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Ineffectiveness of Fenthion, Zinc Phosphide, DDT and Two Ultrasonic Rodent Repellers for Control of Populations of Little Brown Bats (*Myotis lucifugus*)

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Several chemicals are used in an effort to control populations of bats in buildings, usually with the justification that these control measures will reduce the chances of contact between people and rabid bats. However, little brown bats in New Hampshire continued to occupy an old barn in spite of multiple applications of DDT and other pesticides (KUNZ et al. 1977), and the application of pesticides to bats may actually increase the number of contacts between bats and people (BARCLAY et al. 1980). The purpose of this study was to test the effectiveness of three pesticides that have or might be used to control bats in buildings, and to compare these results with data obtained using ultrasonic rodent repellers. Included in our testing was DDT (Rodentrak[R]) which is commonly used in bat control, zinc phosphide (ZP Tracking Powder[R]) which might be used, and fenthion (Baytex[R]) which has been used by some Ottawa pest control operators.

MATERIALS AND METHODS

This study was conducted during July and August 1979 using adult and juvenile little brown bats of both sexes obtained from nursery colonies at Chaffey's Locks and Kemptville, Ontario, and from a swarming site near Renfrew, Ontario (FENTON 1969). Bats were captured in traps (TUTTLE 1974) as they returned to colonies or arrived at the swarming site, and only individuals that had fed immediately prior to capture (determined by palpation of the abdomen) were used in testing. Bats were aged by pelage coloration and by the degree of ossification of the metacarpal-phalanges joints (BARBOUR & DAVIS 1969).

We conducted two series of test exposures of bats to the pesticides. In both series the dosages were measured in a 50 mL graduated cylinder (fenthion) or on a balance (zinc phosphide and DDT). In both series of exposures, groups of control bats were housed in roosts identical to those used for testing. All bats exposed to any levels of pesticides were sacrificed at the end of the 24-h exposure periods.

In the initial tests groups of three bats were exposed to each of five concentrations of three pesticides (fenthion: 28 mg/bat, 14, 7, 4 and 2; DDT: 20 mg/bat , 15, 10, 5 and 2; zinc phosphide 1500 mg/bat,

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1130, 750, 370 and 10). In these experiments the bats were housed in 15 by 15 by 7 cm (480 cm^2 internal surface area) boxes constructed of spruce which were treated with the pesticides before the bats were added. These bats were observed intermittantly over 24 h to document their responses to the chemicals.

In the subsequent tests groups of 20 bats were housed in triangular shaped roosts constructed of aspenite; each roost was 1 m long and the distance to the peak from the bottom was 41 cm (internal surface area 3960 cm^2). A partition divided each roost into two equal sections and a hole in the base of the partition permitted movements of bats from one section to the other. The ends of the roosts were made of lucite which permitted us to observe bats *in situ*. The bats were placed in one section of the roost and the hole in the partition blocked to confine them to that side while the pesticide was applied directly to the group of bats. The fenthion was sprayed and the other two pesticides dusted directly on to the bats; after the application of the pesticides the hole in the partition was opened, allowing the bats to move freely from one section to another. Control bats were similarly confined at the beginning of the experiment. Dosages applied to the bats in these subsequent tests were based on the results of the initial test exposures. The roosts used in these experiments were maintained outside under natural weather conditions to approximate the conditions of a nursery colony.

Observations of bats in the roosts were made through a Zoomar Night Vision Scope on the following schedule: close observation (3 h) of initial reactions to pesticides; subsequent hourly checking of behavior until the time of normal emergence when they were observed closely for two h; and close observation for the final hour of the 24-h exposure period.

We tested the responses of one group of 20 bats to a Rodent Sentry^R model R512-2 and another group to a Urie One^R model 101-60 ultrasonic rodent repellers in the triangular shaped roosts. The acoustic output of these devices was characterized to determine their intensity (using a Bruel and Kjaer 2209 measuring amplifier with 4135 half inch microphone on linear setting; system flat to 40 kHz), frequency (output recorded at 76 cm/s on a Lockheed Store 4D tape recorder via the B and K half inch microphone and analyzed slowed down eight times on a Princeton Applied Research FFT Real Time Spectrum Analyzer Model 4513), and time (using a Tektronix 5A18N storage oscilloscope). The responses of the bats to both devices were monitored over 24 h and compared to control individuals housed in an identical roost.

RESULTS

After 24-h of exposure to five concentrations of fenthion all bats were alive and none exhibited any symptoms typical of organophosphorous pesticide poisoning; there were no obvious differences between treated and control bats; all individuals in both groups could fly.

Some of the bats exposed to the 750 mg/bat dosage of zinc phosphide powder showed tremors within three h of initiation of the experiment, and by the end of 24 h one bat exposed to this dosage was dead. By the end of 24 h all bats in the three higher concentrations (1500, 1130 and 750 mg/bat) suffered from tremors, spasms, and general slowness or lack of control of body movement. Individuals exposed to the two lower concentrations (370 and 10 mg/bat) showed none of these symptoms and behaved the same as bats in the control group.

