Trapping Flies with Acoustics

Artificial calling song attracts female Mediterranean fruit flies

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Fruit flies are common agricultural pests in most parts of the world. The polyphagous Mediterranean fruit fly *Ceratitis capitata* ("medfly") damages more than 250 different types of fruit including citrus as well as many deciduous and subtropical fruits. The common control schemes utilize ultra-low-volume aerial spraying of poison-bait mixture and scattering sterile males. Increased public awareness of the environmental threats from extensive pesticide usage has increased interest in the development of environment-friendly alternatives. Females, which cause direct damage to the fruit, are the main target for control. Attractants, especially for females, are efficient population control tools with reduced environmental impact.

Much of the search for medfly detection and control techniques are focused on mating behavior and sexual communication signals, i.e., chemical lures or shape and color cues, being efficient and highly selective.

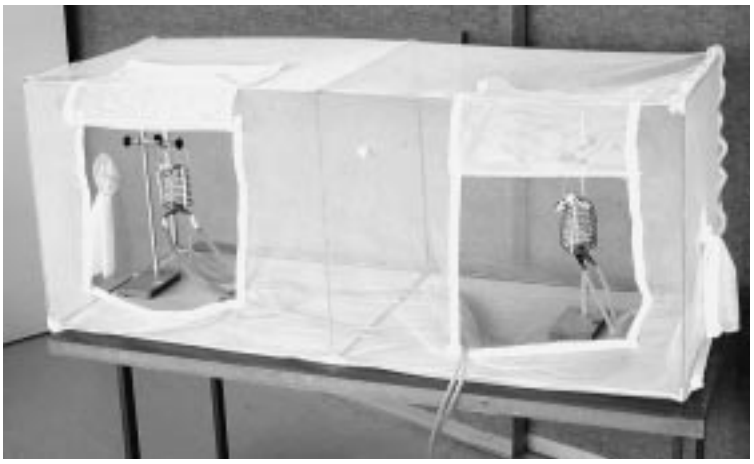
Medfly males produce three distinct sounds as part of their sexual communication ritual: 1) the calling song, produced simultaneously with pheromone emission and often in the absence of other flies in its immediate proximity; 2) the courtship song, an intermittent series of buzzes made when other flies are nearby; and 3) the copula song, a brief sound produced by males when they mount a prospective mate.

There have been only a few attempts to utilize male sounds, natural or artificial, to attract female fruit flies. The calling song — low amplitude vibrations at a frequency of ~350 hertz, has the potential to be utilized as an artificial female attractant. The objective of this study was to evaluate the attraction of mate-seeking female medflies to broadcasting recorded and synthetic sounds.

The behavior of female medflies was observed in an anechoic room with a controlled atmosphere. The laboratory tests were performed with three different sound sources: live calling song, played-back calling song, and synthetic tones. Prior to any intervention we observed the random spatial distribution of the female flies in the chamber.

Attraction of females to caged males in bioassay setup

In order to evaluate the impact of our bioassay conditions on the flies' activity we observed the natural attraction behavior in our experimental setup. Two techniques were employed: visual counting and capture of landing flies. The landing behavior of females in response to the presence of live medfly males calling song was examined in a screen chamber shown below. Two cylindrical net cages were placed at mid-height at the two opposite sides of the chamber. Round landing plates were placed next to each cage, with their planes parallel to the sidewall of the chamber. Five live male medflies were put in one cage, the other cage was left empty as a control, and 40 virgin laboratory females were then released at the center part of the chamber. Landings of female flies on the landing plates were observed during the morning and early afternoon periods of peak sexual activity. The number of landings was recorded every five minutes for one-hour period. The experiment was repeated five times with a fresh group of flies each time.



The net chamber is equipped with speaker attachments.

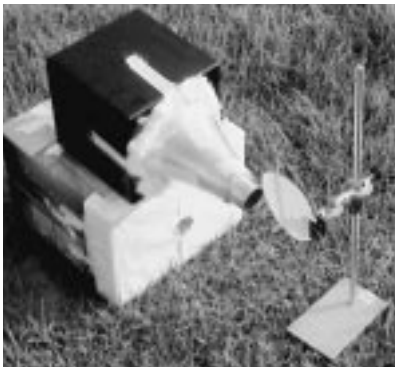
The second technique employed a modified electronic fly killer to capture the female flies approaching the confined males. The electronic zapper was modified by removing the UV bulbs and installing a cylindrical metal screen comprising of two double helices replacing the original screen. The cage was installed inside each helix and placed at mid-height inside the chamber on opposite sides. Five live male medflies were put into the cage, and 20 virgin females

were released in the center of the chamber. Females attracted to the calling males had to pass through the zapper wires, and were killed within 1 centimeter (.4 inch) from the screen.

