing rodent damage in "contact" and "noncontact" farmers' fields during the 1993 transplanted aman rice season.

Damage levels:

Low	0% to 5%
Medium	>5% to 8%
High	>8%

References

Ahmed, M. S., M. Y. Mian, M. E. Haque, A. B. Siddique, and J. E. Brooks. 1983. Rat damage characteristics and assessment methods in deep water rice. Technical Report. No. 21. Vertebrate Pest Section. Bangladesh Agricultural Research Institute. 23 pp.

Benigno, E. A. 1980. Assessing crop damage caused by small mammals. Pages 139-148 *in* F. F. Sanchez, ed. Proc. Symp. on Small Mammals: Problems and Control. BIOTROP Spec. Publ. 12; Los Baños, Philippines; December 6-8, 1977.

Poché, R. M., M. Y. Mian, M. E. Haque, and P. Sultana. 1982. Rodent damage and burrowing characteristics in Bangladesh wheat fields. J. Wildl. Manage. 46(1):139-147.

SWIMMING ABILITY OF SEVERAL RODENT SPECIES

R. K. Pandit and Y. Mian

Different species of rats with different characteristics are available in Bangladesh. Some are good climbers, some are good swimmers. But we don't know which species are good in swimming and how far they can swim. In fact, swimming ability of rats, especially those which are living in the low-lying areas or deepwater rice growing areas, are really important to know when we are concerned with rodent pest management. How far rats can swim from their nests either from bunds/embankments or from a floating mass is still unknown. No in-depth research or studies have been undertaken so far in Bangladesh. In Pakistan, the lesser bandicoot rat (*Bandicota bengalensis*) has been described as a good swimmer that takes readily to water (Brooks *et al.*, 1990). Posamentier and Elsen (1984) described this species as a good swimmer that sometimes swims more than 500 yards from the nearest dry land in flooded deepwater rice fields.

Objectives:

(1) To determine how far each of three species of rats (*Bandicota bengalensis*, *B. indica*, and *Rattus rattus*) can swim before tiring,

(2) To determine the swimming speed of three species, and

(3) To determine whether males and females differ in how far and how fast they swim.

Materials and Methods:

Four adult males and four females of similar body weight of each species will be fasted for at least 3 hours prior to release individually in the middle of the BARI Lake at Joydebpur, Gazipur. Time and distance traveled until each rat tires and stops swimming will be recorded. A rat will be assumed to be exhausted when it floats without swimming. If a rat moves after being approached by the observer or prodded with a small stick, the second stopping point will be considered the final point for the purposes of our data collection. Direction of travel, wind speed, temperature, time of day, and percent of cloud cover will also be recorded.

References:

Posamentier, H. and A. V. Elsen. 1984. Rodent pests, their biology and control in Bangladesh. Bangladesh-German Plant Protection Programme, DAE, and GTZ. 111 pp.

Brooks, J. E., E. Ahmad, I. Hussain, S. Munir, and A. A. Khan, eds. 1990. A Training Manual on Vertebrate Pest Management. A GOP/USAID/DWRC Vertebrate Pest Control Project, National Agricultural Research Centre, Pakistan Agricultural Research Council, Islamabad. 206 pp.

MAINTENANCE OF BARI/VPS RODENT FACILITIES

Animal room	The Animal room shall be maintained in a clean and orderly condition at all times. Unused items (e.g., empty drums, broken cages) should not be stored in the animal room. The floor shall be swept three times weekly (Saturday, Monday, and Thursday) and mopped with water and a disinfectant (e.g., Clorox) on every Thursday.
Animal care	The general condition and apparent health of all animals shall be checked and recorded when the animals are first brought into the laboratory and thereafter daily. Any animals that appear sick or in pain shall be euthanized unless they must be kept alive for experimental purposes.
Cages	Cages should be scrubbed and disinfected every 2 weeks.
Water bottles	All animals shall have *ad libitum* access to water. Water bottles should be cleaned and disinfected weekly, every Saturday. If it is necessary to use water cups instead of bottles, the water should be changed daily and the water cups cleaned and disinfected weekly, every Saturday.
Food	Laboratory rodent chow should be stored in rodent-proof containers that have lids. Animals not being used in experiments shall have *ad libitum* access to laboratory rodent chow at all times. During experiments, food shall be supplied as specified in the study protocol.
Spillage trays	Spillage trays shall be lined with polyethylene liners and covered with absorbent material such as newspapers or sawdust. The lining should be changed three times weekly (Saturday, Monday, and Thursday) and cleaned and disinfected every 2 weeks. Spillage trays should be cleaned and disinfected every 2 weeks, on the same day that the cages are cleaned.

FINAL REPORT

FY-93 Sabbatical Program
(November 15, 1992 - May 1, 1993)

National Institute of Agricultural Technology (INTA)
Parana, Argentina

Richard L. Bruggers
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USDA/APHIS/ADC
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Unpublished Report

June 3, 1993

OBJECTIVES AND GOALS

"Become more informed on vertebrate pest problems and issues in Latin America and research and management strategies used by INTA to resolve them. The sabbatical would also provide the time to learn Spanish, increase my efficiency on the computer, and possibly conduct cooperative research on bird pest management with INTA scientists."

SPECIFIC REPORTING REQUIREMENTS

1. Skills and knowledge acquired for implementation at DWRC.

   At the beginning of this sabbatical, I had very little experience in word processing and no capability of speaking Spanish. Word processing capability is obviously necessary and Spanish language competency will be very important if DWRC is to be involved in wildlife management issues in Latin America. Latin America appears to be the next geographical focus for programs in wildlife conservation and management, natural resource sustainability, and biodiversity maintenance, all current "catch words" for wildlife planning, research, and implementation activities that can easily involve the expertise of individuals at ADC research and/or operations. Although I need considerably more training in Spanish and word processing, I am now more confident of my abilities to travel to Latin American countries and to prepare documents, both at DWRC and on travel status.

   Before leaving DWRC in November 1992, I was in the process of being appointed as ADC Representative to the International Committee of the Neotropical Migratory Bird Conservation Program and DWRC Coordinator for a Cooperative Agreement between DWRC and INTA; Spanish will be useful in each capacity should these opportunities materialize. Likewise, if I continue to improve my Spanish, it should result in DWRC being able to accept more internationally funded consultancies to Latin American countries.

   I traveled to or visited with INTA researchers in 11 of the country's 24 provinces. I think that I understand INTA's priority wildlife research topics, the areas of expertise of its wildlife scientists, and the geographical locations where cooperative research might be the most interesting and productive from the perspective of DWRC and INTA scientists. I also have a general understanding of basic and applied wildlife research being conducted in selective provinces by University or provincial government scientists. This information should be very beneficial for any continued collaboration in research project development or actual field investigations (Appendix I).

   I also visited the Center of Applied Ecology at the University of Cordoba, and discussed with its Director, Dr. Enrique Bucher,

possibilities of cooperation with DWRC scientists in teaching and graduate student research; he seemed interested in pursuing the idea when he visits the United States in June 1993.

2. Accomplishments relative to objectives and individual development.

All objectives of the sabbatical were achieved to some degree. I have a good understanding of the vertebrate pest and wildlife concerns in Argentina, a knowledge of the individuals and organizations involved, and an idea of current activities and future plans to investigate and/or resolve them. I was able to learn enough Spanish to permit me to communicate during daily living situations as well as to read the many documents and publications referenced in the reports generated during this sabbatical. I used WordPerfect to draft all of my documents. Original field research was conducted on (a) the use of leg streamers to mark blackbirds, a technique not before used in Argentina, and (b) the movements of radio-equipped blackbirds in rice fields. Both studies and another original manuscript detailing current vertebrate pest management (VPM) research in Argentina (Appendix II) will be published. In addition, I (a) completed two manuscripts with Pete Savarie (DWRC) and Tom Fritts (USFWS) on Brown Tree Snakes, (b) prepared a first draft of the 1992 Morocco research report into publication format, (c) assisted INTA in drafting a proposal for funding of research on waterfowl management in Argentina, (d) participated in a 1-week VPM Short Course at the University of Cordoba attended by more than 40 individuals (Appendix III), and (e) reviewed the Ph.D. research progress of both Maria Elena Zaccagnini (Argentina) and Ethel Rodriguez (Uruguay), graduate students for whom I served as a committee member at Colorado State University. Finally, I had time to read a considerable portion of Darwin's "Voyage of the Beagle," a classic book particularly relevant to this region of South America.

3. Possible improvements for DWRC's sabbatic program.

Living and working effectively in a developing country can be a very frustrating or rewarding experience depending upon the amount of advance preparation, and host and home country support. The Agricultural Attache at the American Embassy in Buenos Aires was very helpful in this respect. The importance of these components to successfully accomplishing objectives is particularly evident when one also faces a language barrier. I came to Argentina nearly self-reliant, having brought or shipped in advance nearly everything from pencils, tape, and paper to a computer and research equipment; still I had to have my computer repaired upon arrival and needed access to a printer. Other things that I found unavailable I obtained from IPRS/DWRC after arrival. Many things we take for granted in the United States were very expensive, nonexistent, difficult to find, or in short supply in Argentina.

One thing that would have helped this sabbatic that should be considered by individuals attempting to work in a similar situation in the future is to obtain intensive language training before arrival, or to plan to get it immediately upon arrival before getting too involved in daily living and sabbatical activities. One- to two-month intensive courses are available for new arrivals in many countries, as they are in Argentina. I would also recommend that such sabbaticals not be any shorter than 6 months if one is trying to learn a language; I left at a time when I was just beginning to feel relatively comfortable in communicating. It also is important that the host country individuals and organizations with whom one is working understand the concept of a sabbatical. It is a fairly rare concept in most developing countries, and not all understand it.

4. Host facility and personnel providing training.

I greatly appreciate all the logistical and personal support provided by INTA scientist Maria Elena Zaccagnini and her station Director, Dr. Ruben Moresco. My family and I were provided with a large house on the experimental station just outside of Parana, and it was maintained throughout the entire 6 months. I was provided an office and complete access to the rest of the experimental station. On any number of trips out of Parana, I was provided a driver and often lodging upon arrival at my destination; when traveling alone to other INTA research stations, advance arrangements were always made for me.

We also were graciously accepted into the little community of INTA employees and their families who also lived on the experimental station. As a result, we became involved in a number of rural activities such as celebrating almost any occasion with an *asado*, riding tractors and horses, rounding up and milking cows, butchering pigs, and skinning iguanas to name only a few.

5. Recommendations concerning continued exchange with INTA.

There is considerable interest within INTA not only to continue current informal exchanges with DWRC scientists, but also, as indicated by the proposed Cooperative Agreement, to increase and formalize research and training opportunities into more areas of common interests (Appendix IV). As should be evident from the kinds of vertebrate pest and wildlife research activities going on at INTA and other organizations in the country, many opportunities exist to conduct interesting research directly applicable to the DWRC research agenda. However, whether adapting individual research interest as part of a sabbatical or conducting cooperative research within the framework of the Agreement, it will be necessary that both DWRC and INTA have a clear understanding of the objectives, the necessary logistical and human resource requirements, and the ultimate expectations for successfully implementing them; computer time, technician support, vehicles and operating funds at both DWRC and INTA are generally in short supply.

6. Attachments

Wildlife Research Individuals and Organizations in Argentina
Vertebrate Pest Problems and Research in Argentina
Curso de Posgrado en Manejo de Vertebrados Plaga
Cooperative Research and Training Possibilities

Trip Report*

CHAD RODENT CONTROL RESEARCH AND CLOSEOUT OF THE PROJECT

November 27-December 19, 1992

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Unpublished Report

December 31, 1992

* This work was conducted with funds contributed to the U.S. Department of Agriculture (USDA)/ Animal and Plant Health Inspection Service/Animal Damage Control/Denver Wildlife Research Center by the U.S. Agency for International Development under the "Africa Emergency Locust/Grasshopper Assistance Project," PASA AFR-0517-P-AG-9042-01.

OBJECTIVES

The objectives of this TDY were to (1) take inventory and transfer Project equipment and supplies to the Chad Ministry of Agriculture (MOA), (2) prepare and submit a Project Assistance Completion Report to the U.S. Agency for International Development (USAID), and (3) complete any remaining field and laboratory work of the Project. All objectives were met.

ACTIVITIES

A Project Assistance Completion Report was prepared following USAID guidelines and submitted to AID/N'Djamena (Annex I). This brief document described the progress and status of the Project at the time scheduled for closure. Some lessons learned during the Project were included.

The Project equipment and supplies were inventoried on December 3-4, 1992 (listed in Annex II). The disposition of the items was recommended to USAID and the items marked "To the MOA" were turned over to the Director, Crop Protection, on December 17, 1992. The Director indicated a desire to continue the rodent research and control project as an arm of the Direction de la Protection des Vegetaux (DPV) in their new facility at Farcha. DWRC will be most interested in continuing to work with the DPV. The MOA/DPV submitted a workplan (Annex III) in French for continuing work on rodents. The Project vehicle was given to the MOA with the provision that it continue to be used exclusively for DPV rodent control research.

A field trip to N'Gouri and Karal was made to check on the status of rodent populations. At Karal we found normal rodent activity for this time of year. The unusually dense populations trapped by McConnell *et al.* (1992) were undoubtedly due to the rapid rising of Lake Chad and the concentration of rodents just in front of the advancing flood waters. We examined sweet potato fields; there was no evidence of rodent damage at the early growth stage. Burrows of *Tatera* were found, but they were not unusually abundant.

At N'Gouri the situation with the wadi rodent populations was also normal, but on the dunes there was ample evidence that *Gerbillus* populations were extremely abundant. Burrow mounds were found everywhere in previously cultivated millet fields as well as in noncultivated areas. The growth of grasses and weeds had been prolific, and their abundant seedfall led to prolonged breeding by the gerbils. We counted burrows on 1,000-m^2 (0.1 ha) transects on five dunes (Table 1) and found that the density averaged 725 *Gerbillus* burrows/ha.

Table 1. Mean numbers of *Gerbillus* burrows counted on 4- x 250-m transects on dunes near N'Gouri.

Dune	Transects counted	Mean No. burrows/transect
Oumar	3	65.0
JEB	3	75.7
Kiri Kala	4	71.0
Ghoural	3	70.7
Ygra	2	85.0
Total/Means	15	72.5

To test how many burrows were active, we set 100 snap traps each on three dunes. One team set one trap/burrow; a second team set two traps/burrow. Results indicated that one trap/burrow was almost twice as efficent as two traps/burrow and that about 29% of all trapped burrows contained gerbils. This indicated that there were over 200 *Gerbillus*/ha (29% of 725).

This very high density of gerbils has been reached since breeding started in early August (Table 2). We found the breeding effort was still underway. It was apparent from the animals captured that there were three generations present in December: animals that started the breeding in August, their offspring (born in August/ September), and the offspring produced in November (some from a second litter by the older parents and some from the August/September offspring that had now bred--Annex IV). From all indications, the excellent rainfall which produced the first millet crop in years in the N'Gouri area also produced an excellent grass and weed seed crop that may sustain the gerbils well into the dry season.

Table 2. Breeding in *Gerbillus* from N'Gouri, 1992.

Month	No. females examined	No. visibly pregnant	Percent pregnant	Mean litter size
August	4	2	50.0	4.5
September	9	7	77.8	5.6
October	24	13	54.2	3.8
December	20	5	25.0	3.6

In the wadis, we captured 4 *Arvicanthis niloticus*, 8 *Tatera robusta*, 3 *Taterillus lacustris*, 3 *Mastomys natalensis*, 1 *Xerus erythropus*, and 2 *Crocidura* spp. shrews (Annex IV). In road counts on the night of December 9, we counted only 8 *Jaculus*, 1 immature *Gerbillus*, and 1 *Tatera* in 20 km of road, averaging 0.5 rodents/km. This count is 90% less than that Dolbeer (1992) found in late September. This low count could be attributable to the effect of the full moon, which rose about 2 hours before we began our count.

Specimens and skulls were prepared from 6 *Gerbillus*, 2 *Tatera*, and 2 *Taterillus* for training and species identification.

Food preferences studies were completed by Dr. Maho Angaya and Mr. Djibo Koulangar on four species of rodents: *Tatera*, *Gerbillus*, *Jaculus*, and *Mastomys*. Seven cereals were tested: white sorghum, red sorghum, red-white sorghum, maize, rice, millet, and wheat. These studies will be summarized in a technical report.

ORT (Office for Rehabilitation Through Training) Pitfall Trapping

McConnell (1992) established eight pitfall traps in Ghoural wadi near N'Gouri in October 1992 and hired Mr. Oumar Maddou to record the data weekly of the trap captures. Data were available for a 7-week period (Table 3). Only two lizards and numerous beetles were caught despite the appearance of young *Arvicanthis* and *Taterillus* in the wadis.

Table 3. Weekly captures of animals in pitfall traps at Ghoural.

	Captures			
Date	Rodents	Toads	Lizards	Insects
Oct 27	0	0	0	26
Nov 3	0	0	0	13
Nov 10	0	0	1	51
Nov 17	0	0	0	8
Nov 24	0	0	0	27
Dec 1	0	0	0	16
Dec 8	0	0	1	17
Totals	0	0	2	158

ACKNOWLEDGMENTS

I wish to thank Dr. Maho Angaya and Mr. Djibo Koulangar for conducting the food preference studies during the absence of a project leader. The information gained will be of special value in recommending bait ingredients for field use. I especially appreciate the assistance provided by Mr. Dezoumbe Djonret, Assistant Agricultural Development Officer, in closing out the Project. I extend my warm regards to the rest of the USAID staff at N'Djamena for their able assistance. I greatly appreciate the excellent driving by our chauffeur, Mr. Mahamat El-Hadji N'Gaba.

REFERENCES

Dolbeer, R. A. 1992. Rodent control training and rodenticide field trials in Chad. Unpublished DWRC Trip Report, October 7, 1992. 20 pp.

McConnell, J. E. 1992. Chad rodent research and rodenticide field trials. Unpublished DWRC Trip Report, November 19, 1992. 18 pp.

ITINERARY

Date	Location	Activity
Nov 27-28	Denver, Colorado, to N'Djamena, Chad, Africa	Travel
Nov 29-Dec 18	N'Djamena, Chad	Prepared Project Completion Report, conducted field research, inventoried Project equipment, and closed out Project
Dec 18-19	N'Djamena, Chad, to Denver, Colorado	Travel

PERSONS CONTACTED

USAID

Ms. Anne Williams, AID Representative, Chad
Dr. Tribid Mukherjee, ADO
Mr. Son Nguyen, Project Manager, ADO
Ms. Jerry Penno, EXO
Mr. George Zegarac, Controller
Mr. Dezoumbe Djonret, Assistant ADO
Ms. Lenna Flora, GSO Property Manager
Mr. Rodney Johnson, Regional Legal Adviser, Abidjan
Dr. Maho Angaya, Project Assistant

Ministry of Agriculture

Mr. Mahamat N'Garet, Director of Crop Protection
Mr. Djibo Koulangar, Crop Protection Technician

Agricultural Coperative Development International (ACDI)

Mr. John Smith, Project Leader, N'Djamena

Office for Rehabilitation Through Training (ORT)

Mrs. Wendy Asher, Project Leader, N'Djamena
Mr. Tony Johnson, N'Djamena
Mr. Firmin Mansis, N'Djamena

Annex I.

PROJECT ASSISTANCE COMPLETION REPORT
RODENT CONTROL RESEARCH PROJECT
December 1992

INTRODUCTION

The Sahelian region encompasses about 3 billion hectares (20%) of Africa and includes portions of 8 African countries (Cape Verde, Senegal, Mauritania, Burkina Faso, Mali, Niger, Chad, and Sudan). More than 30 million people inhabit the Sahel; of these, 80% are rural and directly dependent upon agriculture. The Sahel has one of the world's highest growth rates (3-5% per annum); its population is expected to exceed 50 million people by the year 2000. The Sahel once was a major food-producing area for northern Africa, but it is now a food-deficit region due to droughts and, among other reasons, crop depredations by birds, rodents, and insects.

Lack of Knowledge

In 1986 several Sahelian countries declared national disasters due to massive outbreaks of rodents. USAID was hampered in providing assistance due to a lack of knowledge of the rodent species concerned, their population dynamics, and effective control measures. Short-term technical assistance was provided by the USDA/APHIS/Denver Wildlife Research Center in the form of 8 TDY's to the Sahel between April 1 and November 10, 1987. The crisis response was inadequate due to poor organization in crop protection and lack of trained in-country personnel, materials, transportation, and time in which to implement needed control measures. To ensure the implementation of effective crop protection measures in the future, it was felt essential to conduct research into rodent biology and control methods; therefore, research was initiated in Chad to monitor rodent populations, evaluate control techniques, and train crop protection personnel to effectively address future recurring rodent population irruptions, such as occurred in 1962, 1975-76, and 1986-87 in the Sahel.

Project History

Two research sites were selected for detailed studies: a recessional crop area near Karal and a dune and wadi agricultural area around N'Gouri. Field work on the Chad Rodent Control Research Project (RCRP) was begun in October 1989. Monitoring of rodent populations was carried out monthly by snap-trapping on transects. The resident Project Leader, Dr. J. Juan Spillett, arrived in N'Djamena in July 1990. Dr. Spillett and his family were evacuated in early December 1990 due to a coup d'etat in Chad. Spillett returned to the Project in mid-March 1991. In

December 1991, Spillett resigned his position and returned home. No field work was done from December 1991 until August 1992. Beginning in mid-August 1992, four one-month TDY visits were carried out until mid-December 1992, when the Project was closed out.

OBJECTIVES

The Project objectives as given in the PASA are to:

(1) Begin to determine the life cycles of the major rodent pests of the Sahel;

(2) Evaluate the efficacy and appropriateness of control methods; and

(3) Prepare training materials on rodent biology and control for use by the Ministry of Agriculture's (MOA) crop protection personnel.

EXPECTED OUTPUTS

(1) A prioritized list of preharvest rodent problems in Chad, according to their nature, extent, and importance.

(2) An initial methodology to assess crop loss due to rodents in vegetable and recession crops.

(3) A report in French and English on comparative, replicated laboratory and/or field trials of rodenticides or control techniques.

(4) A draft training manual on rodent biology and management.

(5) A regional training workshop for at least 15 participants.

(6) Monthly progress reports submitted to ADO/AID/N'Djamena and USDA/OICD.

EXPECTED INPUTS

(1) A resident Project Leader for at least 2 years of the Project life.

(2) Qualified and experienced counterpart personnel appointed by the MOA/DPV who could be trained to assume the responsibilities of the rodent research Project when USAID funding ends.

(3) A qualified USAID Personal Service Contract (PSC) Project Assistant with a degree in Biology.

(4) A reasonably well-equipped office/laboratory facility in which to carry out the laboratory research of the Project.

PRESENT STATUS OF THE PROJECT

- Procurement: This element is completed. DWRC purchased over $14,000 in equipment and supplies, and all have been received by the Project in Chad.

- Construction: The Project occupied an office and laboratory space in September 1990. The Project needed an animal housing facility but never acquired one at the present space. New offices have been constructed at Farcha to house the rodent control unit but are not yet occupied. An old building at Farcha could be remodeled as an animal facility if some funds were available. After completion of the move to Farcha, this element will have been 90% completed.

- Technical Assistance: DWRC provided Technical Assistance in a resident biologist, Dr. J. Juan Spillett, from July 1990 until his resignation in December 1991. During the time no resident was present, DWRC provided 7 man-months of TDY assistance. DWRC further provided three 1-month TDY's during the time the Project Leader was resident to assist him in special studies of rodents and to provide training to counterparts. DWRC provided back-up assistance in procuring supplies and equipment, on literature searches, preparation of a draft training manual, preparation of four technical reports (Attachment 1), and statistical analysis of the trapping data.

- Training: DWRC provided training at two workshops. A 2-day seminar was given in November 1990 to 18 participants from the Ministry, NGO's, and PVO's. A 5-day seminar was presented in September 1992 to 15 participants from the Ministry, NGO's, and PVO's. A 110-page draft training manual was prepared, translated into French, and given to the participants at the September 1992 seminar (Attachment 1). Fourteen issues of "Rat Facts," in English and French, were prepared and distributed (Attachment 1). The resident biologist and the TDY biologists have given training to counterpart staff in rodent identification, specimen preparation, population monitoring methods, toxicity determinations, rodenticide field trials, and collection of population biology data. This element has been 100% completed.

- Inventory: A physical inventory of the Project equipment and supplies was carried out on December 3-4, 1992, at the storage at USAID annex and at the Project's Ministry offices. All items except for a pair of binoculars were accounted for (listing in Annex II). It is recommended that all items be turned over to the MOA/DPV for continued use in their program.

A BRIEF REVIEW OF PROJECT ACCOMPLISHMENTS

- The Project determined that the important rodent species in the Chadian Sahel were the unstriped grass rat (*Arvicanthis niloticus*) and the multimammate rat (*Mastomys natalensis*) along with several species of gerbils that occurred in the same cultivations: the small sand rat (*Gerbillus agag*), the Lake Chad gerbil (*Taterillus lacustris*), and the fringe-tailed gerbil (*Tatera robusta*). On the dunes in millet cultivation, *G. agag* predominated, along with the jerboa (*Jaculus jaculus*). These rodents breed after the beginning of the rainy season, usually in early August through November, in response to the greening of the vegetation and the setting of seed by the grasses and weeds. As the long dry season sets in, they stop breeding and begin their long quest for survival until the next rains.

- In studies testing the toxicity and efficacy of rodenticides against these several rodent species, it was determined that 1% zinc phosphide and 0.005% chlorophacinone and bromadiolone are all effective poisons to use. Studies of the rodents' preferences for baits revealed that millet was preferred by gerbils and the unstriped grass rats, while the multimammate rats preferred rice. The addition of 1 to 2% peanut oil improved the consumption of baits.

- Formal training was given to 33 participants in two workshops/seminars. A draft training manual in English and French was prepared (Attachment 1). Four technical reports were issued, along with 14 issues of "Rat Facts." Two project progress reports were prepared and submitted.

AN ASSESSMENT OF THE EXTENT TO WHICH THE PROJECT HAS RESOLVED OR IS RESOLVING THE ORIGINAL PROBLEM

This has been a difficult project. Project continuity was interrupted for 4 months beginning in December 1990 with the evacuation of the Project Leader and his family due to political instability. The resident Project Leader resigned his position in December 1991. Project activities virtually stopped for 8 months. They were resumed with a series of four TDY visits between mid-August and mid-December 1992, when the Project was closed down. This lack of project continuity made it extremely unlikely the original objectives and outputs could be met.

Because of persistent drought during the period 1990 and 1991, rodent populations were low in the Project sites. On resumption of the Project activities in August 1992, we found that rodent populations were increasing to levels first seen in October 1989, due to abundant rainfall in 1992. This encouraged us to try to meet the originally proposed outputs.

Despite the loss of 12 months of activity, all but one of the original outputs have been met. (1) The major rodent pest species have been identified and the crops they potentially damage have been prioritized, (2) a report on the comparative, replicated laboratory and field trials of the toxicity and efficacy of rodenticides was

issued, (3) a technical report on the food preferences of Sahelian rodents was prepared, (4) a draft training manual on rodent biology and management was written and translated into French, (6) training was presented in two seminars for 33 Chadian participants, and (7) monthly trip reports have been provided to AID/N'Djamena and USDA/OICD. Only the output on an initial methodology to assess crop losses in vegetable and recession crops due to rodents has not been produced, mainly because of very low rodent populations during most of the life of the Project.

The Project has not resolved the issues confronting the country regarding inadequate organization in crop protection and lack of materials and transportation to organize a proper response to outbreaking rodent populations. These issues lie beyond the Project's responsibilities. What the Project did resolve was the issue of training Chadian crop protection personnel in rodent management methods and how to monitor rodent populations in order to predict outbreaks. Recommendations were made concerning baits and rodenticides to use in times of peak populations and the usefulness of trapping as an alternative control method.

DEFINITION OF CONTINUING AND/OR POST-PROJECT USAID MONITORING RESPONSIBILITIES

The Ministry of Agriculture's (MOA) Direction of Crop Protection will take over the functions and responsibilities of the rodent research and control program at the conclusion of the USAID-funded Chad Rodent Control Research Project. The Project will occupy new offices at Farcha shortly. USAID and DWRC should do a followup evaluation of the MOA's rodent control program within the first year after the end of USAID funding. This would involve a 1-month TDY visit by a DWRC biologist. DWRC is interested in extending program advice, providing literature on request, and sending training materials in French when these are completed.

A REVIEW OF DATA COLLECTION RESULTS AND EVALUATIONS REMAINING TO BE UNDERTAKEN

The damage assessment evaluations to vegetable and recessional crops by rodents remains to be done. Suggested methodologies are given in the draft training manual. These essentially will have to be done by the crop protection technicians of the MOA/DPV.

Rodent population monitoring, using simple methods such as (1) inked tracking tiles laid in straight lines at 10-meter intervals in wadis and dunes in cultivated and noncultivated areas, (2) evening road counts of rodents seen per kilometer, (3) burrow counts on transects on dunes, and (4) snap trapping of rodents for reproductive data, should continue to be done in the N'Gouri and Karal areas by DPV personnel.

LESSONS LEARNED

Language: Neither reading nor speaking French, the local language, was a serious disadvantage for the resident project leader and consulting biologists provided by the DWRC. In the future, local language proficiency should be required for any resident project leader. Even for short-term assignments, it would prove beneficial.

Institution-building: When the host country ministry assigns only technicians to work as counterpart staff, it is difficult to build institutionalization into the Project. What is needed is counterpart staff with qualified biological experience and education so they can absorb the training and build a continuing local-based program.

