NOTE

Laboratory and Field Trials with Commercial Ultrasonic Devices Against Three Ant Species (Hymenoptera: Formicidae)[1]

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Several reports have demonstrated the possibility of using ultrasound to manage or repel urban insect pests. Ballard et al. (1984) found that ultrasound increased the activity of the German cockroach, *Blattella germanica* (L.), in wooden enclosures. Like many other insects (Spangler 1988), some ant species produce ultrasound, but its function is unknown (Esperson 1994). There are no published reports on the responses of ants to ultrasound, despite claims made by manufacturers of ultrasonic devices that their units are effective in repelling ants. The Federal Trade Commission has urged manufacturers and retailers of ultrasonic pest control devices to examine their advertising and ensure that they have competent and reliable scientific evidence to support claims that an ultrasonic device eliminates or repels certain pests (Federal Trade Commission 2001).

We conducted laboratory and field trials to determine the repelling abilities of three commercial ultrasonic devices against three common ant species—*Camponotus festintatus* (Buckly), *C. pennsylvanicus* (De Geer), and *Formica pallidefulva* (Latreille). The three commercial ultrasonic devices were labeled as A, B, and C for proprietary reasons. Huang et al. (2000) described detailed sound measurements produced by these devices. Ultrasonic device A generated peak frequencies at 26 kHz and 34 kHz, a sound pressure level (SPL) of 95 ± 1 dB at 50 cm from the source (0 dB = 20 $\log_{10}$(20 μPa/20 μPa), and the sound cycle lasted 0.123 s. Device B generated peak frequencies at 27 kHz and 35 kHz. The unit produced a 92 ± 4 dB sound pressure level at 50 cm and a 0.123-s sound cycle. Device C generated a wide range of peak frequencies between 27.7 and 42 kHz. This unit produced an 88 ± 2 dB sound pressure level at 50 cm, and had a sound cycle that lasted 0.075 s.

In laboratory trials, two enclosures (cubes), each side measuring 1.2 × 1.2 × 1.2 m, were constructed using plexiglas. The two enclosures were connected at the bottom by a 91-cm long square conduit (7.5 × 7. 5 cm) made of cardboard. Plexiglas gates placed at the junction of the conduit and enclosures could be opened or

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closed, and when opened, allowed ants to freely move between the enclosures. In both enclosures, an ultrasonic unit was mounted on the top corner, diagonally opposite from the conduit openings. To remove any bias resulting from unit position, both units were mounted in identical positions within enclosures.

For all trials, dead larvae of the tobacco hornworm, *Manduca sexta* (L.), were provided as food for the ants. In addition, each enclosure contained two 9-cm petri dishes with cotton swabs saturated with distilled water. Half a handful of wood chips were placed in the center of each enclosure. The number of ants in each enclosure was counted daily between 1000–1100 h central time. After ant introduction, the enclosures were covered with black plastic sheets to exclude light. Plastic sheets were removed and the gates were closed temporarily to facilitate counting. All tests were conducted at 23–24°C and 65–80% RH.

Two trials were conducted in enclosures with device A to determine responses of *C. festintatus* to ultrasound. In each trial, a whole colony (150 ants) including queen and workers of *C. festintatus* was released into one of the enclosures and allowed to acclimate to test conditions for 2 (trial 2) or 4 d (trial 1) with the gates closed.

After the acclimation period, the gates were opened and the ultrasonic unit in the enclosure containing the ants was turned on continuously for 9 days. In trial 1, only two ants moved from the enclosure with ultrasound to one without ultrasound 3 days after the unit was turned on. However, the next day, these two ants returned to the ant colony in the enclosure with ultrasound. In trial 2, the ants failed to move from the enclosure with ultrasound to one without after continuous exposure for 9 days to ultrasound.

Two trials were conducted with device B following the protocol used for device A. After a 3-day acclimation period, the ultrasonic unit was turned on continuously for 9 days (trial 1) or 13 days (trial 2). In both trials, the ants failed to move from the enclosure with ultrasound to one without ultrasound.

