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**CONTROL OF MEADOW MICE, KANGAROO RATS, PRAIRIE DOGS,
AND COTTON RATS**

John A. Ludeman

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INTRODUCTION

Meadow mice, kangaroo rats, prairie dogs and cotton rats are broadly classified as field rodents. The control of their populations have been necessary since man first began to farm and raise livestock within the areas in which these rodents live. The intensity of control has varied with land values and the population fluctuation of the rodents. Rodent control, like other farming practices must be profitable to the land owner, or he cannot afford to undertake a control program. If he is to continue in business his control efforts must be done efficiently and as successfully as possible. To accomplish these ends it is necessary to know when to time his program, what to use for best results, and what can be done to lessen the need for repeated treatments.

MEADOW MOUSE CONTROL

Several different mice occupy meadows or grasslands habitats. Ordinarily the term meadow mouse is used for mice belonging to the genus Microtus. These mice are normally found in habitats supporting dense ground cover. Although not aquatic, they prefer semi-wet habitats. More arid sites are populated at times of peak populations.

Microtus feed on vegetative growth such as grasses, roots and seeds. They build and maintain narrow trails which are kept free of leaves, mold, and other extraneous material* Small piles of fresh grass clippings and fecal matter deposited in the trails are signs of microtus activity. Cotton rats leave similar sign but their trails and feces are larger.

CONTROL MEASURES

The control of meadow mice can be achieved in three fashions; sanitation, the use of barriers, and by the use of toxic baits.

Under conditions of normal populations the destruction or removal of ground cover such as grasses and weeds will cause Microtus to vacate an area. Drainage of seeps and wet areas will also aid in reducing localized population build-ups. The mice hesitate to remain where ground cover does not protect them from predators,

Under conditions where individual trees, bushes or vines must be protected, the use of barriers are often successfully employed. This is particularly useful in orchards, and nurseries. Cylinders of hardware cloth (4 mesh to the inch) are placed about the plant to be protected. They should be 12 to 14 inches high and the lower edge set 2 or more inches into the ground. This protective device is not dependable in areas where deep snows are common. Grass and other vegetation should be kept clear of the cylinder.

Removal of Microtus from an area is the surest way of preventing damage. This can usually be accomplished by use of toxic baits. Apple cubes, oats, cracked corn, and wheat are acceptable bait materials. Zinc phosphide or strychnine are recommended for treating the baits. Best results are obtained when baits are placed under cover in the trails. Best bait acceptance occurs during clear warm days as activity is greatest under such conditions.

When extensive areas are to be treated, such as range lands, alfalfa fields etc., trail baiting by hand is often too expensive and time consuming. Under such circumstances mechanical means of bait distribution are used. Efficiency of control is usually lessened when machines are used for such purpose. Chemical fertilizer spreaders, grain drills, modified potato dusters and aircraft have been used to distribute lethal grain baits. Many states have laws regulating the means by which poisoned bait can be exposed.

Hand baiting is the most selective and least hazardous means of distributing baits for Microtus control. One half inch cubes of apple or carrots treated with lethal agents are placed in mouse trails under grass cover, or teaspoonful quantities of poisoned grain are similarly placed. Small handfuls of bait are sometimes broadcast in heavy grass cover in fencerows or along ditch banks. If a broadcast method is used, the cover must be such that the baits fall into the trails used by the rodents.

Grain baits have been distributed with grain drills and fertilizer spreaders. These machines are generally unsatisfactory because the flow of bait can not be readily controlled.

Agricultural Commissioner Loring White of Modoc County, California has developed a machine that introduces toxic grain bait into an airstream developed by a powered blower. This machine mounted on a jeep can be set to deliver as little as 2 lbs per acre of bait in a 30 foot strip to either side of the vehicle. This feature allows it to be used successfully along fence rows, ditch banks and canals.

SELECTION OF BAIT AND FORMULAS USED

When bait is to be exposed by hand i.e. spot or trail baited, a 1% zinc phosphide cereal bait is usually used. For broadcasting applications a 2% zinc phosphide cereal bait gives best results.

