THE EFFICACY OF ULTRASONIC PEST CONTROLLERS FOR FLEAS AND TICKS

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ABSTRACT

Two ultrasonic pest controllers, a pet-collar unit and a large unit for household use, were tested for their efficacy in repelling fleas and ticks in a choice chamber. Neither unit had any affect on the distribution of fleas or ticks in the choice chamber up to 24 h exposure, and activity of fleas, ticks and cockroaches was unimpaired. The study extends and supports previous findings that ultrasound is ineffective as a means of controlling common pests of households and pets.

Key words: Ultrasound, fleas, ticks, pest control

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INTRODUCTION

Ultrasound generally refers to high frequency sound inaudible to the human ear (above approximately 20 kHz). Although inaudible to humans, some insects are capable of detecting ultrasound. In particular, some moths respond, by evasion, to ultrasound in the 20-40 kHz range, the range used for prey detection by many insectivorous bats[1 13]. Such observations provided an early stimulus for investigating the use of ultrasound for the control of agricultural insect pests. Results of field trials, mainly on cotton bollworm, tobacco budworm and cabbage looper moths, are conflicting, some showing promise[6 12] and others no effect at all[1 2]. In contrast, there is no a priori reason to suggest that ultrasound will be effective in repelling other insects, in particular common household pests (mainly cockroaches and fishmoths) and pests of domestic pets (fleas and ticks). There is little evidence that domestic insect pests have receptors capable of detecting ultrasound, although fleas may be capable of detecting ultrasonic frequencies in the region of 100 to 10 000 kHz[3]. This is far above the 20-60 kHz output of commercial ultrasonic pest repellers. Nevertheless, the idea of non-chemical control of household pests is an attractive one, and a wide range of ultrasonic pest controllers claiming to repel insect pests in the domestic environment, is available in the United States and Europe. The efficacy of some of these devices has been the subject of several investigations, both in the laboratory[4 5 10 14] and under more natural conditions[8 10 15]. Most of these studies suggest that ultrasonic devices are ineffective in controlling domestic pest populations, although there is still some controversy on the matter[7].

It is only relatively recently that ultrasonic pest controllers have become available on the South African market, mainly through mail order companies advertising in newspapers and magazines. Subjective reports from purchasers that these devices are effective, led us to test the repellent effects of 2 such devices on fleas and ticks in a choice chamber.

MATERIALS AND METHODS

Adult cat fleas *(Ctenocephalides felis)* were collected from domestic cats and dogs. Fleas were either used on the day they were collected, or kept overnight in a glass jar with animal hair. Fleas were not fed and fresh fleas were used for each trial.

Adult *Rhipicephalus simus* ticks were supplied by the Tick Research Unit at Rhodes University, (Grahamstown, Republic of South Africa) and supplemented with adult ticks recovered from domestic dogs in the Grahamstown area. Because only limited numbers were available, some ticks were used in more than one trial, but none more than 3 times over the entire period of the experiments and not in successive trials.

Two ultrasonic devices, purchased from mail order companies, were tested. The smaller unit, a flea and tick collar unit for pets is made in Taiwan but bears no brand name. It is designed for attachment around the neck of a cat or dog, or to be placed in a kennel or pet basket. The instructions claim that the high frequency sound will work by repelling pests within a range of 4 feet (1,2 m). It further claims that fleas within this range will stop jumping within seconds and so will not jump onto pets fitted with the device.

The larger unit also carries no brand name, nor is there any indication of its country of origin. It is designed for household use and is powered by two 9V batteries or supplied mains adapter. The specifications claim that the unit sweeps continuously over 30 to 65 kHz, has a sound pressure level of 130 dB, and is effective in an area of 2 000 to 2 500 square feet (180-225 m^2). The rate at which the device sweeps its frequency range is adjustable by the user. Both devices were tested before and after the experiments to confirm that they were producing ultrasound.

The test chamber comprised a Y-shaped plywood box with a broad base (16 x 10 x 8 cm) and two narrow arms (30 x 8 x 8 cm). The broad base of the Y was partly divided by a cardboard baffle, effectively dividing the chamber into a left and right side. A 3-piece perspex lid allowed for observation and easy access to the chamber. Linen-covered rectangular holes (6 cm^2) cut in the ends of the arms allowed the ultrasonic devices to be placed immediately outside the chamber with their transponders facing into the chamber. The chamber was lined with dressmaker's batting, covered with white linen, to absorb the ultrasound and restrict it, as far as possible, to one arm of the chamber. Tests with an ultrasonic bat detector (QMC Mini Bat Detector)

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Table 1: **Effect of the pet-collar ultrasound unit on the distribution of *Ctenocephalides felis* in a choice chamber. NS = not significant**