Rodent population monitoring: The Project relied mainly upon snap trapping on transects as the method of rodent population monitoring. Later experience has shown that several methods should be used in conjunction with each other. Burrow counts on transects, along with snap trapping, are probably the best for monitoring *Gerbillus* populations. Road counts at night are best for monitoring *Jaculus* populations since these rodents rarely come into traps. Tracking tiles and snap or live-trapping are best for monitoring *Arvicanthis*, *Mastomys*, *Tatera*, and *Taterillus* populations.

Chad Rodent Control Research Project Reports, Training Manual, and "Rat Facts"

Technical Reports

No. 1. A preliminary research bibliography of rodent pests of the Sahel, Africa. November 1991.

No. 2. Preference by the Nile rat (*Arvicanthis niloticus*) for five cereal grains and two oil additives. February 1992.

No. 3. The toxicity and efficacy of several rodenticides to Sahelian rodent species in Chad. November 1992.

No. 4. Prediction and monitoring of rodent abundance in agricultural areas of Chad, Africa. December 1992.

Training Manual

Les reserches et la lutte contre Rongeurs: Manual de la Formation. September 1992. 110 pp. (French version). Training Manual: Rodent research and control. September 1992. 90 pp. (English version).

"Rat Facts" (English and French)

No. 1. The Sahel and rodents. September 1990.
No. 2. Rodent pests in the Sahel. November 1990.
No. 3. Rodent population dynamics. March 1991.
No. 4. Assessing crop losses to rodents. April 1991.
No. 5. Rodent pests in Africa. May 1991.
No. 6. Rodents and disease. June 1991.
No. 7. The unstriped grass rat. July 1991.
No. 8. Cricetid rodents and the genus *Gerbillus*. August 1991.
No. 9. Rodent control. September 1991.
No. 10. The "sand" gerbil (*Gerbillus andersoni*) of Sahelian Chad. October 1991.
No. 11. The multimammate rat--Africa's most common rodent pest. November 1991.
No. 12. Bait preference by the Nile rat. December 1991.
No. 13. Prevention is better than cure. January 1992.
No. 14. Habitat and food habits of the unstriped grass rat and gerbil. February 1992.

Scientific Manuscripts

Notes on the breeding of *Gerbillus agag* in the Sahel, Chad. (In preparation).

Notes on the occurrence of the Lake Chad gerbil at N'Gouri, Beltram, and Guitè, Chad. (In preparation).

Physical Inventory of the Chad Rodent Control Research Project Equipment, Supplies, and Furniture, December 3-4, 1992

Item Description	S. N.	Model	Source	Quant.	Recomm. disp.
Rangefinder	N/A	# 1200	DWRC	1	To the MOA
Rangefinder carrying case	N/A	# 1200	DWRC	1	" " "
Rolatape	N/A	394	DWRC	1	" " "
Refrigerator, Vehicle	N/A	--	DWRC	1	" " "
Respirator, Comfo	N/A	--	DWRC	4	" " "
Respirator filters	N/A	--	DWRC	4	" " "
Dissecting pans	N/A	--	DWRC	2	" " "
Dissecting kits	N/A	--	DWRC	8	" " "
Spring scale, heavy	N/A	--	DWRC	1	" " "
Spring scale, all-duty	N/A	--	DWRC	1	" " "
Transformer, 1,000 kw	N/A	10F1009	DWRC	1	" " "
" " "	N/A	10F1008	DWRC	1	" " "
Transformer, 500 kw	N/A	10F1009	DWRC	1	" " "
Calipers, dir. reading	N/A	--	DWRC	2	" " "
Cylinder, grad. 25 ml	N/A	--	DWRC	2	" " "
Cylinder, grad. 100 ml	N/A	--	DWRC	2	" " "
Cylinder, grad. 500 ml	N/A	--	DWRC	2	" " "
Balance, electronic	2530	Ohaus	DWRC	1	" " "
Balance, electronic	2858	Ohaus	DWRC	1	" " "
Weight set, metric	N/A	Ohaus	DWRC	1	" " "
Camera, Minolta	2835432	X700	DWRC	1	" " "
" lens, 50 mm			DWRC	1	" " "
" " telephoto	11686225	--	DWRC	1	" " "
Flash, Minolta	4102994	320	DWRC	1	" " "
Forceps, tissue, 10"	N/A	--	DWRC	2	" " "
Forceps, dissecting, 6"	N/A	--	DWRC	3	" " "
Forceps, curved, 4.5"	N/A	--	DWRC	3	" " "
Funnel, polypropylene	N/A	--	DWRC	1	" " "
Video camera, JVC	09500416	GR60	DWRC	1	" " "
Video cam carrying case	N/A	--	DWRC	1	" " "
Filter, pocket, KATADYN	F01070	--	DWRC	1	" " "
Filter, replacement cartridge		--	DWRC	1	" " "
Calculator, TI Scientific		--	DWRC	1	" " "
Bottles, water	N/A	--	DWRC	36	" " "
Tubes, water, ball-point	N/A	--	DWRC	36	" " "
Holders, water bottles	N/A	--	DWRC	36	" " "
Chain, tow	N/A	--	DWRC	1	" " "
Hose, garden	N/A	--	DWRC	2	" " "
Cable, towing	N/A	--	DWRC	1	" " "
Smoke alarms	N/A	--	DWRC	2	" " "
Screwdriver, rechargeable	N/A	--	DWRC	1	" " "
Drill, rechargeable	N/A	--	DWRC	1	" " "

Item Description	S. N.	Model	Source	Quant.	Recomm. disp.
Books:					
Kingdon, East African Mammals			DWRC	1	To the MOA
Rosevear, Rodents of W. Africa			DWRC	1	" " "
Happold, Mammals of Nigeria			DWRC	1	" " "
Bruggers, Quelea quelea			DWRC	1	" " "
Meehan, Rats and mice			DWRC	1	" " "
Dorst & Dandelot, Field guide to larger African Mammals			DWRC	1	" " "
Collins Field Guide to Birds of West Africa			DWRC	1	" " "
Pliers	N/A	--	DWRC	1	" " "
" , needle-nose	N/A	--	DWRC	1	" " "
Tin snips	N/A	--	DWRC	1	" " "
Wrench, adjustable	N/A	--	DWRC	1	" " "
Air compressor, tire	N/A	--	DWRC	1	" " "
Chest, ice	N/A	--	DWRC	1	" " "
Shovel	N/A	--	DWRC	1	" " "
Rake	N/A	--	DWRC	1	" " "
Syringes, disposable	N/A	--	DWRC	4 boxes	" " "
Needles, syringe	N/A	--	DWRC	4 boxes	" " "
Traps, assorted rat & mouse		--	DWRC	24 boxes each	" " "
Saw, bone	N/A	--	DWRC	1	" " "
Tape, plastic, colored	N/A	--	DWRC	15 boxes	" " "
Tarpaulins, plastic	N/A	--	DWRC	3	" " "
Coats, laboratory	N/A	--	DWRC	4	" " "
Bottles, plastic w caps	N/A	--	DWRC	6 boxes	" " "
Charger, battery	N/A	Schumacher	DWRC	1	" " "
Calculator, desk, elec.	N/A	# 121	DWRC	1	" " "
Animal choker, pole	N/A	--	DWRC	1	" " "
Gloves, disposable	N/A		DWRC	3 boxes	" " "
Scales, spring, Pesola	N/A	--	DWRC	12	" " "
Rack, drying, plastic	N/A	--	DWRC	1	" " "
Vials, assorted plastic	N/A	--	DWRC	4 boxes	" " "
Bags, plastic, assorted	N/A	--	DWRC	2 boxes	" " "
Aprons, lab	N/A	--	DWRC	2	" " "
Misc. office supplies	N/A	--	DWRC		" " "
Specimen boxes, wood	N/A	--	USAID	2	" " "
Multiple outlet, elec.	N/A	--	DWRC	2	" " "
Rope, nylon, 100 ft.	N/A	--	DWRC	2	" " "
Caulking gun	N/A	--	DWRC	2	" " "
Caulking, silicon	N/A	--	DWRC	6 tubes	" " "
Siphon, gas	N/A	--	DWRC	1	" " "
Cassettes, video TC20	N/A	--	DWRC	6	" " "
Cassette, video, TC10	N/A	--	DWRC	1	" " "
Film, 35 mm, Kodak	N/A	--	DWRC	9 rolls	" " "

Annex III.

RECEIVED AID / CHAD
Date DEC 11 1992

698-0517

REPUBLIQUE DU TCHAD
MINISTERE DE L'AGRICULTURE
DIRECTION GENERALE
DIRECTION DE LA PROTECTION DES VEGETAUX ET DU CONDITIONNEMENT

N° 1977 /MA/DG/DPVC/92

* Unité - Travail - Progrès *

N'Djaména, le 08 DEC. 1992

LE MINISTRE DE L'AGRICULTURE

A

Son Excellence Madame la représentante de l'USAID

N'DJAMENA

Action: ~~ADO~~
Date: 12/11 Due: 12/22
Info: Palma, ~~[illegible]~~ Mahu
Action taken:

J'ai l'honneur de vous rappeler que par lettre N° 984/MA/DG/DPVC/92 en date du 28-08-92 dont copie ci-jointe, mon département avait exprimé son désir de voir le projet sur la recherche et la lutte contre les rongeurs poursuivre ses activités sous le contrôle de la Direction de la Protection des Végétaux et du Conditionnement. Depuis quelques temps des messages parvenus de la région du Ouaddaï font état d'une recrudescence des rongeurs. Les responsables actuels du projet ne pourront pas s'y rendre en raison de l'approche de la date annoncée pour la fin du projet. Monsieur DJIBO KOULENGAR qui travaille déjà dans le projet sera appuyé par d'autres agents de la Direction de la Protection des Végétaux et du Conditionnement pour mener à bien les travaux.

Un local est déjà mis à la disposition du projet dans l'enceinte de la Direction de la Protection des Végétaux et du Conditionnement à Farcha. Aussi, pour permettre à l'équipe de pouvoir continuer normalement les activités, je vous saurais gré de bien vouloir mettre à la disposition de la Direction de la Protection des Végétaux et du Conditionnement le véhicule dudit projet.

J'ose espérer que cette requête trouvera un écho favorable auprès de vous et vous remercie d'avance des dispositions que vous voudriez prendre pour autoriser la mise à la disposition de ce véhicule à la Direction de la Protection des Végétaux et du Conditionnement.

Je vous prie de croire Madame la représentante, à l'assurance de ma considération distinguée./.-

BAMBE DANSALA

REPUBLIQUE DU TCHAD

UNITE - TRAVAIL - PROGRES

MINISTERE DE L'AGRICULTURE

DIRECTION GENERALE

DIRECTION DE LA PROTECTION DES VEGETAUX

ET DU CONDITIONNEMENT

PLAN DE TRAVAIL DE CONTINUATION

DE PROJET RONGEURS SUR UNE ANNEE

INTRODUCTION

Au cours da la période de recherche de terrain d'Août 1989 à Décembre 1991 (27 mois) à NGOURI et d'Août 1990 à Décembre 1991 (17 mois) à KARAL, le Projet de Recherche sur les Rongeurs au Tchad avait capturé 943 rongeurs dont 96 à KARAL (dans les cultures de décrue) et 847 à NGOURI (dans les Ouaddis et sur les dunes) (J.Spillett 1991; Progress Report 1989-1991; MAHO A 1992; Rapport Trimestriel du 11 Novembre 1991 - 17 Février 1992).

De Janvier à Juillet 1992, aucune activité de terrain n'a été effectuée à défaut du Chef de Projet. D'Août à Novembre 1992, les activités de terrain et de laboratoire ont repris grâce à trois missions successives de biologistes de Denver (JOE BROOKS en Août - Septembre; RICHARD DOLBEER en Août - Septembre et JOHN MCCONNELL en Octobre - Novembre).

Au cours de cette période d'Août à Novembre (4mois), 225 rongeurs ont été capturés dont 68 à KARAL et 187 à NGOURI soit plus d'un tier des captures effectuées sur 27 mois (JOE BROOKS, 1992, Trip Report, Chad Rodent Project, Administration, Researche and Training; RICHARD DOLBER 1992; trip Report: Rodent Control Training and Rodenticide Field Trial in Chad, et JOHN MCCONNELL 1992; Trip Report; CHAD Rodent Research and Rodenticide Fiel Trials).

On remarque qu'il ya augmentation de la population. Cela nécessite donc une surveillance encore plus rigoureuse. Malheureusement, ce Projet arrive à la durée prévue, doit cesser ses activités en Décembre 1992.

Ainsi, compte tenu des résultats actuels de piégeages montrant l'augmentation sensible de la population des rongeurs dans les sites de recherche, le Ministère de l'Agriculture est obligé de continuer les travaux de terrain pour cerner les populations de rongeurs non seulement dans les anciens sites mais aussi dans d'autres régions qui ont fait l'objet des attaques en 1987.

Cette surveillance permettra au Ministère de prévenir les erruptions de populations de rongeurs et donc de limiter les dégâts agricoles. En même temps, la surveillance dans les autres zones permettra de connaître les espèces nuisibles. La surveillance dans les anciens sites de recherche et les zones attaquées en 1987 se fera selon un plan de travail suivant:

I- AU NIVEAU DES BASES

a)- Formation des Chefs de bases:

Tous les Chefs de bases des zones exposées ou ayant fait l'objet d'attaque en 1987 seront formés dans le domaine des tecxhniques de piégeages et de préparation des spécimens. La formation pourra être assurée par MAHO ANGAYA et DJIBO KOULENGAR pendant 2 à 3 jours.

b)- Distribution des piéges:

200 à 400 piéges seront ensuite distribués à chaque Chef de base qui pourra piéger 2 à 5 jours par mois dans sa zone.

II- EQUIPE DE N'DJAMENA

DJIBO KOULENGAR, spécialiste dans le domaine de rongeurs, renforcés par d'autres agents, auront pour tâche:

a)- Travail de laboratoire:

- Analyse des données collectées:
- Préparation du matériel de lutte;
- Autres travaux.

b)- Surveillance générale de la population:

Cette équipe effectuera une fois tous les deux mois une sortie dans les différentes bases pour colleter les données et vérifier les piégeages effectués par les Chefs de bases. Elle procédera à un piégeage maximum de 3 jours pour vérifier les techniques utilisées par les Chefs de bases de différentes zones sensibles. Les espèces inconnues ou nouvelles seront ramenées au laboratoire en vue de leur identification ultérieure.

c)- Surveillance spéciale:

L'équipe de N'Djaména effectuera presque chaque mois le piégeage dans les anciens sites de KARAL et NGOURI afin de comparer l'évolution de la population de ces zones avec les autres. La durée de voyage n'éxcedera pas 5 jours (avec 3 jours à NGOURI et 2 jours à KARAL). Des piégeages se feront dans les lieux habituels: sur les dunes et dans les Ouaddis à NGOURI, dans les cultures de décrue à KARAL.

Les différentes méthodes de piégeage seront utilisées: carreaux de marqueurs, piéges à jarres, tapettes, piéges à captures vivantes.

Les appâts utilisés tiendront compte des résultats de préférence alimentaire effectuée au laboratoire. L'usage d'appât variera en fonction de l'écologie, habitat et l'espèce associée.

NB: Au niveau de chaque base, l'usage d'appât sera fonction de l'espèce.

III - DETAIL DU PLAN DE JANVIER - DECEMBRE 1993

a)- Formation et distribution de piéges: Janvier 1993:

- préparation et formation de Chef de bases dans le domaine de technique de capture et méthodes de préparation de spécimens.
- Distribution des piéges aux Chefs de bases.

b)- Suivi de la population des rongeurs par l'équipes de N'Djaména:

1er - 5 Février:	Piégeage à NGOURI et KARAL
1er - 5 Mars:	Piégeage à NGOURI et KARAL
1er - 15 Avril:	Contrôle général.

Deux ou trois bases peuvent être visitées au cours de ce voyage. Un à trois jours de piégeage peuvent être effectués pour vérifier et comparer les différentes méthodes et résultats.

15 - 30 Avril:	Analyse et comparaison de différents résultats des zones.
1er - 5 Mai:	Voyage à NGOURI et KARAL
1er - 5 Juin:	Voyage à NGOURI et KARAL
1er - 15 Juillet:	- Voyage de contrôle général - Formation ou sensibilisation des paysans de chaque zone exposée - Recherche et description des origines de dégâts agricoles (semences)
15 - 30 Juillet:	Analyse et comparaison des résultats
1er - 5 Août:	Voyage à NGOURI et KARAL
1er - 5 Septembre:	Voyage à NGOURI et KARAL
1er - 15 Octobre:	- Voyage de contrôle général - Vérification et contrôle des données - Recherche des origines des dégâts (récoltes)
15 - 30 Octobre:	Analyse et comparaison des données
1er - 5 Novembre:	Voyage à NGOURI et KARAL

1er - 5 Décembre:	Voyage à NGOURI et KARAL
6 - 30 Décembre:	Analyse de toutes les données

REMARQUES

Au cours de suivi de la population des rongeurs, des mesures de luttes pourront être envisagées en fonction des activités ou indice de la population.

Measurements of rodents trapped at N'Gouri, December 1992

Species	Sex	Wt.	HBL	Tail	H.F.	Ear	Remarks
Trapped on dunes							
Gerbillus agag:							
Animals present in August (6)							
	M	33	98	125	26.5	14.5	Scrotal
	F	30	100	114	25	-	2 sets scars
	F	31	102	110	25	14	Preg + 1 set scars
	F	30	105	123	26	16	2 sets scars
	F	34	102	131	25	14.5	Preg + 1 set scars
	M	34	101	121	26	16	Scrotal
Animals born in August/September (39)							
	M	31	101	121	26	13	Scrotal
	M	31	101	126	26	14.5	"
	M	30.5	100	115	25	16	"
	M	29.5	90	130	26	16	"
	M	28.5	95	130	26	16	"
	M	27	101	123	25	-	"
	M	27	95	113	25	14	"
	M	27.5	95	125	25	16	
	M	26	95	123	26	16	
	F	28	99	128	25	-	1 set scars
	F	31	94	122	25	15	1 set scars
	F	23	92	112	24	13	1 set scars
	F	20	90	125	24	13	1 set scars
	F	27	90	117	25	14	1 set scars
	F	25	97	120	26	-	Preg no scars
	F	22	93	121	25	14	1 set scars
	F	24	93	121	25	-	1 set scars
	F	25	87	115	25	14.5	1 set scars
	F	24	97	130	26.5	-	1 set scars
	F	25	93	122	26	-	Preg no scars
	F	25	95	122	25	13	No scars
	F	20	93	128	26.5	-	No scars
	F	23	98	127	25	14	1 set scars
	F	23.5	92	111	25	15	Preg no scars

Species	Sex	Wt.	HBL	Tail	H.F.	Ear	Remarks
	F	22.5	80	110	26	16	
	F	20.5	90	110	25	U	
	F	21.5	85	108	25	14	
	F	24	95	110	23	13.5	
	M	22	90	121	26	15	
	M	22.5	90	112	25	15	
	M	20.5	90	110	26	15	
	M	24	95	117	25	U	
	M	22	90	110	24	15	
	M	24	90	115	25	16	
	M	23	80	110	26	15	
	M	22	80	108	25	15	
	M	25	90	114	25	14	
	M	23	91	117	26	12	
	U	20	88	114	25	14	
		Animals born in November (21)					
	F	17	90	108	26	15	
	F	16.5	80	110	24	U	
	F	17	80	106	25	15	
	F	19.5	85	104	23	14	
	F	17	80	110	23	15	
	F	18	89	114	25	14	
	F	14.5	80	95	25	14	
	F	12.5	75	85	22	U	
	U	13	78	92	24	13	
	F	U	70	95	24	U	
	M	15	80	110	25	14	
	M	17	80	106	25	15	
	M	16.5	80	97	26	15	
	M	16.5	80	115	25	15	
	M	17.5	80	112	24	15	
	M	18.5	90	120	25	14	
	M	18.5	85	105	26	15	
	M	10.5	65	80	25	14	
	M	10	65	70	23	14	
	F	U	70	92	24	15	
	F	U	75	95	25	U	

Species	Sex	Wt.	HBL	Tail	H.F.	Ear	Remarks
				Trapped in Wadis			
Arvicanthis niloticus:							
	M	136	150	140	32	18	
	F	90	145	125	33	17	
	M	74	140	-	25	15	
	M	40	110	95	25	14	Immature
Tatera robusta:							
	F	80	140	172	37	18	
	M	72	140	165	36	18	
	M	58	137	140	35	16	
	F	U	U	115	32	U	
	F	U	U	140	30	18	
	U	U	135	165	40	20	
	F	73	144	160	40	21	
	M	84	149	187	40	22	
Taterillus lacustris:							
	M	48	127	152	35	18	
	M	62	141	165	35	20	
	F	U	U	U	U	U	
Mastomys natalensis:							
	M	42	115	125	25	19	
	M	24	95	105	20	16	Immature
	M	26	100	110	22	16	"
Crocidura sp.:							
	F	12	85	55	17	10	
	F	14	90	55	15	9	

Trip Report*

REVIEW OF PREHARVEST RODENT CONTROL IN BANGLADESH

February 14-March 8, 1993

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ITINERARY

Date	Location	Activity
Feb 14-16	San Francisco, California, to Dhaka, Bangladesh, via Bangkok, Thailand	Travel
Feb 16-Mar 7	Dhaka, Bangladesh	Consulted with officials at the Agency for International Development (AID)/Dhaka, Bangladesh Agricultural Research Council (BARC), and Bangladesh Agricultural Research Institute (BARI) regarding the status of the annual National Rodent Control Campaign; prepared an analysis of the various rodenticides available to Bangladeshi farmers; and assisted BARI in developing a sampling scheme to better evaluate effectiveness of the campaign.
Mar 7-8	Dhaka, Bangladesh, to San Francisco, California, via Bangkok, Thailand	Travel

EXECUTIVE SUMMARY

The successful implementation of the preharvest rodent control technology in rice in Bangladesh has not been realized due, in large part, to the unavailability of pre-formulated, effective, and inexpensive rodenticidal baits that farmers could use.

Secondly, a meaningful monitoring program has not been developed to evaluate the farmers' effective use of technology at the time of the annual rodent control campaigns. Recommendations addressing these two issues are presented.

OBJECTIVE

The overall objective of this TDY was to review the status of the annual National Rodent Control Campaign in Bangladesh and to recommend measures to improve its effectiveness. Special attention was given to (1) determining which rodenticides are available to Bangladeshi farmers, and (2) assisting BARI with developing a sampling scheme to monitor the effectiveness of the campaign.

BACKGROUND

The principal vertebrate pest problem in Bangladesh is that of preharvest rodent damage to rice and wheat. The focus of research during my term in Bangladesh (1986-1990) was to resolve this problem. The following sequence of steps was used for this purpose:

1. Define the problem (i.e., pest species, damage levels).
2. Develop a strategy of selective annual control (i.e., season and crop type on which to focus).
3. Identify the most appropriate and environmentally responsible control methods (i.e., rodenticides).
4. Test the efficacy of the above and make modifications as necessary (i.e., farmer acceptability.
5. Implement the technology through the Ministry of Agriculture's (MOA) Department of Agricultural Extension (DAE) in coordination with the Vertebrate Pest Section (VPS) at BARI.

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The first four steps had been completed by the time of my departure in September 1990. At that juncture it was mutually agreed upon among AID/Dhaka, DWRC, BARC, and BARI that emphasis should be given to completing Step 5 during the ensuing TDY phase of this project (September 1990-June 1993). The DAE conducts a National Rodent Control Campaign annually. The annual campaigns of 1991 and 1992 followed recommendations developed by USAID/DWRC/BARI research:

- Focus control during the aman rice growing season.
- Target burrowing rodents in farmers' fields at or before the flowering stage of maturity (mid-September to mid-October).

Problems that have not yet been solved include (1) lack of availability of an effective rodenticidal bait, and (2) lack of a meaningful monitoring program to evaluate the effectiveness of the campaign.

RODENTICIDE AVAILABILITY

The successful implementation of the preharvest rodent control technology has not been realized due, in large part, to the unavailability of a pre-formulated rodenticide bait that requires only a single application. The rodenticides presently registered for use in Bangladesh are described below:

Zinc Phosphide

Commercial Origin

- Zinc phosphide is imported by Agrani Traders (Mautail, Mrida Bari, Dhaka) from United Phosphorus LTD., Bombay, India.

Formulation

- The toxicant is imported as a concentrate (80% a.i.) in powder form and has traditionally been marketed unformulated with a small amount in a paper packet, often with no instructions on how to formulate it.

- Proper formulation is essential for effectiveness.

- The most effective concentration is 2%. If higher, rodents detect presence of the toxicant and avoid it.

- A 1-g bait cake (2% a.i) is sufficient to kill burrowing rodents (*Bandicota* spp.).

- Farmers and local extension agents generally do not appreciate these concepts of concentration and dosage.

- Zinc phosphide degrades rapidly under the humid conditions existing in Bangladesh. Commercially available packets of raw zinc phosphide were chemically analyzed at the DWRC in 1989. Most had degraded significantly, making proper formulation by farmers impossible. A number of samples had no detectable amounts of zinc phosphide. Some of these samples were obvious substitutes and adulterants.

Application

- A single application of 1 bait/burrow system is sufficient.

- The 1-g bait cake should be inserted into the most recently excavated tunnel entrance of a burrow system and the entrance hole replugged. This reduces the chances of nontarget wildlife ingesting the poison.

- Zinc phosphide-treated bait cakes are best used only once a year, but in conjunction with the National Rodent Control Campaign in September-October. If used repeatedly, rodents develop "bait shyness"; then the rodenticide becomes ineffective.

Cost

- Zinc phosphide bait cakes are the most cost-effective of rodenticides registered for use in Bangladesh. A single bait cake can be made for less than 0.05 taka.

- In the past, farmers have eagerly purchased bait cakes made by the USAID/DWRC/BARI Project, because farmers were confident in the quality of these bait cakes.

Current Status

- In 1990 the MOA/DAE, which regulates pesticide use, restricted the sale of zinc phosphide to the extent it could only be sold in formulated baits.

- Retailers, however, have not been interested in formulating the baits, complaining that zinc phosphide degrades too rapidly.

- Consequently, zinc phosphide bait cakes have not been available to Bangladeshi farmers.

- The MOA/DAE is now reviewing an application by Agrani Traders to again market unformulated zinc phosphide. This would be a mistake. Because of rapid degeneration, users would not know the percent of active ingredient and would, therefore, be unable to properly formulate baits.

Recommendations

- The MOA/DAE should maintain the current zinc phosphide registration, which allows only formulated baits to be sold.
- Formulation and marketing of zinc phosphide bait cakes should be encouraged once per year in conjunction with the National Rodent Control Campaign.
- A method needs to be developed to reduce the rate of degradation through packaging (e.g., aluminum foil) or formulation (paraffinized?).

Brodifacoum

Commercial Origin

- Brodifacoum is marketed as Klerat®[1] by Imperial Chemicals, Inc. (ICI), Dhaka.

Formulation

- Brodifacoum is marketed as a formulated 5-g wax block bait (0.005% a.i.).
- This formulation has been tested by the USAID/DWRC/BARI Project and found to be effective.
- Degradation is not a problem, and the wax block resists physical weathering.

Application

- A single application of one 5-g wax block/burrow system is effective.
- Baits are inserted into tunnel entrances similar to the method described for zinc phosphate bait cakes.
- This rodenticide can be used repeatedly, as rodents do not seem to develop bait shyness to it.
- This formulation is stable in comparison with the rapid degradation characteristic of zinc phosphide.

Cost

- In 1990, a 5-g block of brodifacoum sold for 1 taka.

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[1] Reference to trade names does not imply endorsement by the U.S. Government.

Current Status

- This product was not available in the markets of Bangladesh for the national campaigns of 1991 and 1992 due to an ownership dispute between ICI and its Bangladeshi partners.

- The Director of the Plant Protection Wing/DAE reported that this dispute would soon be resolved.

Recommendation

- If this product becomes available, its marketing and use should be encouraged.

- Brodifacoum wax blocks should be used in conjunction with zinc phosphide bait cakes, with the use of zinc phosphide restricted to the national campaign and brodifacoum used at all other times.

Bromadiolone

Commercial Origin

- Bromadiolone is marketed as Lanirat® by Ciba-Geigy, Dhaka.

Formulation

- Bromadiolone is marketed as a formulated loose grain bait (0.005% a.i.).

Application

- Bromadiolone requires repeated applications (≥ 3) which make it inappropriate for use in farmers' fields. Farmers are reluctant to have to rebait burrows.

Cost

- Bromadiolone costs 12 taka/100 g, or 0.12 taka/g.

Current Status

- Bromadiolone is the most widely available rodenticide in Bangladesh.

Recommendation

Since bromadiolone loose grain baits are so widely available, they should be evaluated for efficacy in the field by the USAID/DWRC/BARI Project.

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Coumatetralyl

Commercial Origin

- Coumatetralyl is marketed as Racumin® by Bayer AG.

Formulation

- It is a ready-to-use bait (0.0375% a.i.).

Application

- Coumatetralyl is a multiple dose anticoagulant; therefore, it is inappropriate for use in farmers' fields.

Current Status

- This product is not available in local markets.

Aluminum Phosphide

Commercial Origin

- Aluminum phosphide is marketed as Phostoxin® by Degesch. It is also available from India under a variety of other trade names.

Formulation

- Aluminum phosphide is formulated into a ready-to-use tablet.

Application

- A single dose tablet is used as a burrow fumigant.

Cost

- A single tablet costs approximately 2.8 taka.

Current Status

- This product is not generally available to farmers. It is marketed primarily as a fumigant for insects in grain storage godowns.

CONCLUSIONS

1. Inexpensive, ready-to-use, and single dose rodenticides are the ones most likely to be used effectively by Bangladeshi farmers.