In areas where zinc phosphide baits have failed to provide satisfactory control, a 1-12 strychnine poisoned cereal bait can sometimes be used as an alternate bait.

Cereal baits treated with 1080 (sodium fluoroacetate) have been used for Microtus control. Results are no better than when zinc phosphide is employed, so for safety factors use of this poison is not recommended.

RATE OF APPLICATION

Rate of application when hand baiting will vary with the population. One or two baits spots per burrow system is usually sufficient. Where burrows are less noticeable a bait spot every 20 to 30 feet is usually sufficient. When broadcast baiting in fields and pastures, 2% zinc phosphide baits are applied at approximately 4 lbs. per acre. (Approx. 2 kernels per sq. ft.) Six to 10 lbs. of zinc phosphide cracked corn per acre are applied under eastern orchard conditions. Under some field conditions the home range of Microtus is quite restricted, and enough bait must be applied to insure that it is readily available. Local conditions often require special techniques. This is particularly true where other wildlife must be safeguarded.

the following formulas are used for Microtus control,

FOR HAND OR TRAIL BAITING

APPLE BAITS

Cut firm apples into approximately 1/2 inch cubes, (100 pieces per quart are proper size). Piece measured number of quarts in enameled pan and sift on 1 gm. zinc phosphide for each quart of apples. Shake pan gently until each cube of apple is evenly covered with toxic agent.

ZINC PHOSPHIDE TREATED OATS

100 lbs steam-crushed oats
1 lb Zinc Phosphide (powder)
1 $\frac{1}{4}$ pt mineral or corn oil

Blend the oil and zinc phosphide into a smooth suspension and pour over the oats. Stir with a paddle until the black color is evenly distributed over the grain. This mixture can be sacked immediately. If placed in air-tight containers, it retains full toxicity for approximately four months.

STRYCHNINE-TREATED OATS

1 ounce powdered Strychnine Alkaloid
1 ounce Baking soda
1/4 pint heavy corn syrup
3/4 ounce gloss laundry starch
1 pint cold water
12 pounds steam-crushed oats

Add gloss starch to cold water and bring to boil. Cook until starch "clears." Add syrup. Pour liquid over blended powders (strychnine and soda) and stir into a foamy suspension. Pour immediately over oats and stir until evenly coated. Spread grain on paper and allow to air-dry before sacking.

Formulas for semi-broadcast or mechanical distribution.

ZINC PHOSPHIDE- OATS

2 lbs. zinc phosphide powder

20 oz. heavy mineral oil *or plasticized lethecin

100 lbs flattened oat groat or steam-crushed oats

Suspend the zinc phosphide in the mineral oil by rapid stirring, and pour immediately over the oats while they are in motion in a power driven mixer. The black color will indicate when an even distribution is obtained. Treated grain can be sacked immediately.

- * It is difficult to suspend 2 pounds of zinc phosphide in mineral oil or vegetable oil when preparing the 2% zinc phosphide baits. If large quantities of the bait are to be prepared, it is advisable to prepare a plasticized lethecin as follows:

Mix 8| parts of ALCOLEC S to 2 parts by weight of mineral oil. Heat the spreader to 70° C. Stir during the heating process to prevent scorching of the lethecin and to aid in its blending with the oil* When the temperature is reached, beat mixture with a high-speed mixer to complete blending process. The material will have a consistency similar to automobile transmission grease and will, readily suspend the required amount of zinc phosphide power,

ALCOLEC S is obtainable from the American Lethecin Co., Woodside, Long Island 77, New York. Mineral oil can be purchased from Standard Oil. It is listed as #10656 Paraffin Oil, 300 Viscosity.

ZINC PHOSPHIDE- CORN

2 lbs. zinc phosphide powder

100 lbs. coarse, cracked, yellow corn

1 qt. vegetable oil (corn oil preferred)

Mix the zinc phosphide and oil to form a paste. Pour over cracked corn and mix thoroughly.

