DEVICES FOR VERTEBRATE PEST CONTROL: ARE THEY OF VALUE?

ROBERT M. TIMM, Hopland Research & Extension Center, University of California, 4070 University Road, Hopland, CA 95449, USA

Abstract: Electromagnetic, sonic, and ultrasonic devices claiming effectiveness in controlling rodents and other pests have seen resurgence in the marketplace. Laboratory and field tests of such devices have generally failed to show they are effective, despite advertising claims. Rodent burrow exploders have been marketed for use against pocket gophers, ground squirrels, prairie dogs, and other burrowing rodents since the 1980s. Field tests indicate these exploders are expensive to use and typically provide unacceptably low efficacy. Vehicle-mounted devices to scare deer off roadways, with many claiming to generate ultrasonic sound, have been widely sold. Studies reveal that deer are unable to hear ultrasonic sound, and that the devices appear to have no effect on deer behavior. While Federal regulatory agencies have authority to prohibit false and misleading statements in advertising of such devices, enforcement actions and scientific testing on which regulatory actions are based are expensive and time-consuming, and agencies are resource-limited.

Key words: burrow exploders, deer whistles, devices, electromagnetic devices, pest control, repellent devices, rodent control, ultrasonic devices.

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INTRODUCTION

In recent years, an increasing variety of devices for the control of vertebrate pests have appeared in the marketplace. In using the term "devices," I have adapted a definition from Jacobs (2002), as follows: pest control devices are products claimed to effect pest control by non-toxicant means.

In this paper, I discuss rodent control devices that generate electromagnetic fields and/or ultrasonic sound; repellers intended for use on pocket gophers (*Thomomys* spp. and *Geomys* spp.), moles (Family Talpidae), and burrowing mammals; and injector devices that create explosions in rodent burrows. I also mention "deer whistles" and related devices purported to reduce automobile-deer collisions. I will cite evaluations of the efficacy of these devices, insofar as field or laboratory data are currently available, as well as the regulatory environment that permits such products to be manufactured and marketed in the U.S.

There are a number of reasons for the recent "success" of such devices in the marketplace. Among these is the public's desire to find a safe, non-hazardous method of vertebrate pest control. Fitzwater, (1978), reporting on the initial appearance of electromagnetic pest control devices in the 1970s, wrote, "Mankind has become more sophisticated since the Pied Piper enthralled audiences of kids and rats. However, the feat of walking on the moon has again lent credibility to magic flutes. Devices that can be stuck in the ground and plugged into an electrical circuit to drive away rats, gophers, and other animals by electromagnetic impulses are not considered as far out as they have been a few decades ago."

Consumer expenditures on ultrasonic rodent control devices in the U.S. were estimated to total $75,000 in 1978, increasing to $17 million in 1982 (Mix 1984). Currently, one manufacturer of pest control devices marketed via the Internet to homeowners (Lentek International, Inc., Orlando, FL), alone claims sales in excess of 1 million units; the current price of the ultrasonic unit for which this claim is made is $39.60 each (Safe Home Products 2003). By such measures, this industry would appear to have become quite large and is apparently still growing. Some such devices have even been marketed under the trade names of companies with long-term histories of marketing reputable products, including Sunbeam and Victor. Within the past year or two, I have, for the first time, found battery-operated or plug-in rodent control devices being sold on retail shelves in the garden section of my local home improvement store, alongside traditional control tools such as rat, mouse, and gopher traps, and rodenticides.

ELECTROMAGNETIC DEVICES

According to Fitzwater (1978), the genesis of the first electromagnetic pest control device was an incident in 1972. A man in Pine Valley, California, found dozens of dead rats and mice in his workshop, which he reasoned was due to a mis-wired electric guitar that he had forgotten to turn off (Anonymous 1977). Subsequently, he invented, produced, and sold what he called the AMIGO™ device, an acronym for ants, mice, and gophers. Fitzwater (1978) summarized some 16 case histories of attempts to use various commercial electromagnetic rodent control devices. Results were highly variable, but included a high incidence of failure to provide rodent control. In the late 1970s, the EPA took actions to stop the sale of certain electromagnetic devices, based on lack of efficacy (Anonymous 1978, EPA 1979, Conroy 1980).