2. Brodifacoum wax blocks and zinc phosphide bait cakes best meet these criteria.

3. Neither of these rodenticides was available to Bangladeshi farmers for the National Rodent Control Campaigns in 1991 and 1992.

GENERAL RECOMMENDATIONS

1. Encourage private sector interests to market a formulated zinc phosphide bait cake for sale during the national campaign. I discussed this issue with Mr. Bobby Dean (AID/Dhaka/OEE) who was going to ask MIDAS to carry out a feasibility study. Depending on the outcome, MIDAS could provide assistance to a qualifying entrepreneur. I provided a short background paper to Mr. Dean describing the rodenticide problem.

2. If brodifacoum wax blocks become available in the future, the MOA/DAE should be encouraged to promote their use in conjunction with zinc phosphide bait cakes or alone if formulated zinc phosphide does not become available.

3. Encourage the MOA/DAE to not allow the registration and marketing of raw zinc phosphate and to retain the present formulated bait registration.

4. Bromadiolone loose-grain baits should be evaluated in the field by the VPS/BARI to determine whether these baits may be useful to farmers.

CAMPAIGN EVALUATION

Present Methods

The effectiveness of the National Rodent Control Campaign has not been meaningfully evaluated in terms of its impact on reducing rodent numbers. A quantitative and statistically meaningful evaluation is necessary in order to determine whether the campaign is effective or otherwise needs to be modified.

Nonquantitative evaluations using farmer interviews have been conducted each year. In 1992, this evaluation was the responsibility of the Entomology Department of the Bangladesh Rice Research Institute (BRRI); in 1991, it was handled by the VPS at BARI.

The MOA/DAE attempted a quantitative evaluation of rodent damage following the 1992 campaign. The method was to sample the relative proportion of cut tillers in 1-m^2 frames. In the design, a total of 10 frames were to be sampled in each of 10 aman rice fields in each Upazilla. This, however, represents only about 1 ha/ Upazilla being sampled out of the thousands available. Only 12% of the evaluators sent in results. It is, therefore, unlikely that a representative and meaningful sample was obtained.

Proposed Method

The purpose here is not to undertake a comprehensive assessment of the impact of the campaign. This would be an enormous task beyond the capability of the BARI/VPS staff. The method proposed here is designed for a small, well-trained team to complete the evaluation in a reasonably short period of time, and it is intended to provide broad coverage and a statistically meaningful analysis. The proposal that follows was developed with Md. Yousuf Mian, Senior Scientific Officer (SSO), BARI.

Steps

(a) Sampling will be done in each of the four major geographic regions of Bangladesh: Rajshahi, Dhaka, Chittagong, and Khulna/Barisal.

(b) Two districts will be randomly selected within each geographical region.

(c) Within each district, the number of active rodent burrow systems will be counted along 100 separate transects.

(d) Each transect will begin from a randomly selected point along the system of major (all-weather) roads within a district.

(e) The transect will be walked perpendicular to the road for a distance of 500 m. All active rodent burrow systems will be counted within 5 m of either side of the sampler. At a distance of 500 m from the road, the sampler will turn and walk parallel to the road for a distance of 100 m. He will then turn back toward the road and walk a second 500-m transect again, counting the burrow systems along a 10-m wide swath. Therefore, a total area of 1 ha will be sampled along each transect (500 m x 10 m x 2 = 10,000 m^2). Each active burrow system represents a single adult rodent.

(f) This sampling process will be done twice: at the beginning of the campaign (September) and at harvest (December). Transects will be repeated at the same sites.

(g) Counts of active burrow systems for a district will be compared statistically using an independent t-test. If the numbers are significantly higher at harvest as compared with those at the beginning of the campaign, the control campaign was ineffective. If they are significantly lower at harvest, the control campaign was very effective.

(h) It is projected that one man can count 25 transects during a 6-day week. A 6-man team can, therefore, sample a geographical area (e.g., Dhaka) in approximately a 2-week period. Four 6-man teams would be needed for two separate 2-week periods to complete the sampling.

(i) This evaluation would require a budget of approximately $3,500 for personnel (24 men x 28 days x 200 taka/man/day), plus approximately $1,000 for fuel and vehicle maintenance.

Recommendations

- Funding should be found for the above monitoring of the 1993 aman rice crop. PL-480 (Title III) funds may not be available after June 1993. AID/Dhaka may be able to assist in finding a funding source.

- This research should be done by the VPS/BARI who are most familiar with identifying rodent burrow systems. This project should be under the direction of Md. Yousuf Mian, SSO/BARI, who is familiar with the sampling and statistical analysis.

- BARI should be requested to make project vehicles available for this activity.

- A report of the campaign evaluation results with recommendations should be prepared and distributed to all concerned parties and agencies.

PERSONS CONTACTED

AID/Dhaka

Dr. Ray Morton, ADO/AID
Dr. Habibur Rahman, OFA/AID
Mr. Bobby Dean, OEE/AID

Bangladesh Department of Agricultural Extension

Mr. M. M. Malik, Director, Plant Protection Wing/DAE
Mr. Santosh K. Sarker, Plant Protection Wing/DAE

Bangladesh Agricultural Research Institute

Dr. Md. Abdul Karim, Head, Entomology Division
Mr. Md. Emdadul Haque, VPS
Mr. Rajat Pandit, VPS
Mr. Habibur Rahman, VPS
Mr. Yousuf Mian, VPS

Private Individual

Dr. Parvin Sultana

Trip Report*

ASSESSMENT OF THE 1992 BANGLADESH NATIONAL RODENT CONTROL CAMPAIGN

April 14-May 13, 1993

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Unpublished Report

June 15, 1993

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ITINERARY

Date	Location	Activity
Apr 14-15	Denver, Colorado, to Rome, Italy	Travel
Apr 15-18	Rome	Met with personnel of the United Nations Food and Agriculture Organization (FAO).
Apr 18-19	Rome to Dhaka, Bangladesh, via London, England	Travel
Apr 19-May 9	Dhaka	On duty
May 9-10	Dhaka to Manila, Philippines, via Bangkok, Thailand	Travel
May 10-12	Manila	Attended "Agricultural Products Quality Workshop"
May 13	Manila to Denver, Colorado	Travel

SUMMARY

The 1992 Bangladesh National Rodent Control Campaign conducted in October by the Department of Agricultural Extension (DAE) was evaluated. A total of 4,790 rice fields, averaging 0.36 acres each, were examined by local extension office Plant Protection Inspectors and Block Supervisors. Data from 61 of 64 districts, including number of rodent burrows present, size of the rice field examined, and percent of tillers cut (damaged) by rodents, were collected near harvest during the last 2 weeks in November. Mean number of burrows per acre was 3.47 (0.12-12.27) and the mean percent cut tillers was 1.33 (0.06-3.92). Rodent damage was related to the number of rodent burrows present in crop fields near harvest. These data need to be sorted to distinguish fields subjected to rodent control measures from fields which received no rodent control. Effectiveness of the national campaign can then be quantified and the effectiveness of different rodent control techniques used can be compared.

The most effective rodent control technique currently available is applying a 2% zinc phosphide bait cake directly to rodent burrows during susceptible crop growth stages. This method is not widely used by farmers. However, if a quality-formulated product could be made available and promoted by the DAE, rodent damage to maturing rice and wheat could be sharply reduced and the full benefits of the National Rodent Control Campaign realized by Bangladeshi farmers.

OBJECTIVES

The primary purpose of this assignment was to evaluate the 1992 National Rodent Control Campaign conducted by the DAE in cooperation with the Bangladesh Agricultural Research Institute (BARI)/Vertebrate Pest Section (VPS) and to make recommendations for future rodent pest management operational programs and strategies. This consultancy was conducted, in part, with Dr. William B. Jackson, Bowling Green State University, Bowling Green, Ohio, whose primary objective was to evaluate research conducted under the U.S. Agency for International Development (USAID)/Vertebrate Pest Project at BARI. Therefore, my initial work in Bangladesh involved travel, meetings, and discussions in support of Dr. Jackson's consultancy as well as my own.

ACTIVITIES

Italy

Food and Agriculture Organization (FAO), Rome

En route to Dhaka, I visited the FAO Headquarters, Crop Production and Protection Division personnel, to discuss past, present, and future vertebrate pest

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management (VPM) projects and activities. Dr. Gerard Schulten, Chief, Crop Protection Service, mentioned that in September 1991, FAO sponsored a Rodent Workshop in Bolivia. A list of attendees is attached in Appendix I. It is hoped that a proceedings from this workshop will be produced. The FAO/VPM project in Indonesia was completed in 1992. I obtained copies of a draft publication (van de Fliert *et al.*, in prep.) and some extension materials from this project. Presently, FAO is not involved in any VPM project; however, an Asian Integrated Pest Management (IPM) project funded by the Netherlands and Australia is a major activity with specific programs in Bangladesh, Cambodia, China, India, Laos, Malaysia, Philippines, Sri Lanka, Thailand, and Viet Nam. The IPM coordinator for South Asia located in Dhaka was informed of my Bangladesh itinerary, and arrangements were made for me to visit this IPM project.

I discussed recent publications related to vertebrate pest control with Ms. Ilona deBorhegyi, Editor, Plant Production and Protection Division. If a proceedings from the Bolivian Workshop is received, she will edit it and make it available as an FAO publication. We also discussed my "Eastern Africa Rodent Pest Management" manuscript that was recently submitted; money is available for its publication this year.

BANGLADESH

AID/Dhaka

Dr. Ray Morton and Mr. Habibur Rahman, Office of Food and Agriculture, are managing USAID's involvement in the Vertebrate Pest Project at BARI. Their primary Project activities now include completing requirements for ending the large Agriculture Research Project (ARP-II Supplement), under which the Vertebrate Pest Component involving the Denver Wildlife Research Center and the Bangladesh Vertebrate Pest Project at BARI functions. The Vertebrate Pest Project, after 15 years of AID support, terminated in June 1993.

BARI/Joydebpur

Mr. A.N.H. Arangzeb has recently been appointed Director General of BARI to resolve some major administrative problems including a possible reorganization of the BARI system to incorporate a number of existing divisions into separate research institutes in a new research complex. Confounding the administrative problems will be a new USAID funding mechanism being implemented June 1993, which will require BARI to petition the Ministry of Agriculture (MOA) for USAID funds provided in block grant form to support individual research programs (e.g., VPS/BARI). Mr. Arangzeb indicated his interest in the VPS, particularly the efforts to elevate this section to a division due to the unique nature of vertebrate pest problems and solutions--much different from an entomological discipline under which it currently functions.

VPS/BARI

VPS personnel did not participate in training for DAE district supervisors and other extension personnel for the 1992 Rodent Control Campaign. For the 1991 campaign, VPS personnel had given this training at selected Bangladesh DAE district/division field office locations.

The SASS program on the IBM PC had expired and needed an update code number which I obtained from DWRC and entered from the SETINIT menu to provide access through December 1993. At that time, VPS will have to pay for the annual fee to continue use of the software. Occasionally, the IBM PC has not been booting properly; thus, I demonstrated use of the tape backup system, which had not been utilized, and monitored a total backup of files in both C and D drives.

I assisted Messrs. Emdad Haque, Yousuf Mian, and Rajat Pandit in outlining topics for their future research on rodents, birds, and predators. Mr. Mian and I discussed use of botanicals for developing rodenticides and his needs for literature on this topic.

DAE/Plant Protection/Rodent Control Program

During August 1992, in preparation for the 1992 National Rodent Control Campaign, Dr. M. A. Karim, Head, Entomology Division, BARI, and Mr. Santosh Sarker, Rodent Control Specialist, DAE, presented a 1-day training session to approximately 60 Deputy Directors for Agricultural Extension (DDAE's)--one from nearly every district in Bangladesh. Mr. Sarker presented specific methods for counting active rodent burrows and rat-damaged rice tillers as well as information on how to complete the farmer survey forms. Extension materials for the campaign including posters and leaflets were distributed to each district representative for further distribution to local extension offices. The 2-week campaign held in October was also promoted through television announcements and other locally available traditional methods.

Mr. Sarker has collected the farmer survey forms from the 1992 rodent campaign; they were completed in late November by local extension workers. Dr. A.N.M. Rezaul Karim, Head of the Entomology Division at the Bangladesh Rice Research Institute (BRRI), has been given responsibility for evaluating the results and submitting a report to the DAE. He is now having the data entered on a computer. These data are similar to the farmer survey data collected after the 1991 rodent campaign and should be somewhat comparable. Unfortunately, the data compilation will not be completed before June 1993.

In addition to the farmer surveys evaluating the 1992 rodent campaign, DAE local Plant Protection Inspectors and Block Supervisors conducted rodent damage assessments by counting active burrow systems and cut tillers in a minimum of 10 plots (rice fields) that totaled at least 6.8 acres. In each plot, all active burrow openings were counted during late November, and five 0.5- x 0.5-m quadrats were randomly selected to count the enclosed cut and uncut rice tillers. No report has been received from Jessore and Mymensingh Districts; and one district, Narayanganj, reported only partial data. Reported data from the other 61 districts are summarized:

	Mean (max.)	
Division (districts)	Burrows/acre	% cut tillers
Rajshahi (16)	3.02 (8.04)	1.03 (3.61)
Khulna (15)	3.22 (12.27)	1.41 (3.77)
Dhaka (15)	4.33 (10.74)	1.62 (3.92)
Chittagong (15)	2.66 (9.19)	1.11 (2.26)
TOTAL (61)	3.47 (12.27)	1.33 (3.92)

Rodent damage was moderately associated (R Squared = 0.3) with the number of burrows present; however, variation was relatively high with a standard error of the Y estimate of 0.81 (Fig. 1, Appendix II). Comparison with the evaluation data collected from the 1991 campaign, when only burrow counts were made, was not possible (Brooks, 1992). The training provided to personnel conducting the damage assessments was apparently improved in 1992 over that given during the 1991 campaign when only 43 districts reported all the required data. The number of extension Subject Matter Specialists, Block Supervisors, and farmers trained, and rat tails deposited during the 1992 campaign was comparable with the total in 1991 (Brooks, 1992).

Mr. M. M. Malek, Director of Plant Protection, expressed much interest in the use of zinc phosphide (ZnP) as a rodenticide. Claims of ZnP degradation are being made without supporting evidence. The BARI/VPS should immediately prepare for a shelf life and weatherability study to dispute arguments that ZnP degrades too fast. The fact that most of the technical ZnP being sold to farmers in small packets is adulterated is being ignored. Therefore, Dr. Jackson and I prepared a memorandum to Dr. Karim at BARI on the use of zinc phosphide and included enough supporting documents to help Bangladesh officials make their decisions on use and formulation of zinc phosphide (Appendix III).

United Nations Development Programme (UNDP)/FAO IPM Project

The Bangladesh FAO IPM Project, with an office at DAE Headquarters, has been conducting IPM training sessions for selected Bangladeshi farmers. I visited one

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such demonstration at Savar, west of Dhaka. About 50 farmers at this and other sites are exposed to 30 hours of training during a rice crop season when they receive practical exposure in identifying insects and deciding on control methods to use. Rodent pest management should become part of this training program since almost all farmers present affirmed that rodents are a serious problem in their crops. FAO project personnel said that in many of the previous 65 IPM training sessions held in Bangladesh since 1989, farmers consistently voiced their concern of rodent damage to crops.

DISCUSSION

The 1992 National Rodent Control Campaign had a number of quantifiable successes which were the result of good organization, management, and implementation by DAE. An excellent opportunity now exists for improving the delivery of quality rodent control techniques and materials to farmers. The availability of ZnP bait cakes to farmers at a price they can afford should markedly reduce damage at the individual rice farm level. Despite the fact that the ZnP bait cake has been the recommended choice--based on 3 years of laboratory and field research from 1979-1981 and its widespread, successful use in the National Rodent Control Campaigns of 1983 and 1984--no rodent campaign evaluation since 1984 has indicated that farmers are using ZnP bait cakes.

Evaluation data collected during the 1992 campaign were very complete. The efforts by DAE to promote local extension involvement is to be commended. The active burrow and cut tiller counts provided a general assessment of rodent damage; but, unfortunately, it did not demonstrate reduced damage in fields where rodent control was done. The comparison of rice fields with and without rodent control needs to be done to measure any campaign benefit. Different rodent control techniques or materials used could similarly be compared using such data.

Training of local extension officers would be a valuable expenditure of funds that would provide the expertise needed to advise farmers in proper rodent control techniques consistent with the recommendations in the National Rodent Control Plan. A visit to the Tangail District Extension Office where about 30 local extension officers gathered to discuss the rodent campaign revealed that most of them are not familiar with current rodent control techniques and recommendations. Additionally, providing local extension officials with more training in the collection of field data would improve the data collection process. It was possible in the 1991 and 1992 surveys that some inactive rodent burrows were counted as being active burrow openings. Therefore, DAE should continue the pre-campaign training sessions to encourage collecting good field damage data for assessing the National Rodent Control Campaign.

It was obvious during one field trip to Tangail District that the cropping system in this area had changed dramatically since previous observations made in the 1980's. While rice acreage and production has been increasing steadily and yields increasing

rapidly, wheat acreage, production, and yields (which peaked in 1984-85) have been on a general decline through 1989-90 (BBS, 1991). The formerly dominant wheat crop has been largely replaced with boro rice, which is now possible because of the introduction of shallow and deep tube wells for irrigation. By growing boro rice, farmers have been able to triple yields when compared to other rice crops and seasons (Anonymous, 1993). Deepwater rice acreage, which was formerly followed with a wheat crop, has also decreased from about 2.1 million hectares to about 0.9 million hectares (Islam, 1993). The ability of Bangladesh to export rice during the past year and the low market prices for rice are evidence of an abundance of rice in the country.

An abundance of irrigated crops will likely lead to increased rodent problems in rice grown January through May. Prior to irrigation, the dry winter season provided only limited basic needs to support rodent populations that normally decreased because of unfavorable habitat. With irrigation and susceptible crops now abundant, rodent populations will be sustained through decreased mortality and increased reproduction. Furthermore, when the summer crop season starts, usually with the June rains, rodent populations will be higher and probably cause more damage to the aus rice crop than has been experienced before. This potential rodent threat needs to be examined by the VPS and, if verified, the present national rodent control strategy might well need to be modified or completely abandoned in favor of a new strategy that considers these changing agricultural patterns.

Philippines

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On May 11 and 12, I attended the "Agricultural Products Quality Workshop" held in Manila, Philippines, to represent vertebrate pest management concerns in the Asia-Pacific Region. My presentation, "Vertebrate Pests as Constraints to Agricultural Production and Quality in the Asia/Pacific Region," provided the opportunity to exchange information on specific problems of rodents, birds, and other vertebrate pests affecting a variety of private agribusiness ventures within the region.

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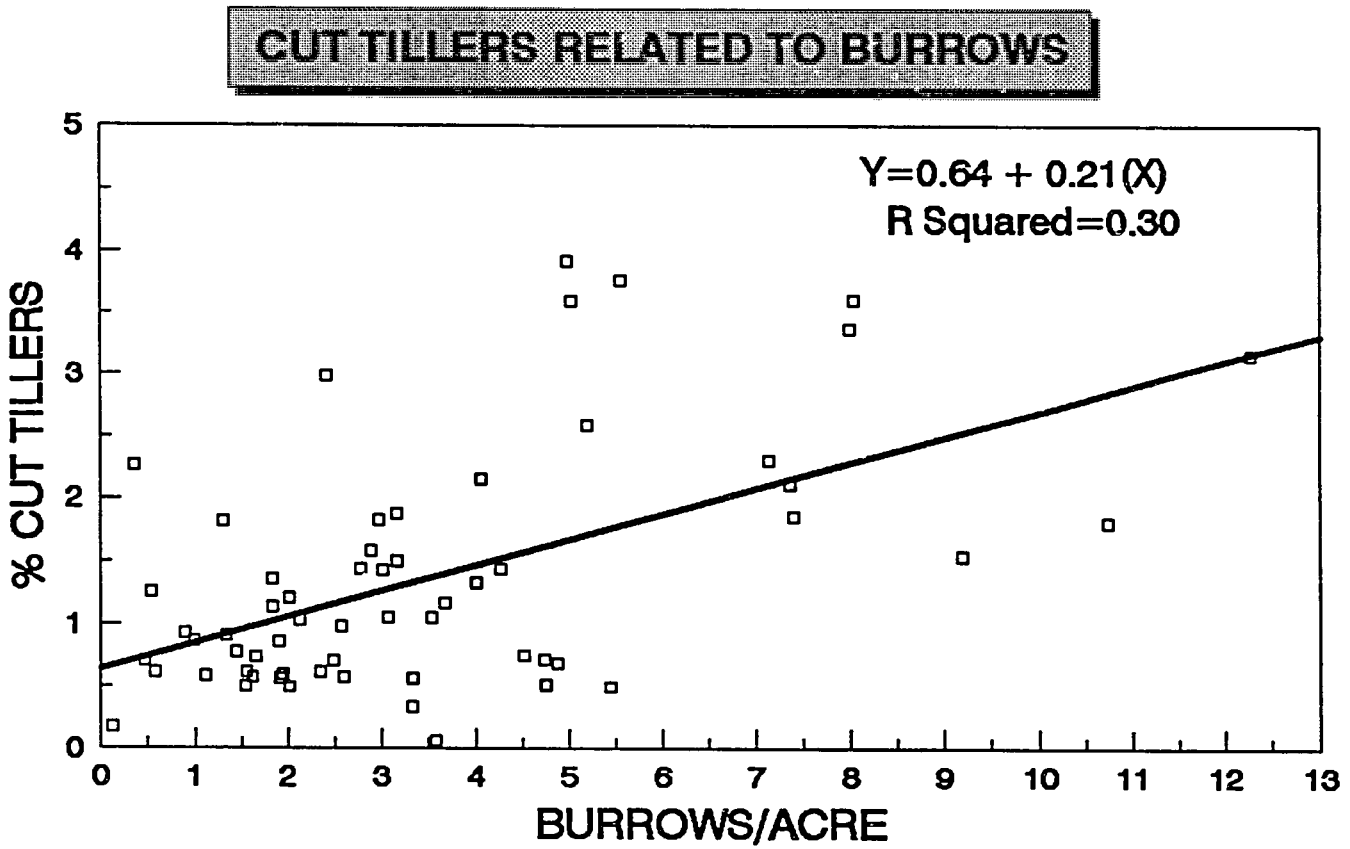

Fig. 1. Relationship of rodent damage to number of burrows in Bangladesh rice fields in November 1992

APPENDIX II

Rodent Damage Assessment in Rice Fields in November 1992

DISTRICT	PLOTS	ACRES(A)	BURROWS(B)	B/A	% CUT TILL
Rajshahi Division (16)					
Natore	30	10.45	20	1.91	0.85
Joypurhat	30	6.80	24	3.53	1.05
Rajshahi	50	14.86	29	1.95	0.59
Thakurgaon	30	9.22	23	2.49	0.70
Dinajpur	120	36.61	41	1.12	0.58
Kurigram	60	16.65	51	3.06	1.05
Naogaon	840	52.47	188	3.58	0.06
Gaibandha	60	25.94	55	2.12	1.03
Pabna	50	21.03	169	8.04	3.61
Lalmonirhat	340	82.54	47	0.57	0.61
Rangpur	60	21.51	62	2.88	1.58
Nilphamari	60	15.09	29	1.92	0.56
Sirajganj	60	18.95	81	4.27	1.43
Bogra	60	11.70	39	3.33	0.56
Panchagarh	60	28.66	211	7.36	2.11
Nawabganj	20	16.05	2	0.12	0.17
			Mean	3.02	1.03
			Max	8.04	3.61
			Min	0.12	0.06
Khulna Division (15)					
Kushtia	60	27.82	65	2.34	0.61
Bhola	550	148.36	723	4.87	0.68
Magura	30	8.99	12	1.33	0.90
Chuadanga	30	11.97	22	1.84	1.35
Jhalokati	10	8.49	14	1.65	0.73
Barisal	10	13.15	34	2.59	0.57
Satkhira	70	21.72	103	4.74	0.71
Meherpur	10	7.08	21	2.97	1.82
Jhenaidah	60	20.17	37	1.83	1.13

DISTRICT	PLOTS	ACRES(A)	BURROWS(B)	B/A	% CUT TILL.
Narail	30	12.94	39	3.01	1.42
Barguna	50	20.53	114	5.55	3.77
Khulna	60	187.85	99	0.53	1.25
Pirojpur	50	16.63	204	12.27	3.16
Patuakhali	40	11.14	10	0.90	0.92
Bagerhat	70	25.84	130	5.03	3.60
			Mean	3.43	1.51
			Max	12.27	3.77
			Min	0.53	0.57
Dhaka Division (15)					
Netrakona	60	21.50	79	3.67	1.16
Kishoreganj	70	18.30	37	2.02	1.20
Jamalpur	70	20.22	56	2.77	1.43
Madaripur	40	9.27	15	1.62	0.57
Shariatpur	50	14.99	161	10.74	1.80
Sherpur	40	8.56	22	2.57	0.97
Dhaka	50	16.96	88	5.19	2.59
Tangail	100	33.20	246	7.41	1.85
Manikganj	70	22.26	159	7.14	2.30
Gazipur	50	16.91	41	2.42	2.98
Narsingdi	50	15.30	69	4.51	0.74
Munshiganj	30	12.00	96	8.00	3.37
Faridpur	80	31.09	48	1.54	0.50
Rajbari	40	11.59	55	4.75	0.51
Gopalganj	50	22.66	113	4.99	3.92
			Mean	4.62	1.73
			Max	10.74	3.92
			Min	1.54	0.50
Chittagong Division (15)					
Brahmanbaria	50	8.22	33	4.01	1.32
Chittagong	180	21.32	71	3.33	0.33
Lakshmipur	20	9.93	20	2.01	0.49
Cox's Bazar	20	41.27	54	1.31	1.81

DISTRICT	PLOTS	ACRES(A)	BURROWS(B)	B/A	% CUT TILL
Khagrachhari	70	224.30	104	0.46	0.70
Feni	40	14.47	133	9.19	1.53
Rangamati	50	20.21	20	0.99	0.86
Noakhali	40	9.41	20	2.13	1.03
Bandarban	50	8.46	46	5.44	0.49
Sunamganj	80	73.94	26	0.35	2.26
Sylhet	50	21.39	31	1.45	0.77
Chandpur	60	14.26	45	3.16	1.49
Habiganj	50	32.55	103	3.16	1.87
Maulvibazar	50	12.78	20	1.56	0.61
Comilla	70	27.61	112	4.06	2.15
			Mean	2.84	1.18
			Max	9.19	2.26
			Min	0.35	0.33
TOTAL (61)	4790	1746.14	4821	211.69	82.76
MEAN	78.5	28.6	79.0	3.47	1.33
MAXIMUM	840	224.3	723	12.27	3.92
MINIMUM	10	6.8	2	0.12	0.06

Regression Output:

Constant	a=0.642554
Std Err of Y Est	0.806973
R Squared	0.301553
No. of Observations	61
Degrees of Freedom	59
X Coefficient(s)	b=0.20579
Std Err of Coef.	0.040774

Date: 6/15/93
To: Dr. Md. A. Karim, Head, Division of Entomology, Bangladesh Agricultural Research Institute
From: Dr. William B. Jackson and Mr. Lynwood A. Fiedler, USAID Consultants
Subject: Zinc Phosphide for Rodent Control

Zinc phosphide has been the most frequently used rodenticide in the world. Its fast action and moderate toxicity are considered assets. It is regarded as environmentally suitable, since formulations used and burrow placements of bait greatly reduce primary and secondary hazards. While acids or bases enhance chemical degredation and phosphine release, under normal conditions both the technical material and prepared baits have an extended shelf life. (See Hood, 1972 for recent review of this rodenticide.)

Numerous studies have documented degredation of zinc phosphide under field or simulated field conditions. Hilton and Robison (1972) found zinc phosphide decomposed over several days in soils---with variations related to soil types and moisture saturation. West et al. (1972-73) and others have shown that baits exposed to rain lose half or more of their toxic material. But more important than partial loss of toxicity is the deterioration of the bait itself with subsequent decrease in rodent acceptance under such field conditions. Baits packaged in plastic or otherwise protected from such weathering by burrow or bait station placement will retain their effectiveness during a baiting campaign. (See Hood, 1972 for reference to specific studies.)

In Bangladesh, singular success in rodent control has been achieved with a 2% zinc phosphide bait cake provided at the Vertebrate Pest Section (VPS) laboratory. Although bait shyness has been demonstrated in some rodent species, the primary rodent pest in Bangladesh, Bandicota bengalensis, has not expressed this phenomenon when tested on bait cakes containing 2% zinc phosphide or less.

The cake [2% zinc phosphide, 2% vegetable oil (soybean), 48% wheat flour, 48% rice-flour] had been thoroughly tested in the laboratory (Poché et al., 1979)and the field (Fiedler et al., 1981) before being released for direct sale (Taka 2) to farmers for placement in burrows in the National Rat Campaigns in 1983 and 1984. Its huge success resulted in no samples being left for shelf stability tests.

Technical (ca 80%) zinc phosphide has long been imported from India (and perhaps other countries as well). Frequently, this is taken by various dealers, often diluted with charcoal, and packaged in 10-gram amounts in folded papers placed in plastic for direct sale to farmers (Taka 3). No directions for actual bait preparation or safe handling are enclosed. An analysis several years ago by the Denver Wildlife Research Center determined that 90% of such samples analyzed were badly adulterated. As a result, Bangladesh officials currently do not approve the reformulation of technical zinc phosphide into small packets for sale to the public. This has raised objections from technical zinc phosphide importers and dealers, who claim that surrounding countries allow this practice and that Bangladesh should also permit it.

While its use in a bait cake was thoroughly documented in conjunction with earlier National Rat Campaigns, zinc phosphide is seldom used by farmers today. Its general lack of availability, the failures ascribed to the adulterated technical material, and the extra effort required to make the bait explain much of this. Yet the need for an inexpensive, effective acute rodenticide remains.