KANGAROO RAT CONTROL (Dipodomys)

Scheduling a control program and selecting the proper bait materials requires a knowledge of the animals habits, and food preferences. Kangaroo rats normally occupy dry grassland areas. They are nocturnal in habit. Their food storage and living quarters are constructed underground. A flat mound is built of dirt taken from the underground quarters. When in their burrows they close the entrance with dirt. During much of the year each burrow is occupied by a single animal.

They are principally seed eaters, but consume small quantities of roots and bulbs. External cheek pouches are used for carrying food to underground storage chambers.

BAIT MATERIALS

Rolled Oats, rolled barley, or milo maize are preferred as bait materials. Strychnine and zinc phosphide are the most generally used toxic materials.

APPLICATION OF BAITS

The object of bait distribution for rodent control is to place the material where the rodent is most likely to encounter it under favorable feeding conditions. Kangaroo rats range widely for their natural food, therefore baits can be widely scattered. Crews, mounted on horse back, in jeeps or pickup trucks, or on foot traverse the area

to be treated in parallel strips. Each pass can be 50 to 300 yards apart, depending upon the degree of infestation and terrain. Baits averaging 40 to 50 per quart are tossed in a wide semi-circle adjacent to trails and burrows.

When possible a pre-poison test exposure of clean bait should be made. In the event it is not accepted by the rodent, no poisoned bait should be exposed.

BAIT FORMULAS

The following bait formulas are used for the control of kangaroo rats.

Ingredients	<u>STRYCHNINE GRAIN BAIT</u>	
	1-16	1-20
Steam Crushed Oats or Whole Oats	800lb.	500 lb.
Strychnine Alkaloid	50 oz.	25 oz.
Sodium Bicarbonate	3 lb.	1½lb. lb.
Glycerine	8 lb.	5 lb.
Salt	24 lb.	15 lb.
◆Standard Spreader	15 qt.	9 qt.

Standard Spreader Preparation

1. Place required amount of Blue Karo syrup (10 gallons) in the steam cooker and bring to slow boil.
2. Add 3 pounds of dry starch, paste in 1½ qts, of cold water for each ten gallons of syrup. (Variation in starches some times make modification of this 3-lb recommendation necessary to secure the desired consistency). Use amounts of prepared spreader as listed in above formula.

Mixing Procedure

1. Weigh grain in hopper scales,
2. Measure the hot spreader required for the batch into mechanical mixer.
3. Add the strychnine and soda to the not spreader while it is being agitated.
4. Add glycerine and mix for 3 minutes.
5. Transfer grain from scales to mixer and the completed strychnine paste from the mechanical mixer to the pressure tank.
6. Close tank and apply steam pressure (90 lb.) to force the solution over the grain in the batch mixer.
7. After the strychnine solution has been applied and the bait mixed for about 1 minute add salt. Mix additional 3 minutes then elevate into storage bins.
8. Allow bait to remain in bins for about 8 hours before sacking.

* Quantity of spreader will vary in different lots of oats, depending on size of kernels, degree of crushing and variety of grain used.

ZINC PHOSPHIDE BAIT (1% STRENGTH)

<u>Ingredients</u>	<u>Quantity</u>
Zinc Phosphide	16 ounces
Mineral or Corn Oil	20 ounces
Steamed-rolled oats or wheat	100 pounds

Directions for Mixing:

1. Weigh oats or wheat and put in mixer.
2. Thoroughly paste zinc phosphide in the oil and pour over the grain in the mixer. Mix thoroughly (for 5-6 minutes).

PRAIRIE DOG CONTROL

Because of the wide range of the prairie dog and differences among the species, it is difficult to make a general or condensed statement covering all control procedures.

Control methods include the use of lethal grain baits, gases, shooting and trapping. The proper time to conduct prairie dog control varies with elevation, location, and species. Control operations are usually begun as soon as clean prebait is well accepted in the spring. If baited too early the grain is not well accepted as the animals are eating young vegetation. If baited too late many of the animals are estivating or hibernating.