Trial No.	No. of fleas	Initial distribution quiet arm	Initial distribution unit arm	Final distribution quiet arm	Final distribution unit arm	χ^2	Significance
1	19	11	8	8	11	1,349	NS
2	21	12	9	9	12	1,215	NS
3	28	5	23	5	23	0,061	NS
4	17	8	9	8	9	0,059	NS
5	33	16	17	17	16	0,030	NS
6	29	11	18	5	24	4,431	$P<0,05$
7	20	6	14	7	13	0,060	NS
8	30	16	14	23	7	5,659	$P<0,05$
Pooled	197	85	112	82	115	0,129	NS

established that no ultrasound from the pet-collar unit penetrated to the end of the "quiet" arm of the chamber. With the large unit in position, ultrasound in the "quiet" arm of the chamber was still detectable, but was substantially less than in the arm with the unit, attenuation being estimated at 80 to 90%. Trials were carried out in a constant environment room at 24°C with a 12L 12D light cycle.

Fleas or ticks were introduced into the chamber at the base of the Y. The number of insects used varied depending on availability, but was never fewer than 11 fleas and 10 ticks. Fleas and ticks were left for at least 60 min to distribute themselves in the chamber and their distribution (left or right arm) noted (initial distribution). The ultrasonic unit being tested was then placed at the end of one of the arms of the chamber and switched on. Initially, the unit was placed at the left and right arms at random based on odd (left) and even (right) numbers generated by a random number generator. In a second trial of the large unit with fleas, the unit was sometimes deliberately placed in the arm containing the most fleas.

After the unit was switched on, the chamber was left undisturbed for 24 h. At the end of the trial, the number of fleas or ticks in each side was again counted (final distribution). Overall, 8 trials were carried out on fleas with the pet-collar unit and 7 on ticks. Fourteen and 6 trials were carried out with the large unit on fleas and ticks, respectively.

Chi-square (χ^2) tests, corrected for continuity[16], were carried out for each individual trial to establish any significant differences between initial and final distributions of fleas and ticks in the chamber and, where χ^2 values were homogeneous, pooled χ^2 were obtained by summing the initial and final distributions.

RESULTS

Electronic analysis showed that the pet-collar unit produced pulsed ultrasound at a frequency of 35 kHz, giving a 2 millisecond (ms) tone burst every 40 ms. The sound pressure level (SPL) of the unit could not be measured, but output from the unit was virtually undetectable with the bat detector at ranges > 30 cm.

The larger unit produced modulating sound which cycled between 20 and 37 kHz with no break in modulations. SPL was not measured, but the unit was detectable with a bat detector for at least 10 m.

Of 8 trials with the pet-collar unit against fleas, 6 trials showed no significant difference in the distribution of fleas before and after the unit had been switched on, one trial showed a significant change in distribution towards the unit and one trial away from the unit (Table 1). Overall, there was no significant change in the distribution of fleas after 24 h exposure to ultrasound (pooled $\chi^2 = 0,129$, $P > 0,50$).

Ticks also showed no response to ultrasound generated by the pet-collar unit, all 7 trials showing no significant differences in their initial and final distributions (pooled $\chi^2 = 0,006$; $P > 0,75$) (Table 2).

Four out of 6 trials on fleas using the large unit, showed a significant change in distribution after 24 h exposure. However, the movement was towards the ultrasound (Table 3). χ^2 values for individual trials were not homogeneous and were therefore not pooled. A further series of 8 trials with substantially more

Table 2: **Effect of the pet-collar ultrasound unit on the distribution of *Rhipicephalus simus* in a choice chamber**

Trial No.	No. of fleas	Initial distribution quiet arm	Initial distribution unit arm	Final distribution quiet arm	Final distribution unit arm	χ^2	Significance
1	20	8	12	10	10	0,469	NS
2	24	13	11	12	12	0,040	NS
3	20	8	12	9	11	0,052	NS
4	20	9	11	10	10	0,273	NS
5	39	22	17	21	18	0,026	NS
6	24	14	10	12	12	0,386	NS
7	20	11	9	10	10	0,051	NS
Pooled	167	85	82	84	83	0,006	NS

fleas showed no significant difference between initial and final distributions after 24 h exposure to ultrasound in any individual trial (Table 4), or overall (χ^2 = 0,082; P > 0,75).

There was no significant difference in the initial and final distributions of ticks in any of the 6 individual trials (Table 5) or overall (χ^2 = 0,219; P > 0,50).

strongly suggesting that the devices are ineffective for repelling fleas and ticks. These results are consistent with previous studies on ultrasonic pest controllers. For example, several studies have shown that cockroaches are unaffected by a wide range of ultrasonic frequencies[4 5 9 10]. More specifically, Rust & Parker[14] found no movement of fleas away from an

evidence that they are not adversely affected by ultrasound. Similarly cockroach nymphs have been found inside ultrasonic pest repellers after trials in apartment buildings, showing that cockroaches were even using the devices for harbourage[10].