The single need is to find an entrepreneur (or group) willing to make the specified bait cakes, maintaining required quality controls, and provide for distribution, especially relative to national campaigns. Labeling would need to include instructions and precautions relative to use. (Such an effort earlier failed because the sale price was specified at Taka 2 - which at best was no more than actual cost.) An enterprise might well start just in certain areas and then expand in subsequent months and years.

We recommend that:

1. Zinc phosphide be made available for farmer use, but only as a 2% bait cake,

2. An appropriate individual(s) or group(s) be licensed to prepare these specified baits and distribute them, provided that:

   -each bait lot be subject to bioassay through feeding trials on Bandicota bengalensis (and chemical assay, if desired) at the Vertebrate Pest Section laboratory and, if found to be effective, certified for sale. (Note that bandicoot rats may not be available in sufficient quantity for all tests, and Norway rats, Rattus norvegicus, may need to be utilized as well.) A standard operating procedure (SOP) following Tobin (1992) should be established for such tests.

3. If still desired for farmers being able to prepare their own baits (which we oppose at this time), such packets of technical or concentrated zinc phosphide shall have detailed graphic explanations of bait preparation, use, and safety practices and be subject to bioassay by VPS.

4. The DAE may wish to consider undertaking the bait cake preparation itself (especially during the initial years) or subsidizing a private sector formulation. In either case, the VPS bioassay requirement should remain in effect.

5. If additional bait formulations are proposed, these will need to be tested at the VPS laboratory for efficacy before being licensed. Each production lot also will need to be subject to bioassay.

The VPS laboratory should also immediately institute shelf-life studies with the bait cake formulation. Since these are extended tests (2 years or more), they should be initiated as soon as possible. Such tests will be for the purpose of validating the experience of other countries for the Bangladesh bait formulation and conditions.

The testing indicated here is not without demands on resources. Animals (Bandicota bengalensis) will have to be trapped, animals rooms will have to be prepared and maintained, and the actual tests will have to be conducted according to established protocols. Appropriate budgetary and personnel resources will have to be made available if these programs are to be accomplished.

BACKGROUND LITERATURE

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*Reprint requested

Trip Report*

ASSESSMENT OF VERTEBRATE PEST SECTION AT BANGLADESH AGRICULTURAL RESEARCH INSTITUTE

April 14-May 3, 1993

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Unpublished Report

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ITINERARY

Date	Location	Activity
Apr 14-15	Bowling Green, Ohio, to to Detroit, Michigan, to Rome, Italy	Travel
Apr 15-18	Rome	Met with personnel of the United Nations Food and Agriculture Organization (FAO).
Apr 18-19	Rome to Dhaka, Bangladesh, via London, England	Travel
Apr 19-May 1	Dhaka	On duty
May 2	Dhaka to Bangkok, Thailand	Travel
May 3-4	Bangkok to Tokyo, Japan	Travel
May 5-7	Tokyo	Personal time
May 8	Tokyo to Detroit, Michigan, to Bowling Green, Ohio	Travel

SUMMARY

The Bangladesh vertebrate pest management (VPM) project has been unique in its length, scope, and accomplishments. A decade and a half of U.S. Agency for International Development (USAID) support allowed appropriate fundamental biological and ecological research, the development of a management strategy for rodents in aman rice, and the testing and validation of the scheme on a national basis.

Unfortunately, just as the "fine tuning" of the system and adaptation to other crops and environments was on the horizon, the project (coordinated through the Denver Wildlife Research Center) was terminated. In addition, new organizational patterns and modes of funding are being put in place in Bangladesh. Such disruptions are likely to be highly detrimental to the VPM programs in the next half-decade if appropriate measures are not taken.

Certainly research on the range of vertebrate pests needs to continue. The management strategy already developed needs to be applied to rodent problems in various crops and cropping patterns. An integrated pest management (IPM) emphasis needs to be maintained. Predator and especially pest bird depredations have had scant attention thus far, and resources need to be diverted to appropriate cage and field studies. Techniques for evaluating crop depredations, both for determining losses and evaluating management success, need to be improved.

The Vertebrate Pest Section (preferably, the Vertebrate Pest Division) cannot possibly train all the specialists and technicians the country needs for such efforts. The job of the VPS is to "train the trainers" in both extension and academia. A real effort in curriculum development to identify vertebrate pests and indicate management strategies is urgently needed at all levels in the educational system.

These diverse needs require continued support and stimulation through short-term and degree training outside the country as well as frequent consultations with appropriate USAID and similar technical personnel.

The opportunity to continue and expand the significant effort in VPM begun in Bangladesh is upon us. Both financial and technical support from the outside is needed. Leadership and administrative support on the inside also is essential. Significant reduction in national food losses is possible, given availability of leadership and resources.

OBJECTIVES (SCOPE OF WORK)

<u>In general</u>--Assess the current research program strategies and priorities of the Bangladesh Agricultural Research Institute (BARI), USAID-funded, DWRC-assisted Vertebrate Pest Section (VPS) under the Department of Entomology; and assist the VPS with the design of and implement action for a research program and research strategy for the 5-year period after USAID funding ends.

In particular--Work with Bangladesh counterparts, and assist in planning and designing as listed below:

(1) Compile a prioritized listing of vertebrate pests and crops in Bangladesh.

(2) Prepare a list of prioritized research and development studies to be implemented during a 5-year schedule.

(3) Plan the role of the VPS in evaluation of the effectiveness of the 1993 and future National Rodent Control Campaigns.

(4) Outline the role and capabilities of the VPS to provide leadership and training to agricultural extension personnel, subject matter specialists, plant protection personnel, and Agricultural Extension Training Institutes in Bangladesh.

(5) Help prepare a list of information transfer topics (curricula development, training manuals, brochures, video training cassettes, etc.) that VPS should develop in the next 5 years.

(6) Report an overall summary of activities including contact made with a copy of all products noted and attached.

DISCUSSION

Introduction

The activities and accomplishments of the USAID/Bangladesh Vertebrate Pest Project during its first decade were reviewed by external consultants in 1989 (Marko *et al.*, 1989). These conclusions and recommendations will not be detailed here, but a copy of the Executive Summary from that document is included here for reference (Appendix 1). Project accomplishments are summarized by Brooks (1993*a*) in the Project Assistance Completion Report.

This analysis will focus on the years since the 1989 review and, in particular, look to the future and at the opinions, opportunities, and demands related to vertebrate pest management (VPM) in Bangladesh.

(1) A prioritized listing of vertebrate pest and crops in Bangladesh

Following from the early involvement of the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), a narrative description of rodent pests was published by Posamentier (1989). In his 1985 trip report, Mr. Fiedler listed pest species and status of information relative to biology and management. This has been updated in Table 1 by the VPS staff.

At meetings with farmers and extension agents, we asked, "What is the most important pest?" Usually the answer was "rats." Insects or other pests were next in line; also, birds were mentioned occasionally.

Clearly, the lesser bandicoot rat (*Bandicota bengalensis*) is the major species of concern. It is ubiquitous in the country.

Especially in deepwater rice, the greater bandicoot rat (*B. indica*) is recognized as an important pest. It is of little importance in structures and upland environments.

The Norway rat (*Rattus norvegicus*) typically is an urban species, but in Asia frequently is displaced by *B. bengalensis*. The soft-furred field rat (*R. [=Millardia] meltada*) has been recorded in project trapping, but it is of limited distribution and not regarded at present as an agricultural pest. Since elsewhere it is considered a pest and it may be expanding its range eastward, it should be watched.

Mice--both the house mouse (*Mus musculus*) and Indian field mouse (*M. booduga*)--are apparently widespread, but are not regarded as important pests. It should be noted that often mice become more evident and often more abundant following effective reduction of rodent populations. Thus increased concern for mice may be expected in the future.

Two species, apparently unimportant in earlier years, now are of concern. The Polynesian rat (*R. exulans*), still seldom recognized in collections, may well be extending its range westward. Recent identifications have been made in the Dhaka and Comilla districts. *R. exulans* could become a pest around houses and in such field crops as sugarcane.

The short-tailed mole rat (*Nesokia indica*), a well-recognized pest in India, has been noted west of the Jamuna River in Pabna District (Posamentier, 1989). Recent reports indicate further range extension and increased crop losses, especially in sugarcane.

Several squirrel species (*Callosciurus pygerythrus*, *Dremomys rufigenis*, and *Funambulus pennanti*) are noted for causing damage locally, but they are not considered as significant problems. Likewise, though depredations by the short-tailed porcupine (*Hystrix brachyura*) may be severe, they are local in nature.

VPS staff also were asked to rate the adequacy of knowledge about various aspects of rodent behavior, damage assessment, and pest management (Table 2). The lesser bandicoot rat and mole rat are best studied and known; but even so, major biological and ecological gaps in understanding exist. This format was originally developed by Fielder (1985), but it was restricted to sugarcane. Improved knowledge is significant, especially related to aman rice.

Avian pest species have been only slightly studied. A recent paper (Ahmed *et al.*, submitted, 1993) summarizes existing destructional and depredation information. Principal depredations by birds are to rice (especially aman) and wheat, although other crops are affected. Weaver birds and sparrows, parakeets, and mynas are most involved, but more than a dozen species have been cited. In a survey, 65% of farmers attested to crop damage. Crop losses are considerable, but largely

unquantified. One estimate puts losses to sprouted wheat at U.S. $30 million, but more reliable data are needed.

(2) Research and development studies (prioritized) to be implemented during a 5-year schedule

Knowledge of the staff (both professional and subprofessional) is necessary to set up achievable research recommendations. The present VPS staff is depleted below even former meager levels. Recommendations for a four-fold increase in personnel have languished. Consequently, I have simply listed and described projects and needs, roughly in priority order, without regard as to whether personnel support will be available.

1. I note in the BARI Master Plan (1990-95) that the program details for management of vertebrate pests include:

   - Determination of the efficacy of blower for fumigating burrowing rats
   - Breeding of bandicoot rat in laboratory
   - Studies on census techniques and predatory behavior of jackal

   I consider only the second item to be of high priority. The blower, for pumping noxious smoke into rodent burrows, may be suitable for some IPM programs (see No. 4, following below in this report); but such techniques are relatively inefficient. Nevertheless, such tools may be popular with some farmers and thus focus attention on rodents and their removal.

2. Since the bandicoot rat is of major importance, being able to maintain laboratory colonies is desirable. To the present, only the large outdoor pens have offered suitable facilities. With the new animal colony building about to be completed, attempts at appropriate caging to permit breeding should be made.

3. Early project control efforts were directed toward wheat (and the aman rice crop, followed by wheat). The need exists to monitor this crop system and update management schemes.

   In all cases, regardless of pest species, being able to document depredation damage and crop loss is basic to sustainable research and management programs. Appropriate evaluation procedures need to be finalized (as in case of aman rice) or developed (as with sugarcane and other crops).

4. Rodents, by far, are the major concern. *B. bengalensis* is the species of greatest importance. Depredations on rice and wheat have drawn the greatest interest. In this context, it would be of value to make an agroclimatic-ecosystem analysis that relates to rodent species (and other pest vertebrate groups). Such a scheme could facilitate development of research priorities.

The present management scheme (Sultana and Jaeger, 1989) was developed with aman rice, and its adaptation to other patterns of the culture should be undertaken. We note, especially, that in the areas traveled during the 2 weeks of the assessment, vast quantities of boro irrigated rice were being harvested. In previous years much of this land had been planted to wheat, mustard, or pulses, or left fallow (Anonymous, 1993). What impact does this increase in irrigation capacity and the change in crop form have on the survival and increase in rats? Should changes in the management scheme developed in this area be considered?

A small, but highly effective, rice IPM training group exists within the Department of Agricultural Extension (DAE) (Ramaswamy, 1993). Its emphasis is on insect and plant disease management. Consideration should be given on how to provide linkage between it and the pest vertebrate programs. It is not a matter of simply adding a day onto the existing IPM workshops. Rather, it requires development of a teaching/demonstration strategy suitable for this particular format. Joint efforts with DAE should be initiated, and prior experience in Indonesia with such a program should be consulted (van de Fliert *et al.*, 1992; Van Elsen and van de Fliert, 1990). As indicated earlier, the smoke blower may be useful in this context, but it needs to be tested and evaluated since these rat burrows are complex and may be plugged readily by disturbed inhabitants. Brooks (1993*b*) in his closeout report of the vertebrate pest research project provides basic concepts appropriate for IPM efforts.

B. indica is an especial problem with deepwater rice. Its status is poorly known, and effective management recommendations need to be developed.

Depredations to sugarcane involve *B. bengalensis*, *N. indica*, and the roof rat (*R. rattus*). (See also discussions of jackals on page 7.) Several damage assessment methods have been tried in preliminary studies, but further evaluation is still needed. Appropriate management schemes need to be validated.

N. indica is increasing its range from the west, though it still is restricted to areas west of the Jamuna River. Even so, it is a formidable pest, in part, because its fossorial habits make control difficult. Its damage to sugarcane and grains is already recognized in Bangladesh as well as heavy local depredations, such as to mango seedlings.

To the east, the lesser bamboo rat (*Cannomys badius*) is a species of limited distribution (by bamboo), but it is poorly known. *R. exulans* apparently is expanding its range westward, and some specimens have been collected west of Dhaka. Its changing distribution should be monitored, since it can cause crop and storage losses and is a disease reservoir of significance.

These two minor species (and others) may be of local importance and deserve study. Mice (*Mus* spp.) have not been mentioned heretofore [listed on p. 4], though they be abundant. Their size is small, and they often are considered

insignificant when balanced with rats. However, if rat populations are reduced, mice may expand into the opened niches and become much more of a problem relative to food loss and disease spread.

Local materials and technologies may exist that would be of value in rodent control. Development of "natural" rodenticides or repellents would provide alternative management tools. Undertaking at least limited investigations could be of value.

The foregoing comments are focused on control or management needs. Meeting such requirements necessarily starts with understanding the basic biology, ecology, and behavior of the pest species in the context of its specific environment. This basic approach--so well exemplified in the aman rice management scheme (Sultana and Jaeger, 1992)--should be exploited in other cases as well.

5. Predators

Both jackals and jungle cats are known predators of rodents. Considerable observation, investigation, and speculation has centered on the question of these predators and rodent population cycles.

These efforts have been focused in one area (Sripur), and a broader analysis of the problem is needed. We noted that in one area (Tangail District) jackals were very much favored animals, and their reduction would have been opposed by extension personnel.

There is reason to look at predators from the viewpoint of preventing their depredations (e.g., to sugarcane, poultry, melons, etc.) rather than simply (in contrast) enhancing their numbers as purported rodent control agents. Modeling has been used extensively in these studies (and with rodents as well). My preference is not to start with a computer model and manipulate various variables, but rather to collect an array of field data and observations; then one can go to a model with some known parameters and determine possible consequences and/or critical data gaps.

With the new VPS predator holding facilities shortly to be available, their optimal use should be considered. The comments in a recent consultant report (Harris, 1992) should be considered carefully. Evaluating feeding capacity on rodents might be one type of observation.

6. Postharvest losses

An initial survey (Mian *et al.*, 1987) documents significant losses to rodents from home storage. A wider geographic base would be desirable. Development of

management recommendations will need to involve DAE and others, since economics, farmer behavior, container design, and other components will be involved. The literature (especially FAO) is extensive in this area, but our ability to adapt individual household use practices is much more limited.

Ultimately, concern extends beyond the home and local store or godown to regional and terminal collections and storage sites. Here, cooperation with the University of Mymensingh presents additional opportunities. See also Brooks (1993*b*) for a proposal to reduce stored food losses.

7. Birds

The recent survey by Ahmed *et al.* (submitted, 1993) cites the dearth of information about depredating bird species and quantification of losses. Methods of measuring losses need to be tested and validated so that field surveys can be completed.

Traditional control methods are relatively ineffective and have high time demands. Such efforts need to be supplemented with additional management tools.

Repellent uses (including consideration of local plant products), application of lethal chemicals, and alternatives, such as trapping, need to be evaluated. Such efforts require extensive basic knowledge of the ecology and behavior of both the depredating and nontarget species.

(3) The role of the VPS in evaluation of the effectiveness of the 1993 and future National Rodent Control Campaigns

Currently, the evaluation of the 1992 campaign is being handled by Dr. A.N.M. Rezaul Karim, Head of the Entomology Division at the Bangladesh Rice Research Institute (BRRI). It is admitted that not all data takers were adequately trained, and the data summaries may be suspect. This evaluation will attempt to review data--not actual measurements of loss. In addition, Mr. Santosh Sarker of the DAE has compiled separate summaries of tiller loss and burrow counts from 61 of the 64 districts. Preliminary examination of these data indicated that "rodent damage was moderately associated with the number of burrows present" (Fiedler, 1993). When the results from Dr. Karim's more complex analysis would be available was not certain.

Several consultants have made detailed suggestions relative to data to be gathered both during and after the campaigns. Much of the information is qualitative, not quantitative. Data handling each year has been different. Year-to-year comparisons are difficult.

In matters relating to demographic, cultural, social, or economic details, which have been queried in various ways during the campaigns, cooperative efforts among the DAE, BRRI, and VPS clearly are in order; and stabilizing the census format as well as insuring adequate training for the data takers should be a priority. [This was done during the training session held in August 1992, which may explain why the data collected during the 1992 campaign evaluation appears to be more complete than in prior years.]

The time for the 1993 campaign and evaluation is fast approaching. The training of trainers, likely in a 1-day session, should be completed in the next couple of months so as to allow adequate preparation for local campaigns (and evaluations) starting in September or October. I was not aware from conversations that such appropriate planning and budgeting had occurred.

During the research that led to the adoption of the burrow baiting technique, burrow counts were utilized in evaluations, and 16 1-ha plots were randomly designated for sampling each of 4,800-ha study sites (Sultana and Jaeger, 1992). In the 1992 campaign, active burrow and cut tiller counts provided an index to rodent damage, but not to the benefits of specific control efforts. Jaeger (1993) has proposed for the current year a modified evaluation procedure but again utilizing burrow counts obtained in a systematic sampling program. Being able to relate such field samples to the control history of the field would increase greatly the value of the survey and evaluation. VPS, given the resources, appropriately could manage a limited evaluation.

(4) VPS role and capabilities to provide leadership and training to agricultural extension personnel, subject matter specialists, plant protection personnel, and agricultural extension training institutes in Bangladesh

The VPS properly relates to other administrative entities through the National Rat Control Campaign Committee, and this should continue. VPS involvement in interagency activities should be in the form of "training of trainers," considering research opportunities in the context of VPS priorities, and responding to special needs or concerns to the extent possible.

In this regard it should be noted that VPS personnel are unique in their specific training and orientation to vertebrate pests, for which training in regular agricultural curricula generally is lacking. This restriction does place special responsibility on VPS scientists to cross disciplinary and organizational lines to facilitate problem-solving where vertebrate pests are involved. (Note the appropriateness of this should BARI elect to reorganize.)

Given adequate and proper training, VPS personnel can participate in teams dealing with vertebrate pest problems in agriculture, forestry, aquaculture, animal husbandry, etc.

Formal training for VPM is distinctive and at the present time largely lacking in Bangladesh. The use of foreign graduate programs is essential. The present staff (including recent resignees) have graduate degrees--many from the Philippines or United States. The need to continue such training is critical, since the USAID fellowship support has been terminated. Alternative support needs to be specified.

VPS should explore opportunities to enlarge the educational scope of academic programs for extension workers. Only in this way can the base of extension be expanded on a national basis. Again, the emphasis should be on program initiation and "training the trainers" rather than assuming full responsibility for such programs.

Both the universities and extension training institutes should be offered content instruction relative to biology of vertebrate pests, losses caused, and remedial effort within the context of IPM. VPS is too small to take on all such institutional responsibilities (even if offered), but should attempt to provide assistance to such programs and to facilitate the training of staff members at these institutions. This could include stimulating and supporting applications for degree and nondegree training at instructional centers.

The VPS is the premier scientific unit in the country relative to identification of pest vertebrates, development of methods for determination of crop losses, and testing of remedial options. None of the universities or other government departments or institutes has either the mandate or such capability. The VPS should not have to conduct national surveys, carry out crop-wide control programs, or train vast numbers of field workers; instead it functions to conduct research and establish VPM criteria and "training of trainers."

Within this context, cross-agency cooperation has occurred. The VPS through extended experimentation developed the field baiting program for aman rice, trained appropriate extension (and related) personnel, and carried out two large-scale field trials. Subsequently, the procedures were incorporated into the National Campaign. In the future, this process needs to be repeated for other depredating species and/or other crop systems.

The roles that VPS personnel can fill are many. That is not the problem. At present the critical need is to maintain the VPS as a functioning unit, preferably as a Vertebrate Pest Division that has staff members experienced with birds, small mammals, large mammals, field and laboratory protocols, and related technologies and that provides appropriate training for its personnel. In the past, local expertise has been supplemented with experts from the United States, Philippines, or elsewhere as appropriate. Again, means to continue such short-term assignments need to be found.

The solid foundation provided by 15 years of USAID support and counsel needs to be maintained and enlarged, and outreach to other branches and agencies should be initiated. This requires commitment on the part of both staff and sponsoring organizations.

(5) Information transfer topics (curricula development, training manuals, brochures, video training, cassettes, etc.) that VPS should develop in the next 5 years

The VPS should focus its efforts on research; it is not charged with preparing training or publicizing materials. To the extent that it can prepare resources for use in "training the trainers," this is legitimate.

In this context, a training manual on pest vertebrate management in Bangladesh is being prepared currently by the DWRC. This will provide source material for the DAE and others to use in preparing their local training materials.

It may be that VPS with its specialized facilities (carnivore pens, large cages, rodent rooms, etc.) and specialized equipment (telemetry, video cameras, etc) can provide the DAE and others with unique visuals or even specimens. But such special services should be specifically requested and appropriately financed.

It is obvious that vertebrate pest management has not been included in either general curricular materials or in the specific courses required of plant protection specialists and technicians. Time did not permit discussions with any of the academic institutions about curricular development or with the DAE relative to modifying applicant requirements. The matter of appropriate formal education being available relative to vertebrate pest management merits concerned discussion and study and could well be the focus of a future consultation.

In this interim period, without formal curricular modification--which may last a decade or more--assistance by VPS personnel to Extension and other agencies in the transfer of research findings and review of training materials for accuracy will be highly desired. For example, Dr. Jeffrey Jackson in an earlier consultation (1992) showed how technology transfer could be illustrated. Such efforts need to be continued.

(6) Overall summary of activities

Most activities were conducted in conjunction with Mr. Lynwood A. Fiedler, Denver Wildlife Research Center, who was assessing the National Rodent Campaign. He remained in Bangladesh a week past my departure and gathered some information that is included in this report.

Mr. M. M. Malek, Director of Plant Protection, is very much interested in the use of zinc phosphide rodenticide baits. Claims of ZnP degradation are being made without support. BARI should immediately prepare for a shelf-life and weatherability study to dispute local claims that zinc phosphide degrades too fast. That most of the technical ZnP being sold is adulterated prior to final sale to farmers is being ignored.

As an interim step, a detailed letter (with attached documents) attesting to the stability and efficacy of properly prepared and distributed ZnP baits has been sent to Dr. Karim for his use at BARI and in subsequent discussions with Division heads (see Fiedler, 1993, Appendix III). In this connection it might be noted that the chemical assay of ZnP baits is difficult because of the complex extraction process. The method, originally developed by DWRC, is available; but it might be desirable to request assistance from the DWRC in this aspect of the assay program so that the methods are wholly validated.

Program materials from several projects were collected during discussions. Since they have not been translated into English, they have not been discussed in the report nor included as a numbered appendix. However, a number of extension materials are available through the DAE.

United Nations Development Programme/FAO IPM Project

The FAO IPM Project, headquartered at the DAE, has been conducting IPM training sessions for Bangladeshi farmers. We visited one such demonstration at Savar. About 50 farmers at this and other sites are exposed to training over a several-week period where they receive hands-on exposure in identifying "good" and "bad" insects and deciding on management methods. Rodents should become a part of this training program, since almost all farmers present affirmed that rodents are a serious problem in their crops.

BARI

We briefly discussed our concerns relative to the continuation of the VPS following the change (and reduction) in funding with the Director General Arangzeb. We also reiterated the recommendation, made repeatedly by past consultants, that the VPS be given Division status. The possible reorganizational changes at BARI were being discussed, and the VPS could readily adapt to such a format.

VPS Facility

While I was in Bangladesh, reconstruction of the predator pens and construction of a new small mammal facility was taking place and scheduled to be completed by early June. The aviary (now workmen's living quarters) should then be revitalized. (Note: Detailed architect's sketches for the new facilities were not available, so it is not possible to offer specific comments on this construction.)

The VPS building needs better maintenance. There were abundant cobwebs. After construction, the dust and dirt problem should be considerably lessened.

Since visitors from other agencies gain an impression from general appearances, having an upbeat image both inside and outside would be a good idea.

The library ought to look like a library: journals and reprints should be filed, a working table made available, and the card index to reprints placed in the library--not the general work room. The current equipment storage that inhibits access to materials should be removed soon. The DWRC has made a major effort (both in dollars and personal efforts) to obtain written materials and distribute them; these should be used frequently. The laboratory work room has numerous traps and rodenticide materials sitting around, apparently left over from days when tours through the facility were more frequent; these should be properly stored. If displays are needed, place trays in existing cabinets so that the trays could be brought out when needed, or secure wall cabinets where such items could be displayed without collecting dust.

The skin and skull collection is in poor shape. For the premier laboratory in the country responsible for pest vertebrates to have such a reference collection is not to their credit. Now that additional rooms will be air-conditioned, I suggest that new efforts be made to obtain quality skins (and skulls) and to store them properly. When field work is not scheduled, a few skins could be prepared; and even with the addition of just one study skin a week, the collection would become a meaningful contribution.

Bulletin boards can be effective communication devices within the staff as well as for visitors. I suggest that some effort be made to upgrade the hall boards with labels and/or new pictures. Graphs from published papers have been partially displayed. This mode of data presentation is highly desired and should be upgraded. The DWRC should be able to help with preparation of materials for display.

The animal room is not well-maintained. While new and much more adequate facilities are about to be available, the present situation does not bode well for the future. A standard operating procedure (SOP) ought to be posted--and followed. See Tobin (1992) for such an earlier recommendation and example.

Various old cages that are taking up shelf space should either be repaired or discarded. Several racks of new stainless steel cages sit there unused, while old galvanized metal cages are in current use. It is noted that the new cages have open tops instead of being fully enclosed; they are designed for white rats and mice that don't jump out--not for wild rodents. This cage design makes laboratory maintenance operations considerably more complex, although adaptations have been developed to facilitate such efforts.

Manpower is a critical matter. Partial explanation for the status of facilities is the lack of individuals to do cleaning and maintenance work. With the new units, the manpower deficit will be even greater. Major efforts need to be expended to secure supplemental funds for labor if the laboratory is to carry out

any of the recommended activities. It does not make sense to have planned and initiated the facilities construction without having also planned for associated personnel.

The computer room, with the addition of a second computer and perhaps another copying machine, will be more crowded. A functional floor plan needs to be developed so as to maximize use of these important equipment items. It would seem reasonable to assure that the supplementary (backup) air conditioning units are repaired and in working condition in case the primary unit is nonoperative.

Finally, without budget allocations for staff, facilities operations and maintenance, and field research (including logistic support), a decade and a half of support and dedication will be greatly diminished. The VPS has the capability in terms of facilities, equipment, and personnel to make significant contributions to BARI and Bangladeshi farmers. But, without administrative support, this will not happen.

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Table 1. Ranking of vertebrate crop pests by VPS staff.

Species	Rice	Wheat	Maize	Stored grain	Sugarcane	Fruits and vegetables
Lesser bandicoot rat (*Bandicota bengalensis*)	3	3	-	3	2	-
Greater bandicoot rat (*B. indica*)	3	1	-	-	-	-
Roof rat (*Rattus rattus*)	1	-	-	3	2	3
Short-tailed mole rat (*Nesokia indica*)	1	2	-	-	2	-
Mouse (*Mus* spp.)	1	1	-	2	-	-
Squirrel	-	-	1	-	-	3
Jackal (*Canis aureus*)	-	-	2	-	3	2
Parakeet (*Psittacula* spp.)	1	1	2	-	-	1
Crow (*Corvus* spp.)	-	1	2	-	-	1
Myna (*Acridotheres* spp.)	1	2	-	-	-	1

3 = Major pest
2 = Serious pest
1 = Local pest
- = Little or no importance as a pest

Table 2. Assessment by VPS staff of adequacy of rodent species-related knowledge (after Fiedler, 1985).

	Nesokia indica	*Bandicota bengalensis*	*B. indica*	*Rattus rattus*
1. Time of invasion into fields	2	2	2	2
2. Distribution around/within field	2	2	-	2
3. Damage assessment techniques	-	-	-	-
4. Damage pattern within field	1	2	2	1
5. Damage level at crop stages	-	-	-	-
6. Effect of alternate crops nearby	-	2	-	-
7. Distribution of species	2	2	1	2
8. Reproductive peak	2	2	-	-
9. Population peak	1	1	-	-
10. Food preference	1	1	-	-
11. Monitoring techniques	-	-	-	-
12. Movement and home range	1	1	-	-
13. Natural enemies	1	1	-	-
14. Economic threshold/injury level	-	-	-	-
15. Control techniques	2	2	-	1

2 = Adequate knowledge
1 = Some knowledge
- = Inadequate knowledge

Appendix 1.