Best control is attained with the baits that are exposed in the morning. The animals feed heaviest during this time of day and more readily accept the bait. It is important that entire towns be treated at one time. The area should not be revisited or disturbed for several days following the exposure of the bait.

CONTROL OPERATION

Before toxic baits are exposed, areas of 1 or more acres should be baited with clean bait as a check for bait acceptance. If prebait acceptance is poor the control operation should be delayed or cancelled. If acceptance is satisfactory the program should proceed. In an organized control operation a crew usually consists of a foreman

and one to three crewmen. They are equipped with gloves, a bag of lethal bait and a long handled measuring dipper. The men can be mounted on horses or on the back of a pickup truck or they can operate on foot. The terrain and size of the operation is often a determining factor. The crew men are spaced 20 to 60 yards apart, and move in parallel lines across the infested area. Measured amounts of bait—a heaping tablespoonful—are scattered over a 4 ft area on the hard ground to one side of the active burrow openings.

Baits placed in open burrows give poor results. This practice should be avoided.

The foreman should make frequent checks to determine that the crew is baiting properly. Over-baiting should be avoided, yet sufficient bait should be exposed to eliminate all prairie dogs occupying the townsite. Amounts required vary with the season and population density. Poisoned bait should not be exposed during stormy weather or if rains appear imminent,

LETHAL BAITS USED FOR PRAIRIE DOG CONTROL

Sodium Fluoroacetate

Since the advent of 1080, (sodium fluoroacetate) prairie dog control has become noticeably less difficult. Steam rolled oats treated with 2 oz of 1080 per hundred pounds of grain is readily accepted, A heaping tablespoonful of the bait scattered over 4 sq ft of hard ground to one side of burrow opening is sufficient for most control operations.

THALLIUM SULFATE

Thallium sulfate treated oats are sometimes used when other lethal agents have failed to reduce satisfactorily the prairie dog populations. Even then thallium is not guaranteed to solve the problem. Its use and application is the same as with 1080 except larger bait spots are used. Crews must be supervised quite closely as thallium is a cumulative poison. Gloves should be worn and washed each day.

ZINC PHOSPHIDE

Zinc phosphide treated cereal baits are sometimes used for the control of prairie dogs. Results with this material is erratic. Area3 should always be prebaited before zinc phosphide is used.

STRYCHNINE ALKALOID

Strychnine treated grain baits work well in controlling the black-tail prairie dog. It is not as effective when used on the Gunnison or Zuni varieties

Application of the baits are the same as when using 1080, except that the bait can be applied by hand without using a dipper or spoon. Baits should average 30 to 40 per quart.

GASES

For clean-up work or in areas where lethal baits can not be used, prairie dogs can be controlled by the use of gases. Carbon bisulfide, calcium cyanide flakes or dust, methyl bromide, and carbon monoxide gas have been used successful. Soil types and soil temperatures may affect the effectiveness of these gases.

TRAPPING

Traps are sometimes used for prairie dog control when only a few animals are involved. No. 0 or No. 1 traps should be set at the side of the barrow entrance rather than directly in the runway. They should be buried level with the surface of the ground. The trap site should be marked so as to prevent loss of traps. Clean oats sprinkled over the trap will act as an attractant to the prairie dog.

FORMULAS

The following bait formulas are used for prairie dog control.

COMPOUND 1080 GRAIN BAIT - (2-100)

<u>Ingredients</u>	<u>Quantity</u>
Steamed-crushed Oats or Whole Oats	800 lb.
Compound 1080	16 oz.
Lecithin	150 oz.
Water	150 oz.
Dye (aniline - brilliant Yellow)	5 ½ oz.

Mixing Procedure:

1. Place water in container and heat.
2. Dissolve Compound 1080 in the hot water.
3. Add lecithin and dye to 1080 solution and heat entire mixture to 70 Deg. C. When mixture reaches 70 Deg. C. or 158 Deg. F. whip with a high speed mixture until completely homogenized.
4. Pour mixture slowly over grain and mix for 5-6 minutes.

