COMPARISONS OF ACOUSTIC COURTSHIP SIGNALS IN WILD AND LABORATORY REARED MEDITERRANEAN FRUIT FLY *CERATITIS CAPITATA*

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A major concern in rearing insects for sterile release is the production of males that are sexually competitive with wild rivals. A means of achieving quality control is to first quantify sexual signals in wild insects and then monitor these signals in laboratory-reared individuals (eg. Boller & Chambers 1977). Male acoustic signals are important components of courtship and territorial defense in lekking tephritids (Sivinski & Burk 1988). The sexual repertoire of the male Mediterranean fruit fly, *Ceratitis capitata* (Wied.), includes three distinct sounds: 1) the calling song, produced simultaneously with pheromone emission and often in the absence of other nearby flies, 2) the approach song, an intermittent series of buzzes made when other flies are nearby, and 3) the precopulatory song, a brief sound produced by males when they mount a prospective mate (Webb et al. 1983). Females in captivity make the equivalent of the first two songs although their function is presently obscure.

We have on two occasions, April 1985 and 1987, recorded Mediterranean fruit flies in Guatemala City, Guatemala C.A. On the first of these occasions we obtained wild flies, reared from maggots in local coffee beans, and fertile laboratory-reared insects produced by the Moscamed Commission facility in San Miguel Petapa. On the second, both fertile laboratory-reared and irradiated sterile laboratory-reared flies from the above facility were recorded.

With our data we can make three comparisons pertaining to the quality of the Guatemalan medfly product: 1) the acoustic signals of wild flies versus those of flies reared in the laboratory for several generations, 2) courtship sounds of sterile flies (irradiated at 17 kR 48 h before eclosion) versus fertile laboratory-reared flies, 3) flies reared in the laboratory in 1985 versus those of the same genetic stock still in the laboratory in 1987. The insects, when recorded, were held in either groups of 10 or less, in 10 cm x 7 cm wire screen cylinders or in large numbers (>100) in 30 cm x 30 cm x 30 cm plexiglass and wire screen cages. A condenser microphone (Sony MTL-96, Sony Corp., New York, NY) was held approximately 1-2 cm from the dorsal surfaces of calling males and the sounds were recorded on a Nakamichi 550 cassette recorder Sounds were later analyzed with a Nicolet 660A fast Fourier analyzer (Nicolt Instrument Corp., Madison, WI). The examined sound parameters were fundamental frequency (peak frequency in the first harmonic bandwidth), first harmonic bandwidth (total range of frequencies about the mode created by the fundamental frequency), and percent waveform distortion (the proportion of energy in a sound that is contained in the first harmonic band; for more details see Webb et al. 1984). Due to imperfect recordings or small sample sizes, not all of these features were measured for each category of fly. Statistical analysis is by Duncan's multiple range test and *t*-test. All results are in Table 1.

There was a significant difference in the fundamental frequency of the calling song of wild males compared to those of both laboratory-reared males and females in 1985 ($P<0.05$). However, there were no differences among flies of the three groups in bandwidth or distortion of the song. The approach song of the wild male was also produced at a higher frequency than that of the laboratory-reared male ($P<0.002$). A possible contributing factor to the lower frequency of the reared flies was their notice-

TABLE 1. THE ± MEAN STANDARD ERROR AND NUMBER OF OBSERVATIONS ( ) OF VARIOUS ASPECTS OF THE CALLING AND APPROACH SONGS OF WILD AND REARED MEDITERRANEAN FRUIT FLY.

	Calling Song				
	Wild ♂	1985 reared fertile ♂	1985 reared fertile ♀	1987 reared fertile ♂	1987 reared sterile
Fundamental frequency	355±12.1 (14)	319±12.6 (23)	326±33.2 (9)	339.7±38 (30)	365.5±16.6 (14)
Bandwidth	82.7±11.7 (6)	81.2±22.9 (15)	64.3±17.4 (9)	108.7±34.9 (30)	127.328.3 (14)
Distortion	.43±0.1 (4)	0.47±0.1 (11)	0.56±.14 (7)	–	–
	Approach Song				
Fundamental frequency	195±24.5 (8)	167.7±10.4	– (6)	–	–

ably greater size. In *Anastrepha suspensa*, another singing tephritid, male size is negatively correlated to calling song frequency (Burk & Webb 1983, Webb et al 1984).

Fertile and irradiated flies that eclosed within a week of each other differed in fundamental frequency ($P<.003$) but not bandwidth. Note that the calling song frequency of irradiated males more closely resembles the higher frequency of the wild males' song.

Males from the same colony reared 2 years apart bore significant differences in the fundamental frequency ($P<.003$) and bandwidth ($P<.009$) of their calling song. The increased frequency in the later group is more similar to the song of wild flies.

In summary, there were some differences between song characteristics of wild and laboratory-reared males. but song characteristics appear to be relatively labile, bear large amounts of variance and are not exaggerated either by domestication or irradiation. If anything these two processes appeared to increase the resemblance of reared to wild flies. Information that a major courtship component is not necessarily drastically altered in sterile-released flies may be of some comfort to Mediterranean fruit fly breeders.

Obtaining this sort of data can be accomplished with commonly available electronics (tape recorders and microphones). While analyses such as ours require more sophisticated equipment, similar results can be obtained from a simple sonograph. Program personnel interested in including tests of acoustic signals in their quality control protocols might contact us (JCW) for advice.

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WITHIN-PLANT DISTRIBUTION OF *HELIOTHIS ZEA* (LEPIDOPTERA: NOCTUIDAE) EGGS ON STRAWBERRY

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The corn earworm, *Heliothis zea* (Boddie), prefers to oviposit on the flowering and fruiting stages of a wide variety of plant species (Hardwick 1965, Johnson et al. 1975). Eggs are placed directly on the flowers and fruit of some plant species (Nishida & Napompeth 1974, Latheef & Ortiz 1983), whereas on other species eggs are placed on foliage near flowers and fruit (Hillhouse & Pitre 1976, Alvarado-Rodriquez et al. 1982).

In coastal southern California, *H. zea* has been an occasional pest on strawberries, *Fragaria ananassa* (L.) (Oatman 1969, Wiesenborn et al. 1988). The objective of the present study was to determine the within-plant distribution of *H. zea* eggs on strawberry.

Adult *H. zea* were taken from a laboratory colony established 10 months (ca. 10 generations) earlier with larvae collected from sweet corn in Orange County, CA. Five male and 5 female newly-emerged adults were kept in each of eight 3.8 liter waxed-cardboard ice cream containers and fed 20% honey solution. Moths 3-7 days old were used to determine ovipositional preference when eggs were observed in all 8 containers.

Each of four 1.8 m long, 1.7 m wide, 1.8 m high nylon-mesh cages were placed over 10 "Chandler-Parker" hybrid strawberry plants at the University of California South Coast Field Station, Santa Ana, CA. Plants were at the phenological stage typically present when *H. zea* adults emerge from overwintering pupae and were arranged in two rows on a single raised bed covered with clear-plastic mulch. Ten male and 10 female moths were released into each cage at 6 p.m. PST and allowed to oviposit for 2 nights. Average air temperature was 16°C.

The acceptability of fruit vs. leaves, young leaves vs. old leaves, and upper vs. lower surface of leaves to ovipositing *H. zea* was compared with chi-square tests adjusted for small sample size (Sokal & Rohlf 1981). Flowers were not included, because oviposition did not occur on them. The number of eggs on each plant structure type in all cages