Mole Control-A Historical Perspective

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ABSTRACT: Various methods and approaches, including chemical and physical repellents, flooding, burrow fumigants, poison baits, vibrating devices and exclusion, have been explored for reducing mole problems. In addition to these, habitat management through reducing the moles food supply has received considerable attention, but environmental concerns and the lack of consistent results have tempered this approach. Over the years, trapping remains the best and most useful method of mole control. The pros and cons of some of the methods are discussed, along with some historical perspectives. The emphasis is placed on the Broad-footed mole, *Scapanus latimanus*, of California.

KEYWORDS: mole, *Scapanus latimanus*, mole control, poison bait, burrow fumigants, repellents, traps, trapping, exclusion

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INTRODUCTION

Moles are essentially a subterranean living animal belonging to the order Insectivora. Their diet consists principally of insects, earthworms, and other invertebrates. Depending on the species, some may consume up to about 20% vegetable matter. They are capable of causing some damage to crops and ornamentals, but they are most detrimental in turfed areas where their unsightly mounds continue to plague those attempting to establish and maintain turf on golf courses, sport playing fields, cemeteries, parks, and a variety of other landscaped areas.

This paper discusses mole control, past and present, with emphasis on the Broad-footed mole, *Scapanus latimanus*, which is the most widely distributed and common mole pest in California (Figure 1). While there have been some changes through the years in the methods used and their importance in reducing the problems moles cause, the single most useful control method, trapping, has changed very little over the past 100 years. Each of the major management methods or approaches are discussed separately.

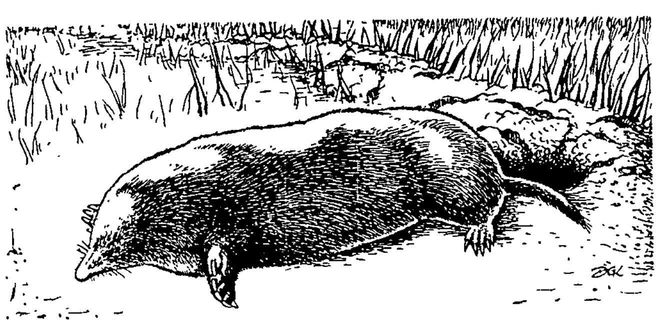

Figure 1. The Broad-footed mole, *Scapanus latimanus*, the most widely distributed mole in California.

CONTROLLING MOLE FOOD RESOURCES

The restriction of available food is often an approach to vertebrate pest management. Since moles thrive largely on diets made up of invertebrates such as earthworms and grubs, then one useful approach is to limit their invertebrate food resources. The most practical method of lowering the invertebrate population is through the use of pesticides, principally insecticides. This approach to mole management has been practiced in the past and was most frequently conducted for the protection of turf. Anecdotal or subjective evidence varies—from reported success, to those who claim it had no negative effect on the mole population. Both of these observations are probably true, and reasons for this seem readily apparent, although supportive evidence by way of field evaluations is lacking.

Different soils support different invertebrates and at varying population levels. Yet, for the most part, we know little about what species of invertebrates are present and how numerous they are in any given soil area; nor do we know what invertebrates are critical to the mole's survival. We know that some mole species do feed on some vegetation, hence a dramatic reduction in invertebrates may be compensated for, in part, by a greater plant intake. While the application of selected insecticides, and even some fungicides, may control some invertebrate species, other species may survive in adequate numbers so that the mole's invertebrate food supply is not critically affected. The penetration of the insecticide into the soil and its persistence will also influence its ability to reduce invertebrates over time. If this control approach is selected, use only pesticides recommended for turf situations and apply at recommended rates.

Even if the application(s) of an insecticide are effective in significantly reducing the mole's food resources, it still may take some time for moles to die out or move to an area where food resources have not been limited. Reduced food resources may actually temporarily result in an increased search for food and this, in turn, may result in more tunneling damage to turf, at least for a time. Trapping as a supplement to this control approach is always advisable.

