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RODENTS AND MOLES AS PESTS IN BULB PLANTINGS

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CONTENTS

	Page		Page
Introduction.....	1	Bulb classes and pest relations—Continued.....	
Practices affecting the bulb-pest problem.....	1	Ixias and sparaxis.....	7
Relative palatability of the common bulbs.....	2	Lilies.....	7
Mammal pests of bulbs.....	2	Preventive measures.....	9
Bulb classes and pest relations.....	3	Active deterrents.....	9
Narcissus.....	3	Exclusion by barriers.....	9
Tulips.....	4	Trapping and other control measures.....	10
Gladiolus.....	5	Moles.....	11
Bulbous irises.....	6	Mice and rats.....	12
Crocuses and hyacinths.....	7	Pocket gophers.....	13
Freestias.....	7	Rabbits.....	16

INTRODUCTION

Bulb growing in the Pacific Coast States has of recent years developed along progressive lines, particularly in the production of forcing stock. The climate and soils of the Puget Sound and lower Columbia River sections and of western Oregon have been found peculiarly adapted to the growing of the more hardy types of flowering bulbs, and those of southern California to the less hardy species. With the extension of bulb culture to fields of many acres, damage by rodents and birds assumed such proportions as to prompt investigations to develop remedial and preventive measures, the results of which are presented in this circular.

While the special investigations in the field of bulb growing and in the control of rodent pests that affect the industry have been conducted on the Pacific coast, from Bellingham, Wash., to San Diego, Calif., the findings and recommendations will in the main apply equally well to almost any other section of the country. With the exception of the pocket gopher, which is widely distributed in the western and in the southeastern parts of the United States, representatives of the groups of small burrowing animal pests of bulbs here considered are likely to be found in any parts of the country where bulbs are grown in garden or field.

PRACTICES AFFECTING THE BULB-PEST PROBLEM

Complicating the problem of dealing with rodents and other mammals that may interfere with the production of bulbs is the prevailing practice among growers of moving their stocks to new ground

from year to year. This is done principally to avoid mixing the planted varieties with volunteer growth, but sometimes to benefit by better soil conditions. In shifting the planting stock, the experienced bulb grower, who prepares his ground in accordance with accepted precultural methods and proper fertilization, also takes into account the injurious rodents that may infest either the tract itself or the adjoining waste lands. Such growers do not need to be urged to clean up the lands as completely as possible in advance, rather than to subject valuable bulbs to the menace of hungry rodents, the relations of which to their environment have already been disturbed to some extent by cultivation. This freeing the lands of injurious mammals should start at least a year before the bulbs are to be planted, and earlier if possible.

RELATIVE PALATABILITY OF THE COMMON BULBS

The palatability of the bulbs more commonly grown has been tested in the laboratory both by human taste and by repeated experiments with the smaller rodents in captivity. Not only have the likes and dislikes of the animals experimented with corresponded closely with those of the human palate, but later investigations in the field have borne out the conclusions reached in the laboratory.

In general, bulbs of tulips, Dutch and Spanish irises, and crocuses (corms) are found to be readily acceptable both to rodents and to the introduced ring-necked pheasant.¹ Hyacinth, freesia, lily, and grape hyacinth (*Muscari*) bulbs are perhaps less relished by rodents but are often seriously damaged locally, and only narcissus seems to be practically immune to their attack. The corms of gladiolus apparently are not sought after by most rodents, but sometimes the smaller-sized planting stock is stored by pocket gophers in considerable quantity. These corms have a bitter, pungent taste but are not more unpalatable to man than are the roots of certain wild plants to be found in the pocket gopher's stores. Bulbs of ixia, sparaxis, and scilla, which are not so extensively grown, may be classed with those of indifferent but not unpleasant flavor.

Some bulbs are distasteful and sometimes have poisonous qualities. Dutch authorities report the poisoning of pigs and calves by narcissus bulbs, fed them at times when there was a surplus of this product and a scarcity of other forage. In Pammel's manual of poisonous plants it is stated that many members of the amaryllis family have acrid properties, that some of them are poisonous, and that poet's narcissus produces intense gastroenteritis. In a catalog of the poisonous plants of all countries are listed several species of narcissus and hyacinth.