EVALUATION OF VERTEBRATE PEST MANAGEMENT COMPONENT AGRICULTURAL RESEARCH PROJECT I - II BANGLADESH

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I. EXECUTIVE SUMMARY

In 1978, the U.S. Agency for International Development (USAID) began providing assistance to the Bangladesh Agricultural Research Council (BARC) in response to their strategic plan to address serious crop losses caused by vertebrate pests. A Vertebrate Pest Section (VPS) was created within the Bangladesh Agricultural Research Institute (BARI) to develop the long-term research capacity to meet the continuing challenge of vertebrate pest management. The research program has resulted in the development of reliable estimation methods which currently place pre-harvest rice and wheat losses from rats at U.S. $130 million annually (Taka 4,277 million).

The overall objectives of the Vertebrate Pest Component (VPC) within the USAID-financed Agricultural Research Project (ARP-I and ARP-II) have been to:

- identify vertebrate pest problems;
- evaluate control techniques;
- develop strategies to manage vertebrate pests;
- train staff; and
- develop institutional identity, leading to institutionalization of vertebrate pest management research and extension capacity in Bangladesh.

The originally approved work plan called for a research focus on wheat, primarily as a result of the larger national effort at the introduction and expansion of wheat production in response to import substitution pressures. While accepting the national prioritization of wheat as the crop of focus for the research program, the VPC work plan was developed in explicit recognition that real success in long-term pest management strategies (rat control in wheat) would not be forthcoming following various short-term campaigns (e.g., offering bounty on tails). Rather, a field-oriented research and extension program needed to be developed which could provide continuous feedback to the basic vertebrate biological research effort. In the case of the Lesser Bandicoot Rat (*Bandicota bengalensis*), which is the major pest in wheat and rice in Bangladesh, control techniques needed to be developed and tested to intervene at the most vulnerable point in the rodent's reproductive life cycle, which can shift over time due to environmental factors.

Within the VPC wheat research program, the work plan called for rodent biology studies and rodenticide testing as a basis for evaluating a management strategy which would be economically feasible and acceptable to small farmers. The wheat rat control

research program continued for six years (1978 to 1984) and through its first full-scale field test to determine the efficacy of zinc phosphide baiting techniques. The field test proved successful in controlling rat populations in wheat using BARI laboratory-prepared bait. However, subsequent use of zinc phosphide baits by small farmers failed because locally produced baits proved adulterated. Farmers lost confidence in the technology and the situation reverted back to traditional individual methods of control, which, by their nature, are not effective.

At this point, there was a hiatus in the resident Denver Wildlife Research Center (DWRC) research leadership with a one-year transition of team leaders. During this period, DWRC intermittently provided the future resident team leader to VPS on short-term assignment. The transition period was used by DWRC to assist the VPS staff in examining the shortcomings of the previous research focus and field campaigns. At this time, rice was identified as the priority crop in which to control vertebrate pests due to its importance in national agricultural production and small farm income.

Since 1986, the VPS, with the consistent leadership of the DWRC resident team leader and support of DWRC U.S.-based research facilities, has developed a control technique for rats in *T. Aman* rice (the major rice crop) which explicitly recognizes the problems incurred with previous control strategies. Demonstration of this new management technique for *T. Aman* rice will occur in September and October of 1989.

The institutionalization process of the vertebrate pest management capacity within BARI has taken great strides forward with the formal degree training of two masters degree and three Ph.D. scientists who now hold research positions in the Vertebrate Pest Management Section within the Division of Entomology. However, institutionalization within the originally envisioned context of creating a "division" for vertebrate pest management within BARI has not occurred, primarily as a result of administrative decisions made within the existing Division of Entomology. Sustainable vertebrate pest management research capability requires a field research orientation to provide important behavioral and biological feedback to on-station basic research programs. This field orientation is at odds with the more traditional entomological research approach which is dependent upon laboratory control. Consequently, until the issue of administrative autonomy for the VPS is resolved within BARI, sustainable institutionalization of vertebrate pest management research capacity will remain limited.

The VPS, in collaboration with DWRC, has substantially met its work plan and has managed project implementation well. Deviations have resulted from a need to study additional aspects

of the management program more carefully. The success is due to a dedicated staff and their vigorous work under rigorous conditions. However, having substantially met the terms of the original work plan is not a reason to curtail support to the institutional development of the VPS. Rather, the continued strengthening of the VPS to enable them to respond to the changing nature of the vertebrate pest spectrum over time is prerequisite to increasing overall output and farm-level incomes in Bangladesh.

Rodent Control

From early in the project, it was recognized that pre-harvest rat damage was the most serious vertebrate pest problem in Bangladesh. Research findings suggested that:

- damage was economically significant;
- the major pest species was the Lesser Bandicoot Rat (*Bandicota bengalensis*);
- losses were greatest in wheat and deepwater rice;
- zinc phosphide baits were a cost-effective, environmentally suitable, and practical means of control; and
- baiting was most effective if directed at the rat burrow systems before panicle development.

Transferring this technology to the farmers was the objective of VPS/BARI's participation in the 1983 and 1984 National Rat Control campaigns organized by the *Gesellschaft fur Technische Zusammenarbeit* (GTZ)/Department of Agricultural Extension (DAE), in cooperation with the Food and Agriculture Organization (FAO). The campaigns were successful in increasing farmer participation in pre-harvest rat control.

However, by 1986, it was evident that this technology was not taking hold, and farmers were losing confidence in the control methods. There were two general explanations for this:

- the zinc phosphide baits were ineffective; and/or
- the farmers were seeing no overall reduction in rat numbers.

In 1986, a long-term research plan designed to resolve the pre-harvest rat problem was developed by the VPS/BARI scientists and the DWRC team leader. First, a large-scale field study was undertaken to determine a strategy for when and where control

should be focused in order to be the most cost-effective. This assumed that long-term population reduction was impractical and annual control was necessary. Secondly, the control methodology was re-evaluated and an alternative method identified, which did not depend on the market-available bait in question and therefore avoided potential problems related to food preferences. In addition, the problems with the use and marketing of zinc phosphide were identified.

At the time of this evaluation, plans were underway to re-introduce the modified pre-harvest rat control technology to the Bangladeshi farmers. However, the approach this time was more systematic, and the results were vigorously monitored to identify where in the extension process problems were occurring:

- farmer acceptance;
- farmer training; and/or
- product quality and availability.

Rodenticide Quality

Assuring rodenticide quality is essential to successful control campaigns. Past efforts have faltered because of adulterated zinc phosphide. A current study by DWRC determined that 19 of 21 brands available to farmers were substandard and would not kill rats. While the VPS demonstrations scheduled for Fall 1989 will use VPS-prepared baits of documented toxicity, future campaigns must be guaranteed ready availability of effective rodenticides.

Vertebrate Pest Section Administration

VPS is currently a section under the Division of Entomology (BARI). Project as well as BARC and BARI documents have recommended that VPS be separated and given division status. It has been indicated that this may be accomplished under the next five-year plan (to be initiated in 1990). In taking this highly recommended administrative action, it is important for BARI to assure that sufficient operating resources also are transferred.

The new Division Head should be highly qualified. The individual should have an outstanding academic record and have directed significant research projects under both laboratory and field conditions. Careful selection of the Division Head is important, as the individual will have major responsibility for being an effective departmental spokesperson.

One problem with administrative assignments is that very promising research programs must be suspended because of the "red tape" demands on time. One consideration might be to institute a rotating chair, whereby an individual would be nominated to the post for a year (perhaps renewable for a second year), and then the responsibility would move to another member of the division.

Since most scientists receive little or no administrative training in their academic program, some consideration should be given to this type of training. The individuals currently in Ph.D. programs at Colorado State University will receive some training in research administration, but broader aspects (e.g., financial planning and personnel enhancement and management) are not included. The United States Department of Agriculture (USDA)/Office of International Cooperation and Development (OICD) and various land grant universities have developed more comprehensive training programs which are accessible through AID-supported participant training, and both present and future staff members should be considered for inclusion in these programs.

Graduate Education

Currently, all VPS professional staff have at least one graduate degree outside the country. This breadth of international experience is very beneficial and highly desirable. Such a standard should be maintained for future staff members.

The last of these scholars will not return for several years, but recruitment of additional individuals and planning for funding should be initiated to replace individuals leaving the program and to meet expansion needs.

Only one of the present staff has specific training with pest bird management. Since this area is one of future concern, plans should include training for additional expertise in this area.

Denver Wildlife Research Center (DWRC)

Since 1978, ongoing support by DWRC has included equipment procurement/shipping/installation, literature searches, statistical consultation, and manuscript preparation and review. DWRC staff have arranged various U.S. observation tours for Bangladeshi participants. Several Bangladeshi U.S. degree participants, including two currently in doctoral programs at Colorado State University, have been advised and assisted by DWRC staff.

Other Bangladeshi participants have taken part in DWRC-provided, in-country, short-term training programs. DWRC technical consultants have assisted with on-site staff training in preparation for handling and observing jackals, including radio telemetry, pesticide efficacy testing, and design of statistically appropriate sampling procedures. The DWRC International Pest Research Section frequently has assisted in research design, collection of field data, data interpretation, and administrative matters.

The DWRC Analytical Chemistry Section recently completed an assay of over 100 samples of 21 brands of zinc phosphide, finding that only 10 percent of them would make effective baits. Another set of samples is currently being tested.

If sufficient funding is available, it is likely that after 1990, DWRC personnel support will be in the form of short-term TDY assignments. This should be satisfactory--assuming that the personnel, support, and organizational matters already indicated move forward satisfactorily. This is consistent with DWRC's philosophy of VPS becoming a "sister institution" and sharing expertise and technology.

The Vertebrate Pest Section Linkage with Farming Systems Research

Integration of the VPS research results into ongoing FSR activities under ARP-II has been discontinuous and severely limited by organizational and professional constraints. However, the need for VPS to maintain links to the Bangladeshi farmer has been consistently met through the cooperation between VPS staff and the Department of Agricultural Extension. This reached a high point in 1984 and has been sustained, although recently at a lower level of activity, while developing basic biological information on rat control strategies in *T. Aman* rice production.

There are a number of organizational and professional constraints to improved VPS/FSR integration. Of those reviewed during evaluation, the most outstanding were:

- lack of reliable economic data from crop loss estimates and costs of implementing rodent control recommendations at the farmer level.

- delay in building a complete FSR research team under ARP-II, which did not allow sufficient time for its members to focus on VPC research recommendations and incorporate them into current off-station testing; and

- strict adherence to an agreed-upon research plan for VPS to develop the basic biological information for a rat control strategy in *T. Aman* rice which has limited the opportunity for VPS contact with FSR personnel at the field and national levels.

Sustainability of the Vertebrate Pest Section

Sustainability of the VPS within the BARI research organization can only result from the overall creative output of each member of the VPS research team. This can be facilitated by a well-designed and administrated professional relationship with other existing research sections in BARI. Presently, the VPS is in an ambiguous organizational and professional position in that it does not fit the traditional concepts of research methodology and approach of Integrated Pest Management (IPM) and entomology within BARI. This situation results in competition for available resources within the same division, which, when related to the lower divisional priorities of vertebrate pest management research, does not argue well for institutional sustainability of this capacity. It will require a restructuring of the VPS as a separate division in BARI to achieve the full potential of its staff.

Administrative restructuring of the VPS to establish it as a division will require careful examination of the leadership available in-country and being trained outside the country. As discussed above, supplementary training to improve research management and administration should be considered a priority use of participant training funds.

The VPS will only be sustainable in the political and economic sense if it can demonstrate its capacity to provide technical solutions to the control of economic vertebrate pests of the Bangladeshi farmer. This capacity can be realized if administrative and organizational funding permit ease of access to the farmer. Transportation, per diem, and research material have to be made available on time. In the particular case of the upcoming field verification trials, dependable access to funding will be critical, as the results of these trials pull together the basic parts of a biological study that was expensive and difficult to carry out. The successful implementation of VPS' large-scale farmer verification trial in September will assure a comprehensive strategy for a national effort to control rats in *T. Aman* rice. This has both political and economic implications for the sustainability of the VPS.

In order to further strengthen the VPS and improve its utility in generating viable technical options to the Bangladeshi farmer, the recently established National Committee for Vertebrate Pest Research has to fulfill its function by

facilitating the integration of VPS research with Farm Systems Research (FSR) and national extension programs, and should assume the role of developing policy on national vertebrate pest management issues.

The level of technology recommended by the project features a simple, pre-mixed, environmentally safe, locally manufactured rodenticide that can be applied easily by the individual farmer. Its low cost (0.05 Taka/bait), makes it available to all farmers. The results from previous controlled farmer testing in wheat indicate that when farmers can buy a quality formulated and unadulterated zinc phosphide rat bait, they will continue to purchase and employ it as a rodenticide. The sustainability of this technology can only be maintained if those regulatory agencies that provide oversight for bait manufacturers fulfill their functions.

Conclusion and Selected Recommendations

The VPS is achieving a major objective of being able to transfer a control strategy for bandicoot rats in rice to the farmer community. Continued activity relative to this technology transfer as well as development of control strategies for other cropping schemes and other pests (e.g., birds, jackals, wild pigs) is highly desirable.

VPS has performed a highly creditable research task and is now entering an extensive field-testing phase to adapt its research findings to farmer needs. The management strategy for the bandicoot rat in rice, if adopted by farmers, will reduce significantly pre- and post-harvest losses. The evaluation of the socioeconomic aspect of the technique is the critical last phase of this long and highly important research and development effort.

Carrying through the program fully from the start with basic research on the biology of the rat species to the adaptation of techniques, to the crop environment, and finally, to farmer-initiated implementation, is important. It becomes a model which can be replicated by VPS staff and extended to other important cropping systems and pests. Only through mounting the effort to replicate the research methodology developed thus far can the sustainability of staff capacity and the process of institutionalization be assessed.

Selected Recommendations:

It is recommended that, as a minimum, planned USAID obligations to VPC and the DWRC be continued through ARP-II (1993). Maintaining adequate and continuous funding will allow for important short-term technical and other DWRC facilities' support to VPS after 1990.

The establishment of VPS as a separate division in BARI should be accomplished within the year. Designating the new Division Head is an extremely important administrative decision. The most qualified individual in academic preparation and laboratory and field research experience should be selected.

The Plant Protection Department (PPD) of DAE should alert its staff to the serious problem of zinc phosphide adulteration. PPD should initiate an inspection, testing, and enforcement program to remove these substandard chemicals from the market.

Government of Bangladesh (GOB) consideration should be given to local entrepreneurial groups who could manufacture and guarantee quality baits in their region. Women's groups, especially those aided by Nongovernmental Organization (NGO) financing, might be considered.

The evaluation team recommends that VPS immediately solicit the services of a Bangladeshi economist with strong field experience to develop a sound quantitative basis for interpreting the results of the VPS field test in September. A regional FSR agronomist now assigned to multilocation testing should also be seconded for the duration of the Fall 1989 VPS field testing and take an active role in the VPS on-farm testing activities. These assignments could serve an important function in establishing linkages with existing FSR programs and provide essential in-service training required for sustainable implementation by FSR personnel of future rat control technology.

The Technical Committee formed by the BARC should be convened and strengthened to improve VPS' coordination and input into extension, as well as FSR and national vertebrate pest management policy. The socioeconomic information resulting from the Fall 1989 field test should be utilized by the National Committee on Vertebrate Pest Research to ensure that this information is transferred to the Department of Agricultural Extension and other BARI/FSR activities. The committee should also study the forthcoming information to determine if there are policy issues that remain to be resolved in relation to the pest management technology transfer process. This committee should respond immediately to its terms of reference, including meeting at least once each quarter (Appendix 4.0).

In order to support the immediate needs of the Fall 1989 large-scale test of rat control in *T. Aman* rice, timely allocation of financial and other field research resources should be made to the VPS. It is suggested that due to the critical role of this September trial, alternate means of funding should be considered if PL 480 funds cannot be easily accessed. The use of PL 480 funds should be phased in systematically, so that current research plans are not limited by loss of funding.

Trip Report*

CLOSEOUT OF THE BARI/USAID/DWRC VERTEBRATE PEST RESEARCH PROJECT IN BANGLADESH

1978-1993

May 5-31, 1993

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Unpublished Report

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ITINERARY

Date	Location	Activity
May 5-6	Denver, Colorado, to Bangkok, Thailand	Travel
May 7	Bangkok to Dhaka, Bangladesh	Travel
May 7-30	Dhaka	Consultancy to close out the Bangladesh Agricultural Research Institute (BARI)/U.S. Agency for International Development (USAID)/Denver Wildlife Research Center (DWRC) Vertebrate Pest Project in Bangladesh and make recommendations for future activities.
May 30	Dhaka to Bangkok, Thailand	Travel
May 31	Bangkok to San Francisco, California	Travel
June 1-4	San Francisco	Annual Leave
June 4	San Francisco to Denver, Colorado	Travel

OBJECTIVES

The primary purpose of this travel was to close out the BARI/USAID/DWRC Vertebrate Pest Project at the Vertebrate Pest Section (VPS)/BARI, Joydebpur, Bangladesh, and to make recommendations for future activities at the VPS and possible cooperation between DWRC and the VPS, should funds become available. All USAID resources to the VPS ended on June 4, 1993, with the closeout of the Agricultural Research Project-Phase II Supplement. USAID requires a Project Assistance Completion Report (PACR), including accountability for all nonexpendable property items. This was completed and submitted on May 20, 1993. Secondary objectives were to try to find other funding for the VPS in the future, help plan future research studies, and assist the VPS in payment for commodities and construction at the VPS site.

PROJECT HISTORY

The Vertebrate Pest Component (VPC) was created in 1978 as a part of the Agricultural Research Project-Phase I (ARP-I). The project was implemented as a section, the Vertebrate Pest Section (VPS) under the Division of Entomology at the Bangladesh Agricultural Research Institute (BARI) at Joydebpur.

The VPS was assisted in its research, technology development, strategic planning, technology transfer, and training by the Denver Wildlife Research Center (DWRC) of the U.S. Department of Agriculture (USDA) through a Participating Agency Service Agreement (PASA) between the USDA and the U.S. Agency for International Development (USAID). The DWRC provided technical assistance in the form of three successive resident wildlife biologists from 1978 until 1990. DWRC provided 11 TDY short-term consultants to the VPS between November 1991 and close of the project in June 1993. Thirty-four other TDY's were provided between 1978 and 1990. DWRC also assisted in the procurement of equipment, supplies, library resources, chemical analyses, radiotelemetry, and training of counterpart scientists.

Five counterpart VPS scientific staff took advanced degree academic training (M.S. or Ph.D.) overseas, and some of the other scientists participated in short-term training abroad. Four of the five recipients of advanced degree training are still with the VPS.

The VPS initiated pest definition studies and by early in the project (1983) had defined the major and minor pests of preharvest crops and postharvest stored foods in Bangladesh. Damage assessments and crop loss estimates showed that rodents were significant pests of wheat, rice, and farm-stored paddy, and that jackals caused significant damage to sugarcane and melons and a considerable loss of farm poultry.

A technology was developed to deal with rodent losses in wheat and rice, and through cooperative ties with the Department of Agricultural Extension (DAE), DWRC and VPS scientists attempted to transfer this technology to farmers through national rodent control campaigns. A country-wide strategy to control rodent damage to transplanted

aman (T. aman) rice was adopted by national authorities in 1990. The implementation of the final phase of the technology transfer strategy was attempted cooperatively with the DAE in country-wide rodent control campaigns in 1991 and 1992, and the campaigns are scheduled to be continued.

Other research was developed on pest bird problems in sprouting wheat and ripening maize. The status of the jackal as a pest of field crops and a predator on chickens and rats was evaluated. Postharvest losses of stored paddy in farm households were assessed, and a strategy for preventing losses was tested.

Where there was no capability in 1978 by the Government of Bangladesh (GOB) to assess the problem of vertebrate pests in agriculture and attempt their resolution, this capability is now institutionalized in the VPS and with its scientists in BARI. The facilities and equipment at VPS are some of the finest in vertebrate pest management in Asia. This capability can only be maintained in the future by adequate funding of research operations at the VPS from the Ministry of Agriculture and BARI as the program enters the new operations phase.

ACTIVITIES

Project Assistance Completion Report

The VPS project nonexpendable property items, including vehicles and motorcycles, were inventoried as to condition and whether used or unused. All nonexpendable property items were recommended to be turned over to the VPS for their continued use in carrying out research and development activities. The PACR, which was written and given to USAID on May 20 for their comments, included five recommendations concerning future evaluations, monitoring of progress, budgetary constraints, and divisional status for VPS/BARI).

Integrated Pest Management (IPM) and Rodent Control

On May 19, I met with Dr. S. Ramaswamy, IPM Specialist for South Asia, who coordinates the Food and Agriculture Organization of the United Nations (FAO)/IPM Project in Bangladesh. The FAO/IPM project in Bangladesh is attempting to transfer IPM principles and practices to farmer groups that are growing rice. Groups of 50 farmers in selected areas are given 30 hours of practical, hands-on training in insect and disease IPM practices in their own rice fields. More than 60 groups have been trained in the past 2 years. Dr. Ramaswamy was quite receptive to having this IPM project include rodents as well as other vertebrate pests, since rodents obviously are a major constraint to increasing rice production in Bangladesh. On May 26, VPS counterpart scientists met with Dr. Ramaswamy to discuss possible VPS involvement in the on-going

IPM project in Bangladesh. A draft IPM proposal pertaining to rodent control was presented and discussed (Appendix I).

DANIDA Project to Strengthen Plant Protection and IPM

The Counselor at the Royal Danish Embassy, Mr. Egon Madsen, was contacted to get information on a DANIDA (Danish International Development Agency) fact-finding team that was gathering information on how DANIDA could fund a project to strengthen plant protection and IPM in Bangladesh. He referred me to Mr. Ole Setner, Chief Team Leader, and Mr. Jesper Hansen, Team Member. I contacted Mr. Hansen by phone, and we discussed their proposal. Possibly another team will come later to look into issues like vertebrate pest management. I provided them with a copy of the PACR. I hope the report will be carried back to DANIDA headquarters and will be used to develop a working relationship with the VPS.

Department of Agricultural Extension (DAE)

Considerable time was spent with Mr. Santosh Sarker in designing a new poster and new brochure for the 1993 rodent control campaign. Some information from the 1992 campaign was prepared by Mr. Sarker and forwarded to the DWRC. Mr. Sarker reviewed the draft training manual prepared by Dr. Sayed Ahmed. The zinc phosphide policy draft prepared by Mr. Fiedler and Dr. Jackson was reviewed and discussed. This policy draft was prepared in response to the DAE giving consideration to dropping the requirement that zinc phosphide in Bangladesh can only be used in readymade baits. The pesticide distributors are refusing to formulate the baits and instead want to return to distributing small packets of technical-grade zinc phosphide for farmer use.

VPS Construction and Procurement

Vouchers for the three newly purchased air conditioners, computer, photocopier, and construction of the jackal facility and animal-holding laboratory were prepared by VPS personnel and submitted to USAID for payment.

The USAID Mission approved the VPS's request to procure a new computer and color photocopier, and both were acquired before my departure.

Renovation of the office/laboratory building was finished by early May; and by May 29, the new animal-holding facility was 95% completed and the jackal holding pens were 90% completed. With completion of the office renovations and the new animal-holding buildings, the VPS probably has one of the best vertebrate pest management research facilities in Asia.

Future VPS Research

The VPS staff was concerned about future research directions and the importance of verifying the effectiveness of the countrywide rodent control strategies. In cooperation with them, we prepared two research proposals, one on the shelf life of readymade zinc phosphide baits (still in draft) to evaluate one of the tools used in controlling rodents during the national campaigns. Another proposal concerned verifying the postharvest rodent control strategy of reducing rodent populations in farm structures between June and December by householder use of anticoagulant baits (Appendix II).

DISCUSSION

The technical assistance issues expected of the project have been completed by the DWRC. However, a number of other issues relating to the future status of the VPS are crucial to its continuing success and need to be addressed. The operational budget for the coming years is dependent on how BARI will divide up the block funds given them by USAID and how much funding comes from the Government of Bangladesh. In discussions with the Director-General at BARI, he indicated that all scientists at BARI would have to submit their research proposals, with justification, priorities, national significance, and resource needs clearly spelled out. This will require the VPS scientists to make good proposals with sound justification and rational budgets.

The proposed divisional status for the VPS would enhance its chances for a better cut of the BARI budget. This was recommended by the 1988 External Evaluation Team and is being considered by the BARI administration; but it is not very likely to happen. The Director-General repeatedly referred to disciplines, such as soil science, plant pathology, and entomology. Apparently vertebrate pest management is regarded as a nondiscipline.

Without external donor funds, the fieldwork of the VPS will quickly stop. That happened this past year: the VPS has received only 500 taka ($12.50) from the BARI administration and just received 20,000 taka ($500) in promised PL-480 funds. Attempts to uncover other donor funding sources for the VPS in the short time available were not very promising. The FAO/IPM project would be pleased to have VPS participation, but it has not agreed as yet to provide funds. The proposed DANIDA Project may consider picking up the VPS as a part of strengthening plant protection and IPM in Bangladesh, but a strong proposal from VPS is needed for their consideration.

There are still many unresolved areas of research in vertebrate pest management in tropical agroecosystems, such as those of Bangladesh. Many of the Bangladesh farmers face problems with vertebrate pests every cropping season. They still face losses in rice and wheat despite research and technology development because it is so difficult to transfer these technologies on a countrywide scale. Even the simple option of using a readymade quick-killing bait is still not available to farmers to solve their problems because of pesticide formulators' reluctance to provide the baits. Incentives are needed

to provide motivation to private pesticide dealers and formulators so that they might take advantage of such opportunities.

Acknowledgments

The help of the scientists at the VPS is gratefully appreciated. My relationship with them goes back 12 years, holding fond memories for all of us. Ending a project of this kind is difficult and saddening. I wish them well in future ventures and hope that the VPS and the DWRC can find ways to continue as "sister research centers."

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AN INTEGRATED PEST MANAGEMENT APPROACH TO RODENT CONTROL

VERTEBRATE PEST SECTION, BARI

Introduction

The devising of an integrated pest management (IPM) program for rodent control in a tropical agroecosystem is needed in Bangladesh. IPM uses a multifaceted approach to control of animal populations in crops--the use and encouragement of predators, the physical methods of removal of pest animals, habitat manipulation, and a minimum of chemicals or their use as a last resort. IPM relies upon threshold levels at which action is taken. It uses population monitoring and feedback to determine when further management actions are required.

IPM has worked quite well in managing the impact of insect populations in certain crops, most notably cotton and rice. But rodents require somewhat different approaches in their management than do insects. Rodent predators are usually larger animals and are not very abundant under the best of circumstances. Some predators, snakes, for example, are as unwanted as the pest rodents, and it is hard to encourage people to increase their numbers.

In Indonesia, Thailand, and Bangladesh, IPM approaches in rice, working closely with farmers, have shown how the use of pesticides can be cut drastically, yet rice yields continue to rise. An IPM program for rodents needs to be developed that can be complementary to the insect and plant disease IPM programs presently in place. Not to consider rodents in an IPM scheme is to omit from the program one of the important pests that farmers face every year. IPM extended without rodent control is incomplete and may lack credibility at the farm level.

IPM Elements

IPM uses monitoring of the pest population to see if it crosses a certain threshold level. Monitoring is usually done by the farmers themselves, and then they make the decisions regarding when to take action. The threshold level is usually the point at which the control actions are economically justified, i.e., their cost equals the cost of the crop losses. These economic threshold levels (ETL) are usually determined for each crop in an area based upon local experience. When the pest population rises above the ETL, then a decision is made to take action, using the most efficient and economic control methods.

Management practices are then carried out in a coordinated, cooperative manner by all farmers in the area. These consist of habitat manipulation, cultural practices, physical methods of rodent killing, rodent-proofing, encouraging of predators, bounties on rodent

killing, and finally, chemical control methods as necessary. Through monitoring, it can be determined when further action is needed.

Population Monitoring

Monitoring observations for rodent damage and/or rodent burrow systems in rice fields can be done by individual farmers or by trained farmer/observers, the latter inspecting a series of fields in a village area and reporting the tabulated findings back to the village council or the local extension worker. Monitoring observations are taken weekly, beginning at the tillering stage.

The observer counts the number of rodent burrow systems in each field and records the field area, or he counts the number of rodent-damaged rice hills (a rice hill is one rice plant with multiple stems) in a sample of 5 or 10 hills per field, randomly selected. When damaged hills or the number of rodent burrow systems reaches a predetermined threshold level, action is called for. At this point, a collective decision is made by the group of rice farmers to organize coordinated rodent control measures.

As a guide as to where the ETL should lie, consider that one rat living in a rice field can consume and destroy 70 grams of rice per day, or about 5 kg in a 70-day growth period. When production of aman rice averages only about 650 kg per acre (Bangladesh Annual Statistics, 1992), the loss of 5 kg is equal to an 0.8% loss of yield, 2 rats would cause a loss of 1.5% and 3 rats, 2.3%. The loss of 2% should be the threshold for action, since 10 kg of rice is worth about 100 taka on the market, more than enough to justify the cost of IPM. So two rodent burrow systems/acre is a good level at which to take action. As for damage to rice hills, the 2% level is another good guide. This level should be determined more accurately in field studies.

Management Practices

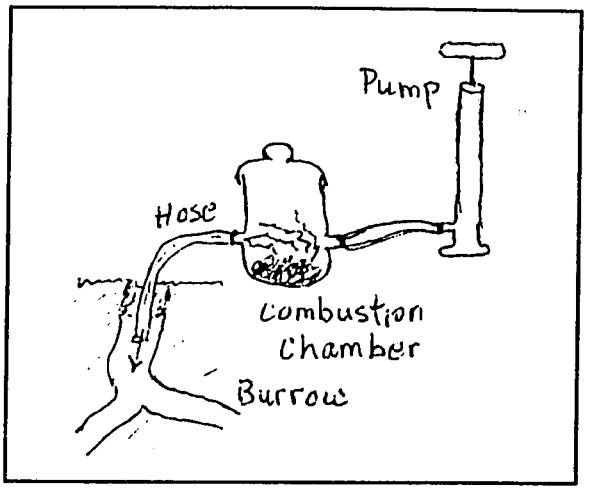
Physical Methods

Farmers traditionally employ several indigenous methods of rodent control in their fields. None of the indigenous methods have been evaluated for efficacy.