THALLIUM SULFATE 1-65 STRENGTH

<u>Ingredients</u>	<u>1-65 Strength</u>
Steam-rolled oats	500 lb.
Thallium Sulphate	7 ½ lb.
Yellow Dextrin	5 lb.
Glycerine	4 lb.
Water	5 ½- 6 gal.

Mixing procedure:

Weigh oats and put into wooden box mixer. Paste dextrin with a little of the cold water. Mix the dextrin paste with 5 gallons water, add thallium and glycerine and heat to boiling by means of a live steam jet and continue boiling until thallium is dissolved. (Condensation should be limited to 1 gallon, since the total moisture should not exceed 6 gallons). Pour paste over grain in mixer and run machine for 12-15 minutes. Spread bait and allow to dry for 24 hours. Caution: Use graniteware kettles and spoons. Avoid letting thallium mixture come in contact with metal such as galvanized iron or zinc in any form.

ZINC PHOSPHIDE BAIT - (1% Strength)

<u>Ingredients</u>	<u>Quantity</u>
Zinc Phosphide	16 ozs.
Plasticized Lecithin	20 ozs.
Steam-rolled Oats or Wheat	100 lbs.

Mixing procedure:

1. Weigh oats or wheat and put in mixer.
2. Thoroughly paste zinc phosphide in the lecithin and pour over the grain in the mixer. Mix thoroughly for 5-6 minutes.

Note: ZnP bait is also produced in 1½ and 2% strengths. This is accomplished by merely increasing the quantity of zinc phosphide accordingly.

STRYCHNINE OATS BAIT

<u>Ingredients</u>	<u>Strengths</u>	
	<u>1-16</u>	<u>1-20</u>
Steam Crushed Oats or Whole Oats	800 lb.	500 lb.
Strychnine Alkaloid	50 oz.	25 oz.
Sodium Bicarbonate	3 lb.	1½ lb.
Glycerine	8 lb.	5 lb.
Salt	24 lb.	15 lb.
*Spreader	15 qt.	9 qt.

Spreader Preparation

1. Place required amount of Blue Karo syrup (10 gallons) in the steam cooker and bring to slow boil.
2. Add 3 pounds of dry starch, paste in 1½ qts. of cold water for each ten gallons of syrup. (Variation in starches some times make modification of this 3-lb. recommendation necessary to secure the desired consistency). Use amounts of prepared spreader as given in above formulas.

Mixing Procedure

1. Weigh grain in hopper scales.
2. Measure the hot spreader required for the batch into mechanical mixer.
3. Add the strychnine and soda to the hot spreader while it is being agitated.
4. Add glycerine and mix for 3 minutes.
5. Transfer grain from scales to mixer and the completed strychnine paste from the mechanical mixer to the pressure tank.
6. Close tank and apply steam pressure (90 lb.) to force the solution over the grain in the batch mixer.
7. After the strychnine solution has been applied and the bait mixed for about 1 minute add salt. Mix additional 3 minutes then elevate into storage bins.
8. Allow bait to remain in bins for about 8 hours before sacking.

* Quantity of spreader will vary in different lots of oats, depending on size of kernels, degree of crushing and variety of grain used.

COTTON RAT CONTROL - (Sigmodon)

The physical appearance of a full grown cotton rat resembles that of a small norway rat. The habits of the cotton rats however more closely resemble those of meadow mice. Their diet is mainly plant materials such as grass stems, roots, and seeds. Nests are underground cavities lined with soft grass. They build and use well defined trails leading from their burrows to food supplies. Short section of cut grass stems are quite noticeable in and along the trails. They prefer to live under heavy grass or weed cover. When this is sparse they increase the number of burrows as added protection from predators. They are subject to the same population fluctuations commonly associated with Microtus.

CONTROL

Control is usually achieved by exposure of toxic treated baits such as oats, corn, wheat, maize, carrots, sweet potatoes and white potatoes. Open ditches and metal barriers have been used to protect high value crops when toxic materials were ineffective.