MAMMAL PESTS OF BULBS

The chief smaller mammals the activities of which interfere with bulb growing in the Pacific Coast States are moles, mice, rats, pocket gophers, and rabbits.

¹ Sometimes ring-necked pheasants also completely demolish small tulip, iris, and crocus plantings in garden or park by prodding into the earth with the beak to tear out the bulbs and tender underground parts of the stems for food. Control measures should be undertaken only after consulting local game wardens, as these birds are protected by law, and therefore as a rule should be frightened but not destroyed.

Moles (*Scapanus*) are distributed generally in the coastal belt of Washington, Oregon, and northern California, and more locally in the southern parts of the last-named State.

The meadow mouse (*Microtus*), the white-footed mouse (*Peromyscus*), and the common brown rat (*Rattus*) are three rodent genera that may be found in favorable environment almost anywhere throughout the country.

Pocket gophers (*Thomomys*) range throughout the bulb-growing districts of the western coast, except in agricultural lands of western Washington, where they occur mainly on the prairies just south of Puget Sound.

Rabbits include the snowshoe hare (*Lepus washingtoni*), occurring sparsely in western Washington; the black-tailed jack rabbit (*L. californicus*), throughout the humid coastal belt of California and north into the Willamette Valley of Oregon; the cottontail (*Sylvilagus auduboni*), in the Sacramento Valley of California and the coastal belt to the south; and the brush rabbit (*S. bachmani*), found in the coastal belt of California and up along the Oregon coast nearly to the Columbia River.

Though the grower of bulbs on a commercial scale may suffer heavier individual losses and the plant breeder perhaps more exasperating damage from depredations by burrowing mammals, it is the keeper of the home garden who has the greater ground for complaint and the greater need for advice. The commercial grower, with much at stake, usually takes pains to seek out and adopt measures of pest control without delay, but the average home gardener, frequently puzzled and not knowing what to do, is apt to postpone aggressive action.

The types of soil more commonly chosen for commercial bulb growing are those of valley floors or prairies—places likely to be infested by burrowing mammal pests, particularly moles and meadow mice. Within their ranges, however, these two groups of animals respect no bounds set by slope or contour. Where snow falls in winter or where mulching with leaves or straw is practiced, the grower will have to be more than ordinarily vigilant, for these pests work best under cover and keep busy all winter.

With respect to the losses in bulbs stored in sheds or warehouses, it need only be said that the kinds that are relished by the wild rodents may be just as acceptable to any mice and rats that infest such quarters.

BULB CLASSES AND PEST RELATIONS

NARCISSUS

By reason of distasteful and sometimes poisonous qualities, the various types of narcissus—daffodils, jonquils, poeticus, polyanthus (bunch flowered), and others—are practically free from rodent attack. In a few cases that came under observation in southern California, narcissus bulbs had been removed by pocket gophers, probably from the instinct of the rodents to store things that at first contact seem edible. The likelihood of mechanical damage by moles and rodents to narcissus plantings in field rows is slight, as the plant structures are fairly tough and not easily torn or broken. In beds,

however, where orderly arrangement is desirable, and in the lighter field soils, where the drying of the roots may result from the passage of a mole down the rows, the presence of these small burrowers should not be tolerated.

TULIPS

Tulips appear to be the frailest in structure of all the bulbous plants commonly grown, and the underground parts at least as inviting as any other to the appetites of small burrowing animals. More complaints are made about the damage these animals do to tulips than to any other class of bulbs, the charge usually being laid at the door of the mole. This insectivorous animal, the principal diet of which in humid climes is earthworms, is often directly responsible for the loss of bulbs. Captive moles held under conditions as natural as possible eat tulip bulbs regardless of the size, but never

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FIGURE 1.—Damage to tulip planting done by pocket gophers: 15,000 bulbs destroyed, Salem, Oreg.

store them or any other food supplies. Moles may often follow planted rows on account of the presence of fertilizer in them and their consequent attraction for worms and insects.

Being frail, the tulip plants are sometimes seriously damaged by moles passing along the rows beneath the surface and breaking every stem in their progress. The bulbs may or may not be taken later, but the wilting and discoloring stems betray the damage.

Mole runways are often used as highways by rodents, including mice, pocket gophers, and, occasionally, young rats, and this makes it difficult to determine the relative damage done to tulip beds by each kind of animal. The meadow mice, however, do considerable burrowing on their own account, leaving open holes here and there.