- Trapping, with locally made bamboo traps is practiced by a few farmers; however, because of theft of traps placed in fields, this method is not popular. Glue boards might be an acceptable alternative, but these have never been evaluated in the field. Locally made steel-base traps are available, but they are considered too expensive for farmer use, especially considering theft of traps in the fields.

- Watering, the pouring of water into rodent burrows, is not often practiced in field situations; instead, it is generally a household endeavor where burrow systems are generally less extensive. Watering requires several participants ready with sticks to kill rodents emerging from burrow systems.

- Smoking, which may have the most applicability to field situations, is practiced traditionally with dried chilies or chili powder. Other materials that could be burned include rice or wheat straw, jute waste, used motor oil, or yellow sulfur. Usually the materials are inserted into the burrow opening and lighted with the hope that the smoke will penetrate the burrows. Smoking could be made more effective by using a small metal combustion chamber, connected to a bicycle pump on one side and a smoke outlet hose on the other, leading into the burrow system. Smoking also requires several participants standing by with sticks and ready to kill rodents emerging from the burrows.



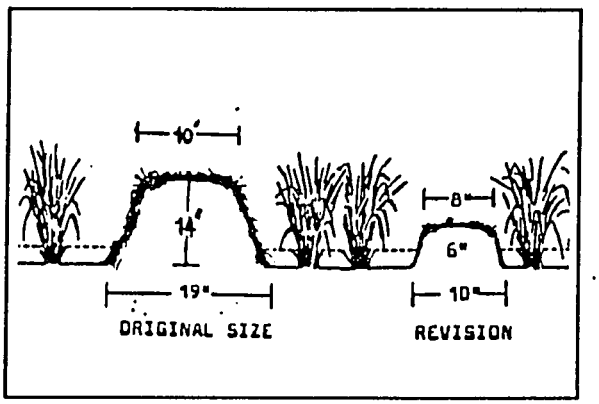
- Digging is sometimes practiced, but mostly this is done after the harvest in order to reclaim the stored rice or wheat panicles, which does no good for controlling rodents. The digging should be done at the time the field is prepared so that any rodents living in the area are eliminated before planting.

Habitat Manipulation

- Weed control is conducted on dikes (bunds) and within fields. Weeds provide food and cover to rodents while the rice is still in the vegetative stages, encouraging rodents to live on dikes and within fields. The weeds provide rhizomes, leaves, stems, and seeds to the rodents. Where weeds are removed, rodent populations decrease and rice yield increases.

- Synchronous planting of rice by cooperating farmers in villages will tend to disperse rodent populations uniformly. No one field will receive excessive rodent populations as they do when planted either earlier or later than the majority.

- Dike (bund) areas should be limited by either having larger fields and/or cutting dikes to where they are no wider than 15 cm. Burrowing rodents prefer wider dikes (30-40 cm or more); making them smaller reduces the capacity for the dikes to support more rodents.



- Manage the water levels so that no more than 15 cm of dike is above the water level. Burrowing rodents prefer higher dikes. Keeping dikes lower or closer to the water discourages rodents.

Biological Control

- Predators, such as jackals, foxes, mongoose, jungle cats, owls, monitor lizards, and snakes prey upon rodents in rice fields. Their numbers should be encouraged in most cases, not reduced. Jackals, foxes, and jungle cats prefer thick, protected vegetation in which to hide during the day; some of these areas should be retained around the rice fields. Owls can be encouraged by making artificial nest boxes and placing these around villages. Owls are declining in numbers throughout Bangladesh because the older trees they prefer for nesting are being cut and removed. One jackal can kill and eat 4 rats each night, more than 1,400 per year.

- Very few diseases and parasites exert enough pressure on rodent populations to cause significant effects. However, when populations are stressed (severe weather, flooding, etc.), diseases and parasites may become an important cause of mortality for a limited period; but they are of little practical value in an IPM program.

Bounties

- The payment of bounties for killing rats can have a profound effect for a short period. The payment should be encouraged before rodents can cause the most damage to the rice crop. In the case of transplanted aman rice, this would be before the flowering stage. Payments should not be made for rodents killed during other periods.

Chemical Control

- Chemical control means the use of poisons, fumigants, tracking powders and tracking gels/greases, repellents, aversive agents, and sterilants. Those most frequently used for field rodents are poison baits and burrow fumigants.

- Poisons consist of fast-acting (acute) toxicants and slow-acting (chronic) toxicants. The best example of a fast-acting poison is zinc phosphide, which kills rodents within 24 hrs after it has been eaten. Zinc phosphide is usually mixed with cereal grains or flours made into "bait cakes," with a little vegetable oil added for attractiveness. Slow-acting poisons are anticoagulants which, when consumed over a period of several days, cause the rodents to bleed to death internally. These are usually mixed into baits the same as zinc phosphide. The fast-acting poison baits need to be used only for one night. However, they give only about a 50-70% kill when they are used, and they cannot be used again against the same population. Anticoagulant poisons usually require that baiting be done for several nights (2-5)

and the main mortality of the rodents will not take place for about a week after baiting starts. Anticoagulant baits can give kills of 90 to 95%; if baiting is continued, it can give complete clearance of the rodent population. Farmers prefer to see dead rodents the next day and to bait only for one night; this makes anticoagulants much less popular with farmers than fast-acting poisons.

- Poison baits are placed right into the burrow openings and the burrows then sealed with soil. This minimizes the exposure of nontarget animals, is an environmentally sound practice, and is easily understood and accepted by the farmers.

- Burrow fumigants consist of aluminum phosphide tablets that release phosphine gas when the tablets are exposed to moisture in the rodent burrows. The release may be rather slow, however, sometimes giving the rodent time to seal off the burrow system and escape unharmed. Also, these tablets are more expensive than fast-acting baits.

- Toxic gels/greases consist of waste motor oils mixed with zinc phosphide. This mixture is painted onto the opening of the rodent burrow or onto a piece of bamboo inserted into the burrow.

Training Methods

It is proposed that the Vertebrate Pest Section (VPS)/BARI participate in the United Nations Food and Agriculture Organization's (FAO) Integrated Pest Management (IPM) program in Bangladesh. The present IPM program does not include much information on rodent control for farmers. Considering the damage that rodents can cause in the rice agroecosystem, there is every reason why rodents should be a part of any IPM program. To leave them out is remiss.

The Vertebrate Pest Section scientists could attend the IPM training sessions for farmers and provide training in the methods mentioned above, including the monitoring procedures. At the same time, they could gather data on where to set the economic threshold level (ETL). The VPS program could be viewed as a small addition to the existing program. Since it involves environmental considerations, it will require some sources of funding in this area.

Appendix II.

A VPS/DWRC COOPERATIVE RESEARCH PROPOSAL

A STRATEGY TO REDUCE POSTHARVEST STORED FOOD LOSSES

Several studies by the VPS/BARI of the rodent fauna of farm household structures in Bangladesh have shown that three rodent species predominate: house mice (*Mus musculus*), roof rats (*Rattus rattus*), and lesser bandicoot rats (*Bandicota bengalensis*). Their numbers fluctuate according to monsoon flooding and the quantities of stored foods, mainly stored rice (paddy). Loss estimates, based upon the amounts of foods that rodents could consume or hoard, were in the range of 50 kg/farm family/year. These estimates did not take into account for foods wasted or contaminated.

These losses can be reduced by reducing the number of rodents in farm structures. The most obvious time to do this is from June until December, which corresponds to the time when rodents breed and increase in number and also when the maximum amounts of stored foods are present and at risk.

Rodents can be reduced in number by removal (killing) methods, such as by extensive household trapping or killing with poison baits. Several studies indicated the presence and fluctuations of the rodent populations, but only one study of the comparative effects of two rodenticides in island/villages indicated the potential of this method to reduce rodent numbers in farm structures.

Purpose of the Study

The purpose of the study is to verify the strategy of using rodent population reduction methods to reduce the losses of stored foods in farm households. Rodent numbers are highest from June until December, corresponding with the maximum amounts of stored foods in the households. Householder use of anticoagulant baits inside farm structures was carried out in a previous study comparing two rodenticides on island/villages. The hypothesis here is that rodent numbers and rodent activity can be reduced by householders periodically poisoning them with anticoagulant baits. Reducing rodent numbers will reduce losses of stored foods.

Methods

Two groups of farm household structures will be compared: one group, a reference, where no attempt will be made to reduce rodent numbers; the other group will have the householders attempt to reduce rodent numbers through the use of anticoagulant baits at regular 3-month intervals. Lanirat®[1] (bromadiolone) baits, the most widely available rodenticide on the open market in Bangladesh, will be used.

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[1] Reference to trade names does not imply endorsement by the U.S. Government.

Tracking tiles will be used to assess the rodent activity before population reduction. Tiles will be placed in both groups of households for 2 nights; they will be set on machas (shelves or platforms), dholes (paddy storage baskets), and on floors.

Baiting will be attempted for 1 to 2 weeks by giving each householder a 100-g packet of Lanirat bait. They will be instructed to divide it into 10 portions and to place each portion in a place where rodents are expected, but to keep it protected from children, pets, and poultry.

After 2 weeks, allowing time for mortality, tracking tiles will again be set to determine any decrease in rodent activity. Tiles will be set also in the untreated group of households.

Again, at 3-month intervals, tracking tiles will be set to assess rodent activity in the two groups of households. It is expected that activity will be increased in the previously treated households. A second treatment with Lanirat will be attempted by householders for 2 weeks. Posttreatment activity will be assessed at both treated and untreated households.

A final assessment will be made at 6 months, and a final treatment will be conducted. The results of the activity measured will be statistically compared at the end of the trial. The cost:benefit of the operation, comparing control costs with potential stored grain savings, will be calculated. The results will indicate the efficacy of householder-attempted rodent control.

The trial will be conducted in farm households near the BARI, Joydebpur, campus.

RODENT CONTROL TRAINING AND RODENTICIDE FIELD TRIALS IN CHAD

TRIP REPORT

26 AUGUST - 27 SEPTEMBER 1992

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Project Leader

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RODENT CONTROL TRAINING AND RODENTICIDE FIELD TRIALS IN CHAD-TRIP REPORT (26 AUGUST - 27 SEPTEMBER)

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INTRODUCTION AND OBJECTIVES

The Chad Rodent Control Research Project was initiated by the Denver Wildlife Research Center in October 1989 and field work on rodents in the Sahel region was carried out until the departure of the resident Project Leader, J. J. Spillett, in early December 1991. No field work was subsequently done until the arrival of J. E. Brooks from the Denver Wildlife Research Center on 11 August 1992. Maho Angaya, the Project Assistant hired 2 weeks prior to Spillett's departure, carried out limited laboratory work in the interim but spent most of his time translating into French all project documents as well as the training manual drafted by J. E. Brooks.

J. E. Brooks was in Chad from 11 August to 13 September 1992. The objectives of his trip were to 1) reactivate the project by preparing budgetary and administrative details in agreement with USAID/Chad and developing work plans for the project through the completion date of 31 December 1992, 2) revisit project sites at N'Gouri and Karal to obtain information on the status of rodent populations in preparation for rodenticide field trials, 3) prepare and present a 5-day seminar on rodent control and research techniques in N'Djamena to Chadians from various private and government organizations involved in agricultural production, and 4) conduct laboratory toxicity studies of rodenticides on multimammate rats (Mastomys natalensis) and unstriped grass rats (Arvicanthis niloticus). All objectives were met and have been documented (Brooks 1992).

The objectives of my overlapping trip to Chad from 27 August to 27 September were to 1) assist Brooks in the planning, preparation and presentation of the 5-day seminar, 2) conduct field trials of rodenticides to obtain information on bait acceptance by rodents, efficacy in reducing rodent populations, and hazards to nontarget species, and 3) continue collecting data on the biology and status of rodent populations in the Sahel region of Chad. In addition, I had the opportunity to make limited observations and assessments of bird damage to

agricultural crops and provide some training in bird damage control. My trip itinerary is listed in Appendix A.

RESULTS

Seminar on Rodent Research and Control

Brooks (1992) has documented the success of the 5-day seminar (8 - 12 Sept. 1992), in which 15 participants from 9 locations in Chad received training via lectures, hands-on laboratory work, practical field demonstrations, and a comprehensive training manual. Although there were many administrative and logistical obstacles and challenges in organizing and presenting the seminar (e.g., locating various instructional supplies in N'Djamena, not to mention dealing with a planned national workers strike and a major religious holiday during the week of the seminar), we had 100% attendance and excellent attentiveness and response by the participants. The closing ceremony, in which certificates were presented to participants and speeches were made by the USAID Representative and the Minister of Agriculture and Rural Development, was covered by Chadian television and radio. The seminar was personally a rewarding experience.

Brooks (1992) has already provided details on the seminar participants and course of instruction related to rodents. Because there was considerable interest by the participants in bird damage to agricultural crops, some seminar time was devoted to this topic which I will summarize here. A demonstration was given on the deployment of mylar ribbons and eye-spot balloons to frighten birds in grain fields. Each participant was given a 100-m roll of ribbon to take home and use as a demonstration project in a local field of millet or sorghum. A bird-resistant variety of millet, with bristles (awns) protecting the grain, was compared with a bird-susceptible variety during a lecture session. Then, a damage assessment demonstration was conducted in a ripening millet field at Gassi Seed Farm 15 km from N'Djamena in which a sample of 100 heads from bird-susceptible varieties averaged 24% (SD=27%) loss of grain to birds (73% of the heads were damaged). An examination of 20 heads of the above-described resistant variety in an adjacent plot revealed no damage.

Field Research-Karal/Beltram

Brooks (1992) documented the results of this 2-day trip (29-30 Aug) in which field and village rodent trapping was conducted. In addition to the rodent work, we located a ripening maize field west of Beltram within a few kilometers of Lake Chad in which 44 of 150 ears examined (29%) were damaged by birds. Damaged ears averaged about 25% of the grain destroyed, indicating a total loss of grain in the field of about 7%. The damage appeared to be at least several days old and we saw no flocks of birds in the field; thus, the species responsible for the damage was undetermined. I did note red bishops (Euplectes orix) nesting around the maize field. Wet ground prevented us from driving closer to Lake Chad to examine other maize fields.

Field Research-Gassi Seed Farm

Brooks (1992) documented rodent trapping and monitoring results on 20 August and 3 September from this farm about 15 km E of N'Djamena. Additional trapping and monitoring were done on the night of 10-11 September as part of the training seminar. The results from all 3 nights are summarized in Table 1. Snap traps were baited with peanut butter and live traps (approximately equal numbers of Tomahawk and Japanese) were baited with potatoes or fresh sections of maize on the cob. Overall, only 3 rodents (2 Mastomys natalensis and 1 roof rat [Rattus rattus]) were captured in 176 trap-nights. Three shrews (insectivores) were also captured and 10% of the tracking tiles (15 x 15 cm white linoleum with 1/2 of the surface coated with a thin layer of a 90% mimeograph ink-10% peanut oil mixture) showed small mammal tracks. The seed farm had dense vegetation around the buildings and agricultural fields but no unstriped grass rats were trapped or observed.

As noted above in the Seminar section, grain loss to birds of 24% was estimated in 1 ripening millet field at the seed farm. Damage appeared to be primarily by village weavers (Ploceus cucullatus) although other species of small birds, including cut-throat weavers (Amadina fasciata), were also observed in the field. The farmer was attempting to protect the 0.5-ha field with a rather elaborate system of metal cans containing pebbles suspended at millet-head height from ropes strung from poles

throughout the field. One person, who apparently guarded the field throughout the day, could rattle all of the cans by pulling on a main rope from the field edge.

Field Research-N'Gouri

Field work was conducted near N'Gouri, about 200 km from N'Djamena on the NE side of Lake Chad, from 15 - 22 September. We conducted rodenticide field trials in 4 wadis (interdune depressions or oases where hand irrigation from shallow wells is used to grow grain and vegetable crops). We also monitored rodent populations and made notes of birds in the wadis and on the dune areas surrounding the wadis where dryland cultivation of millet is undertaken. Bird observations were made to obtain information on species causing agricultural damage and on species that might be impacted by rodenticide baitings.

Rodenticide trials-- A 1% zinc phosphide (ZP) bait was prepared by mixing 1 part ZP formulation (96% ZP) with 94 parts millet and 1 part peanut oil. A 0.005% Chlorophacinone (CP) bait was prepared by mixing 1 part CP formulation (0.28% CP in mineral oil) with 55 parts millet. The bait was mixed 4 to 6 days before using and stored in clearly labeled, heavy plastic bags.

The 4 wadis selected for the trials were within 5 km of N'Gouri. All were oval shaped, about 200 to 250 m long by 100 to 150 m wide, and surrounded by thorn fences 0.5 to 1 m high and 0.5 to 1.5 m wide. Each wadi was inspected before the trial began to look for rodent activity (cut vegetation, pathways in thorn fence); to ask the local farmer if rodents were a problem; and, if conditions appeared satisfactory, to obtain permission from the farmer to run the trial. The baiting and monitoring procedure was explained to the farmer and his field workers, they were warned about the rodenticide bait, and they were asked to look for sick or dead rodents and birds during the trial.

In each wadi, 50 stations for monitoring and baiting rodents were established at 10-m intervals along a 500-m section of the thorn fence that appeared to have the most rodent activity (generally about 50 to 75% of the total length of the fence was covered). Pretreatment monitoring of rodent activity was done by placing on the ground in the thorn fence at each station a tablespoon (about 15 g) of untreated millet in a pile, a tracking tile, and a snap and/or live trap for 1 or 2 nights. We placed

these materials in runways whenever possible and tried to place the bait deep enough in the thicket to be inaccessible to birds. Traps, tiles and bait were checked daily. The amount of bait removed was estimated in 25% increments (0, 25, 50, 75, 100% removal) and replenished to the original amount when ≥ 50% was removed. The observer noted if insects appeared responsible for bait removal. Tracking tiles were examined for the presence of rodent track(s) which, if present, were wiped clean with a cloth.

After the pretreatment period, baiting with rodenticide was conducted for 3 to 4 nights in the 2 wadis treated with ZP and for 4 to 5 nights in the 2 wadis treated with CP. Treated bait was placed and monitored in the same manner as done for the untreated millet. A 1- to 2-night posttreatment monitoring period using tracking tiles and traps was then conducted in each wadi. Observers looked for sick or dead rodents and other wildlife as they walked through the wadis and alongside the thorn fences daily in their inspections of the baiting and monitoring stations. In addition, the perimeter and interior of each wadi was searched for 1.5 to 2.0 person-hours (4 to 5 people each searching 20 to 30 minutes) during the posttreatment period.

Overall, bait acceptance by rodents appeared good during both pretreatment and treatment periods. During pretreatment, 36 to 88% of the stations had ≥ 25% of the millet removed overnight, apparently by rodents (Tables 2-5). During the first 2 nights of the treatment period, 28 to 64% of the stations had ≥ 23% of the bait eaten overnight in the CP-treated wadis (Tables 2, 3) and 40 to 52% had bait eaten in the ZP-treated wadis. Insects (primarily ants and beetles) removed ≥25% of the bait at about 5% of the stations.

Wadis with ZP-treated millet showed a greater reduction in rodent activity posttreatment than did wadis with CP-treated millet. Bait piles eaten declined from 50 and 88% during the pretreatment period to 4 and 8% on the last day of treatment for the 2 ZP-treated wadis. Positive tracking tiles declined from 42% in both wadis during pretreatment to 2-9% during posttreatment. Captures in snap traps were also down from 8 and 22% pretreatment to 2 and 0% posttreatment (Tables 4, 5).

For CP-treated wadis, bait consumption showed no consistent pattern of decline during the 5-day treatment period compared to the pretreatment levels. Positive tracking tiles actually

increased from 8% pretreatment to 18% posttreatment in 1 wadi (Table 2) and decreased from 28% to 8% in the other wadi (Table 3). Captures in live traps did show a decline from 12 and 18% pretreatment to 0% posttreatment.

A total of 26 rodents was trapped in the 4 wadis in 523 trap nights (221 live traps, 277 rat snap traps, 25 mouse snap traps). Species composition was Arvicanthis niloticus (65%), fringed-tailed gerbils (Tatera robusta) (19%), naked-sole gerbils (Taterillus sp.) (12%) and ground squirrel (Xerus erythropus) (4%) (Table 6).

One dead rodent and 1 dead bird were found in the wadis during the treatment-posttreatment period. In Kaya Wadi (Table 4), 1 dead Tatera robusta was found on 19 September (2 days after ZP-treated millet placement) at a burrow entrance about 5 m from the thorn fence. An autopsy revealed Zn-treated millet in the stomach. In Goural Wadi (Table 2), a pigeon-sized bird (as yet unidentified to species), was found on 22 September (6 days after CP-treated millet placement). An autopsy revealed only insects in the stomach and no evidence of hemorrhaging or liver discoloration. Thus, it is doubtful that this mortality was related to the treatment.

In conclusion, the rodenticide field trials indicated that 1% ZP-treated millet can be used in Wadi thorn fences to reduce rodent populations. There was no evidence of mortality to nontarget species in the ZP trials. For CP, the test results were not clear-cut. Although bait acceptance appeared good, feeding and tracking tile activity did not show consistent declines after 5 days of baiting. Because CP is a slow acting anticoagulant toxicant, perhaps significant mortality did not occur until 6 or 7 days after feeding when our posttreatment evaluations were terminated. Additional, longer-term field studies are needed to clarify this issue.

Miscellaneous rodent monitoring activities-- We placed mouse snap traps overnight in 6 dune areas and rat snap traps in 1 of these areas. In 281 trap nights, we captured 8 sand gerbils (Gerbillis andersoni) (Table 6). This low trap success was somewhat surprising because most traps were placed near what appeared to be active burrows of Gerbillis andersoni or jerboas (Jaculus jaculus).

We conducted 3 roadside censuses by vehicle at night near N'Gouri to count rodents. Surprisingly, although no Jaculus jaculus were captured in snap traps in the dunes, this species was commonly seen at night along the road, averaging 4 individuals/km (Table 7). Jaculus appeared to be most common in areas of sparse vegetation such as where millet fields were adjacent to the road. We found them relatively easy to capture by hand; 12 were captured in this fashion, primarily by Maho Angaya.

We excavated 2 burrow systems of Gerbillis andersoni in the dunes on 15 September and found 3 juveniles in each. These 6 gerbils were kept in captivity during our stay in N'Gouri. We found that they highly preferred grasshoppers as a food to rice or maize. They would aggressively attack and eat grasshoppers placed in the cage. Arvicanthis, Tatera and Jaculus in captivity did not exhibit this behavior toward insects.

We monitored 1 pitfall trap (a clay container about 50 cm deep and 30 cm in diameter at the opening) which had been installed in the ground next to the thorn fence in Goural wadi sometime previous to our arrival. The trap contained water about 10 cm deep. One juvenile Arvicanthis was captured over the 8-day period of monitoring.

Table 8 summarizes reproductive data for adult female rodents autopsied. Data are meager for Tatera and Arvicanthis because most individuals of these species were captured in live traps in wadis during the rodenticide trials and marked and released.

Bird damage--There was considerable bird activity in and around many of the upland (dune) millet fields which were beginning to ripen in mid-September. Because of above-average rainfall this year, the ripening millet crop was considered outstanding by the local farmers. Golden sparrows (Passer luteus) were common in the area, often seen in the millet fields and in thorn trees where they were nesting. Other finch-like birds were also present in the millet but our impression was that Passer luteus was the most common bird. In spite of the bird activity, virtually no bird damage was noted in 10 millet fields that I walked through on the dunes. Perhaps bird damage will occur in October as the crop reaches final maturity. Bird damage was obviously of concern to farmers because most fields had some

type of scarecrow or flagging to frighten birds. The only significant bird damage I noted was to a small (10 x10 m) plot of mature millet in Guini wadi. Here, 26 heads examined averaged 61% of the grain removed by birds.

Comparison of rodent monitoring methods

Overall, snap traps appeared to be the least effective means of monitoring rodent populations, both at Gassi Seed Farm (Table 1) and around N'Gouri (Table 6). At Gassi, snap traps had 0% capture success compared to 4% for live traps and 10% for tracking tiles. At N'Gouri in the wadis, rat snap traps had a 1.4% success rate compared to 10.0% for live traps and 17.5% for tracking tiles. In the dunes, where snap traps were placed primarily around active burrows, trap success was only 3.3%. When the data from Gassi and N'Gouri are combined, there are significant ($P \leq 0.01$) differences in success among tracking tiles (16.7%), live traps (7.8%) and snap traps (1.9%) (X_2 = 83.5, 2 df, Table 9). Brooks (1992) also noted much better success with live traps than with snap traps at N'Gouri in August 1992.

Acknowledgements

I especially commend Dr. Maho Angaya for the excellent translation he did for the training manual, for the outstanding job of helping to organize and lead the seminar, and for his expertise and enthusiasm in the field work. I recognize Joe Brooks for his leadership and professionalism in the seminar and for his advice and assistance in preparing me for the field work. I also commend our driver, Mahamet El-Hadji N'Gaba, for his driving skills and able assistance with the field work. Working with these 3 people was a rewarding and pleasurable experience during a very challenging assignment.

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1. Small mammal trapping and monitoring effort and success for live traps, snap traps, and tracking tiles set overnight in vegetation next to agricultural fields, in a seed storage warehouse, and in a millet-okra field at Gassi Seed Farm 15 km east Djamena, Chad, 1992.

	Habitat	Live traps		Rat snap traps		Mouse snap traps		Tracking tiles	
		No. of traps	No. of captures (% success)	No. of traps	No. of captures (% success)	No. of traps	No. of captures (% success)	No. of tracking tiles	No. (%) marked
ug	Field edge	30	3 (10)[a]						
ep	Field edge	38	2 (5)[b]					36	6 (17)
	Storage	10	1 (10)[c]	5	0 (0)	5	0 (0)		
ep[d]	Field edge	25	0 (0)			25	0 (0)	24	0 (0)
	Millet-okra field	23	0 (0)						
	Storage	10	0 (0)	5	0 (0)				
		136	6 (4)	10	0 (0)	30	0 (0)	60	6 (10)

[a] Two shrews (Crocidura flavescens), 1 hedgehog (Erinaceus albiventris).

[b] Two Mastomys natalensis.

[c] One Rattus rattus.

[d] Heavy rain (>25 mm) during the night of 10-11 September may explain the total lack of trapping and tracking success on this

Table 2. Bait piles fed upon, tracking tiles marked, and traps capturing rodents at Goural Wadi near N'Gouri, Chad during field trial of chlorophacinone (CP), 16 to 22 September 1992.

	Pretreatment activity (16-17 September)			Treatment period bait consumption (CP-treated bait piles eaten[a] [N=50])					Posttreatment activity (21-22 September)		
	Bait piles eaten[a] (N=50)	Positive tracking tiles (N=100)	Captures in live traps (N=50)	Sep 17	Sep 18	Sep 19	Sep 20	Sep 21	Positive tracking tiles (N=100)	Captures in: live traps (N=20)	Captures in: snap traps (N=50)
No.	18	8	9[b]	19	32	38	28	20	18	0	1[c]
%	36	8	18	38	64	76	56	40	18	0	2

[a] At least 25% of bait pile removed overnight.

[b] Five Arvicanthis niloticus, 2 Taterillus sp., 1 Tatera robusta and 1 Xerus erythropus. Seven of the 9 were marked and released.

[c] One Tatera robusta.

Table 3. Bait piles fed upon, tracking tiles marked, and traps capturing rodents at Assakandori Wadi near N'Gouri, Chad during field trial of chlorophacinone (CP), 17 to 22 September 1992.

	Pretreatment activity (17 September)				Treatment period bait consumption (CP-treated bait piles eaten[a] [N=50])					Posttreatment activity (22 September)	
	Bait piles eaten[a] (N=25)	Positive tracking tiles (N=50)	Captures in snap traps (N=25)	Captures in live traps (N=25)	Sep 18	Sep 19	Sep 20	Sep 21	Sep 22	Positive tracking tiles (N=50)	Captures in live traps (N=20)
No.	10	14	0	3[b]	14	28	22	18	10	4	0
%	40	28	0	12	28	56	44	36	20	8	0

[a] At least 25% of bait pile removed overnight.

[b] Two *Tatera robusta* and 1 *Taterillus* sp.. One of the *Tatera* was marked and released.

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Table 4. Bait piles fed upon, tracking tiles marked, and traps capturing rodents at Kaya Wadi near N'Gouri, Chad during field trial of Zinc Phosphide (ZP), 17 to 22 September 1992.

	Pretreatment activity (17 September)			Treatment period bait consumption (ZP-treated bait piles eaten[a] [N=50])				Posttreatment activity (21-22 September)	
	Bait piles eaten[a] (N=25)	Positive tracking tiles (N=50)	Captures in snap traps (N=25)	Sep 18[b]	Sep 19	Sep 20	Sep 21	Positive tracking tiles (N=100)	Captures in snap traps (N=50)
No.	22	21	2[c]	25	29	28	2	9	1[d]
%	88	42	8	50	58	56	4	9	2

[a] At least 25% of bait pile removed overnight.

[b] Three Arvicanthis niloticus caught in 25 live traps set during first night after Zn-treated bait was placed. One of the trapped animals was dead in trap and Zn-treated millet was found in stomach. The other two captured rats were marked and released.

[c] Two Arvicanthis niloticus.

