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AZ1639 Revised 10/15

Sonic Pest Repellents

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Introduction

Sonic pest devices are tools that emit sound in the attempt to repel, deter, or kill unwanted animals such as insects, rodents, birds and large mammals. These devices, depending on the target species, cover a wide range of the acoustic spectrum from below what humans perceive (infrasonic) to above our hearing range (ultrasonic). Infrasonic is characterized as sound below 20Hz, whereas ultrasonic sound is defined as sound above 18,000 Hz. Ultrasonic devices are typically marketed to target arthropod (including spiders, scorpions and insect pests) and mammal pests, while devices targeting birds operate within our normal hearing range (i.e. electronic devices playing back distress calls, racket bombs, and propane cannons).

There are many commercially available sonic pest devices that claim to be effective. Bolstering these claims are positive customer reviews such as "This device has completely rid my home of spiders, ants, beetles, and flies" or "My cockroach infested house was entirely cleared by this product". Many of these devices claim to treat any pest problem, just simply turn the dial to hone-in on the target species. When reading such testimonials and claims two questions should come to mind--are these claims too good to be true and what scientific data supports the use of such products?

At a Glance

- Here we evaluate currently available sonic devices, and look at new developments in sonic pest repellents
- Scientific studies show commercially available devices to be ineffective
- Devices developed by researchers demonstrate positive results, but have yet to be marketed

Sonic pest devices widely range in price ($10.99-$2,900) and the pests they target. Dating back to the 1960's and 70's, the track-record of sonic pest devices has been questionable. However, although these devices have had mixed results, the

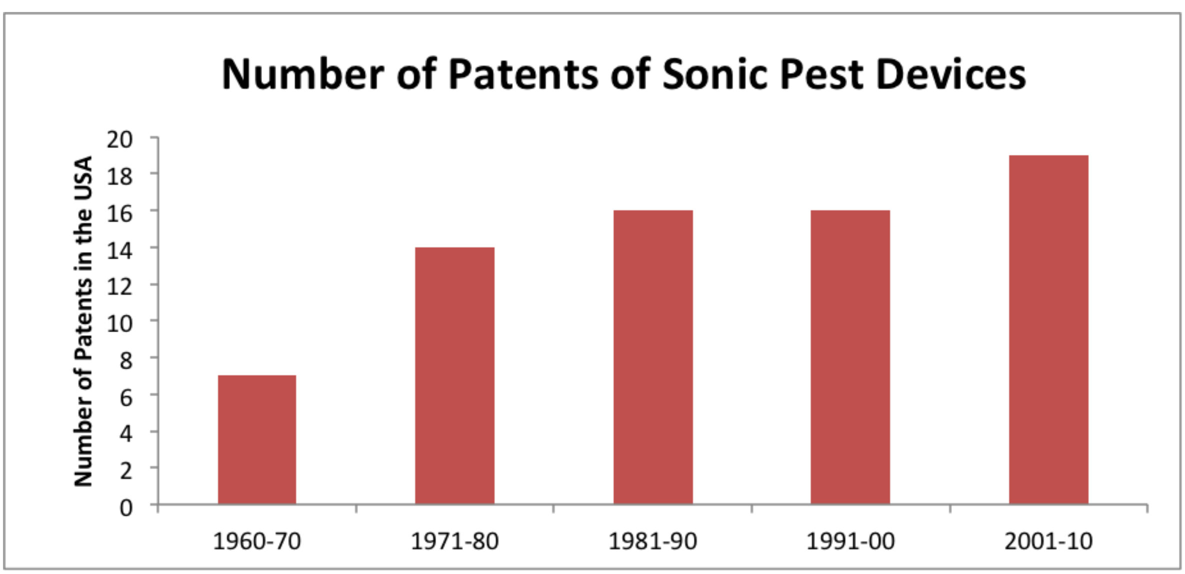

Figure 1 The number of sonic pest (repellent) device patents in the United States starting with the first patents in the 1960s to 2010. This figure only includes issued patents; it does not include patent updates, or patents for pest detection.

desire for a more environmentally friendly control of pests, and the ease of use, has driven their proliferation. Figure 1 illustrates the number of sonic pest device patents in the United States over the past five decades.

