TRAPPING MALE ORIENTAL FRUIT FLIES (DIPTERA: TEPHRITIDAE): DOES FEEDING ON A NATURAL SOURCE OF METHYL EUGENOL REDUCE CAPTURE PROBABILITY?

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Males of the oriental fruit fly, *Bactrocera dorsalis* (Hendel), are strongly attracted to methyl eugenol (ME), a naturally occurring compound reported from ten different plant families (Metcalf 1990). Increasing evidence indicates that this attraction reflects enhanced competitiveness in sexual selection: males that feed on pure ME (Tan & Nishida 1996) or flowers containing ME (Shelly, unpublished data) or ME-like compounds (Nishida et al. 1997) have a pronounced mating advantage over unfed males. Control efforts take obvious advantage of this association, and traps baited with ME and insecticide have been used in numerous programs of "male annihilation" (Cunningham 1989). In fact, ME traps were successful in eradicating *B. dorsalis* from entire islands in the western Pacific (Steiner et al. 1965).

Despite its past successes, the effectiveness of this method is potentially constrained by at least two factors. First, individual males display variable levels of attraction to ME, and this variation appears to have a heritable component (Shelly 1997). Consequently, prolonged, low-level use of ME traps could select for non-responsiveness to the lure and thus inadvertently reduce the likelihood of eradication (Cunningham 1989). In addition, Shelly (1994) demonstrated that *B. dorsalis* males that fed on ME were less likely to be captured in traps than control males. Thus, the possibility exists that males that have located and fed on natural sources of ME will avoid ME traps, thereby hampering control efforts.

Here, I describe field experiments that examined whether males that fed previously on flowers of *Cassia fistula* L., which contain ME (Kawano et al. 1968), or flowers of *Fagraea berteriana* A. Gray, which contain ME-like compounds (Nishida et al. 1997), were less likely to be trapped in ME traps than control unfed males.

Flies used in all experiments were from a laboratory stock started with 300-400 adults reared from field-collected mangos. The colony was housed in a large screen cage (1.2 m by 0.6 m by 0.6 m) with superabundant food (a mixture of honey and protein hydrolysate) and water. Ripe papayas were provided periodically for oviposition. Room temperature was maintained at 20-22°C and 65-75% RH, and under these conditions generation time was about four weeks. The experiments were performed when the colony was 3-7 months old, and correspondingly the flies used were 3-7 generations removed from the wild. Sexes were separated within seven days of eclosion, well before reaching sexual maturity at 15-20 days (Foote & Carey 1987).

Males in the treatment category were exposed to flowers either one time only ("single feeding" trials; both plant species) or two times ("repeat-feeding" trials; *F. berteriana* only) prior to release. The single-feeding trials were conducted as follows. For *C. fistula*, flowering stems were removed from a tree growing near the laboratory, put in water, and then placed into screen cages (30 cm cubes). A total of 140-160 flowers was placed in a given cage. Flowers of *F. berteriana* were obtained commercially as leis (a Hawaiian necklace of flowers). Flowers were used on the day of purchase (presumed fresh), and 40-50 flowers were placed in each cage. Flowers of both plant species were placed in the cages at 0800 hr and immediately thereafter I introduced 50 males (22-26 days old) per cage (along with food and water). Males had been marked

one day earlier by cooling them for several minutes and then placing a dot of enamel paint on the thorax. Males were removed at 1500 hr and then transferred to 5-l plastic buckets with a screen top until release either one or seven days later. Although systematic observations were not made, most males moved onto the petals of both plant species and began licking them within minutes of being placed in the cage.

In the repeat-feeding trials, treated males were exposed to *F. berteriana* two days after the initial exposure following the same procedures as above. As in the initial feeding, most males quickly moved onto the flowers and began feeding. Trapping tests were run seven days after the second feeding of treated males.

For all trials, males in the control category were not given access to flowers prior to release and were isolated from the flower-containing cages to prevent exposure to floral volatiles. Control males were chilled and marked (with a different color) the same day and held under the same conditions as their counterpart treated males. Control males were approximately the same age as treated males upon release.