Three trials were conducted with device C using workers from a colony of *C. pennsylvanicus* collected from the Tuttle Creek State Park, Manhattan, Kansas. In trial 1, 35 workers were released into each enclosure and allowed to acclimate for 2 days with the gates open. The number of ants in each enclosure after 2 days was equal (31–32/enclosure). The ultrasonic unit in one of the enclosures was turned on for 2 days while the unit in the other enclosure was turned off. After 2 days, the ultrasonic unit was turned off, and the unit that was previously inactive was turned on for an additional 2 days. The same protocol was used for trial 2 using 40 worker ants. The number of workers found in both enclosures was similar in the presence or absence of ultrasound. In trial 3, 70 worker ants were introduced into an enclosure and allowed to acclimate for 2 days. The ultrasonic unit was turned on in the enclosure where the workers were originally introduced for 2 days. All workers moved from the enclosure with ultrasound to one without ultrasound. The ultrasonic unit in the enclosure with the workers was turned on for an additional 11 days while the other unit was turned off. During the 11-day period, none of the workers moved from the enclosure with ultrasound to one without ultrasound. Device C may have initially repelled the workers in trial 3, but subsequent exposure for 11 days failed to elicit any movement.

In the field trial, each of 18 metal trash cans of 19.5-liter (5 gallon) capacity was filled with 910 g of trash collected from a garbage dumpster outside the Department of Entomology, Kansas State University, Manhattan, Kansas. About

230 g of peeled fruits, grapes, and pork meat (in 2:2:1 ratio) were added to each trash can. Trash cans were placed in an open area in the Tuttle Creek Park on 8 September 2000. A disposable yellow color sticky trap (B&G, Plumsteadville, Pennsylvania) was taped upside down over the top of each trash can. A completely randomized design was used for the experiment with the ultrasonic devices (A, B, and C) and status (one/off) as the two main factors. The distance between any two adjacent trash cans was 6.1 m. There were six treatment combinations (two states of the ultrasonic unit (on/off) × three commercial devices). Each treatment combination was replicated three times. The ultrasonic unit was mounted on a 76.2-cm wooden stick with the ultrasonic transducer facing toward the trash can. The distance from the top of the trash can to the ultrasonic unit was about 60 cm. Active ultrasonic units were connected to electrical power outlets. After 10 days, ants inside sticky traps and inside the trash cans were killed using the pesticide Camicide (Campbell Chemicals, St. Louis, Missouri) and brought to the laboratory for identification and counting. The temperature and humidity during the entire test period ranged from 6–43°C and 22–83%, respectively. Data on the number of ants captured in traps, those found in trash cans, or both in traps and trash cans (total) were subjected to two-way analysis of variance using the PROC GLM procedure (SAS Institute 1990), to determine significant differences among devices and between the on and off status of devices.

Several ant species, including *F. pallidefulva, Paratrechina longicornis* (Latreille), *Paratrechina melanderi* (Wheeler), *Lasius neoniger* Emery, and *Monomorium minimum* (Buckley), were captured in traps. The overwhelming majority of captures were that of *F. pallidefulva* workers (94% of total ant species). Therefore, statistical analysis was conducted only on *F. pallidefulva* data. Despite the large variation in the number of ants captured, our data failed to show any significant repelling abilities of all three ultrasonic devices against *F. pallidefulva*. Numbers of *F. pallidefulva* captured in traps, numbers found in trash cans, or numbers in traps and trash cans were not influenced by the devices ($F \leq 0.80$; df = 2, 12; $P > 0.473$) or their on/off status ($F \leq 0.17$; df = 1, 12; $P > 0.586$; Table 1). The interaction between device and device status (on/off) also was not statistically significant ($F < 0.95$; df = 2, 12; $P > 0.413$).

The three commercial devices used in our study failed to repel *C. festintatus, C.*

Table 1. Responses of *Formica pallidefulva* to ultrasonic pulses from three commercial devices.

Treatment		No. of insects (mean ± SEM)		
Device	Status	In trap	Inside trash can	Total[a]
A	Off	1.7 ± 1.7	8.0 ± 4.0	9.7 ± 5.7
	On	3.3 ± 2.4	6.0 ± 5.5	9.3 ± 7.8
B	Off	7.0 ± 7.0	7.0 ± 2.6	14.0 ± 7.0
	On	2.0 ± 2.0	7.3 ± 2.6	9.3 ± 1.5
C	Off	2.7 ± 2.7	10.0 ± 6.2	12.7 ± 8.8
	On	14.3 ± 12.4	11.3 ± 7.0	25.7 ± 12.8

[a]Number of ants in traps plus those found inside trash cans.

pennsylvanicus, and *F. pallidefulva* in laboratory and field trials. Similar negative findings with ultrasound have been reported against corn earworm adults (Shorey et al. 1972), cockroaches (Koehler et al. 1986), mosquitoes (Sylla et al. 2000), and fleas and ticks (Hinkle et al. 1990, Brown & Lewis 1991, Dryden et al. 2000).

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