Last year, Jacobs (2002) noted, "Recently, products claimed to work via electromagnetism have crept back onto U.S. markets even though EPA concluded more than two decades ago that low-level electromagnetism as a pest control principle was essentially worthless." For example, the "Pest A Cator" device manufactured and marketed by Global Instruments Ltd. of Trenton, Missouri, is advertised to work as follows: "Just plug the PEST A CATOR into a standard 110 volt outlet and it starts working." "PEST A CATOR uses pulse or electromagnetic technology designed to work through a building's wiring to upset nesting sites of roaches and rodents within walls, ceilings, and floors... The PEST A CATOR uses the wiring in your home to turn the whole place into one huge, pest irritating machine which forces them to leave the premises... The unique activity sends a pulsating signal throughout the wiring of homes, businesses and other structures. This silent pulse annoys insects and rodents, driving them out from behind walls, floors and ceilings where they hide and nest"(Global 2003).

While there is evidence that electric and magnetic fields can affect the physiology and behavior of rats (*Rattus* spp.) and other animals, and a wide variety of physiological effects have been identified, these effects differ among various research studies and are difficult to interpret (Kaufman and Michaelson 1974). In summarizing the topic of electromagnetic devices for rodent control, Meehan (1984) concluded "...scientifically conducted tests with commercially available electromagnetic devices have failed to produce any gross change in the behaviour of rats or mice despite some testimonials from ‘satisfied customers’ who claim they have been at least partially successful. Examination of some machines has failed to detect any measurable magnetic output, whilst others produce no more than an electric soldering iron!”

ULTRASONIC DEVICES

Devices claiming to repel or control rodents by means of ultrasonic sound have been manufactured and marketed at least for several decades. Ultrasonic sound is generally defined as sound at frequencies above the level of human hearing, or greater than about 20 kHz. According to Meehan (1984), interest in ultrasonic sound for rodent control dates to 1948 (Frings 1948).

It is well understood that rats and mice communicate by means of ultrasonic vocalizations, particularly in the range of 40 - 50 kHz (Riley and Rosenzweig 1957), and that certain ultrasound can influence their behavior and physiology (Meehan 1984). Very intense sound can cause audiogenic seizures in mice, but not typically in rats (Lehmann and Busnel 1963). Injury or death in rodents can occur from exposure to intense ultrasound; mice exposed to 20 kHz at 160 dB will die of overheating within 1 minute (Allen et al. 1948). However, audiogenic seizures have not been induced in rodents in their natural environment, and it is unlikely that this could be reliably accomplished because of problems caused by signal strength attenuation with distance and by sound shadows. Similarly, the impracticality of generating sufficient thermal effects from sound energy to kill free-roaming rodents or insects makes its use unlikely (Bomford and O’Brien 1990). Ultrasonic devices marketed for rodent control generally do not generate sound with an intensity of more than 130 dB at a distance of 1 m from the speaker (Lund 1988).

Lund (1988) enumerates several theoretical reasons why ultrasound devices are unlikely to be effective in rodent control:

1. Commensal rodents, especially rats, are highly adaptable and capable of habituation to many environments, including noisy locations (e.g., mills, airports).
2. Rodents subjected to auditory stimuli at regular intervals typically habituate within 5 minutes to 48 hours.
3. High-frequency sounds are highly directional, do not reflect around corners or solid objects; the higher the frequency, the less likely they can penetrate into rodent burrows and nests.
4. If ultrasonic devices were as harmful to rodents as claimed, they would likely have negative effects upon humans, pets, and domestic animals.
5. Sound intensities > 110-120 dB are considered harmful to humans, and such sound in the work environment is prohibited in many countries.