Within its natural range, the pocket gopher is always a menace to tulip growing (fig. 1). This applies particularly to districts of western Oregon, where pocket gophers of a large species or of one or more smaller species are likely to be locally abundant. The menace is the

greater because the smaller species often fill in the older runways with the soil excavated from the new and thus leave above ground no evidence of activity to betray their presence. By contrast, the mole keeps open and in repair all parts of its runway system, except the upridged hunting paths in drier weather. Ridged runways constructed by the mole are at times used in the lighter soils by small species of pocket gophers—both in Oregon and in California.

The pocket gopher is a miner, storing in underground chambers its treasures of roots and bulbs by the handful or the peck. The shallower caches can be located later by the thick tufted growth of tulip plants at the surface; the deeper stores, usually the larger, may be sought out and recovered by the grower if he has the will and patience to dig out the runways in time to salvage the planting stock. This will probably be sadly mixed, however, as to varieties. Loss of tulip

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FIGURE 2.—Pocket gopher damage to gladiolus planting, near Encinitas, Calif.

bulbs to pocket gophers will occur at any time from the day they are put into the ground to the time the plants flower, but the greater damage to beds or fields usually occurs in winter, when they are less closely watched.

GLADIOLUS

The gladiolus bulb (or corm) is less esteemed as food by burrowing mammals than are the tender bases of the stems, but that arch enemy of edible underground plant structures, the pocket gopher, may not have its way in a gladiolus planting without serious risk to the floral products and hence to the grower's profits. A single pocket gopher will make a large desert spot in a "glad" field (fig. 2); for the animal stores inordinately by instinct, without respect to its needs. Observations or complaints of damage by field and meadow mice to gladiolus are not unusual, but the loss from such depredations is not great.

Moles will upset the arrangement of things in an exasperating way, and by upheaving along the rows cause the younger plants to die out there.

Since the gladiolus is commonly grown in midsummer, with the bulbs safely stored in winter, the risk of damage from burrowing rodents is restricted to the season when the fields are under closest observation. Offsetting this advantage, however, is the fact that the plants are fed upon at night by wild rabbits of several species (fig. 3) in the coast region and sometimes by deer in outlying districts. In their nocturnal forays on the gladiolus plantings, the rabbits, coming in from adjoining shelter of brushlands, feed consistently on the new growth in areas already pastured, in preference to foraging on the taller and less succulent plants at first neglected.

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FIGURE 3.—Gladiolus planting eaten down by rabbits, near Encinitas, Calif.

Plant breeders, originators of new varieties of gladioli, take the utmost precautions to forestall any rodent damage to their highly prized stocks. Whether founded on actual varietal differences in the palatability of gladiolus bulbs, or possibly on other factors, there is a widespread opinion among growers in some districts that rodents show a preference for some horticultural varieties over others.

BULBOUS IRISES

Dutch and Spanish irises have come to be grown commercially on the West coast in recent years, largely to supply a product for forcing under glass. Bulbs and stems alike have found favor with some rodents as a source of food supply, though the underground structures are more often attacked. In the extent of damage to bulbs, meadow mice are the chief offenders in the Puget Sound district, and pocket gophers in southern California and in Oregon. In southern

California the tops also of the iris plants are eaten by rabbits, which, however, do not appear to relish them so greatly as they do the gladiolus leaves. Moles do comparatively little injury to iris plantings, as the stems and leaves are fairly tough and pliable.

In protecting this bulbous crop, an ounce of prevention is worth the proverbial pound of cure, for damage to iris plantings is most likely to occur when they are receiving the least attention from the grower, that is, late in fall and throughout the winter. Injury to the bulbs from mice may certainly be expected if open burrows or other signs of these little rodents are found in the iris beds or in nearby shelters and waste lands. Such injury will continue, as in the case of tulips, up to the time the plants flower. Iris usually makes a quick growth above ground late in the fall, too, so that the tender stems are thus exposed to attack by rabbits.

In a region inhabited by the pocket gopher, this rodent is a greater menace to iris growing than is the meadow mouse, both because the latter is usually less common in the pocket gopher's range and because of the pocket gopher's habit of storing quantities of food.