By the end of the 24-h exposure period all bats in roosts with 20 mg/bat DDT were dead and those in all of the other concentrations showed signs of poisoning, including tremors, spasms, and lack of control over body movement, but only one additional death occurred by 24 h. Bats exposed to the 5 mg dosage showed the same signs of poisoning within 2.5 h of initial exposure, and by the end of 24 h only the control bats would have been capable of flight.

In the subsequent tests we used the following levels of pesticides: 28 mg/bat fenthion, 750 mg/bat zinc phosphide, and 15 mg/bat DDT. It is unlikely that dosages this high would be achieved during application of pesticides in the field unless very large quantities of the pesticides were applied to the roosts under treatment. After 24 h all of the 20 bats (8 ♀♀ 2 ♂♂ adults; 5 ♂♂ 5 ♀♀ subadult) exposed to the fenthion dosage were alive, capable of flight, and apparently unaffected by the pesticide. Immediately after the fenthion was applied 12 of the 20 bats moved from the treated to the untreated side of the roost, suggesting that the fenthion might be an effective repellant. There was no evidence that adults were more affected in this context than subadults, or males more than females. At the end of the 24 h period distribution of bats between treated and untreated sides of the roost did not differ significantly from that of the control roost.

After 24 h three of the 20 bats (8 ♀♀ 2 ♂♂ adults; 5 ♂♂ 5 ♀♀ subadults) exposed to 750 mg/bat of zinc phosphide were dead and three others showing signs of severe distress; the remainder (70%) were mobile and would have been capable of sustained flight. The dead included two adult males and an adult female. The bats showed no initial reaction to the application of the pesticide and no movement to the untreated side of the roost.

Only one of the 20 bats (8 ♀♀ 2 ♂♂ adults; 5 ♂♂ 5 ♀♀ subadults) exposed to the DDT powder was dead at the end of 24 h (a subadult male), but five others showed signs of distress. After 24 h all of the survivors would have been capable of sustained flight, and there was no initial reaction to the pesticide or avoidance of the treated side of the roost.

Before either of the rodent-repellers was turned on the bats were confined to the side of the roost closest to the device being tested, and the control bats were similarly confined to one side of their roost. The output of the devices we tested had intensities of over 120 dB SPL at 10 cm (re 2×10^{-5} N/m^2 at frequencies of 19 kHz (Urie One) or 23.5 and 30.7 kHz (Rodent Sentry). The bats (2 groups, each including 8 ♀♀ 2 ♂♂ adults; 5 ♀♀ 5 ♂♂ subadults) showed absolutely no reaction to the signals from either machine; they neither moved away from nor towards the devices and by the end of the 24 h period of observation the same number had moved to the untreated side as had changed sides in the control group. Bats hanging on the repellers at the beginning of the experiment did not move away when the machines were turned on.

In the subsequent testing of the pesticides and in the experiments with the rodent repellers bats moved back and forth between treated and untreated sections of the roost, but in no case did their distribution between the two sections of the roosts differ significantly from the control groups.

DISCUSSION

Our data suggest that fenthion, zinc phosphide, DDT, and the ultrasonic rodent repellers we tested are not effective in the control of little brown bats (Myotis lucifugus). We suspect that our data will prove applicable to most other temperate insectivorous bats. The discrepancy between the initial and subsequent testing of the zinc phosphide and the DDT with respect to bat mortality is clearly a function of the space to which the bats were confined. Powders will be generally ineffective against bats which roost from the tops of structures whatever doses are applied because the powders will accumulate on the floor.

Our results support those of other studies (KUNZ et al. 1977, BARCLAY et al. 1980) which indicate that pesticides are not very useful in bat control. Reduction of the chances of contact between bats and people requires rapid immobilization of the bats to minimize the number of individuals escaping from a treated colony. None of the poisons we tested acted quickly enough to accomplish this, even though the doses were applied were high and potentially more effective because of the confined spaces in which the bats were housed. The results of this study clarify the increased contact between bats and people after spraying (KUNZ et al. 1977, BARCLAY et al. 1980) in that DDT does not rapidly kill or immobilize bats.

It is not surprising that relatively high intensity ultrasonic sound does not repel bats such as little browns that echolocate given the intensity and frequency characteristics of their own vocalizations (GRIFFIN 1958). The results we obtained in this study and others which indicate that bats are attracted to the sounds of other bats (FENTON 1980) make acoustic approaches to bat control unlikely alternatives to other means such as lighting LAIDLAW & FENTON 1971) or sealing of access routes (BARCLAY et al. 1980).

The results of our study indicate that fenthion, zinc phosphide and DDT are not effective in the control of little brown bats and further application of these pesticides to colonies of bats is a useless and unnecessary contamination of the environment.

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