While modifying mole habitat to reduce food resources might seem in line with touted IPM approaches, the use of insecticides for this purpose is, at best, a most inefficient use of pesticides, especially when the results, relative to mole control, are so variable and unpredictable. Although the practice is legal, some believe this borders on pesticide misuse. In view of the present environmental concern over pesticides, their use, as a roundabout method to manage moles, is an approach which some find difficult to support, especially since many of the invertebrates killed (i.e., earthworms) are in no way harmful. With due considerations, this approach to mole control is, at present, infrequently recommended here in California unless there are compelling reasons and no suitable or practical control alternatives for the situation.

REPELLENTS

A number of chemical substances have been registered and/or used in the past for mole control. Few, however, have demonstrated any effectiveness, and most lacked any scientific basis for potential repelling efficacy. Paradichlorobenzene "PDB" and naphthalene are often mentioned in the literature for mole control. Various home remedies such as lye, kerosene soaked rags, castor oil, and castor bean pumice represent some of the other substances that have been recommended in the past. Currently Mole-Med™ and Scoot Mole™ are the only two chemical mole repellents that the author is aware of that are being sold. Both materials are said to be derived from castor beans. Castor bean products have not been particularly effective in the past, and only time will tell if these new products are effective and live up to their claims.

The mole's feeding and subsurface activity patterns help lend credence to the effectiveness of various odoriferous or potentially objectionable substances as repellents, in spite of the fact that they do not work. Those convinced of their effectiveness and who tout their use are nearly always individuals with relatively small gardens. The reasons for this are simple, moles are a relatively solitary animals except for when breeding and rearing young, and they have large complex tunnel systems which may extend for several hundred lineal feet. Moles may work one portion of their tunnel system for a few days and then move on some distance away to another portion of the system, which may be in the neighbor's yard. Hence, the application of some obnoxious substance just prior to or immediately following the mole's shift in its feeding location will be credited to the effect of the repellent. When the mole returns a week or two later, the gardener is convinced it is a new mole.

Many nonchemical repellent items, placed in the mole's tunnels, have also been suggested as home remedies. These include ground or broken pieces of glass, used razor blades, sections of barbed wire, or thorned rose bush canes. Some of these are actually more hazardous to the gardeners themselves than to the moles. When moles run into the unfamiliar foreign object in their tunnels, they may simply circumvent the object by blocking those tunnels off with soil and then proceed to dig new tunnels, just as they do with a poorly set trap. There is no convincing evidence that these sharp, potentially harmful items cause any mortality or that they resulted in the mole leaving the immediate area.

Planting a row of *Euphorbia lathyris*, sometimes referred to as the mole plant or gopher purge, as a garden perimeter barrier to moles is suggested in many garden publications, but these, too, are ineffective. Because of their general lack of effectiveness, repellents of any type play an insignificant role in mole control.

BURROW FUMIGANTS

A wide variety of fumigants have been explored or registered for moles, including such materials as calcium cyanide, carbon bisulfide, methyl bromide, carbon tetrachloride, sulfur dioxide, ethylene dibromide, aluminum phosphide, and gas cartridges. Most have not proven all that effective—for several reasons. Moles have the ability to quickly plug their tunnels with soil, thereby blocking off toxic gasses before lethal levels have been reached. The applied fumigant may also escape to the surface through the complex of shallow subsurface feeding tunnels. Where the moles are well established and have been in place for some time, the burrow system may be so extensive that the normally recommended dose of fumigant may be inadequate. The soil texture may be such that too much of the fumigant is diffused into the soil or escapes from the system and the lethal threshold is never achieved or is not sustained for an adequate period of time.