Utilizing song and synthetic tones

Calling song playback and synthetic tone attraction bioassay were aimed to evaluate female attraction to prerecorded and synthesized sounds. Calling songs of a male medfly were recorded in an anechoic chamber at the USDA-ARS Center for Medical, Agricultural, and Veterinary Entomology. A 25-second segment of calling song recorded from an individual male was selected and played as a continuous loop using a 100-watt sub-mid-range 13-centimeter (5-inch) loudspeaker amplified with a 100-watt speaker amplifier and playback equipped with a sound funneling apparatus. Synthetic tones comprised of sine-wave signals at 150, 250, 350, and 450 hertz

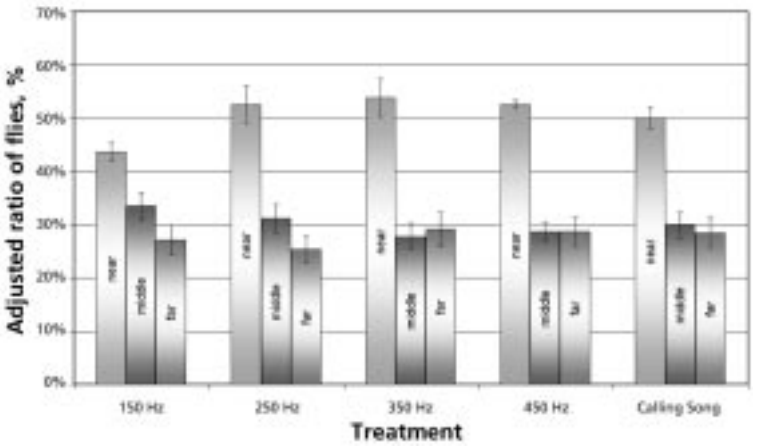
All tests were conducted in the net chamber furnished with two loudspeakers (one active and a dummy as control), one installed at each end of the cage. Round landing plates were placed perpendicularly in front of the speakers as shown below. Each experiment lasted two hours and involved 20 female flies, which were released in the middle of the chamber. The sound was turned on and off at 10-minute intervals at two intensities: 67 and 110 decibels. The experiments were repeated five times per day, and the flies were replaced daily. The length of the cage was virtually divided into three equal sections (referred to as "near" - the section closest to the active speaker, "middle," and "far"). Prior to each experiment, the distribution of the flies in the cage was sampled and recorded. During the playbacks of the tones, the number of flies in each virtual section of the cage was recorded every five minutes.



The speaker is equipped with a funnel.

Results and conclusion

With male flies confined to a net cage, 72.8 percent of the female flies were attracted to the presence of the male flies and landed within their proximity, while no landing was observed next to the empty cage at the opposite end of the chamber. When an electric zapper was employed, any fly passing within the vicinity of the device was shocked and captured. The mean capture rate of female medflies by the zapper next to the male cage was 47.4 percent, while only 9.1 percent were captured by the control zapper. This tendency was expected and conforms with similar results reported in the literature and used as an indicator that the chamber and the equipment do not interfere with natural behavior.



Adjusted average landing counts of wild female flies attracted by male calling song and by synthetic tones played at 110 decibel sound intensity; vertical bars delineate confidence limits of the mean value (_ = 0.05). (near – close to the active speaker).

After the installation of loud-speakers we observed an unexpected biased spatial distribution of fly landings in the control chamber, when no sounds were played, and the female flies significantly preferring the central section of the chamber. We were not able to explain this bias, therefore, we used this spatial distribution as our reference (baseline) and all further findings were accordingly adjusted.

It was observed that the female flies significantly prefer to land in the vicinity of the active speaker playing recorded calling song and artificial tones as demonstrated in the bar graph below.

Thus, it could be concluded that the experimental setup employed in this study had no influence on the expected behavior of flies and that the technique employed herein (now patent pending) can be used to attract female flies in order to monitor and control the fruit fly pest. R

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