Toxic materials include strychnine, zinc phosphide and thallium sulfate.

Placement of the bait is the same as for Microtus.

Trail baiting under grass cover and near burrows openings is efficient and selective. Fresh baits (1 cube) are placed at intervals of 10 to

15 ft. Teaspoonsful of grain bait are similarly placed. In the early spring, treatment of fence rows is usually sufficient. When rats later invade fields, baits should be exposed in every 5th or 6th row. The areas may require retreatment at intervals as these animals quickly reinvade favorable habitats. It is advisable to change baits and toxic material when retreating an area.

MECHANICAL BARRIERS

At times cotton rat populations increase to population peaks which are difficult if not impossible to control satisfactorily by means of toxic baits. Under such conditions, when crops of high value are endangered, protection has been achieved by the erection of solid metal barriers, or by encircling the area with trenches 16 inches wide and 40 inches deep. Mechanical trenching tools can readily construct such trenches in suitable soil. Sides of the trench must be vertical so the entrapped rats cannot climb out. Small bait spots of poisoned grain placed in the bottom of the trench at intervals of 200 feet will aid in preventing the escape of rats that fall into the open trench.

PROCEDURES TO BE USED TO PROTECT BENEFICIAL WILDLIFE Areas inhabited by cotton rats are often prime bird habitats. Gallinaceous birds are highly resistant to strychnine. Vegetable baits treated with zinc phosphide are seldom attractive to birds. Baits placed under cover may be accessible to quail, but relatively safe from other birds.

In no event should grain baits be used in the open near utility lines or fences when doves are known to be present.

Baits dyed yellow, green, or black are effective deterrents to birds in some areas.

FORMULAS

The following formulas have been used effectively for controlling cotton rats.

STANDARD STRYCHNINE BAIT

Ingredients	Strengths	
	1-16	1-20
Steam Crushed Oats or Whole Oats	800 lb.	500 lb.
Strychnine Alkaloid	50 oz.	25 oz.
Sodium Bicarbonate	3 lb.	1½ lb.
Glycerine	6 lb.	5 lb.
Salt	24 lb.	15 lb.
♦Standard Spreader	15 qt.	9 qt.

Standard Spreader Preparation

1. Place required amount of Blue Karo syrup (10 gallons) in the steam cooker and bring to slow boil.
2. Add 3 pounds of dry starch, paste in 1½ qts. of cold water for each ten gallons of syrup. (Variation in starches sometimes make modification of this 3-lb. recommendation necessary to secure the desired consistency). Use amounts of prepared spreader as listed in above formulas.

Mixing Procedure

1. Weigh grain in hopper scales.
2. Measure the hot spreader required for the batch into mechanical mixer.
3. Add the strychnine and soda to the hot spreader while it is being agitated.
4. Add glycerine and mix for 3 minutes.
5. Transfer grain from scales to mixer and the completed strychnine paste from the mechanical mixer to the pressure tank.

6. Close tank and apply steam pressure (90 lb.) to force the solution over the grain in the batch mixer.
7. After the strychnine solution has been applied and the bait mixed for about 1 minute add salt. Mix additional 3 minutes then elevate into storage bins.
8. Allow bait to remain in bins for about 8 hours before sacking.

* Quantity of spreader will vary in different lots of oats, depending on size of kernels, degree of crushing and variety of grain used.

ZINC PHOSPHIDE GRAIN BAITS

Ingredients;

1-1/2 pounds zinc phosphide
1 pound vegetable oil or Lecithin
100 pounds grain

Mix zinc phosphide and oil until all of the toxicant is in suspension. Pour over grain and mix well. (No drying necessary.)

ZINC PHOSPHIDE SWEET POTATO BAITS

Ingredients;

1-1/2 pounds zinc phosphide
2 pounds vegetable oil
100 pounds **sweet potatoes** (Cut in 1/2" to 3/4" cubes)

Dust zinc phosphide over sweet potatoes and mix until uniformly gray. Then add oil and mix until black.