Burrow fumigants, such as gas cartridges currently available to gardeners, have their best chance of working if used on moles which have just invaded an area, as their burrow systems will be less extensive. Be sure to apply a cartridge into the main tunnel and not into the shallow feeding tunnels. A cartridge should be placed in two or more locations of what is believed to be the burrow system of one mole. Some smoke escaping to the surface will provide some assurance that the gas has penetrated the entire burrow system. If smoke is not visible, placement of additional cartridges may be indicated. Professionals in mole control have found that results are enhanced by attaching a hose to the exhaust of a small gas engine, using the exhaust pressure to rapidly force the toxic smoke from the cartridge through the mole's burrow system. Rapidly forcing the toxic gas through the burrow system may overcome the mole before it has a chance to plug off the toxic gas. Turning on the sprinkler to wet the soil surface of the garden or turf prior to the application will aid in retaining the toxic gas in the burrow system. If new mole activity appears two or three days following the initial application, then repeat the treatment procedure. Several applications may be needed; persistence is the key to success.

The effectiveness of gas cartridges is so limited that the author rarely recommends them for commercial growers or for large landscaped or turf areas. As a possible alternative to trapping, they are offered to the homeowner who finds fumigants such as the gas or smoke cartridges much easier to use. Currently aluminum phosphide, a restricted use pesticide, is available and is used by some professionals in the midwest and east for mole control. Reported success is variable, depending on the site and soil conditions. Here, in the far west, results with aluminum phosphide for mole control have been poor.

POISON BAITS

A number of mole baits have been marketed in the past, but few were even moderately effective—for two major reasons. First, the principle diet of moles consists of insects, earthworms, and other invertebrates; this makes the formulation of an effective bait difficult, especially if you are trying to prepare a bait which can be marketed and can meet the requirements for a reasonable shelf-life. Second, finding that ideal single feeding toxicant which is essentially odorless and tasteless and to which moles are highly susceptible, is a significant challenge. These two factors, plus the fact that our mole species are difficult to maintain in confinement, make the evaluation of experimental bait formulations, as well as suitable toxicants, very difficult to adequately test when conducting bait development research under controlled conditions.

The desire for an effective mole bait led to a considerable number of trial- and error-type studies with perishable and nonperishable toxic baits. Perishable baits made of fresh earthworms were generally considered best by the professionals in mole control, although some used freshly ground meat. The fresh baits were treated with a prescribed amount of strychnine (sulfate or alkaloid), thallium sulfate, or 1080 (sodium fluoroacetate). The treated baits were applied to the burrows shortly following preparation—before they began to deteriorate. Such baits were not generally used by home gardeners, as some toxicants, such as 1080, were not available to the public. Of these freshly prepared baits, 1080 treated earthworms gave, by far, the best results. None of these baits could be formulated today because of pesticide registration restrictions.

The commercial baits which did appear on the market were generally formulated with a variety of ingredients, including grains, raisins, peanuts, hemp seed, and dried meat. These usually contained arsenic, strychnine, or thallium sulfate. In recent years, zinc phosphide has been added to this list. In some states an anticoagulant rodenticide, chlorophacinone, was also registered for mole control. Of all the limited number of commercial mole baits, thallium sulfate treated peanuts seems to have gained the greatest use. As was the case with both perishable and nonperishable baits, they were placed into each burrow system in two, and preferably more, locations. The main tunnels were located by probing, and the bait applied through the enlarged probe hole. Unfortunately, none of the commercially available mole baits were all that effective and, for various reasons, most have disappeared from the market. In recent years, the use of a mole bait is rarely suggested for their control.

TRAPPING

Trapping is by far the most applicable and dependable method of mole control available. Trapping, to be successful, requires a good knowledge of the moles burrowing and food habits and how they respond to foreign objects placed in their paths. It is labor intensive and, therefore, relatively expensive if a trapper is hired on an hourly basis and contracted by the job. An experienced professional mole trapper, however, can trap many more moles than the novice. Over time, with practice and experience, most anyone can become a proficient trapper.

The development of mole traps in North America has a traceable history of at least 150 years. The local blacksmith made the first examples about that long ago. These were large, cumbersome devices but, judging by their designs, it is obvious that the makers were familiar with the mole's habits as they had figured out the basic principles required of an effective trap. Around 1885, the first few kinds of commercially produced mole traps began to appear on the market, but by the 1900s there was a proliferation of mole traps representing many unique designs. A search through the trap patents issued around that time is both an interesting and enlightening undertaking and reflects the rapid advances being made during that period of the industrial revolution. Intrigued by trap designs and their trapping mechanisms, the author has included a few drawings of some of these early traps to provide some historical perspective into traps and mole trapping (Figure 2).

The best mole traps are distinctly different from effective pocket gopher traps. The most effective traps are designed so that no part of it obstructs the mole's tunnel, and it is triggered by a pan that lies horizontally on compressed soil and out of the animal's path. The trap is activated by soil heaved upward against the pan as the mole reestablishes its tunnel. The three best and most popular mole traps were all patented around 1900 and have changed very little over the years. These are the scissor-type Out O' Sight Mole Trap, the harpoon- or spear-type Victor Mole Trap, and the choker loop-type Nash Mole Trap (Figure 3). All have horizontal pans and have stood the test of time. In California, the Out O' Sight and Victor mole traps are the two most frequently used. Of these two, the Out O' Sight is considered the most effective by professional mole trappers. The Nash Mole trap is about equally effective, but this trap is not readily available in this state as it is rarely stocked by hardware stores.

Traps normally are sold with instructions for use which provide details on how and where to set the traps. It is important to understand mole burrowing habits and how the tunnel system is constructed. Moles produce very shallow tunnels that ridge up the soil or turf, providing an easily visible indication of their presence. These are thought to be mostly feeding tunnels and the same tunnel may not be used by the mole on a regular basis. For this reason, setting traps in these very shallow tunnels does not produce results as often as does setting the trap in the deeper, much more frequently used tunnels. Most experienced trappers prefer to set traps in these deeper tunnels as the trapping success is superior, with more moles caught per trap set. In order to set traps in the deeper tunnels, which are generally from about 8 to 12 inches below ground, they must first be located. To find these tunnels requires the use of a steel probe which is inserted at 3 to 4 inch intervals across an area between the fresh mole mounds, the assumption being that there is probably an underground tunnel that connects these two mounds. This is where experience is most critical in the ability to quickly locate the deeper tunnels.

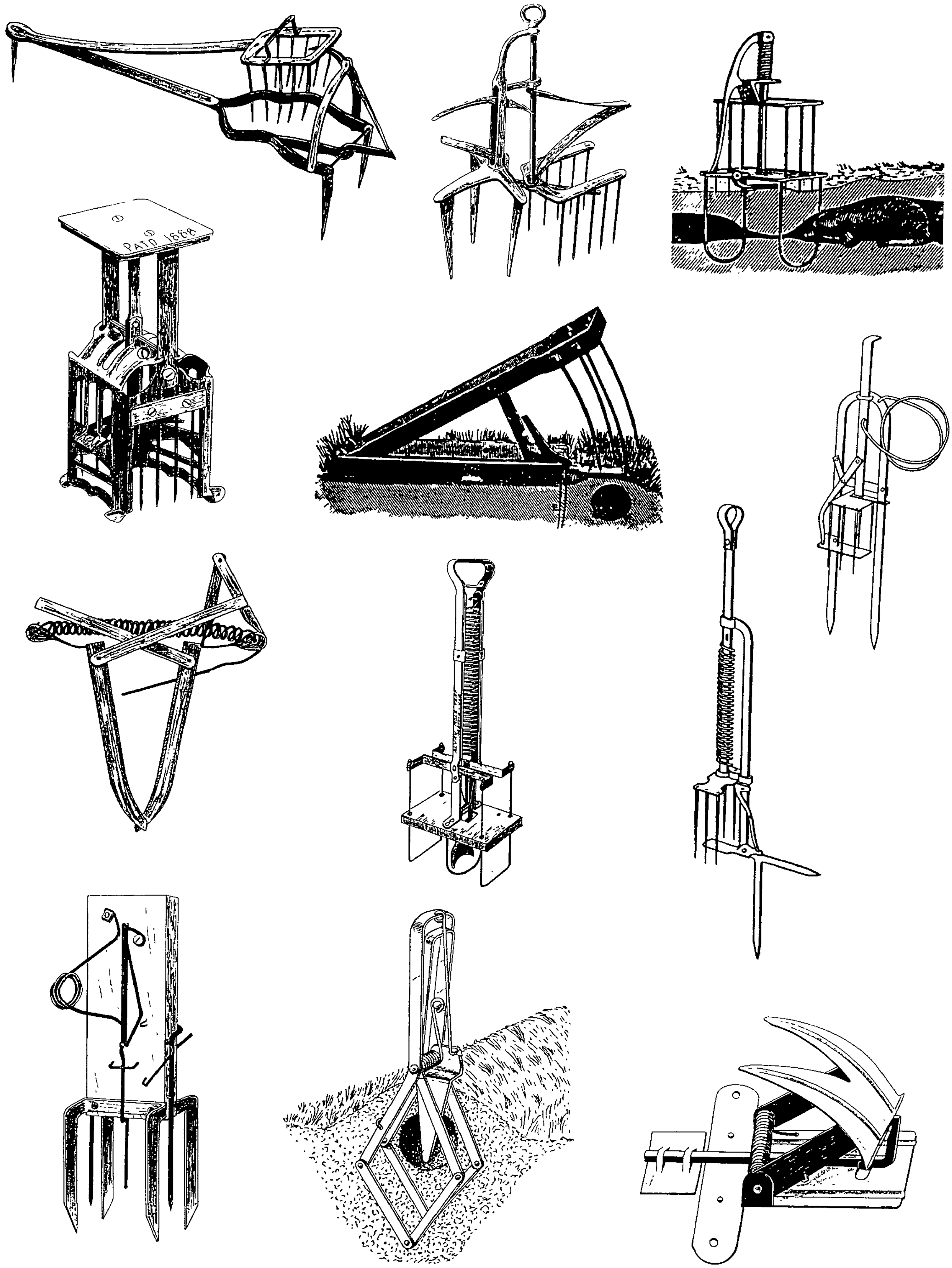

Figure 2. Illustrations of some of the mole traps dating from about 1860 to 1970. (First row, L to R) Hand forged mole trap, unidentified commercial trap, Mabbett's mole trap. (Second row, L to R) Van Wormer, Daffodil, Side-spring. (Third row, L to R) Chandler, Alvau. Wherry. (Fourth row, L to R) Wyman's, Mole-choke, Taylor's Sure Kill.

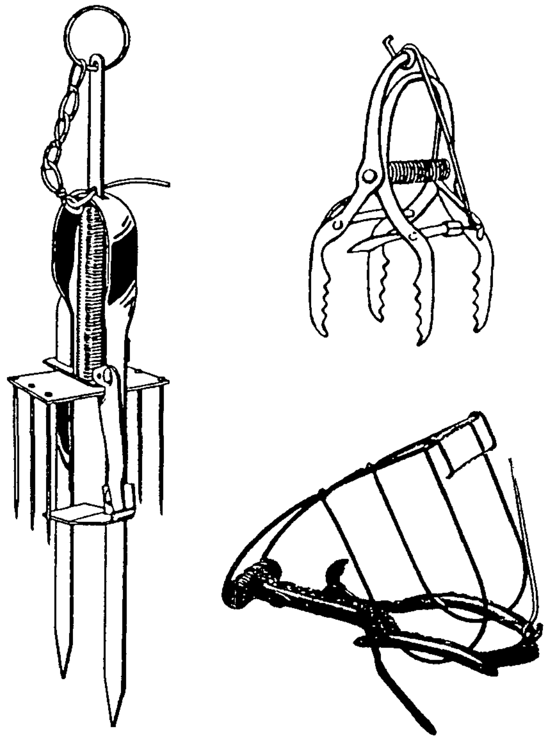

Figure 3. Three of the most popular mole traps in current use; Victor mole trap (left), Out O' Sight mole trap (top right), Nash mole trap (bottom right).

As the steel probe enters a tunnel, a difference in soil friction on the probe will be noticeable. A well designed probe with a slightly enlarged tip will greatly aid in locating the tunnels. Once the deeper, frequently used, main tunnel is found, a shovel or spade is used to dig a hole down to the tunnel. The hole should be no larger than is necessary to provide room for the trap. The soil where the trap is set needs to be sufficiently loose and free of rocks so that the trap will function properly. The exposed tunnel hole is back filled with about three inches of fine soil, just enough to cover the exposed tunnel. This backfilled soil is tamped slightly and the set trap is pushed into place so that the pan rests on the compacted soil. No part of the trap should obstruct the tunnel. As the mole proceeds to push through the slightly compacted soil plug in its path to reestablish the tunnel, it will cause an upward pressure on the pan and the mole is caught.

VIBRATING DEVICES

For 50 years or more, small windmill devices that produce a clippity clop sound have been sold to home gardeners for mole control. Such windmills, with their wind activated hammers, are said to produce a vibration which is transferred from the windmill's head, downward through the support post, into the soil. The soil vibrations are advertised as having the capability of repelling moles from the area. The fact that moles can apparently detect unfamiliar ground vibrations and will normally scamper back to their underground nest when detecting an approaching source of vibration, adds some credence to this control approach. This sensitivity to vibrations is confirmed by radio tagged moles, monitored from above ground. However, this little bit of mole behavior is misleading, as moles readily become accustomed to these vibrations and soon learn to live with them. The habituation is readily apparent by noting that moles have learned to live alongside busy railroads where, each time a train passes, the ground vibrates for distances of several hundred feet from the tracks. The same is true for roadways used by heavy trucks, and major airport runways, where both moles and pocket gophers seem to thrive unaffected. There is no evidence that any of these marketed mole windmills live up to their advertised claims.

In recent years battery powered electric vibrator devices have appeared on the market and are advertised to resolve mole and/or pocket gopher problems. Some incorporate and promote sound or magnetic fields along with the vibration to assist in convincing gardeners that they have truly entered the technological age of pest control. Until such devices are proven effective, buyer beware!

FLOODING

Flooding a burrow system to drown or force the mole above ground, where it can be dispatched, is often tried. This approach has the greatest chance of succeeding if the property is being invaded by moles for the first time. Flooding success is greatest if a couple of five gallon plastic buckets are filled with water so that the burrow system can be flooded with a copious amount of water. The amount of water that can be delivered from a bucket will greatly exceed that which will come from a garden hose and has a greater chance of overwhelming the mole's tunnel system. Where moles are already well established, their systems are extensive. In this case, flooding them out with a hose rarely produces the desired result. Where water conservation is critical, this method of mole control is very wasteful of that resource, particularly in view of its lack of effect.

EXCLUSION

Some gardeners have resorted to planting bulbs which are sensitive to mole disruption or heaving in wire mesh baskets, such as those used to prevent pocket gopher damage. The bottom of raised flower or vegetable beds can be lined with 1/4 or 1/2 inch wire mesh to exclude both moles and pocket gophers.

Underground wire mesh barriers have also been explored. A two foot deep, six inch wide trench is dug, in which is placed 36 inch wide hardware cloth with a 1/4 or 1/2 inch mesh. Before placing the hardware cloth perpendicularly in the trench, the bottom six inches are bent outward at a 90° angle. Six inches will also be left protruding above ground. Rarely can this effort be justified; it is expensive and, although it may have a temporary effect, it is not a lasting solution since moles are very capable of digging deeper than 24 inches. Such a below ground barrier will only slow their movements for a time and sooner or later the barrier will be breached.

PREDATORS

Avian predators, such as red-tailed hawks and barn owls, occasionally take moles, as do some mammalian predators such as fox, coyotes, and badgers; however, such predation, has little if any negative effect on mole populations. Their nearly exclusive subterranean habits provide moles with an environment relatively safe from predators. Domestic dogs and cats that are good hunters sometimes catch moles in home gardens. Every mole taken by your pet means one less you may have to trap, but you cannot depend on dogs or cats by themselves to keep your garden free of moles.

ACKNOWLEDGMENT

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