In one series of trials spanning eight years of attempts to use sound in rodent control strategies, researchers reported “...acoustical frightening devices produced only negative results.” (Sprock et al. 1967, Howard 1968). As a result of renewed marketing activity of ultrasonic devices in the 1970s, efficacy test protocols for such devices were developed jointly by EPA and the Denver Wildlife Research Center beginning in 1981. A goal of the development of test protocols was to assist in ensuring that manufacturers’ claims of safety and efficacy were being met (Shumake et al. 1984).

Tests of 11 ultrasonic rodent control devices at the Danish Pest Infestation Laboratory, including devices with varying frequencies and random intervals between signals, indicated that apart from an initial repellency lasting 30 min to 3 hrs, no durable influence on rat behavior could be achieved (Lund and Lodal 1984). Similarly, Meehan tested 4 ultrasonic devices in a large outdoor pen with largely negative results. One device claiming to be effective over an area of 330 m^2 was not able to cover 1 m^2 (Meehan 1984, Lund and Lodal 1984).

British scientists tested about 20 different ultrasonic devices for repellency using brown rats (*Rattus norvegicus*), and a lesser number, black rats (*R. rattus*) and house mice (*Mus musculus*), in both indoor and outdoor experimental situations, and in practical field trials. Regardless of whether the sound stimulus was variable, random, and/or intermittent, "none of the units produced anything more than a partial repellency for a day or so which was soon overcome" (Rentokil Ltd. 1959-1983).

Bomford and O'Brien (1990) noted that many published tests of ultrasonic rodent repellers have lacked appropriate experimental controls, thus precluding conclusions about damage levels in the absence of devices being evaluated. They also noted that "before" is not a control on "after" in time-sequence experiments, because treatment is confounded with time. Further, they describe the problem of pseudoreplication, which occurs if either treatments are not replicated or replicates are not statistically independent and data are analyzed as though independence exists. This confounds site and treatment effects (Bomford and O'Brien 1990). Despite shortcomings in experimental design, they concluded, "...devices producing sounds other than communicative signals (alarm and distress) have no persistent effect on animals' space use or food intake. These devices produce, at best, short-term damage reduction... Sonic pest control devices should be viewed with considerable skepticism by legislators, pest controllers, and consumers... Ultrasonic devices do not meet the claims made for them" (Bomford and O'Brien 1990).

MOLE AND GOPHER REPELLERS

Various devices continue to be marketed with claims that they repel moles, gophers, and other burrowing mammals. They are sometimes as simple as toy pinwheels and windmill "clackers" that make audible sounds as they rotate, and as "high tech" as electronic battery-operated or solar-powered stakes that purport to repel animals by means of generating sonic or ultrasonic sound transmitted through the soil, e.g., Weitech's "Burrowing Rodent Repeller" (Weitech 2003). Claims for these electronic repellers include effectiveness against moles, gophers, ground squirrels (*Spermophilus* spp.), ground hogs (*Marmota monax*), voles (*Microtus* spp.), shrews (Family Soricidae), pocket mice (*Perognathus* spp.), and other burrowing creatures, with an effective area of up to 1,052 m^2 (18.3-m radius from device). Specifications on the sound produced by such devices often claim output in the sonic range from 2 - 5 kHz, with some devices claiming to also produce sound in ranges from 5 - 12 kHz and in the ultrasonic range of 18 - 50 kHz (Biocontrol Network 2003).

Koehler et al. (1990) reviewed information about such devices, stating "...there are no acceptable scientific studies to support their efficacy." Nevertheless, such devices are often recommended in gardening magazines and guides, and occasionally in extension bulletins. For example, in a Michigan publication, Dudderar (1998) stated, without citing research that confirms his opinion, "Any device that imparts a vibration into the ground repels moles. The range of these devices is limited, making them practical only in small areas such as a small garden or flower bed. The more vibration the device imparts into the ground, the more effective it will be."