Sound has been used for millennia to scare off pest species, with its humble origins likely starting with loud claps and yells in ancient agricultural fields. The use of electronic sound as a treatment option for pests largely took root during the 1950's and 60's, although attempts were made earlier such as the work of Frings (1948) discussing the potential use of ultrasonic sound to control rodents and insects, and Kahn and Offenhauser (1949) who tested the effectiveness of sound to combat mosquitos. The surge of using sound to deter pests likely coincides with technological advancements of the time; the invention of the transistor by Texas Instruments in 1954, the first commercially available portable stereos, the invention of compact cassettes by Philips in 1962, and the refining of dynamic and condenser microphones, giving the ability to record quieter sounds with less noise. Early studies illustrating positive results were focused on various pest bird species. For example, researchers Frings and Jumber (1954) played starling distress calls into open air to successfully disrupt normal roosting patterns. Currently there are many sonic bird repellent devices in the market that utilize distress calls.

How they Work

Sonic pest devices are either plugged into an outlet or battery powered. Many of the patents use vague wording to describe how the devices operate, such as 'the device controls pests with high-frequency sound' or 'it repels pests', often lacking measurable results to support these claims. However, it can be assumed that sonic pest devices either disrupt the normal acoustic communication of target pests, or simply drive them away by means of annoyance, fear, and/or confusion. When these devices operate in the infrasonic/ultrasonic range, the sound they emit is inaudible to humans, conveniently making for a device that does not drive humans away as well. However, it is important to note that other non-target mammals, such as dogs, hear ultrasonic sounds.

Following we discuss studies that have tested devices that are currently on the market and new developments of devices that target specific pests with specific sounds.

What doesn't work?

Many studies have tested the effectiveness of the sonic pest devices, most illustrating their ineffectiveness. Researchers in the entomology department at Kansas State University have conducted several studies on commercially available devices. One of these studies tested three devices marketed for pest control on three ant species (Huang et al. 2002). They found none of the devices were able to repel ants in field and laboratory trials, although one device appeared to briefly repel ants in the laboratory before losing effectiveness.

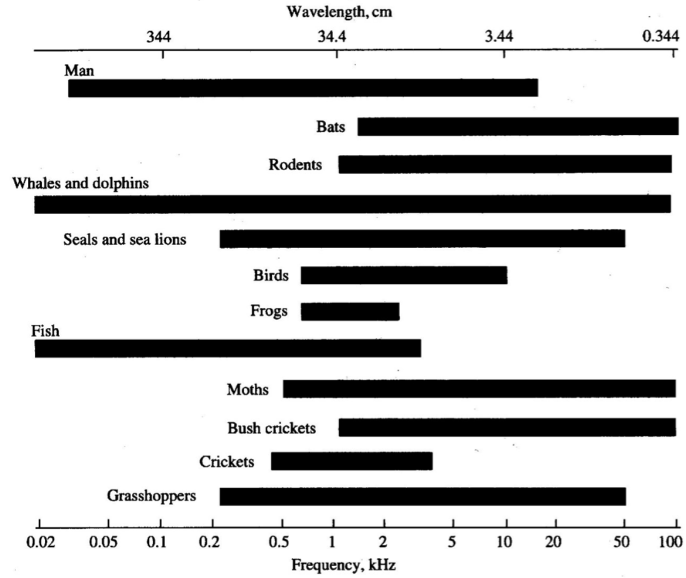

Figure 2. Example animal hearing ranges (Dusenbery, 1994).

Several studies have targeted cockroaches for ultrasonic device testing without success (Schreck et al. 1984; Gold et al. 1984). One of the most comprehensive studies tested nine devices on the German cockroach (*Blattella germanica* (L.)) (Koehler et al. 1986). None of the devices were able to illicit a response, illustrated by equal numbers of cockroaches entering rooms both with and without sound. Ahmad et al. (2007) also conducted an experiment with German cockroaches as well as two species of mosquitoes. Using a device especially designed to produce a wide range of ultrasonic sounds so they could test many frequencies. They also found no behavioral response in any of the test species.

Yturralde and Hofstetter (2012) tested four commercial ultrasonic devices to determine their effectiveness against bed bugs. In choice test trials, no device illustrated any effect on bed bugs. When the bed bugs made a choice, it was found that roughly equal numbers were located near the ultrasonic devices as the control side without ultrasonic sound.

Interestingly, some devices marketed to repel mosquitoes have been shown to attract mosquitoes. A study that tested three commercial sonic devices found that with the devices activated there was an increase in bite-rate by as much as 50% (Andrade and Cabrini 2010).

Ahmad et al. (2007) set up an experiment with a device especially designed to produce a wide range of ultrasonic sounds so they could test many frequencies. They found no behavioral response from two species of mosquitos or German cockroaches.

In a study testing the effectiveness of an ultrasonic device on rats and mice, it was found that they had a mild aversion to the sound (Greaves and Rowe 1969). However, this dislike diminished over time, especially after a reliable food source was discovered near the sonic device. Even after the food source was removed the rats and mice continued to explore the room with ultrasonic sound, expressing habituation to the sound. Habituation is a decrease in response to a stimulus, and is often cited in studies testing the efficacy of sonic pest devices. For example, initial sound emitted from sonic devices may be interpreted as a threat, but after a short period passes without physical harm pests grow more comfortable. The researchers in this particular study do suggest that well placed ultrasonic devices may aid in repelling pests.

This list of studies that discredit the efficacy of commercially available sonic devices is by no means comprehensive. There are other study results illustrating the ineffectiveness of other available devices. We have not reported these study results due to a desire to keep this publication brief.

What works?

Although many of the commercially available sonic pest devices show poor results, the use of sound as a viable treatment option still exists. Studies focusing on mosquitoes and pest bird species have shown limited positive results. For example, in 1949 researchers effectively used recordings of female mosquito mating sounds, broadcasted through loudspeakers, to attract male mosquitoes to traps (Kahn and Offenhauser 1949). Also, Kahn and Offenhauser found that sound emitted by a similar mosquito species had no effect on the mosquito they were testing, supporting the use of highly specific sounds in sonic devices rather than generic computer-generated tones.

Other work further supporting the use of sound occurred in 1988, when researchers successfully employed Canada geese alarm calls, resulting in a 71% reduction in goose numbers. When these alarm calls were coupled with racket bombs, geese numbers were reduced by 96% (Mott and Timbrook 1988). More recently the use of sound has been tested on prominent forest pest such as bark beetles. Testing has revealed that bark beetles can be adversely affected when certain, biologically relevant sounds are played back. Such results demonstrate reduced entry into ponderosa pine logs by southern pine beetle by 72% when their stress call was played back (Aflitto and Hofstetter 2013).

Studies that have used ultrasound to deter Indian meal moth in stored grain have shown a reduction in offspring and lower growth rates of offspring in the presence of ultrasonic waves (Huang et al. 2003).

The majority of success using sound to combat pests involves devices developed by professionals and researchers. This success is likely attributed to the development of techniques and devices that target specific species. When a specific species is targeted, greater consideration is given to hearing mechanisms, biologically relevant sounds, and particular behaviors that can then be incorporated into the design. These devices often use biosonic sounds, or sounds that are derived from an organism, as opposed to many of the commercially available devices that often use generic sine waves or computer-generated tones. Additionally, the majority of positive results stem from ex situ studies, that is to say, a limited number of successful studies were conducted in 'natural' environments.

Conclusion

Commercially available sonic pest devices for use in residential applications have not been shown to be effective in scientific studies. For this reason, use of these devices is not advised to treat common pest problems. Although some researchers are developing sonic techniques that illustrate promise for very specific pests, these technologies are yet to be commercially available. As our understanding increases of how pest species receive and process sound, more relevant sonic devices may be developed. The allure of sound as a treatment for pests will remain into the future—motivated by the fact that if they are successful they will be more environmentally friendly and safer for humans.

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Originally published: 2014

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