[d] One Arvicanthis niloticus.

ıle 5. Bait piles fed upon, tracking tiles marked, and traps capturing rodents at Guini Wadi ır N'Gouri, Chad during field trial of Zinc Phosphide (ZP), 19 to 22 September 1992.

Pretreatment activity (19 September)			Treatment period bait consumption (ZP-treated bait piles eaten[a] [N=50])			Posttreatment activity (22 September)		
Bait piles eaten[a] (N=50)	Positive tracking tiles (N=50)	Captures in snap traps (N=18)	Sep 20	Sep 21	Sep 22	Positive tracking tiles (N=50)	Captures in live traps (N=18)	Captures in snap traps (N=50)
25	21	4[b]	20	21	4	1	1[c]	0
50	42	22	40	42	8	2	6	0

[a] At least 25% of bait pile removed overnight.

[b] Three Arvicanthis niloticus and 1 Tatera robusta captured. One Arvicanthis was marked released.

[c] One Arvicanthis niloticus captured.

Table 6. Trapping effort and success for live traps, rat snap traps and mouse snap traps in 4 Wadi and 6 dune locations near N'Gouri, Chad, 16 to 22 September 1992.

	Live traps			Rat snap traps			Mouse snap traps			Tracking tiles		
Habitat	No. of trapping sessions[a]	No. of trap nights	No. of captures (% success)	No. of trapping sessions[a]	No. of trap nights	No. of captures (% success)	No. of trapping sessions[a]	No. of trap nights	No. of captures (% success)	No. of tracking sessions	No. of tracking-tile nights	No. marked (% success)
Wadis	10	221	22 (10.0)[b]	7	277	4 (14)[c]	1	25	0 (0)	11	550	96 (17.5)
Dunes	0	0	0 (0)	1	35	0 (0)	6	246	8[d] (3.3)	0	0	0 (0)
Total	10	221	22 (10.0)	8	312	4 (1.3)	7	271	8 (3.0)	11	550	96 (17.5)

[a] Number of nights in which 18 to 50 traps or tracking tiles were placed in a Wadi or dune.

[b] Fourteen *Arvicanthis niloticus*, 4 *Tatera robusta*, 3 *Taterillus* sp., and 1 *Xerus erythropus*.

[c] Three *Arvicanthis niloticus* and 1 *Tatera robusta*.

[d] Eight *Gerbillis andersoni*.

Table 7. Nighttime census of rodents within 10 km of N'Gouri conducted by driving vehicle along road at 5-20 km/hr and counting rodents observed in headlights.

Date	Start time	Distance covered	Total number observed (number/km)			
			Jaculus jaculus	Gerbillis andersoni	Tatera robusta	All species
14 Sep	1900	10 km	40 (4)[a]	15 (1.5)[a]	2 (0.2)	57 (5.7)
18 Sep	1930	5 km	25 (5)[b]	2 (0.4)		27 (5.2)
20 Sep	1930	5 km	14 (2.8)[b]	2 (0.4)		16 (3.2)
Total		20 km	79 (4.0)	19 (1.0)	2 (0.1)	100 (5.0)

[a] On the first night, we probably misidentified some Jaculus as Gerbillis.

[b] On these 2 nights we hand-captured 11 Jaculus by chasing them on foot with a flashlight.

Table 8. Reproductive information for adult female rodents captured and autopsied at N'Gouri, Chad, 15-22 September 1992.

Species	No. of adult females autopsied	No. pregnant	Litter size		
			x	SD	(range)
Jaculus jaculus	5	1	4	0	(4)
Tatera robusta	2	1[a]	6	0	(6)
Gerbillis andersoni	9	7[a]	5.6	1.2	(4-7)
Arvicanthis niloticus	1	0[a]	0		
Xerus erythropus	1	0[a]	0		

[a] The females that were not pregnant had recently given birth and were lactating.

Table 9. Overall comparison of snap traps, live traps and tracking tiles for monitoring rodent populations at Gassi Seed Farm (Table 1) and N'Gouri (Table 6), Chad, August - September 1992.

Monitoring method	No. of trap or tracking nights	No. of captures or positive tracks	% success
Live traps	357	28	7.8[a]
Snap traps	623	12	1.9[a]
Tracking tiles	610	102	16.7[a]

[a] The ratio of successful to unsuccessful trap or tracking nights is significantly different among the 3 methods (X_2 = 83.5, 2 df, $P < 0.01$)

Appendix A. Trip itinerary for Richard A. Dolbeer

Dates	Locations	Activity
26-27 August	Sandusky, OH to N'Djamena, Chad	Travel via Cleveland, New York City and Paris
27-28 August	N'Djamena, Chad	Prepared for training workshop
29-30 August	Karal, Beltram	Field studies
31 Aug.-7 Sep.	N'Djamena, GASSI	Prepared for training workshop Prepared for field studies
8-12 September	N'Djamena, GASSI	Presented training workshop
13 September	N'Djamena	Prepared for field studies
14-23 September	N'Gouri	Field Studies including rodenticide field trial
24-26 September	N'Djamena	Project administration, data analysis, seminar presentation
27 September	N'Djamena to Sandusky, OH	Travel via Paris, New York City, and Cleveland

Trip Report*

AN ASSESSMENT OF RODENT POPULATIONS IN NIGER

September 8-30, 1993

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ITINERARY

Date	Location	Activity
Sep. 8-10	Denver, Colorado, to Niamey, Niger	Travel
Sep. 10-19	Niamey	Assessed rodent populations in an agricultural area near Kollo.
Sep. 20	Niamey to Zinder, Niger	Travel
Sep. 21-24	Zinder	Assessed rodent populations in an agricultural area near Zinder, and conducted a workshop on rodent control.
Sep. 25	Zinder to Niamey	Travel
Sep. 26-28	Niamey	Wrote reports, debriefed USAID on findings, and prepared specimens.
Sep. 29-30	Niamey to Denver, Colorado	Travel

ABSTRACT

Two agricultural areas in Niger were surveyed using different monitoring methods to determine relative rodent activity. Multimammate rat (*Mastomys* sp.) and Nile rat (*Arvicanthis* sp.) populations appeared to be low based on trapping, tracking, and food disappearance methods. Gerbil (*Gerbillus* sp.) populations in millet fields appeared to be at moderate levels based on trap success and burrow counts. A 1-day rodent control workshop was conducted in Zinder for 21 agricultural agents from several different regions in Niger.

OBJECTIVES

The purpose of this trip was to assess rodent populations in agricultural areas of Niger using comparable methods being used in Chad for direct comparison. Trapping, counting burrows, and using tracking tiles to determine rodent activity were proposed in different agricultural areas. A 1-day workshop was planned and held near the end of this assignment for crop protection personnel.

ACCOMPLISHMENTS

Monitoring Research: An agricultural area near Kollo, about 30 km from Niamey, was selected for comparing various methods designed to monitor pest rodent populations. The study area had previously been known to contain *Mastomys* sp. and *Arvicanthis* sp., two well-known field pests in Africa. The methods compared included using snap traps, tracking tiles, food piles, and live traps. A 1-ha area with maturing okra, sorghum, maize, manioc, and fallow portions was marked to identify nine 100- to 120-m transects. Four of the nine transects were used for setting snap traps: one small (mouse size) trap and one large (rat size) trap were placed every 10 m for a total of 24 traps/120-m transect. Two 100-m transects were used to place one tracking tile every 10 m. One transect was used to place 10 small piles of millet seed every 10 m to measure seed disappearance, presumably by rodents. Finally, two transects were used to set local live traps (11 x 11 x 35 cm), one every 10 m, for a total of 20 traps.

The study area was established on September 15, and all traps, tiles, and food piles were set by 1400 hrs. The monitoring area was checked twice a day (morning and late afternoon) through September 17. Rainfall had not been abundant at this site, and the soil was relatively dry.

Snap trapping resulted in few captures--one giant African rat (*Cricetomys gambianus*), four hedgehogs (*Erinaceus* sp.), and four toads (species unknown)--and most of the traps remained undisturbed (Table 1). Tracking tiles also indicated low rodent populations in the study area since none of the tiles was tracked. Food piles were less convincing since >25% millet seed disappeared only on 1 of 10 piles on day 1 and on 5 of 10 piles on day 2. However, the disappearance may have been due to something other than rodents. Live trapping produced no captures or sprung traps in 80 trap-days/nights.

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Table 1. Snap-trapping results from 384 trap-days/nights at Kollo, Niger, from September 15-17, 1993.

	Captures			Trap condition		
	Cricetomys	Erinaceus	Toad	Missing	Sprung	Unsprung
Snap traps a.m.						
Large	1	4	2	0	4	85
Small	0	0	2	0	11	83
Snap traps p.m.						
Large	0	0	0	0	0	96
Small	0	0	0	1	2	93
Total	1	4	4	1	17	357

To confirm the low rodent populations apparently being observed, 12 large snap traps were also set along a field edge which contained vegetation, trees, and other cover that was ideal for *Arvicanthis* and *Mastomys*. After two checks on September 17 (a.m. and p.m.), only one female *Mastomys*, two toads, and three sprung traps were recorded.

In the second agricultural area, near Zinder, a site was selected which had typical crops that included millet intercropped with a legume bean. The millet was flowering and would be harvested by the end of October. The beans were both flowering and with mature pods. Soil was sandy with a rolling terrain and some weeds (grasses, striga). Normal rainfall had thus far occurred.

Two areas were marked off--one for comparing different methods for estimating abundance or activity of rodents, the other for marking all burrows and setting a trap to determine active burrows. The first area enclosed seven 250-m transects spaced 15 m apart. Two transects contained either small snap traps or large rat traps, four transects contained either live traps, tracking tiles, or food piles, while the remaining transect was used for counting rodent burrows. Traps, tiles, and food piles were all spaced 10 m apart along the randomly selected transects. Transects were established in the afternoon and checked the following mornings and afternoons. The second area (30 x 30 m) was randomly selected and all burrows were marked. A small snap trap was set adjacent to each burrow. Peanut butter was used for bait in all traps. Peanuts, coated with peanut butter, were used in live traps.

The first night, a heavy rain with strong wind occurred from 1900-2000 hr. Large snap traps (25) caught two hedgehogs, while four traps were sprung and one was missing (Table 2). The small traps (50) caught 1 *Gerbillus*, while 1 trap was missing and 16 were sprung. The tracking tiles were completely unreadable from the abrasive effects of the rain, sand, and wind. The storm apparently affected the food piles, since no millet seeds remained at any station. Three different burrow counts along the 2- x 250-m area resulted in an average of 8.3 burrows present or 166 burrows/ha. The second study area contained 16 burrows/900 m^2 or 177 burrows/ha.

Table 2. Results from Zinder.

SNAP TRAPS

		Captures		Trap condition			
	Day	Gerbillus	Erinaceus	Missing	Sprung	Unsprung	Total
Snap traps							
Large	1	0	2	1	4	18	25
	2	0	0	2	3	20	25
Small	1	1	0	1	16	32	50
	2	1	0	1	14	34	50
Live traps	1	0	1	0	0	24	25
	2	0	0	0	0	25	25

TRACKING TILES

	Neg.	Pos.	% Pos.	Notes
9/21-22	24	0	0	Rain, wind, sand obliterated ink & prints
9/22-23	15	9	38	No rain

FOOD PILES

	Disappearance	No disappearance	Notes
9/21-22	9	16	Rain interference
9/22-23	21	4	No rain

BURROW COUNTS

Method A. Transect	No./area	No./ha	Notes
Count 1	10		Observer Lynwood
2	10		Observer Mihai
3	5		Observer Hamma
mean	8.3/500 m^2	166	
Method B. Area			
Count	16/900 m^2	177	8 traps sprung, 7 unsprung, 1 capture

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Although weather was uneventful during the second night of trapping, results were similar to those from the first night. The rain had no apparent effect on sprung small traps (16 sprung with rain, 14 sprung without) or sprung large traps (4 vs. 3). Tracking tiles were easily read the second day, but unfamiliarity with typical *Gerbillus* footprints made it difficult to differentiate rodent marks from marks made by other animals. However, with more experience and some cage trials, tracking tiles should be easy to use and very useful. On the second day, 9 of 24 tiles contained prints which were probably made by a rodent. Twenty-one of 25 food piles had substantially less (>25% disappearance) millet on the second night, but whether all of this was due to rodents remains to be confirmed. One *Gerbillus* was captured in the second study area. The three *Gerbillus* caught in small snap traps at Zinder were examined and appropriate measurements recorded (Table 3).

Table 3. Measurements of captured *Gerbillus* sp.

Date	Sex	Wt. (g)	HB	Tail	Ear	Hindfoot	Embryo	Mammae	Testes
9/22	F	28.5	96mm	120mm	15mm	23mm	2+3=5	2+2=8	——
9/23	M	29.5	90	130	15	25	——	——	Scrotal, large
9/23	M	37.5	92	131	15	27	——	——	Scrotal, large

Training: A 1-day workshop on rodent control was held in Zinder and attended by 21 agricultural agents who came from agricultural offices throughout Niger (Appendix I). The field study site was used to demonstrate the use of traps, tracking tiles, food piles, and burrow counts. Lectures were given in a conference room at the regional Ministry of Agriculture headquarters, and French language copies of a training manual on rodent research and control were given to each participant. This training manual entitled "Les recherches et la lutte contre les Rongeurs, Manual de la Formation" was developed by the Chad Rodent Control Research Project.

DISCUSSION AND RECOMMENDATIONS

Mastomys and *Arvicanthis* populations, which were very low, are normally more plentiful after the rainy season; their populations peak in December-January. *Gerbillus* populations were higher, but probably not at their peak density yet. Weed and crop seeds were abundant, particularly from some maturing millet stalks that were lodged on the ground. The small mouse traps used for catching *Gerbillus* did not appear to be very effective (trap success was low). It might be better to use museum special traps to capture rodents; also, these traps would not damage as many skulls during time of capture.

The monitoring methods tested for *Gerbillus* were not effective. The standard closed/open hole technique would be much more effective to determine active burrows than setting traps near openings. The food pile disappearance method needs to be used with containers that would hold the millet seeds, limit ground-dwelling insects, facilitate the determination of an estimated 25% or more disappearance of grains, and be attractive to *Gerbillus*. The tracking tile method needs further testing in cages to positively identify *Gerbillus* and other rodent footprints. A firmer tile with a rougher surface, or a surface that was weathered prior to its first use, would withstand hot temperatures and hold ink and prints better during severe rain storms.

During millet seeding, damage by *Gerbillus* and other dryland Sahelian rodent species needs to be confirmed. These rodents may or may not be causing economic losses to millet. Methods are needed in Niger to assess *Arvicanthis* damage to winter (December-February) vegetables, such as tomatoes and beans. Rice matures in December and is harvested in January; but the significance of rodent damage to rice and the economic loss remains unknown.

Specific monitoring techniques for specific areas and crops need to be recommended along with specific control recommendations for specific crop damage problems before any regional training in the Sahel is conducted. For example, in Niger, a burrow count along a 2- x 250-m strip would be ideal for estimating *Gerbillus* populations in dryland agriculture. If that is a problem, this pest could be controlled in seeded millet by using an acute rodenticide applied to burrows during the 2 weeks prior to planting. In contrast, control of *Arvicanthis* damage to winter vegetables would require very different monitoring and control methods.

Zinc phosphide apparently is not available in Niger. Of the 21 participants (crop protection specialists) polled at the workshop in Zinder, no one knew of the presence of any zinc phosphide in markets. Aluminum phosphide fumigation tablets were available, and a few agents had seen brodifacoum wax blocks. If an appropriate rodent control measure requiring a rodenticide is necessary, that rodenticide needs to be made available in local markets and at a reasonable price so that farmers will purchase and use it.

CONTACTS AND ACKNOWLEDGMENTS

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Mr. Thiougoune Mamadou, Regional Director, Crop Protection, Ministry of Agriculture, Zinder

Appendix I

Rodent Training Session
Zinder, Niger
September 24, 1993

Name	Service
1. Boubacar, Nouhou	SDPV/TA
2. Abdou, Chaibou	SDPV/ZR
3. Maina, Lauel	APV/Illéla
4. Laouali, Sada	APV/Dakoro
5. Ama, Amadali	APV/Madaroum
6. Boureima, Mamoudou	APV/Keita
7. Saidou, Boubé	APV/Dosso
8. Toumone, Souley	APV/Maradi
9. Laouali, Toli	APV/Agadez
10. Weider, Mohamed	APV/Tarenozaime
11. Amadou, Dan Tani	SDPV/Agadez
12. Issaka, Daouda	APV/Fidingne
13. Jdrissa, Agali	APV/Tillaberi
14. Falalou, Rabilou	Naike
15. Seriba, Souleymane	APV/Doutchi
16. Naussa, Serkin Gatass	APV/Gauré
17. Mahawadou, A. T. Damara	DDA/CUN/C.I. (Niamey)
18. Jaitourasé, Aarfa	DDA/CUN/Pepoue (Niamey)
19. Abdou, Booua Ibrahim	SAPV/Dosso
20. Ousmane, Alazaba	DDPV/Diffa
21. Hallo Boubacar, Abdoulaye	DA/CUN II

Trip Report*

SURVEILLANCE AND PREVENTION OF RAT INFESTATIONS IN THE PRIBILOF ISLANDS, ALASKA

September 19-29, 1993

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ITINERARY

Date	Location	Activity
Sep 19	Denver, Colorado, to Anchorage, Alaska	Travel
Sep 20	Anchorage	Flight canceled
Sep 21	Anchorage to St. Paul	Traveled, made field observations, and prepared for training sessions
Sep 22	St. Paul	Conducted training, inspected vessels, visited bait sites, and made field observations
Sep 23	St. Paul	Inspected harbor, surveyed fish processor, and met with fishing industry representatives
Sep 24	St. Paul to St. George	Traveled, inspected harbor, and held program for school children
Sep 25	St. George	Conducted training
Sep 26	St. George	Trapped lemmings; prepared agenda for meeting with agencies
Sep 27	St. George to Dutch	Traveled, inspected harbor area, and questioned individuals about rats
Sep 27	Dutch Harbor to Anchorage	Travel
Sep 28	Anchorage	Met with concerned agency representatives
Sep 29	Anchorage to Denver, Colorado	Travel

BACKGROUND

The on-shore fishing industry is currently expanding in the Alaskan Arctic and is slated for extensive development on St. Paul and St. George Islands in the Pribilofs. At present, there is no evidence that Norway rats (*Rattus norvegicus*) or roof rats (*Rattus rattus*) inhabit either of these islands. If rats become established in the Pribilofs, they could cause severe environmental changes in the present ecosystems and have detrimental effects to the 3.5 million nesting seabirds on the islands (The Pribilofs are part of the Alaska Maritime National Wildlife Refuge, which is under the U.S. Department of the Interior/Fish and Wildlife Service [FWS]). Both islands have some unique populations of breeding birds and small mammals. About 90% of the world's population of red-legged kittiwakes (*Rissa brevirostris*) nest and breed on the Pribilofs during the summer. The Pribilof shrew (*Sorex hydrodromus*) occurs only on St. Paul Island and a single species of brown lemming (*Lemmus nigripes*) occurs only on St. George. A list of birds and mammals found on the Pribilofs is given in Appendix I.

Arctic foxes (*Alopex lagopus*) are found in the Pribilofs. If rats were present, they might tend to increase fox numbers by providing them with alternative foods during the critical winter months when bird populations are low. This could possibly increase the impact of foxes on the native avian fauna during the nesting season. There is a high likelihood that rats could prey on eggs and nesting birds. There is some concern that rats might carry and transmit diseases to the fur seals (*Callorhinus ursinus*).

These potential problems present a unique opportunity to set up a complex and cooperative program involving the Pribilof islanders, fishing industry, FWS, Alaska Department of Environmental Conservation (ADEC), Alaska Department of Fish and Game (ADFG), U.S. Coast Guard (USCG), U.S. Department of Commerce/National Marine Fisheries Service (NMFS), and the U.S. Department of Agriculture (USDA)/Animal and Plant Health Inspection Service (APHIS)/Animal Damage Control (ADC)/Operations, and the USDA/ APHIS/ADC/Denver Wildlife Research Center (DWRC). The primary objective of this program would be to prevent the establishment of rat populations on the Pribilof Islands.

Norway rats are found on 21 of the Aleutian Islands and on Kodiak Island (Bailey 1993), where they were introduced accidentally through shipwrecks or from anchored vessels (Appendix II). This shows that rats have the ability to adapt to the Arctic environment and sustain themselves in island ecosystems. Since several important harbors in the Aleutians and on Kodiak Island are rat-infested, fishing and cargo vessels coming from these harbors to visit the Pribilofs could also become rat-infested.

The harbors at both St. Paul and St. George are being enlarged and developed to berth large vessels, which will provide ample opportunity for rat-infested fishing or cargo vessels to visit the Pribilofs. Since an increase in fish-processing facilities and fish wastes will be a result of the fishing industry development in the two Pribilof harbors, should rats reach shore, they would have excellent opportunities to become established--unless steps are taken to prevent their introduction. If no actions are taken to try to prevent rat infestations on the Pribilof Islands, it is inevitable that rats will reach the islands and become entrenched.

ACTIVITIES

St. Paul

During the course of 3 days on St. Paul Island, a number of rat situations were observed, and actions and possible recommendations were discussed. On our arrival at St. Paul on September 21, we visited the harbor area, drove to the western side of the island to the wreck of the *Terminator*, and observed fur seal rookeries.

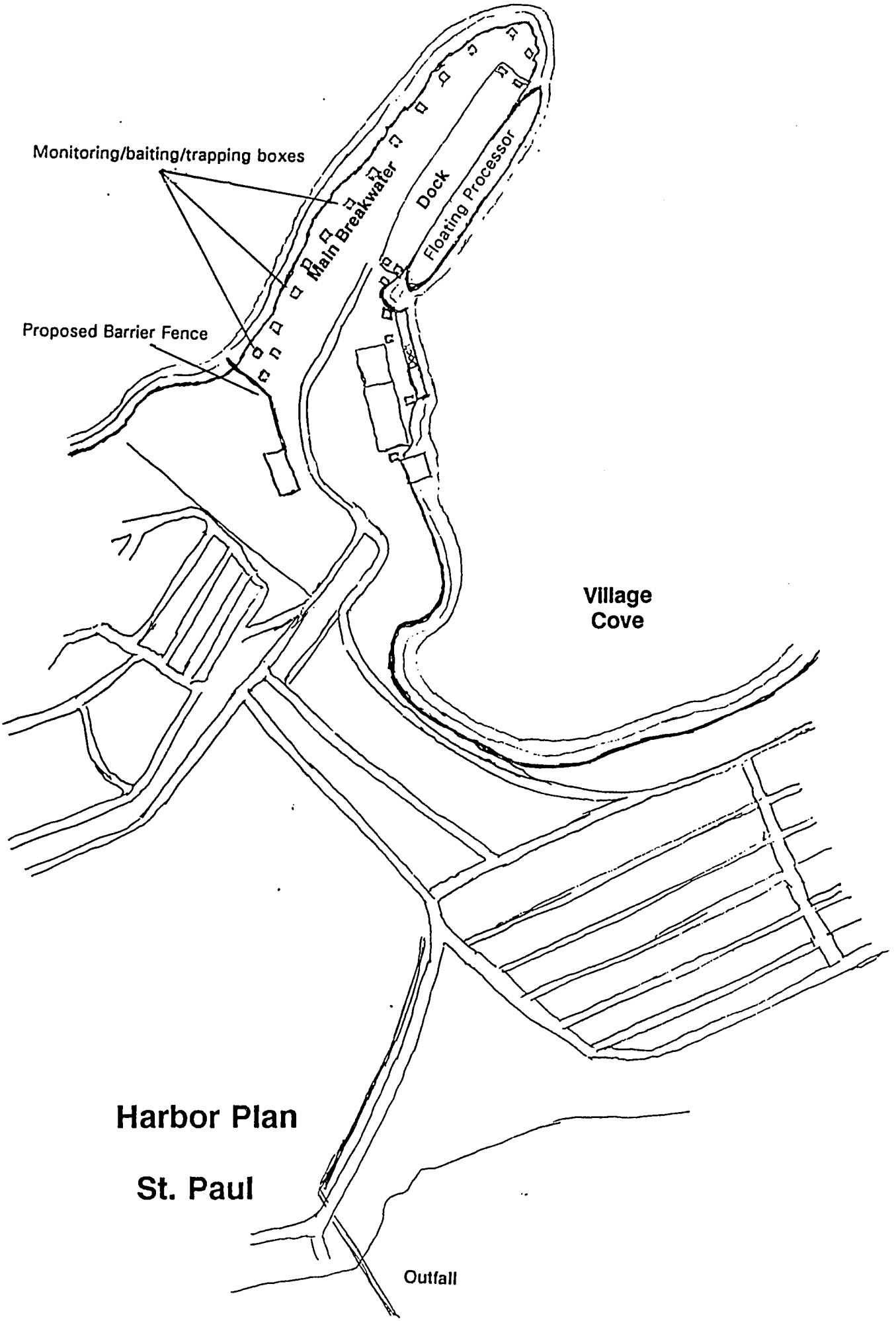
On the morning of September 22, training sessions on rat biology and control were held in the community hall; 37 individuals participated. In the afternoon, 30 participants were taken through a cargo vessel and shown inspection procedures and rat signs to look for (the vessel was not rat-infested).

On September 23, we looked at the harbor facilities and decided on additional sites for placing bait/trap stations in the breakwater and adjacent cliff areas. These bait stations, designed by Mr. Art Sowls and constructed by Mr. Sowls and Mr. Stefan Melvidov in August 1993, consisted of wooden boxes, about 2 feet square, containing a metal bait station and a baited rat trap. About 15 of the baiting/trapping boxes had already been installed. Their locations in the harbor are shown in the harbor map. These bait stations are being checked about every 2 weeks for rat activity. They serve not only to control rats that may be introduced into the harbor area, but also act as monitoring and detection devices. Discussions were held about constructing a barrier fence between the end of the breakwater and the cliffs, where nesting bird colonies are found. Although rats could cross around the fence on the seaward side, this barrier would provide another line of defense if it were heavily supplied with baiting/trapping boxes, and it would help to prevent rats from establishing on the island. On the evening of September 23, we met with four representatives of the fish processing industry to discuss their concerns with the proposed St. Paul city ordinance and their interest in cooperating to keep rats off vessels and prevent rat introductions on-shore.

PVC plastic pipe could be used in breakwater situations where extra bait stations might be desirable to supplement the bait/trap stations already in use or being proposed. We obtained a sample section of pipe and prepared a modified bait station using a tin can as the bait holder. We also discussed methods of fastening them in place.

The drain openings on the dumpsters should be screened or closed since they allow rats to enter the bottoms of the dumpsters and gain access to the garbage. If they were closed, numerous small (¼") drainage holes should be drilled in the dumpster bottoms. Dumpsters without lids should not be used in the harbor area since the foxes use these for feeding and scatter the contents outside on the ground.

Additional baiting/trapping sites should be established around on-shore fish processing plants, at the community store where foodstuffs are warehoused, around dumpsters, and in back of the restaurant. The sewer system of the City of St. Paul should be surveyed to determine whether rats could exist there. Also, it should be surveyed periodically for sign of rats.


Monitoring/baiting/trapping boxes
Main Breakwater
Dock
Floating Processor
Proposed Barrier Fence
Village
Cove
Harbor Plan
St. Paul
Outfall

Places where rats might survive over winter would include the sewer system, community store warehouse, back of the restaurant, around and under dumpsters, inside and around fish processing plants, and at the city dump. All these sites should have bait/trap boxes placed and should be monitored twice monthly.

Rats escaping ashore in the summer months could become established in the bird colony adjacent to the breakwater, where they could cause severe problems. They could live in the rip-rap of the breakwater and feed on waste food scraps carried in by foxes or feed in overflowing dumpsters.

St. George

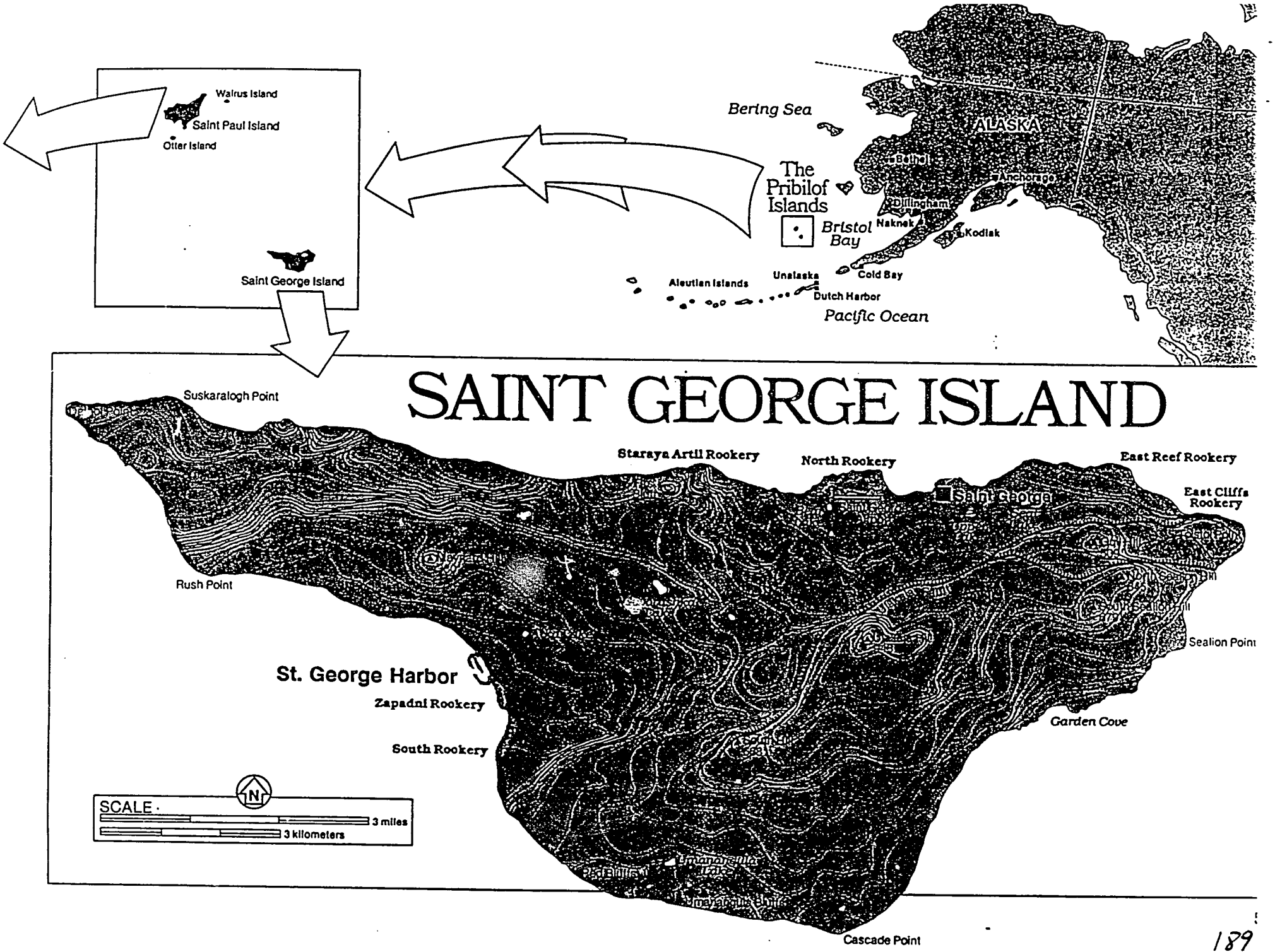
We arrived in St. George on September 24. In the afternoon, we observed the breakwater and harbor area. Construction and dredging are still being done, but large processor boats are expected to be in place by January 1994. At the ends of the breakwater are breeding colonies of auklets. It would be very easy for rats to reach these and cause severe problems. The harbor is located on the far side of the island from the village of St. George (see map). It is not likely that rats would be transported to the village; however, once rats are on the island, they can cross overland. If processor ship garbage is to taken to the village dump, this would be a probable site where rats might become established.

On September 25, we trained two individuals: Ted Lekanof, the Assistant Harbormaster, and Will Williams, the Village Public Safety Officer. Their training included watching two videos: one on rat biology and behavior, the other on a rat eradication campaign on Breaksea Island near New Zealand. That evening, we set mouse traps for lemmings. The next day, we picked up our traps containing two captured lemmings.

Dutch Harbor

We briefly visited Dutch Harbor on September 27 to seek information on rat infestations. Dutch Harbor was reported to us as being rat-infested by several observers. Dutch Harbor is the primary harbor for the catcher boats, fish processors, and trampers, which also visit the Pribilofs. Many fish processor boats use the Dutch Harbor facilities. One of these facilities is at Ocean Systems, Inc. (OSI), at which fish processors and catcher boats moor. According to two OSI employees, rats occur around the docks and adjacent structures. One employee reported seeing rats around her living quarters. The other employee told us that a report had been issued regarding a rat survey completed in Dutch Harbor; we requested a copy. A taxi driver reported that rats were occasionally seen during the night around Captains Bay and the spit past the airport, where floating fish processors were moored.

We saw abundant harborage on docks. Rats could easily be carried onto vessels by nesting inside bundles of netting. No vessels that we observed were using rat guards. Catcher boats could easily be infested with rats in this harbor.


Walrus Island
Saint Paul Island
Otter Island
Saint George Island
Bering Sea
ALASKA
Bethel
Anchorage
The Pribilof Islands
Dillingham
Bristol Bay
Naknek
Kodiak
Aleutian Islands
Unalaska
Cold Bay
Dutch Harbor
Pacific Ocean
SAINT GEORGE ISLAND
Suskaralogh Point
Staraya Artil Rookery
North Rookery
East Reef Rookery
Saint George
East Cliffs Rookery
Rush Point
Sealion Point
St. George Harbor
Zapadni Rookery
South Rookery
Garden Cove
SCALE
3 miles
3 kilometers
N
Cascade Point

Anchorage

A meeting was held in FWS conference room on September 28 to discuss the importance of the wildlife resources on the Pribilof Islands and their threat by potential rat infestations. Representatives of ADEC, NMFS, USCG, FWS, USDA/APHIS/ADC/Operations, and USDA/APHIS/ADC/DWRC were present. Topics included the potential for rat introductions into the Pribilofs, the role of ADEC in inspection and regulatory activities of the fish processing industry, the role of the USCG in inspecting and boarding vessels and in cases of oil spills and shipwrecks, and especially the interest of the NMFS in protecting fur seals. All parties agreed there is a potential rat problem and that a preventive approach is best. Several tasks were set for future activities: a contingency plan for shipwrecks, continued involvement of the FWS in rat prevention at St. Paul and St. George Islands, the firming up of the St. Paul city ordinance, and production of a video training tape by the FWS, NMFS, and ADEC; and all agencies agreed to coordinate closely with each other.

DISCUSSION

What steps must be taken to institute a cooperative program to prevent the establishment of rats in the Pribilofs? These are some of the steps needed:

- First, create an awareness of the potential problem among all the concerned individuals, agencies, communities, and industry.

- Next, examine the situation in the entire context of the Alaskan maritime environment. Look at the potential routes of entry that rats may take in reaching the Pribilofs. Determine the routes of entry with the highest risks. Try to assess the risks of rats reaching the Pribilofs by trying to answer these questions:

  What proportion of cargo vessels come from rat-infested ports?

  How many cargo vessels call at the Pribilofs/year?

  What is the probability that rats are introduced as part of off-loaded cargo? How much cargo is brought into the Pribilofs/year.

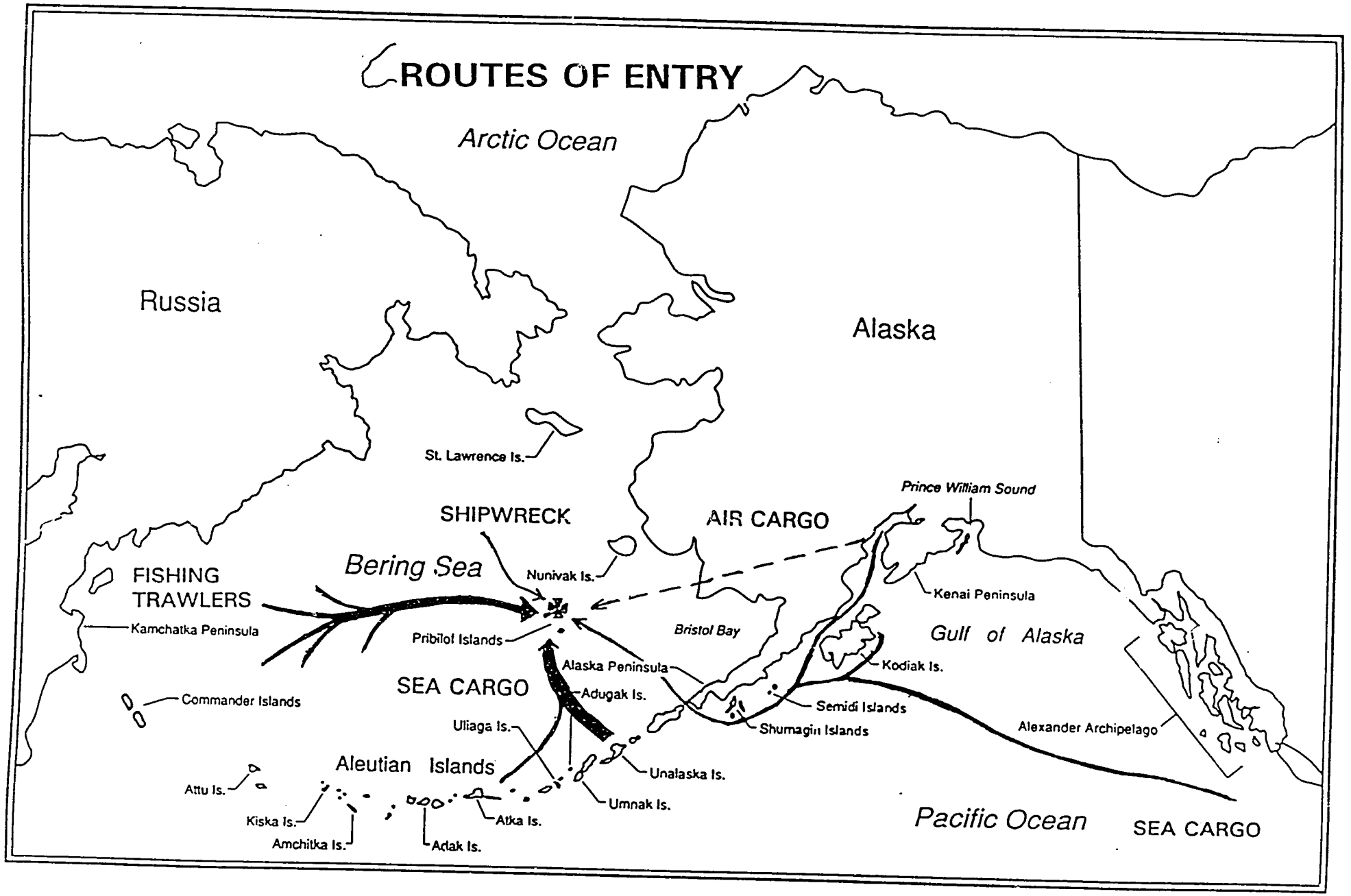
  What is the probability that rats are introduced by escaping from rat-infested vessels in the harbor?

  How many vessels are rat-infested? Cargo vessels, fish trawlers? Where do these vessels come from? Home port? Registry?

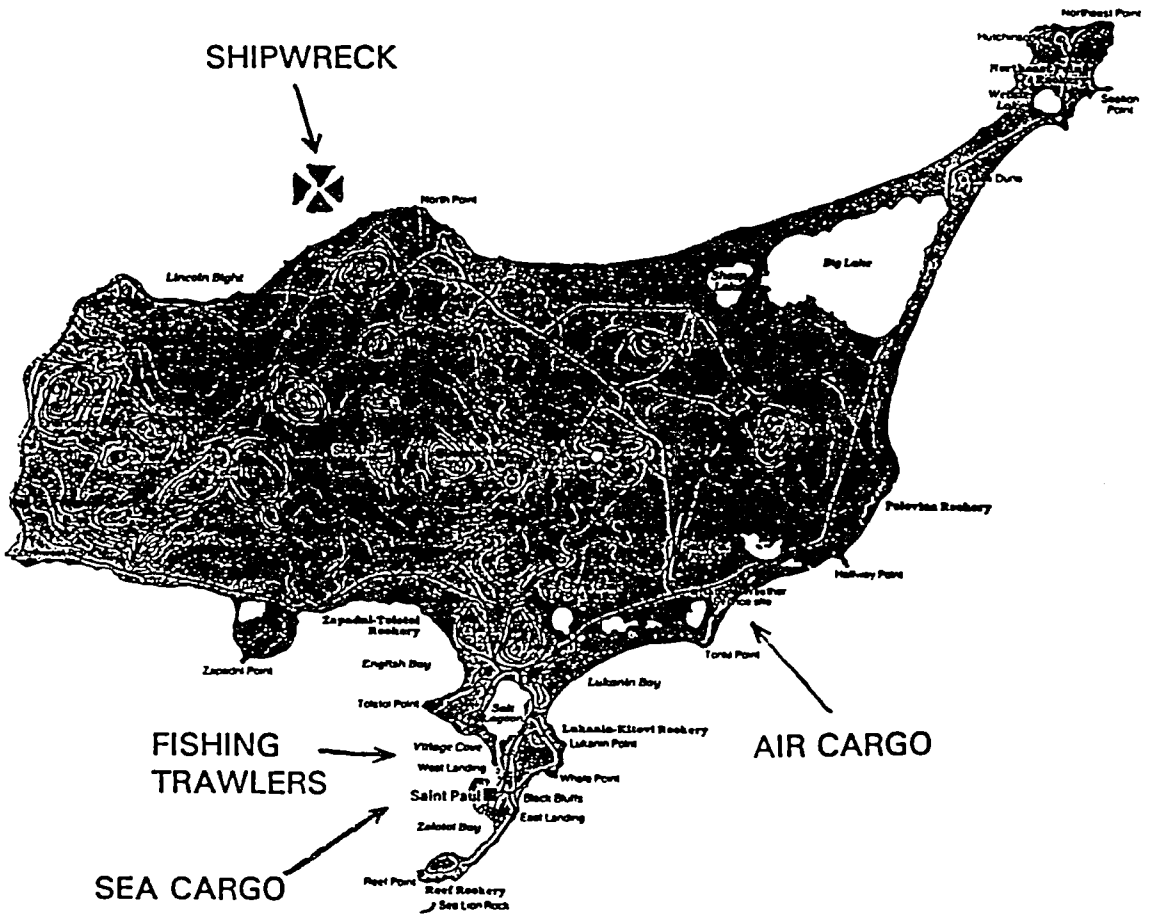
  How many shipwrecks occurred on the Pribilofs in the last decade? How much may this be expected to increase?

  How many shipwrecks on the Pribilofs may have been rat-infested?

  What is the probability of rat-infested air cargo?


ROUTES OF ENTRY
Arctic Ocean
Russia
Alaska
St. Lawrence Is.
Prince William Sound
SHIPWRECK
AIR CARGO
Bering Sea
Nunivak Is.
FISHING
TRAWLERS
Kenai Peninsula
Kamchatka Peninsula
Pribilof Islands
Bristol Bay
Gulf of Alaska
Alaska Peninsula
Kodiak Is.
SEA CARGO
Adugak Is.
Commander Islands
Semidi Islands
Uliaga Is.
Shumagin Islands
Alexander Archipelago
Aleutian Islands
Unalaska Is.
Attu Is.
Umnak Is.
Kiska Is.
Atka Is.
Pacific Ocean
SEA CARGO
Amchitka Is.
Adak Is.

ROUTES OF ENTRY



- Begin immediately to guard against rats coming from vessels calling at the St. Paul and St. George harbors. Do this by requiring inspection of certain vessels before allowing them to dock or discharge cargo. If vessels are rat-infested, require them to be treated until rat-free. Vessels are infested if signs of rats are seen aboard (droppings, live or dead rats, rat nests, gnawings, etc.). Collect data on how many (%) vessels are rat-infested over a year's time, what previous harbors had they visited, what was the registry or national origin of the vessels, in order to begin a risk assessment of the introduction of rats into the islands. This assessment should also be made to determine the risk of a rat-infested vessel being shipwrecked on either of the islands.

- Set up a surveillance system for the early detection of rats should they come ashore despite all precautions. This could be done with the use of monitoring/baiting/ trapping boxes around the harbor area and the periodic use of traps at the village dump sites. Whenever any sign of rats is detected, or if live or dead rats are seen, there should be a rapid and massive response to wipe out any threat. Realize that any detection method has a lower level at which rats may be present, but where the method is not sensitive enough to pick up their presence. Other methods may be used, i.e., examination of predator (fox) scats, owl pellets, or food remains at eagle or falcon nests, looking for evidence of rats. Be prepared to run a continuing program for rat detection for at least 50 years if this is to be a serious attempt to prevent rat infestations.

- Have a contingency plan for any shipwrecks that may be rat-infested. If the ship is grounded near shore and is safe to board, it may be treated with poisons and traps as soon as possible after being wrecked. If it is impossible to board the vessel, then a cordon must be set up on the island where rats can be expected to swim ashore. Take account of prevailing currents that may sweep rats ashore miles from the wreckage site. Any response to shipwrecks should be massive and swift in order to succeed. Materials for rat control should be stockpiled on the islands in readiness for immediate use. If the response is delayed by administrative problems or by severe weather, then a survey of the island area where rats could be expected to come ashore should be done as soon after as feasible. Again, a massive effort to poison and trap rats ashore should be done even if only minimum evidence is found that rats may be present.

- The other Alaskan harbors (mainland or Aleutian or Kodiak Islands) where vessels may visit before calling at the Pribilofs should be examined to assess the potential risk of rats being transported from them to the Pribilof Islands.

- What actions can be taken? Try to answer these questions or propose these actions:

  Surveillance and inspection of in-coming vessels. All vessels? Only those coming into harbor? Only those coming from rat-infested harbors? Who will inspect? Harbor inspectors? Alaska Department of Environmental Conservation? National Marine Fisheries Service?

Monitoring for rat infestations. Set up baiting and inspection scheme in harbor and fish processing areas? Check predators for rat evidence? Foxes, owls, eagles (scats, pellets, nest debris). Rat guards on all berthing vessels? Educational efforts at the school and community levels to create awareness of the potential problems? Trap at the refuse dump? Commitment to a long-term program?

Contingency plans for when rats are detected. Poison intensively with acute and chronic raticidal baits, trap intensively, and monitor to evaluate success in eliminating infestation.

Contingency plans for dealing with shipwrecks that may be rat-infested? What to use, how to use, when to use? Rapid response and implementation is the key to success. This means that control materials must be stockpiled on the islands.

Training for vessel inspection. Training in inspection methods, rat signs to look for, and biology of rats aboard ships.

Training for rat control. Training in control methods, poisons, traps, biology and behavior, safety in use of pesticides, certification for handling pesticides.

Community awareness of rat problem. Brochures, bulletins, photonovella, school projects, town meetings.

Severity of rat infestations in other Alaskan port areas? Possible source for introduction into Pribilofs.

How serious are the rat problems in other Alaskan ports that vessels may visit before coming to the Pribilofs?

What is the risk of rats getting aboard vessels from such ports?

What can be done to alleviate the risks? Rat control in other port areas?

RECOMMENDATIONS

1. All dumpsters in the harbor and village areas in St Paul should have lids to prevent foxes from entering and scattering the contents on the ground. The drain hole in the dumpster bottom should be plugged or screened, and smaller (¼") holes should be drilled for drainage. Rats potentially could live under dumpsters and feed by entering the bottom drain hole.

2. The harbor monitoring/baiting/trapping boxes at St. Paul should be continued and additional ones installed around docks, fish processing plants, along waterfront rip-rap areas, and in the breakwater area. These are an excellent means of detecting and controlling rats when and if they reach shore. Each box (approximately 2' x 2 ' x 10") contains a metal bait station and either a baited rat trap or a sticky board. The boxes

are essentially locked, requiring a Phillips head screwdriver for removing four screws before they can be opened. The bait station is baited with a 1- or 2-dose second-generation anticoagulant or a paraffin block containing diphacinone, the most potent of the first-generation anticoagulants. The methods of baiting are consistent with EPA requirements and follow the labels on the rodenticidal baits. These boxes are checked for activity every 2 weeks. Old baits should be replaced every 3 months unless they are moldy; if moldy baits are found, they should be replaced immediately. If rat activity is ever detected at a bait box, then baiting and trapping activities should be intensified in the area.

3. Monitoring/baiting/trapping boxes should be placed at strategic locations in the City of St. Paul where rats may appear: the community store warehouse, behind the restaurant, inside and around fish processing plants. These should be maintained on the same schedule as the harbor boxes. Old baits should be replaced every 3 months unless they are moldy; if moldy baits are found, they should be replaced immediately.

4. Monitoring/baiting/trapping boxes should be augmented by using PVC plastic pipe bait stations in the breakwater areas at St. Paul and St. George. These can be modified to prevent children from reaching inside and gaining access to baits. They could be anchored by U-bolts or other fastening methods so that they would not be disturbed by foxes.

5. The village sewer system in St. Paul should be surveyed for evidence of rats and whether rats could exist inside. Rats need places where they can live in dry pipes or in burrows using breaks in the sewer for harborage.

6. The village dump at St. Paul should be trapped periodically for the presence of rats, since it appears they could survive the winter at the present site. If the dump were operated as a cut-and-fill operation, this would greatly reduce the chances that rats would become established. Better yet, if the village could incinerate all combustible wastes, this would eliminate the threat of rats living at the dump. If garbage wastes from floating processors and on-shore fish processors are to be placed in the present dump, it is a must that the operation change to cut-and-fill or incinerate.

7. Vessel inspection at the St. Paul harbor for the presence of rats is an excellent idea, but difficult to carry out in practice. Trying to inspect all catcher boats before they tie up to discharge their catch would be impractical and questionable since they rarely could be expected to have rats aboard. Periodic inspection of catcher/processors, floating processors, and on-shore processors is done by the Alaska Department of Environmental Conservation, and this activity would be expected to increase at St. Paul and St. George, especially if the use of the NMFS staff houses could be made available for ADEC inspectors while in St. Paul/St. George. Perhaps the vessels most likely to need inspection are the trampers that moor in the harbor to load finished fish products from the processors. These vessels, coming from a variety of national registries, would be the class of vessels most likely to have rats on board. They may be moored for periods of several days while loading cargo, giving rats aboard ample time to try to escape ashore. All trampers seeking to moor at St. Paul and St. George should be inspected

by city inspectors before being given mooring permission. The City of St. Paul will have to decide in its city ordinance whether or not to allow those vessels with rat signs to dock.

8. A barrier fence between the breakwater and the cliffs at St. Paul harbor would be feasible. It must terminate into the sea on the seaward side of the breakwater and tie into one of the buildings on the harbor side. A strip of sheet metal 1-foot wide would have to be installed at the top of the fence to keep rats from climbing over. The mesh would have to be not larger than ¼" to prevent rats from passing through. The fencing should be buried 18" into the soil and a lip of fencing should be turned into the harbor area another 12". The biggest problem with fence installation occurs at the seams of sheet metal or at the posts, where nails are often used; such areas provide a means for rats to climb. Numerous monitoring/baiting/trapping boxes should be placed along the inside perimeter of the fence. While true that rats may circle around this fencing, it provides one more barrier to their movements and may prevent their direct entry into the cliffs with the breeding bird populations in the summer.

9. The most likely time for rats to be introduced and become established in the Pribilofs would be the period between April and October. This is because of several factors: rats from Aleutian island and mainland ports would have breeding rat populations at this time; this would be the most favorable time weatherwise for rats to become established ashore; and during these months, rats could gain access to breeding bird colonies, become established, and begin breeding. There should be special vigilance during these months to watch for and quickly report any sightings of rats in the harbor area.

10. A media awareness program of brochures, posters, videos, displays, news programs, television programs, and school programs should be launched and maintained. These programs should emphasize the unique importance of the Pribilofs, the immense damage that rats could cause to the islands' ecosystems and fauna, the diseases and economic damage that rats could cause, and the need for community involvement and commitment by all concerned parties to act together in preventing rats from becoming established on the islands.

11. More persons on St. Paul and St. George Islands should be certified in the use of pesticides for rat control. Personnel are needed to back up the one person on each island that is currently certified. Most of the work of monitoring/baiting/trapping is arduous and deals basically with negative findings over a long period of time. Some kinds of incentives are needed to maintain interest among the persons involved.

12. Additional training in rat biology, behavior, and control should be given at both St. Paul and St. George to locals, city workers, fish processors, and school children.

13. A training video on rat signs and vessel inspection procedures should be prepared in a cooperative venture by the FWS, ADEC, and NMFS and made available to all interested parties.

14. There is a need for a shipwreck rapid response team on either St. Paul or St. George Islands. This team should consist of at least four persons who are trained in rat control methods of poison baiting and trapping. Not only should they be trained for shipwrecks, but they should have immediate access to stockpiled equipment and supplies.

    They should first ascertain if a wrecked vessel is rat-infested by questioning crew members, officers, or the captain from the wrecked vessel. If this is not possible, the team should visit the vessel, if safe to do so, and look for rats or rat signs. If the vessel can't be reached and its rat-infestation status is unknown, it should be treated as though it is rat-infested.

    If the vessel can be baited and trapped, the team should do this by placing baits and traps in places most likely for rats to appear (galley, food storage rooms, cargo holds). This should be continued for at least a week, if possible.

    On-shore, set up two beach-perimeter lines of bait stations, one near the shoreline with stations at 30-m intervals. Behind this first line, set up a second line about 100-200 m inland, with bait stations at 100-m intervals. If prevailing currents are likely to sweep swimming rats several kilometers down the beach, run the perimeter baiting line for 2-3 km along the beach in this direction. Continue baiting for 3-4 weeks, replenishing baits at weekly intervals even if baits are not eaten. Bait takes will indicate the presence of rats ashore. (Shooting of rats might be considered.)

    If delays of several days to a week are encountered in reaching the wreckage site, the beach perimeter should still be baited since it is highly probable that rats will stay near the shore if food can be found, i.e., along the beach, in the rocks, bird nests on the lower cliffs, etc.

    Operational procedures and options should be spelled out in a handbook. Training exercises are suggested. There is a need to stockpile bait containers, traps, and baits; and the team will need a Zodiac inflatable boat or Boston whaler for reaching shipwrecks. Also, CB radios or walkie-talkies will be needed, and close coordination with the USCG will be essential.

15. Data regarding rat infestations on catcher boats and trampers are needed in order to assess the risks and to determine whether these need inspection. NMFS observers on catcher boats can help supply this kind of data. Data on rat infestations on trampers can only be obtained by inspection of vessels entering the harbors at St. Paul and St. George.

16. Studies on the ability of rats to survive shipwrecks and swim ashore in Arctic waters are required to assess the risks involved with shipwrecks and harbor escapes of rats. Studies could be carried out at the FWS facilities at Adak. Norway rats caught on the island alive could be released at varying distances from shore and observed for their abilities to reach shore and survive. Adak could also serve for training the rapid response team in exercises for shipwrecks. The team could set up beach perimeter

baitings and test their efficacy against rats released from offshore. Some rats could be tagged with radio transmitters to see what proportion survive control efforts after reaching shore. A cooperative effort to conduct these studies could be arranged among the FWS, ADC/Operations, and DWRC.

17. Studies are needed to determine the interactions between rats and breeding bird colonies in the Aleutians. Kiska Island, where Norway rats exist both with and without breeding bird colonies, would appear to be ideal for these studies. Again, this could be a cooperative study among the FWS, ADC/Operations, and ADC/DWRC (research). Perhaps a multiyear study by a Ph.D. graduate student from the University of Alaska might be arranged, with the FWS, ADC/Operations, and DWRC acting as co-advisers.

18. Surveys of rat infestations at other Aleutian harbors are needed. These could be carried out for the FWS by either DWRC or ADC/Operations. This information will help in preventing rats from reaching the Pribilofs.

ACKNOWLEDGMENTS

I wish to acknowledge the help given me by Mr. Art Sowls on this assignment. He kindly arranged our agenda each day, worked out logistics, found excellent accommodations on each island, and provided background information that greatly helped me. I thank the Fish and Wildlife Service, Alaska Regional Office, for providing funds for this consultancy. It was a pleasure to work with Mr. Daniel Zatz, video photographer, Homer; and Mr. Richard Reynolds, ADEC, Dutch Harbor.

I especially appreciated the hospitality of the Pribilof Islanders and wish them well in this unique endeavor.

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Dave Cormany, National Marine Fisheries Service (NMFS)
Paul O'Neil, USDA/APHIS/ADC, Olympia, Washington

Dutch Harbor

Richard Reynolds, Food Processing Inspector, ADEC

Appendix I. Birds and mammals found on the Pribilof Islands

Nesting seabirds on the Pribilofs

Red-legged kittiwakes (*Rissa brevirostris*)
Black-legged kittiwakes (*R. tridactyla*)
Common murres (*Uria aalge*)
Thick-billed murres (*U. lomvia*)
Crested auklet (*Aethia cristatella*)
Least auklet (*A. pusilla*)
Parakeet auklet (*Cyclorrhynchus psitticula*)
Horned puffin (*Fratercula corniculata*)
Tufted puffin (*F. cirrhata*)
Red-faced cormorant (*Phalacrocorax urile*)
Short-tailed shearwaters (*Puffinus tenuirostris*)
Northern fulmars (*Fulmarus glacialis*)

Other birds

Bald eagle (*Haliaeetus leucocephalus*)
Peregrine falcon (*Falco peregrinus*)
Snowy owls (*Nyctea scandiaca*)

Mammals on the Pribilofs

Arctic fox (*Alopex lagopus*)
Caribou or reindeer (*Rangifer tarandus*)
Northern fur seal (*Callorhinus ursinus*)
Pribilof shrew (*Sorex hydrodromus*)
Cat (*Felis catus*)
House mouse (*Mus musculus*)
Brown lemming (*Lemmus nigripes*)

Appendix II. Islands in the Alaska Maritime National Wildlife Refuge on which Norway rats (*Rattus norvegicus*) were introduced (Bailey 1993).

Island	Date of introduction	Source
Adak	ca 1940	FWS 1981, Murie 1959
Akutan	<1937	Murie 1937
Amaknak	early 1800's	Zeillemaker and Trapp 1986
Amchitka (Makarius, Bat, Bird Rock)	ca 1940	Manville and Young 1965
Atka	<1936	Murie 1959
Attu	ca 1940	FWS 1980, Murie 1959
Bolshoi Islets	<1936	Murie 1959
Great Sitkin	?	Murie 1959
Kagalaska	?	West 1987
Kiska	ca 1940	Murie 1959
Kodiak	<1920	Clark 1958
Little Kiska	ca 1990	G. Byrd, Adak, Alaska, pers. commun.
Oganen	?	Nysewander et al. 1982
Rat	<1780	Brechbill 1977
Sanak	<1950	R. Mack, King Cove, Alaska, pers. commun.
Sedanka, Seal Rocks	?	Nysewander et al. 1982
Shemya	<1940	FWS 1980
Unalaska	1828	Elliot 1875

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