RODENT BURROW EXPLODERS

A rodent control device, sold under the brand name Rodentorch, was developed in Nevada in the 1980s and sold for several years in the western states through various distributors. The device was a portable system, used to inject a mixture of explosive gases (propane and oxygen) into a rodent's burrow system, and then to ignite the gases, causing an explosion that presumably kills rodents by concussion. Currently, two devices using the same concept are marketed by Rodex Industries of Midvale, ID, the "Rodex 4000" and the "Rodex 5000," primarily through equipment dealers in states west of the Mississippi River. The device consists of a metal applicator wand used to inject the gases into burrows; a torch handle containing a valve, and an ignitor switch that fires a spark plug at the opposite end of the wand; regulators for each of the two gas cylinders; and 15 m of gas hose.

Several efficacy evaluations of these devices have been conducted against ground squirrels in various environments during recent years. The Rodentorch device, when used in Montana against Richardson ground squirrels (*Spermophilus richardsoni*) and black-tailed prairie dogs (*Cynomys ludovicianus*), showed poor results: after 45 seconds of gas injection before ignition, the device reduced ground squirrel activity only 40.6%, as compared to 90.8% and 83.7% reductions when using the incendiary USDA-APHIS gas cartridge and aluminum phosphide tablets, respectively (Sullins and Sullivan, 1992). After a 30-second injection into prairie dog burrows, a 13% reduction in activity was achieved, and after a 60-second injection time the efficacy was increased to 63.3% (Sullins and Sullivan 1992). Whisson (1998) used the Rodentorch to control Belding ground squirrels (*Spermophilus beldingi*) in Siskiyou and Modoc Counties, California. She stated "Rodentorch was not effective, reducing populations by only 38.1%." A ground squirrel control guide published by Alberta Agriculture (2000) states "Gas exploding devices... have not proven to be safe, reliable, or effective. The best studies have shown that oxy-acetylene or propane/oxygen mixtures injected for 45 seconds and then ignited only reduced ground squirrel populations by about 40 per cent and did so at a very high cost." Advertised retail cost of the Rodex 4000 and Rodex 5000 systems are $1,395 and $1,845, respectively (Rodex 2003); additional costs include purchase of the gases, labor costs of operators, and personal protective gear (eye and ear protection face shields, etc.). The low level of efficacy achieved to date using such devices is considered poor and "is not at a level generally recognized as adequate for long term population reduction" (Sullins and Sullivan 1992). To my knowledge, efficacy of such devices against pocket gophers has not been reported in the scientific literature. Regardless of efficacy, the cost of labor of application greatly limits the use of these devices, as well as the use of most fumigants in general.

Fire hazards caused by explosions occurring at burrow entrances at some distance from the site of injection and ignition are not insignificant. A recent efficacy trial of a Rodex device for control of California ground squirrels (*Spermophilus beecheyi*) had to be terminated after the researchers, using what they believed to be prudent precautionary measures, accidentally set fire to a grassy field site, burning 30 acres and threatening an adjacent residential subdivision before the fire was extinguished by a responding engine company (T. P. Salmon, UC Davis, personal communication).

VEHICLE-MOUNTED DEER REPELLERS

Vehicle-mounted devices that emit sound, either in the sonic or ultrasonic range, have been developed as an alleged solution to the increasing problem of vehicle-deer collisions. Ultrasonic wildlife warning whistles, which were invented in Austria in 1979 (Romin and Dalton 1992), have been marketed widely in Europe and the U.S. during the past two decades. These relatively inexpensive devices are claimed to produce sound in the ultrasonic range of 16 - 20 kHz, as a result of air flow, when mounted on the front bumper of a vehicle moving at a speed of about 30 mph or greater. Some devices claim deer can detect the whistle up to ¼ mile away and thus will be scared away from the path of an oncoming vehicle so equipped.

Several field and laboratory tests of such devices cast doubt on the effectiveness of such devices. In laboratory tests of one brand of whistle, staff at the Denver Wildlife Research Center used compressed air at different pressures to evaluate the sound produced by the device (Fitzwater, 1990). They concluded that it was no more complex than a simple whistle: it produced sound measured at about 3.4 kHz, with no significant ultrasonic frequencies present. Amplitude was 65 dB at a distance of 6 feet– only a little better than a person's shout (Fitzwater 1990). Romin and Dalton (1992) conducted a pilot study of two brands of deer whistles (one of which was the same brand tested by by the Denver Wildlife Research Center), mounted on the front of a pickup truck that was driven at 65 km/hr (40 mph) along a road through a Utah wildlife management area where free-roaming mule deer (*Odocoileus hemionus*) were visible within 100 m of the road. In replicated trials, the researchers did not detect any differences in responses of 150 groups of deer to vehicles, whether equipped with the devices or not.

Schwalbach (1989) summarized trials on deer whistles conducted by individuals at the Georgia Game and Fish Department and the University of Wisconsin. Personnel blew the whistles by mouth near some captive deer, but noted no response. Attempts to measure the sound emitted from the devices when mounted on a vehicle driven at speeds from 25 to 55 mph yielded no ultrasonic frequencies. A Wisconsin undergraduate, found that the three whistles he tested produced ultrasonic frequencies up to 48 kHz, but in the presence of 7 species of ungulates (including 45 white-tailed deer, *Odocoileus virginianus*), only one response was noted. In that instance, a single bull elk, in response to a low-pitched (sonic) tone from one whistle, charged a fence in a rage and in doing so broke a 2 × 4 post, bugled, and urinated. Results were summarized as "…it is highly unlikely that an ultrasonic signal produced by the whistle devices would reach a deer at a decibel level such that it would be detected at even 10 meters, much less than the 300 to 400 meters claimed" (Schwalbach 1989).

University of Georgia scientists studying the hearing ability of white-tailed deer concluded that deer cannot hear sounds with frequencies of 6 to 20 kHz, and thus like humans, do not perceive ultrasound (Schwalbach 1989). Audiograms of 5 anesthetized, bottle-raised white-tailed deer by Texas A & M University scientists showed evoked potentials in a frequency range of 0.5 – 12 kHz at intensity levels up to 85 dB; at intensity levels of 95 dB, a response was obtained at 16 kHz. Overall, it was clear that the greatest hearing sensitivity in the deer was between 1 and 8 kHz, with a marked peak at 4 kHz. This compares favorably to the sound characteristics of recorded deer vocalizations (which range between 1 and 9 kHz), and reinforces the conclusion that deer do not hear ultrasonic sound (Risenhoover et al. 2003).

Most recently, an animal bioacoustics and audiology expert at the University of Connecticut, tested 6 deer whistles in the laboratory and in the field, discovering they typically produced sound either at a frequency of 3 kHz or at 12 kHz. A report of his work (Palmer 2002) states that the hearing range of white-tailed deer is between 2 and 6 kHz, thus concluding that deer are incapable of hearing the 12 kHz signal. The report also noted that the 3 kHz signal was only 3 dB louder than the road noise created by the test car, so that signal would be "buried," even under conditions of light traffic and no wind. Scheifele concluded, "All in all, the air-fed whistles do not make sense to me acoustically" (Palmer 2002).

Following the Connecticut research, an electric, vehicle-mounted, sound-generator device has come onto the market. The "Hornet Electronic Deer Avoidance System" claims to generate a sound wave at 5 kHz with a secondary frequency at 18-20 kHz, detectable at 1,600 ft from the vehicle with an effective range of 700 ft, that is enhanced by reverberation and reflection of the signal off the road surface. Advertising for the device makes the claim that the device was tested "on deer accident-prone policy and emergency vehicles over a 3-year period with more than 6 million proven accident-free miles" (XP3 Corp. 2003). Even if deer can hear the electronic signal, the key question is whether such a device alerts rather than startles the animals (Palmer 2002). Effectiveness of any such device is dependent upon the stimulus' initiating flight behavior, rather than becoming the proverbial "deer in the headlights."

THE REGULATORY ENVIRONMENT

Jacobs (2002) in explaining the EPA's philosophy and current policy toward regulation of pest control devices, noted that "Devices are regulated under FIFRA but do not have to be registered... devices must comply with...Federal regulations pertaining to misbranding, including prohibitions against statements in labeling that are "false or misleading." ...The lack of a registration requirement means that EPA makes no findings regarding the efficacy and labeling of devices before they reach the market in the U.S. This circumstance essentially places the burden of proof on EPA in proceedings against devices for violations of FIFRA." This is basically consistent with the EPA's current philosophy regarding most vertebrate repellent products for which efficacy data are not required because the products "...tend not to be labeled for public-health uses" (Jacobs 2002).

Jacobs (2002) also noted, as a personal opinion, "Many pieces of literature for rodent repellent devices are loaded with statements which seem to me to be 'false or misleading' or at least highly questionable." He went on to add, "EPA typically has prevailed in proceedings against vertebrate pesticide devices, but such efforts have been resource-intensive for the Agency." During the early advent of electromagnetic devices in the 1970s, some manufacturers found they could effectively stay one step ahead of the regulatory agencies by continually changing their products, if only in small ways. Thus, if a device was tested and found ineffective, the manufacturers could simply claim that they now had a new, improved model available, and the regulators would have to re-initiate the time-consuming and expensive testing process.

Despite the difficulties of policing the diversity of devices that have been marketed, the EPA took action in 1979 to remove from sale several electromagnetic pest control devices, following $100,000 worth of laboratory and field testing ordered by the Agency. The tests repeatedly found that the repeller devices had no effect on caged rodents, bottled insects, or pest-infested field sites. In the case of 3 of the devices, no electronic field was detected emanating from the units (Smith 1979). Between 1985 and 1994, the Federal Trade Commission (FTC) brought complaints for "false and deceptive advertising claims against several manufacturers of ultrasonic devices. Sonic Technology Products Inc. (Green Valley, CA) signed a consent decree in 1994, requiring it to cease claiming that its PestChaser device would "get rid of" rodents and that it works on fleas. Its modified claim was that the unit would simply "repel" rodents (Read 1999).

Jacobs (2002) perceived that "With a relaxed enforcement presence over the past dozen years or so, the marketing of vertebrate pest control devices seems to be expanding, despite recent efforts by the Federal Trade Commission," the agency that has authority to prohibit false advertising through the Federal Trade Commission Act. Another tactic of manufacturers and advertisers of devices is to modify their claims of efficacy by including such wording as the following:

> "...if there is an infestation of rats, mice or roaches, the consumer WILL see more during the first four weeks or so, because the PEST A CATOR is helping drive them out of the walls. We recommend using traps, glue boards, etc. the first few weeks to help clean up the initial problem. As with any pest management technique, no one method is completely effective, and a program of integrated management involving a variety of techniques and practices is most likely to provide the desired results" (Global 2003).
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> "Don't leave doors, windows, basements, and garage doors open as new rodents or pests may wander in briefly before they are affected and repelled by the unit. Avoid leaving human, animal, or pet food supplies in open areas, which can attract new rodents or pests before they are affected by the unit" (Global 2003).
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> "The use of the Hornet, along with driver awareness, has been proven to reduce the risk of animal/vehicle collision by more than 70%" (XP3 Corp. 2003).

Such verbiage within advertising undoubtedly give marketers something of an "out" when arguing their case in regulatory proceedings, making it more difficult for effective prosecution of "false and misleading" claims.

Despite such advertising manipulations, the FTC recently issued a complaint against a major manufacturer of electromagnetic, ultrasonic, and other pest repellers, Lentek Corp. of Orlando, FL. In this complaint, the FTC stated "the respondents do not have a reasonable basis for claims that ultrasound will eliminate or repel pests, including rodents and many insects, from a user's home." The complaint charges as false the company's claim that "...some PestContro devices drive away pests by altering the electromagnetic field of home wiring," and that there is no basis for claims "...that particular devices repel or eliminate pests in a space of a certain size (e.g., 2500 square feet) or that other products repel deer, racoons, skunks, or similar animals from a yard" (FTC 2002). As of this writing, the FTC's actions against this company are still in process.

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