For a given test, groups of 200 control and 200 treated males were released between 0900-1000 hr at a large grassy lawn on the campus of the University of Hawaii at Manoa. Ten Steiner traps baited with 2 ml of ME (plus naled) were placed singly in trees in a circle (50 m radius) around a central release point. Traps were checked 72 h after release, and flies were examined individually in the laboratory for markings. Daytime temperatures ranged from 24-33°C during the releases. Ten releases were conducted for all experiments; trap catches were compared using a Mann Whitney test, a nonparametric analogue of the Student's t test (Zar 1996).

In the single-feeding experiment, the numbers of control and treated males captured did not differ significantly for releases conducted one or seven days after feeding by the treated males for either plant species (Table 1; $P > 0.05$ in all comparisons). Likewise for both plant species, the numbers of males (control and treated combined) did not differ significantly between releases conducted one and seven days after floral exposure to the treated males ($P > 0.05$ for both species). There was also no significant difference found between *C. fistula* and *F. berteriana* in the trap catches of treated males ($P > 0.05$; data combined over one and seven day intervals for each plant species).

In the repeat-feeding experiment, the mean numbers of control and treated males captured were not statistically different (Table 1; $P > 0.05$). There was also no evidence that repeat feeding on *F. berteriana* lowered capture probability; the mean number of treated males captured in single-feeding tests (performed seven days after floral exposure) was similar to that observed for treated males in the repeat-feeding tests.

TABLE 1. NUMBERS OF CONTROL (UNFED) AND TREATED (FED) *B. DORSALIS* MALES CAPTURED IN ME-BAITED TRAPS. MEANS ± 1 SD ARE PRESENTED; N = 10 IN ALL CASES.

			Post-feeding interval	
Plant	Feeding	Male type	1 day	7 days
C. fistula	Single	Control	45 (19)	42 (13)
		Treated	49 (15)	43 (11)
F. berteriana	Single	Control	53 (22)	42 (10)
		Treated	50 (18)	41 (15)
F. berteriana	Repeat	Control	—	45 (19)
		Treated	—	41 (15)

The present study provides no evidence that prior feeding on natural sources of ME or ME-like compounds affects subsequent trap capture of *B. dorsalis* males. This finding conflicts with that observed for males fed pure ME (Shelly 1994) and suggests that the reduced capture probabilities noted in that earlier study resulted from ingestion of an unusually high dose of ME. The present findings indicate that ME-bearing plants have only a minor effect (if any) on control efforts against *B. dorsalis*. However, additional tests using different plant species and perhaps longer or more frequent feeding opportunities are clearly needed to evaluate the robustness of the present results.

Summary

Field experiments were conducted to determine whether males of the oriental fruit fly, *Bactrocera dorsalis*, that fed previously on flowers of *Cassia fistula*, which contain methyl eugenol, or flowers of *Fagraea berteriana*, which contain methyl eugenol-like compounds, were less likely to be trapped in methyl eugenol-baited traps than control, unfed males. Results indicated that floral exposure had no significant effect on male capture probability in tests conducted one or seven days after flower-feeding by the treated males, respectively.

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References Cited

CUNNINGHAM, R. T. 1989. Male annihilation, pp. 341-351 *in* A. S. Robinson and G. Hooper (eds.). Fruit flies: their biology, natural enemies, and control, vol. 3B. New York, Elsevier.

FOOTE, D. H., AND J. CAREY. 1987. Comparative demography of a laboratory and a wild strain of the oriental fruit fly, *Dacus dorsalis*. Entomol. Exp. Appl. 44: 263-268.

KAWANO, Y., W. C. MITCHELL, AND H. MATSUMOTO. 1968. Identification of the male Oriental fruit fly attractant in the golden shower blossom. J. Econ. Entomol. 61: 986-988.

METCALF, R. L. 1990. Chemical ecology of Dacinae fruit flies (Diptera: Tephritidae). Ann. Entomol. Soc. America 83: 1017-1030.

NISHIDA, R. T., T. E. SHELLY, AND K. