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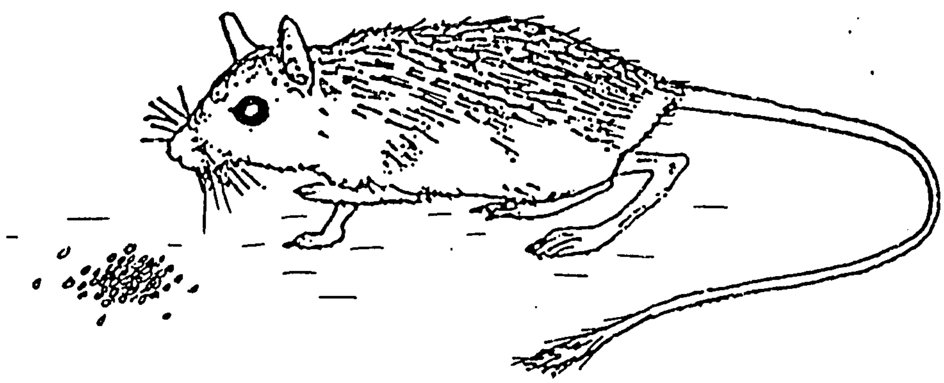

A Cooperative Program

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Government of Chad/Ministry of Agriculture and Rural Development,
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Abstract: The toxicity and efficacy of several rodenticides against common Sahelian pest rodents were tested in the laboratory and in field trials in Chad. Zinc phosphide at 1% concentration on whole millet with 2% peanut oil was very effective against the unstriped grass rat (*Arvicanthis niloticus*) both in laboratory and field trials. Intake of 49 mg/kg or more of zinc phosphide was lethal for this species. When 1% zinc phosphide baits were offered to 10 multimammate rats (*Mastomys natalensis*), 7 of 10 died. Rats survived doses of 48 and 52 mg/kg, but all rats eating 69 mg/kg or more died. Zinc phosphide baits (1% concentration) in field trials against rodents living in wadis near N'Gouri gave 79 and 95% reduction in rodent activity measures after a 3-night exposure period. Zinc phosphide baits (1%) used against *Gerbillus* species living on dunes near N'Gouri gave between 15 and 73% reduction in rodent activity measures when exposed for 3 to 4 nights. Bait acceptance appeared excellent. Chlorophacinone and bromadiolone at 0.005% gave complete kills of group-caged multimammate rats with 3 nights of feeding. Chlorophacinone and warfarin gave 91 and 94% reduction in activity measures when used against rodent populations living in wadis in one trial, but results were inconclusive in another trial. The approximate 3-day LD_{50} of chlorophacinone for unstriped grass rats, based upon stomach gavage, was less than 0.7 mg/kg for the 3 doses.

INTRODUCTION

The Sahel zone in Africa experiences outbreaks of rodent populations periodically after prolonged droughts are broken by several seasons of normal rainfall. Outbreaks were recorded in the 1940's, the mid-1970's and the mid-1980's. The outbreaks are becoming more catastrophic because of increasing human and animal use of the Sahel zone, with the concurrent widespread disturbance of the delicate Sahelian ecosystem. During the last two outbreaks, local governments and international relief agencies were almost totally lacking in planning for the eventuality, except for the Government of Sudan. Outbreaking rodent populations threaten crops at sowing and ripening stages but control measures, if any, have typically been taken after populations reached peaks and long after the crop damage was done. Rodent species most numerous in these widespread outbreaks are the unstriped grass rat or Nile rat (*A. niloticus*) and the multimammate rat complex (*Mastomys Praomys* species), although gerbil (*Taterillus* species) may also be involved.

Little information about the toxicity and field efficacy of rodenticides to Sahelian rodents has been reported in the literature. Gill and Redfern (1977) reported on laboratory feeding tests of five rodenticides against unstriped grass rats. The poisons, warfarin, coumatetralyl, chlorophacinone, difenacoum, and calciferol, were all toxic at concentrations recommended for control of the Norway rat in the United Kingdom. Kassab *et al*. (1963) fed baits with 0.1 and 0.04% warfarin to unstriped grass rats and found the mean days to death were 3.1 and 7.5 days, respectively, with no apparent unpalatability in either case. Both warfarin and zinc phosphide were used in the

Sudan (Schmutterer 1969) and in Kenya (Taylor 1968). Adesuyi (1966) in Lagos, Nigeria, found that 0.05% warfarin killed all unstriped grass rats after 6 days of continuous feeding. LaVoie (1988), using caged unstriped grass rats in Chad, found that 2% zinc phosphide killed 3 males and 2 females when they were each offered 1 g of the bait overnight. Soliman (1980) found that the unstriped grass rat was quite susceptible to zinc phosphide, requiring only 0.18% for an LC_{50} concentration. In tests on rats in enclosures, using zinc phosphide at a 0.18% concentration in baits, he killed 21 of 23 rats in 3 nights of exposure.

Vissault and Raban (1976) compared chlorophacinone and warfarin in the laboratory and found that 0.005% chlorophacinone was more active than 0.025% warfarin against multimammate rats (*M. natalensis*). After 3-day feeding trials, kills of 29/30 and 8/19 were obtained respectively. Schmutterer (1969) describes poison treatments in Sudan, where 3% zinc phosphide and warfarin in crushed dura were used. Taylor (1968) reported rapid and inexpensive control measures taken against multimammate rats in a wheat- and maize-growing area near Kitale, in Kenya in 1962, using warfarin and zinc phosphide in cereal bait. Gill and Redfern (1979) reported on the laboratory assessment of 7 rodenticides against multimammate rats. The poisons, warfarin, coumatetralyl, difenacoum, brodifacoum, bromadiolone, calciferol, and zinc phosphide, were all toxic at concentrations used against Norway rats, although several were unpalatable.

Mitchell (1987) ran a field trial of 0.025% warfarin against multimammate rats and Egyptian gerbils (*Gerbillus* species) in flood recession and wadi crops in central Chad. Warfarin bait reduced multimammate rat burrow counts 60% in sweet potato plots (where other rodent species may be present) and 96% in sorghum, vegetables, and forestry plots. Baiting against *Gerbillus* in sorghum plots gave only 63% control; more baits per hectare may have been needed.

To provide more current and complete information on rodenticide efficacy in the Sahel, we conducted laboratory and field studies in Chad in 1988 and 1992. Several rodenticides and rodent species were tested. The rodents studied included unstriped grass rats, multimammate rats, Egyptian gerbils (*Gerbillus* species), slender gerbils (*Taterillus lacustris*), and fringed-tailed gerbils (*Tatera robusta*). The rodenticides tested include zinc phosphide, and the three anticoagulants: warfarin, chlorophacinone, and bromadiolone.

METHODS AND MATERIALS

Zinc Phosphide

Zinc phosphide used in these tests contained 95.4% active ingredient. Zinc phosphide was mixed at a 1% concentration into baits of millet containing 2% by weight peanut oil. All tests with zinc phosphide were run as free-choice tests, with millet plus 2% peanut oil offered with and without the 1% zinc phosphide. Multimammate rats and unstriped grass rats were sexed, weighed, and individually caged. They were given food cups overnight. The amounts eaten from each cup were determined the following morning. Mortality was observed for 3 days following the test.

Chlorophacinone and Bromadiolone

Chlorophacinone was obtained as the 0.28% concentrate in mineral oil from a commercial source. The 0.28% concentrate was diluted with mineral oil to concentrations containing 0.028%, 0.014%, and 0.007% active ingredient. This was administered by stomach gavage to unstriped grass rats, so that 1 ml/100 g body weight equalled 0.7, 1.4, and 2.8 mg/kg doses. A supply of the 2% powdered concentrate was obtained from LIPHATECH, Milwaukee, Wisconsin. This assayed at 1.97% purity according to the LIPHATECH specification sheet. Bromadiolone was obtained as the 1% powdered concentrate (in wheat flour) from LIPHATECH, Milwaukee, Wisconsin. We tried to mix this with mineral oil for stomach gavaging but the mixture would not pass through the gavage needle. Due to this, no attempts were made to estimate its LD_{50}. The LIPHATECH analysis indicated the concentrate assayed at 1.04% purity.

The commercial chlorophacinone concentrate and the bromadiolone concentrate were applied to millet to give 0.005% concentrations and 1% peanut oil was added. These two baits were offered no-choice to 6 groups of multimammate rats, caged 3 to 6 rats per cage. Two groups were given a 2-day exposure, another 2 groups were exposed 3 days, and a third two groups were given a 4-day exposure. After the poison test, fresh millet was offered. Mortality was observed for 10 days after initial exposure. Death by hemorrhage was verified by necropsy.

Test Animals

Rats for testing were obtained from the wild by means of live-capture traps. Multimammate rats were trapped from households and shops in the city of N'Djamena, while unstriped grass rats were trapped from wadis near N'Gouri. They were returned to the laboratory at the Rodent Control Research Project in N'Djamena for acclimatization. Some multimammate rats were caged as small groups in cages measuring approximately 75 by 18 by 18 cm. The individually caged rats were restrained in live traps, either Japanese-design or the Tomahawk type. Food cups were made from empty milk tins wired to the bottom of the cages or traps to prevent spilling. In one of the first tests, they were not wired down and spilling of cups was common.

Individually caged animals were weighed and sexed before each trial. All animals dead on anticoagulant trials were necropsied to determine if hemorrhage was obvious or if the liver was pale or discolored. After testing, animals were observed for mortality for up to 10 days following the test.

Field Trials

Field trials of zinc phosphide, warfarin, and chlorophacinone were run by LaVoie in 4 wadis at N'Gouri in April 1988. Pre- and posttreatment rodent activity was estimated by using cracked sorghum in food stations for 2 days. A 50-g scoop was used to measure out the grain into a 1-quart milk carton at each station. The grain was poured back into the scoop the following morning. If the grain did not fill the scoop, the station was considered active. The activity index was calculated as the total percent active bait stations.

Wadis were baited by placing rodenticidal baits about every 10 m in the thorny fencerows surrounding the cultivated areas. Zinc phosphide was baited once, while chlorophacinone and warfarin were baited a second time 5 and 6 days, respectively, after the initial baiting. Bait was placed in 50-g amounts at each baiting site. Bait was placed down burrow openings and in runways whenever possible. Posttreatment food station activity was begun 3 days after the zinc phosphide baiting and 15 to 16 days after the initial anticoagulant baitings.

Zinc phosphide baits of cracked sorghum contained 2% active ingredient and 1% cottonseed oil. The anticoagulant baits were prepared from cracked sorghum coated with 1% cottonseed oil. Warfarin was used at a 0.025% concentration and chlorophacinone at 0.005%.

Field trials of millet baits containing 1% zinc phosphide and 0.005% chlorophacinone at N'Gouri were carried out in September 1992 by Dolbeer (1992). Trials were carried out in wadis where unstriped grass rats and fringed-tailed gerbils predominated. 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 surrounding the cultivated area. Pretreatment monitoring for rodent activity was done by using bait piles, tracking tiles and snap or live traps for 1 or 2 nights. Bait takes were scored in 25% increments and tracking tiles were scored as positive or negative. After the pretreatment period, baiting was done with rodenticide baits for 3 to 4 nights in the 2 wadis treated with zinc phosphide and for 4 to 5 nights in the wadis where chlorophacinone was used. Treated baits were placed and monitored in the same manner as done for the untreated millet. During and following the treated period, observers searched the entire area for sick or dead rodents and non-target animals. A 1- to 2-night posttreatment monitoring period using tracking tiles and traps was then conducted.

Trials of 1% zinc phosphide mixed with millet baits were carried out in October 1992 by McConnell (1992) on 4 dunes near N'Gouri, and targeted almost exclusively at *Gerbillus* species (Some *Jaculus jaculus* may have come to the bait stations). Pretreatment rodent activity was estimated by captures with live traps, with tracking tiles, and with millet bait stations. Two parallel lines, about 20 m apart, each consisting of 20 live traps, 25 tracking tiles and 25 bait stations were set at intervals of about 10 m in both uncultivated and cultivated (millet) fields on dunes. Activity was measured for 1 night. Bait stations were marked positive when 20% or more of the bait was removed. Zinc phosphide baits were then set in 25 bait stations at 10-m intervals on a line approximately in the center between the 2 parallel lines. Each bait pile of 15 g was covered with a PVC pipe cut in half lengthwise, measuring 30 to 45 cm in length and 6 cm in height. Bait was replenished when necessary and left exposed for 3 or 4 nights. Posttreatment activity was measured as above except 25 mouse snap traps were used instead of the 20 live traps on each monitoring line. Each dune trial area was searched for animal carcasses by 5 people for 20 minutes each day of the 3- or 4-day trial.

RESULTS

LD_{50} Studies

The 3-day gavage test of chlorophacinone to unstriped grass rats indicated that even the lowest dose of 0.7 mg/kg was lethal (Table 1). Based upon these findings, the approximate LD_{50} would be less than 3 daily doses of 0.7 mg/kg.

Table 1. Effects of three daily doses of chlorophacinone on unstriped grass rats given by stomach gavage.

Dosage given (mg/kg x days)	Mortality (No. tested/ No. dead)	Mean day of death
0.7 mg/kg X 3	2/2	4.0
1.4 mg/kg X 3	2/2	4.0
2.8 mg/kg X 3	2/2	2.0

This indicates that unstriped grass rats feeding on baits containing 0.005% chlorophacinone would require only 3 days for complete mortality. The average daily consumption by unstriped grass rats of 4 to 5 g of bait would give a 3-day intake of 6.0 to 7.5 mg/kg of chlorophacinone, far more than a lethal dose.

Attempts were made to dose bromadiolone to unstriped grass rats, but the suspension of the concentrate in mineral oil blocked the gavage needle, so no tests were done.

Feeding Tests

Chlorophacinone and Bromadiolone

Two groups of multimammate rats, grouped 3 to 6 animals per cage, were offered chlorophacinone (0.005%) and bromadiolone (0.005%) no-choice mixed with millet and 2% peanut oil for 2 to 4 days (Table 2). These results indicate that both chlorophacinone and bromadiolone, at 0.005% concentration in food baits, could be expected to give excellent kills of multimammate rats when fed upon for 3 to 4 days in the field. With chlorophacinone, the first deaths occurred on day 2 of the trial, and the mean days-to-death were 3.7 days (range 2-8). For bromadiolone, the first death occurred on day 3 and the mean days-to-death were 5.3 (range 3-6).

Zinc Phosphide

Two groups of multimammate rats, 7 caged together in each group, were given a free-choice between millet baits with 2% peanut oil, with and without an added 1% zinc phosphide. In the first group, 2 rats were killed (28%) after having eaten an average of 89 mg/kg of the poison. The group consumption of plain

Table 2. Effects on multimammate rats of feeding for several days on baits containing 0.005% chlorophacinone or bromadiolone.

Toxicant	No. rats	No. dead	Mean weight (g)
<u>Chlorophacinone</u>			
2-day exposure	5	3	44
3-day exposure	4	4	54
4-day exposure	3	3	52
<u>Bromadiolone</u>			
2-day exposure	6	4	48
3-day exposure	5	5	44
4-day exposure	5	5	66
<u>Reference</u> (10 days)	5	0	54

bait was 12.0 g and of the poison, 1.1 g. In the second group, 3 rats were killed from an average intake of 31 mg/kg of the poison. The group ate 9.0 g of plain bait and 0.4 g of poison. These results indicate that zinc phosphide is not very promising for the control of this species.

Eleven individually caged multimammate rats were given a 1-night free-choice feeding on plain millet baits containing 2% peanut oil with and without an added 1% zinc phosphide (Table 3). The zinc phosphide killed 7 of the 10 rats exposed to it. The dose of zinc phosphide eaten ranged from 48 to 150 mg/kg; and while the 2 rats eating 48 and 52 mg/kg survived, all rats eating more than 69 mg/kg died. This preliminary trial shows that multimammate rats will eat baits containing 1% zinc phosphide and that doses containing ≥69 mg/kg will kill them.

Table 3. Effect on multimammate rats of feeding on plain millet baits and baits containing 1% zinc phosphide for 1 night.

Animal No.	Sex	Weight (g)	Amount of bait eaten Plain	Poison	Result	Dose of ZnP (mg/kg)
1	M	74	0.16	0.08	Escaped	?
2	M	74	0.0	0.93	Dead	123.7
3	F	50	0.51	0.62	Dead	124.0
4	F	51	0.0	0.75	Dead	150.0
5	F	51	0.23	Spilled	Alive	?
6	M	65	0.21	Spilled	Dead	?
7	M	68	Spilled	Spilled	Dead	?
8	M	48	Spilled	0.25	Alive	52.5
9	M	48	1.4	0.0	Dead	?
10	F	49	4.4	0.24	Alive	48.0
11	F	43	0.0	0.30	Dead	69.3

Four individually caged unstriped grass rats were given a free-choice of millet baits with peanut oil and with or without 1% zinc phosphide for 1 night (Table 4). Results indicate there is no aversion by unstriped grass rats to eating zinc phosphide baits and the 1% concentration in baits should prove adequate in the field.

Table 4. Effect on unstriped grass rats of feeding for 1 night on plain millet baits and baits containing 1% zinc phosphide.

Animal No.	Sex	Weight (g)	Amount of bait eaten Plain	Poison	Result	Dose of ZnP (mg/kg)
1	M	121	3.53	0.20	Alive	16.6
2	F	109	0.67	0.53	Dead	48.8
3	F	102	0.23	1.21	Dead	118.6
4	F	86	1.90	0.65	Dead	75.4

Field Trials

The earlier field trials of LaVoie (1988) are summarized in Table 5. All rodenticides tested gave excellent results in these trials, primarily against unstriped grass rats living in the wadi fencerows.

Table 5. Summary of wadi rodenticide evaluations conducted in April 1988 at N'Gouri, Chad.

Wadis	Treatment	Kg of bait/ha First	Second	Total	Activity index Pre-	Post-	Percent change
Kaling	Zinc phos.(2%)	2.3	-	2.3	39	0	- 100
Kaya	Chloroph.(0.005%)	1.9	0.9	2.8	45	4	- 91
Yagra	Warfarin (0.025%)	1.5	1.1	2.6	49	3	- 94
Molo S.	Control 0	-	-	-	21	25	+ 17
"	" "	-	-	-	21	13	- 37

Dolbeer (1992) carried out field evaluations of 1% zinc phosphide and 0.005% chlorophacinone mixed into millet baits with 2% added peanut oil. Results are summarized in Table 6. The zinc phosphide gave a 79% and 95% reduction in tracking tiles activity, respectively, in the 2 wadis where used. Bait acceptance was good for 2 to 3 nights of the baiting period. Pretreatment trapping indicated that unstriped grass predominated at the 2 wadis.

The chlorophacinone treatments gave inconclusive results. At 1 wadi, tracking tile activity actually increased after treatment, but the number of animals captured after treatment was reduced 89%. Bait consumption here was excellent; positive takes were found at 76% of all bait stations by the third

Table 6. Wadi field trials at N'Gouri using zinc phosphide and chlorophacinone, 1992.

Wadi	Treatment	Activity index (%) Pretreatment Trapping	Pretreatment Tracking tiles	Posttreatment Trapping	Posttreatment Tracking tiles
Kaya	Zinc phosphide	8	42	2	9
Guini	" "	22	42	6	2
Goural	Chlorophacinone	18	8	2	18
Assakandori	"	12	28	0	8

night. Pretreatment trapping indicated that unstriped grass rats, slender gerbils, fringed-tailed gerbils and ground squirrels were present. One fringed-tailed gerbil was caught posttreatment. At the other wadi, activity measured on the 5th night after baiting began was reduced 71% on tracking tiles and no rodents were captured. Three had been captured before treatment, 1 slender gerbil and 2 fringed-tailed gerbils.

Trials of zinc phosphide on dunes against *Gerbillus* species done by McConnell (1992) are summarized in Table 7. Trapping did not give good estimates of rodent activity, while tracking tiles indicated only half to one-third the activity seen at bait piles. Reduction in activity at bait piles ran 15, 48, 54, and 65%, respectively, at the 4 sites. Tracking tiles indicated that activity was reduced 71, 60, 62, and 73%, respectively, at the 4 sites. Bait acceptance was excellent at the 4 sites, with 36, 43, 41, and 46%, respectively, of the bait stations positive during the trials. Dead *Gerbillus* found during the carcass searches numbered 1, 0, 6, and 9, respectively, at the 4 sites. All had zinc phosphide/millet in their stomachs. No nontarget dead animals were found. Since *J. jaculus* may frequent the same areas, they could have found the bait stations, but because the bait stations were only 6 cm in height, they probably did not try to enter them.

Table 7. Dune field trials near N'Gouri using 1% zinc phosphide/millet baits, October 1992.

Dune area	Pretreatment activity: Bait piles $n = 50$	Pretreatment activity: Tracking tiles $n = 50$	Pretreatment activity: Captures live traps $n = 40$	Posttreatment activity: Bait piles $n = 50$	Posttreatment activity: Tracking tiles $n = 50$	Posttreatment activity: Captures snap traps $n = 50$
Madeklia	13	7	0	11	2	0
Yagra	27	10	0	14	4	0
Boholi	24	8	0	11	3	1*
Wolaldji	29	11	1*	10	3	2*

* *Gerbillus* species only captured.

DISCUSSION

Chlorophacinone appears to be an excellent choice of anticoagulant against unstriped grass rats based upon laboratory trials. Three daily doses of 0.7 mg/kg of chlorophacinone by gavage proved lethal, indicating that unstriped grass rats are very susceptible to its effects. Gill and Redfern (1977) reported that chlorophacinone at 0.005% killed all rats in from 5 to 15 days when feeding no-choice to complete mortality and that the mean intake of active ingredient was 25 to 30 mg/kg. The unstriped grass rats they used for testing were derived from animals captured in Kenya, brought to England, and established as a breeding colony. There may be a difference in response to the toxicant in animals from different geographic areas.

The response of multimammate rats to chlorophacinone and bromadiolone indicates that this species also is very susceptible to both. On the group feeding trials, animals began dying as early as the second day on chlorophacinone and the third day from bromadiolone. Three days feeding on either material at a 0.005% concentration gave complete mortality. Gill and Redfern (1979) reported also that multimammate rats, when tested with the WHO protocol with 0.005% bromadiolone, showed the least 50% lethal feeding period (LFP) of the 5 anticoagulants tested, including brodifacoum. They state, "The results with bromadiolone suggest that this poison is at least as effective as difenacoum and brodifacoum against *Mastomys*." In their trials of multimammate rats feeding on 0.005% chlorophacinone, they observed 19/20 killed at 3 and 4 days feeding, and 20/20 at 5 days. Vissault and Raban (1976) found that 0.005% chlorophacinone was more active against multimammate rats than was 0.025% warfarin; after 3-day feeding tests, kills of 29/30 and 8/19 were obtained, respectively.

Zinc phosphide appeared to be more effective against unstriped grass rats than against multimammate rats. Gill and Redfern (1979), offering zinc phosphide at 3% no-choice in medium oatmeal bait, found only 6 out of 10 multimammate rats were killed and that some animals survived 219 and 441 mg/kg intake of the poison. When they went to 4% zinc phosphide, they killed all 10 animals on the test. No-choice tests do not offer the animal an alternative to the poison bait and hence are somewhat unrealistic in predicting what might happen in the field. In the feeding tests described here, we found that given a choice, some multimammate rats ate very little of the poison bait. Consumption of plain baits by the multimammate rats in groups was much more than the consumption of poisonous baits, 12.0 g versus 1.1 g and 9.0 g versus 0.4 g, resulting in the survival of 9 of the 14 rats tested. We did not see individual animals surviving more than 52 mg/kg of zinc phosphide, however.

Zinc phosphide at a 1% concentration in millet baits gave good results when used against several species of rodents living around wadis near N'Gouri. The decline in activity at tracking tiles was 79 to 95%, and animal captures declined 73 to 75%. The findings with chlorophacinone at 0.005% concentration were not conclusive since the posttreatment observations were made before all animal mortality could have taken place. Even so, at Assakandori wadi, the tracking tile activity declined 71% within 4 days after the start of the poisoning period. LaVoie (1988) obtained a 91% reduction in activity measure 15 to 16 days after the start of poisoning with 0.005% chlorophacinone and 94% reduction when using 0.025% warfarin. Pretreatment trapping by Dolbeer (1992) indicated that the predominant rodent was the unstriped grass rat, with some fringed-tailed gerbils present.

The acceptance of both 1% zinc phosphide baits and the 0.005% chlorophacinone baits appeared to be good to excellent on all the trials run by Dolbeer (1992). At peak consumption, 42% and 58% of the zinc phosphide bait piles at Guini and Kaya wadi, respectively, were partially eaten and bait takes remained good for 2 and 3 days at each wadi. The acceptance of the chlorophacinone baits reached peaks of 56% and 76%, respectively, at Assakandori and Goural wadis.

Detailed searches were made for dead or sick animals at each wadi at N'Gouri. There was no evidence of mortality to nontarget species. One dead fringed-tailed gerbil was found at Kaya wadi with zinc phosphide bait in its stomach. A pigeon-sized bird was found dead at Goural wadi where chlorophacinone was used. Only insects were found in the bird's stomach, and there was no evidence of hemorrhaging or liver discoloration. It is doubtful that this mortality was related to the rodenticide treatment.

Zinc phosphide treatments against *Gerbillus* appeared to have been effective in reducing activity by between 15 to 73%, depending upon the activity measure used. These are not exceptional rates of activity reduction but are about the norm for zinc phosphide. The use of the PVC pipe bait stations may have excluded *J. jaculus* from the baits since none were found dead in the treated areas. No nontarget animals were found poisoned in the field trial areas despite intensive searches by the field team.

RECOMMENDATIONS

1. Based upon the toxicity tests and field trials reported here, we would recommend the use of either 0.005% chlorophacinone or bromadiolone in millet baits, with the addition of 1 to 2% peanut oil, against unstriped grass rats and multimammate rats.

2. Zinc phosphide at 1% mixed with millet and 1 to 2% peanut oil is an excellent choice to use against unstriped grass rats and *Gerbillus* species where a quick "knock down" of populations of these species is desired.

3. When any of the baits are used, they should be placed in protected areas, such as thorny fencerows or covered with PVC pipe bait stations so that birds and other nontarget animals will have difficulty in reaching the baits.

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