CROCUSES AND HYACINTHS

The crocus and the hyacinth are early spring bloomers out of doors, the former from a corm, the latter from a bulb. The crocus corm is as edible as a nut and thus readily finds favor with burrowing rodents as an article of food. As usually planted about the home premises, it remains in the ground throughout the year, and is thus always exposed to attack by mice working either independently or in mole runways. It will, of course, also be eaten and stored by the pocket gopher, and at the time of the plant's flowering the beds are sometimes raided by ring-necked pheasants. Commercial plantings of crocus and hyacinth on the west coast are small. The hyacinth bulb, though less attractive to rodents than the crocus corm, is subject to serious attack at times. The grape hyacinth (*Muscari*) may be classed with the hyacinth in this respect.

FREESIAS

In southern California freesias are grown commercially under field conditions, sometimes many acres in a planting. The bulbs receive considerable attention from any pocket gopher within striking distance. As a result large gaps appear in the fields (fig. 4) where the bulbs have been taken before top growth began. Freesias are not safe from the pocket gopher until harvested. The plant structures above ground are apparently not favored as forage by the rodents.

IXIAS AND SPARAXIS

Smaller plantings of ixia and sparaxis in the same general district of California were subject to some injury from pocket gophers, but the greater harm was done by rabbits nibbling the tops to the ground.

LILIES

Lily growers are particularly annoyed by the presence of moles and other burrowing animals in their plantings, as the crop is often

grown from the seed and it requires at least 3 years to produce merchantable bulbs. The seedling plants, in beds, should be protected by mole- and rodent-proof barriers where possible, unless the

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FIGURE 4.—Pocket gopher damage to freesias, near San Fernando, Calif.

premises are comparatively free from these pests. In field or garden culture bulbs of most classes of lilies are subject to attack by pocket gophers and meadow mice, the former storing them in large quantity as they do any food they favor. When treated as an all-year-round

crop in the ground, lily plants need watching for signs of rodent damage at seasons when cultivation is not in progress.

PREVENTIVE MEASURES

Efforts made to eliminate damage by burrowing animal pests may include the selection of a location for bulb growing that is free from them, the exclusion of pests from the field, and the control of those present. If preventive measures are possible, so much the better, as they forestall all injury; but control is usually the most practicable. One of the difficulties is the fact that the conditions of soil and climate essential to successful bulb culture are usually also favorable for one or more animal pests. The richest soils for growing bulbs generally have the heaviest mole infestation, because of the abundance of mole food. Mice, while fluctuating seasonally in numbers, usually are most numerous where rank vegetation affords food and cover.

A site on which some of the destructive forms can be avoided may be selected for growing the bulbs. The pocket gopher, as previously stated, is restricted in distribution; the commercial grower should endeavor to plant on land that is free from this pest. Areas adjoining brushy, timbered, or uncultivated land should be avoided if possible, as such lands generally harbor mice and rabbits and, in the Northwest, some moles. It is almost impossible to find a place entirely free from pests.

When an area is selected that is infested with destructive animal pests, every effort should be made to get rid of them before planting the bulbs. Having freed the land from the pests, the grower may take steps to exclude others or to destroy any that succeed in entering. Exclusion is costly and not wholly effective. Methods of destroying the invaders are less expensive and more practicable.

ACTIVE DETERRENTS

If there are moles, mice, or pocket gophers on the premises, vigilance is the price of success with bulbs and flowering plants having edible root structures. The use of deterrents introduced into the soil at planting time, such as naphthalene flakes and other substances having a more or less persistent and obnoxious odor, has not proved effective in protecting the bulb beds from rodents and moles; nor does putting offensive substances into mole runs at any time, assure the gardener that he will thenceforth be free of the pest. Usually in repairing their runs the animals will bury the material or will dig new burrows near the old. The so-called "mole plants"—castorbean, milkweed, and others—have been more celebrated in oft-told tales than effective in actual service in keeping moles away from gardens and flower beds.

EXCLUSION BY BARRIERS

Deep plowing is advised for breaking up existing mole runways as much as possible. As a temporary protection to a field of growing bulbs an enclosure ditch 12 to 18 inches deep may be made. While this is not a perfect barrier to small burrowing animals, it checks them and makes it possible to detect more readily the entrance of a

mole or a pocket gopher into the planting. These should then be trapped at once.

Some protection of bulb beds against moles and burrowing rodents in gardens, lawns, and parks may be insured by providing a fence of galvanized hardware cloth, $\frac{1}{2}$ -inch mesh, 36 inches wide, buried 30 inches, with 6 inches turned out at the bottom.

Where certain valuable plants require special protection, particularly from moles, and the plot for their propagation is sufficiently permanent, simple concrete barriers (fig. 5) 1 inch or more thick have been found more durable, and hence cheaper in the long run, than the galvanized hardware cloth. They may be constructed with

comparatively small outlay for labor and materials as follows:

Pour a cement mixture between the outer vertical bank of a narrow ditch and a movable 20-gage sheet-metal form (30 by 36 inches) placed to support the concrete temporarily on the inner side. Such a barrier need not be more than 1 inch thick and should be 30 inches deep. Moles and pocket gophers rarely go deeper in search of food. The metal forms are to be kept in place 1 inch from the outer bank while the ditch is being filled on both sides at the same time—

concrete on the outer

side and earth on the inner side, as moles would be less likely to burrow down through the solid outer earth than through the fill. As the filling proceeds the metal forms are pulled out and shifted farther along, one at a time, without waiting for the cement to dry. Two or three such portable forms will be needed to keep the work going. An inch of one edge of the forms may be bent at right angles to strengthen it and to serve as a handhold. A mixture of 1 part portland cement, 2 parts sand, and 3 parts gravel (not too coarse) is recommended for the 1-inch wall.

TRAPPING AND OTHER CONTROL MEASURES

Fencing or otherwise excluding burrowing pests is not always practicable. In most cases it will be necessary to supplement this method of control by trapping and other means.

FIGURE 5.—Method of construction of concrete barrier 1 inch thick and 30 inches deep, to exclude burrowing animal pests from areas where certain valuable plants require special protection. Concrete is poured on the outside of the metal form while earth is filled in on the bed side, after which the form is moved forward without waiting for the concrete to dry.

MOLES

The only remedy for the mole nuisance that has been found to be consistently effective is the trap. The animal is easily taken in specially designed traps adapted to its peculiar habits. Mole traps on the market are of two general types, the gripping (figs. 6 and 7) and the harpoon. Gripping traps are of several designs, including the scissors-jaw trap (fig. 6, *A*), the choker-loop trap (fig. 6, *B*), and the diamond-jaw trap (fig. 7). The harpoon, or spear-type, trap, is used more commonly in the eastern part of the country, where the moles throw up few mounds but make mainly the ridged runways. The other types are used along the Pacific coast. Wherever possible, however, traps of any of the three types should be set in unbroken land, such as in sod, along fence rows, and in paths where the runways are more likely to be of a permanent nature. Best results are obtained when the soil is moist.

All gripping-type traps are set in practically the same manner.

FIGURE 6.—Mole traps of the gripping type, in position for a catch: *A*, scissors-jaw trap; *B*, choker-loop trap.

By selecting a fresh mound and probing around or directly under it with a slender rod, one can locate a straight stretch of runway essential to the proper setting of these traps. Dig a hole across the runway no longer than the width and length of the trap, keeping in mind that the trigger pan is set at right angles to the course of the runway. The hole should be an inch deeper than the lower level of the runway. After removing the dirt from the hole construct a narrow ridge of firmly packed soil across the center of the hole, about 3 inches high, obstructing at right angles the course of the runway. Set the trap and place it in the hole, pressing the trigger firmly upon the constructed ridge. The jaws or loops should encircle the course of the opened runway and rest firmly on the bottom of the excavation. To exclude all light from the ends of the runway, fill in the hole with moist soil, free from sticks, stones, or clods that might interfere with the operation of the trap. The choker-loop type is preferable in gravelly and heavy clay soil. Either type may be used in fine soil. For deep runs, additional digging is necessary to allow the heavier metal parts of the loop to rest on the level.

The harpoon type of trap was designed primarily for the ridged runways of the eastern mole. It is set by firmly pressing down about 3 inches of the ridged runway and forcing down the anchor prongs so that the trigger rests snugly upon the depressed part of the runway and at right angles to its course. It is well to spring the trap a few times to make sure that there are no obstructions to the impaling spikes. This trap may be used for the deeper runways, the same instructions being followed that were given for the other types of traps.

Traps should be visited twice a day. When a mole is caught, the hole should be left open and the trap moved to the next active

system. To ascertain whether runways are active, test openings may be made in advance of setting.

For additional information on mole control, consult Farmers' Bulletin No. 1716.

MICE AND RATS

In plantings of bulbs and root crops the presence of native mice—meadow mice—is indicated by small open burrows, usually about an inch in diameter; by small well-beaten trails in dense vegetation; and by wilting and dying plants. Favorable conditions for their increase in numbers, with consequent greater damage, are created

FIGURE 7.—Diamond-jaw trap, of the gripping type; sprung when the trigger (directly in the runway) is moved to either side.

by such cover as rank growth along fence rows or borders and other litter, also by existing mole and pocket gopher runways, in which they are trespassers. Often, too, the white-footed mouse is there, and sometimes the introduced house mouse.

Deep plowing, clean cultivation, and where cover for valuable forms of wildlife is not a consideration, clean fence rows and borders aid materially in checking mouse damage. Control of these mice may involve the use of poisoned grain, usually to be obtained from county agricultural agents or horticultural commissioners. Detailed information concerning methods of mouse control in field and orchard is given in Farmers' Bulletin No. 1397.

Poisoned-bait material should be distributed not only over the infested garden or bulb field but also in the bordering fence rows, ditch banks, and immediately adjacent waste lands. A teaspoonful of bait should be placed here and there in the runways, the intervals

determined by the extent of the infestation. Field mice feed mostly under cover, so the bait must be placed accordingly. This method of placement is effective in good weather and prevents needless destruction of other forms of life.

In localities where the rainfall is heavy or continuous over long periods it may be necessary to use small shelters or caches for the baits. A convenient shelter is an old tin can (fig. 8) with the top partly cut out and so bent as to protect the opening of the can and at the same time permit the mice to enter. Small drain-tiles or inverted V-shaped troughs make satisfactory shelters. Tubes 9 inches long, 2 inches in diameter, made from sheets of medium-weight asphalt building paper, cut to 9 by 14 inches, may also be used. The grain baits may be put in or under these shelters, which are placed along the mouse coverts or at burrow openings in the bulb plantings. The grain left in these caches will mold, so instead of baiting too heavily at a time, it is better to use small quantities of bait and replenish them frequently. The baits may also be placed within the runways of moles and pocket gophers

by using a small probe to make a hole. Through this the bait is dropped, and then the opening is carefully closed.

Perhaps the chief interference by the common brown rat with the bulb industry is in its destruction of the bulbs in storage, whether in buildings or buried in

FIGURE 8.—Simple bait shelter for field and orchard mice, made of an ordinary tin can, which protects the bait from the weather and makes it accessible to mice only.

the ground. Rodent-proof methods in the construction of storage facilities are the only absolute safeguard against the rat, though infestations can be reduced by systematic poisoning work. Detailed information on rat control is given in Farmers' Bulletin No. 1533; and on rat proofing buildings and premises in Farmers' Bulletin No. 1638.

POCKET GOPHERS

Signs of the pocket gopher's presence about gardens or fields are the mounds of earth it heaps upon the surface from underground excavations made in search of roots and bulbs. Unusually large mounds or numbers of them in close association may indicate food-storage chambers and nests in the near vicinity. Often, however, the only signs of a pocket gopher's activity for a time are inconspicuous traces of fresh-loose earth in cracks of the soil or holes where the feet of farm animals have broken through. Unlike mole-hills, which are built up by successive upheavals through the center of the pile, pocket gopher mounds are accumulations of fine, loose

earth pushed from the burrow in irregular dumps around an exit that is freshly made or an old one reopened for the purpose.

Pocket gophers cannot be so easily excluded from bulb beds by barriers in the soil as are moles, for they wander about more frequently on the surface at night or when disturbed by agricultural operations, than do moles. Pocket gophers are not difficult to control, however, as they take poisoned bait readily and are easily trapped with simple devices adapted to their peculiar habits. Traps will usually enable the home gardener to keep the premises free from this rodent pest. In operations on a larger scale, however, poisoned baits may be used to better advantage.

Some of the simplest and most effective of special pocket gopher traps are shown in figure 9. These are intended to be set in the open throats of short laterals leading from the main runway, where dirt has been thrust out. If entrance is made into the burrow itself, two traps must be set, one facing each way, the trigger ends adjacent. The trap must be pressed down firmly on the floor of the run to prevent its being pushed out or upset. It should also be secured by a small stake and heavy cord, or light pliable wire, so that it will not be dragged back by the pocket gopher into the runway, or carried away by a cat or other prowling animal and lost with the catch. By covering the jaws of the trap with fine soil as it is placed within the runway, and excluding light at the point of entry, this trap sometimes proves effective also with moles. This manner of setting is of advantage where both moles and pocket gophers use the same burrow.

Other pocket gopher traps are on the market, one in the form of a small wood or metal box without bottom or front end. More time is required to set this, as the runway has to be excavated more extensively to adjust it. In cases where a pocket gopher learns to avoid some other trap, it may be caught in some type of box trap. A good tool for use in setting pocket gopher traps is a strong plant trowel with a narrow blade.

Excepting the Willamette Valley pocket gopher, which prefers green food, all the Pacific coast species readily take sweetpotatoes. Carrots are well taken in some localities as also are the tender tips of green alfalfa. In the Midwestern States pocket gophers of the genus *Geomys* take heavy steamed-rolled oats as well as the vegetable-root baits; they also accept wheat, but not so readily.

The vegetable-root baits, cut into pieces one-half inch square and $1\frac{1}{2}$ inches long, are dusted with powdered strychnine alkaloid in the proportion of 16 quarts of bait to 1 ounce of the poison. When alfalfa tips are used, 10 pounds are dusted with 1 ounce of the strychnine. The poisoned grain may be obtained through the county agricultural agent.

The poisoned baits, two or three pieces, may be introduced into the pocket gopher's burrow through an opening made with a probe constructed of $\frac{1}{2}$ -inch iron pipe, or with a plant trowel, at places where fresh dirt has been pushed out. The openings should be closed afterwards without covering the bait or disturbing the runway any more than necessary. Two bait placements should be made to every system, the extent of which, though generally difficult to determine, may be gaged by the arrangement of fresh mounds on the surface.

FIGURE 9.—Simple and effective traps (*A* and *B*) for pocket gophers, showing also (*C*, in phantom view) one set placed in a lateral of a pocket gopher runway.

After the poison has been applied two or three times a few rodents may be left that refused to take the baits or did not find them. These may be trapped. Trapping is better also on planted areas, because intensive cultivation there disrupts the runways, and also in loose soil, where the surface indications are often lacking and the presence of the pocket gophers unnoticed until the bulbs fail to come up or the tops are pulled down or become wilted. In such cases the runways are located with a probe or by the giving way of the ground when walked over.

The large pocket gopher (*Thomomys bulbivorus*), found in the Willamette Valley, Oreg., is probably the least troublesome to the bulb grower. Its presence is always indicated by its large mounds, which are usually fan-shaped. It may be controlled by the use of either poison or traps. Poisoned bait is prepared by dusting 10 pounds of red clover tops with 1 ounce of powdered strychnine alkaloid. Dig in from the mound and follow the lateral, which is often plugged with excavated earth, to its intersection with the main runway, where a handful of the bait is placed. The opening is then carefully closed with clods and soil so as to exclude all light, leaving the runway in as natural a condition as possible.

A special type of trap is used for this pocket gopher, the details of which may be obtained from the county agricultural agent. Additional information is given in Farmers' Bulletin 1709, Pocket-Gopher Control.

RABBITS

In situations where certain summer-flowering bulbous plants, as gladiolus, ixia, and sparaxis, are being grown near brush lands or other cover favorable for rabbits, these larger rodents sometimes frequent the plantings at night and nibble the foliage to the ground. Their invasions may be prevented by enclosing the field with a fence of poultry netting, 1 yard wide, supported by temporary stakes. The bottom edge of the fence should be 6 inches in the soil, to discourage the rabbits from digging under. When the rabbits are not numerous, box traps baited with apple, or the timely use of a shotgun will give protection, in lieu of a fence. Measures of control of cottontail rabbits that may do damage in bulb plantings are discussed in Farmers' Bulletin 702, Cottontail Rabbits in Relation to Trees and Farm Crops.