The claim in the instructions accompanying the pet-collar unit used in the pre-

Table 3: **Effect of the large ultrasound unit on the distribution of *Ctenocephalides felis* in a choice chamber during the first series of trials**

Trial No.	No. of fleas	Initial distribution		Final distribution		χ^2	Significance
		quiet arm	unit arm	quiet arm	unit arm		
1	24	21	3	8	16	59,520	P < 0,001
2	34	18	16	8	26	10,655	P < 0,001
3	17	3	14	2	15	0,010	NS
4	18	9	9	1	17	12,500	P < 0,001
5	42	21	21	18	24	0,595	NS
6	11	6	5	1	10	7,425	P < 0,001

Table 4: **Effect of the large ultrasound unit on the distribution of *Ctenocephalides felis* in a choice chamber during the second series of trials**

Trial No.	No. of fleas	Initial distribution		Final distribution		χ^2	Significance
		quiet arm	unit arm	quiet arm	unit arm		
1	43	31	12	32	11	0,029	NS
2	42	30	12	33	9	0,729	NS
3	39	30	9	31	8	0,036	NS
4	21	11	10	16	5	3,866	P < 0,02
5	33	6	27	3	30	1,273	NS
6	45	6	39	5	40	0,048	NS
7	37	5	32	2	35	1,445	NS
8	46	34	12	34	12	0,028	NS
Pooled	306	153	153	156	150	0,082	NS

DISCUSSION

Ultrasonic sound is rapidly attenuated by distance and is diffracted by solid objects. In the present study, absorption and attenuation was such that either no or very little ultrasound was present in the "quiet" arm of the choice chamber. If ultrasound generated by the devices repelled insects as claimed, one would expect a significant movement of fleas and ticks away from the ultrasonic units into the sound shadow of the "quiet" arm. Such movement was not observed, ultrasonic device in a cardboard tube. Furthermore, Dryden et al[8] and Schein et al[15] showed that pet-collar devices were ineffective in reducing flea numbers on cats and Schein et al[15] found no difference between numbers of fleas and ticks initially placed on dogs with ultrasonic pet-collars and on control dogs, even after 14 d exposure.

In the present study, fleas and ticks were observed on the linen at the end of an arm of the choice chamber within one cm of the transponder, supporting

sent study that fleas will cease jumping within seconds of exposure to the collar, is also unfounded. Fleas in the chamber were regularly observed to jump and previous studies have demonstrated that ultrasound has no effect on fleas' jumping or on their normal circadian rhythm of activity[11 14]. Rust & Parker[14], however, showed that bursts of CO_2 did elicit increased activity, as might be expected of insects that rely on CO_2 concentration and thermal and visual cues to locate hosts. Ticks in the present study, on the

Table 5: **Effect of the large ultrasound unit on the distribution of *Rhipicephalus simus* in a choice chamber**

Trial No.	No. of fleas	Initial distribution quiet arm	unit arm	Final distribution quiet arm	unit arm	χ^2	Significance
1	20	9	11	11	9	0,455	NS
2	20	10	10	10	10	0,050	NS
3	14	4	10	6	8	0,788	NS
4	10	4	6	6	4	0,938	NS
5	30	18	12	17	13	0,035	NS
6	20	12	8	10	10	0,469	NS
Pooled	114	57	57	60	54	0,219	NS

other hand, showed little movement after initially distributing themselves in the chamber, even when they had settled within one cm of the ultrasonic devices. Gently exhaling in their vicinity, however, did elicit movement showing that they were not immobilised by the ultrasound.

The leaflet accompanying the large unit used in the present study also claims that the unit will stun larger insects such as moths, bees and cockroaches, rendering them immobile and allowing them "to be swept away at leisure". To test this claim, a single trial with 7 cockroaches (*Periplaneta americana)* was carried out. The trial was conducted as described for fleas and ticks, but cockroaches were provided with food and water and a cardboard tube was placed at the end of each arm of the chamber as harbourage. Ultrasound from the large unit had no noticeable effect on cockroach activity, cockroaches at night being especially active with no signs of immobility. Although there were too few cockroaches for statistical purposes, there was also no change in their distribution after 24 h exposure to ultrasound, but after 48 h all 7 cockroaches were clustered in the tube immediately in front of the ultrasound unit, but immediately moved when disturbed.

In addition to activity, ultrasound has also been shown to have no effect on reproduction in either cockroaches[10] or fleas[8 10], the latter despite claims that the use of ultrasonic pet collars inhibit flea population growth[7].

The present study demonstrates that the 2 ultrasonic devices tested fall short of claims in their specification and instruction leaflets with regard to their performance. Furthermore, the study has failed to substantiate that these ultrasonic devices have any efficacy in repelling common household pests. On the contrary, this and other studies have shown such devices to be ineffective for controlling fleas, ticks or cockroaches.

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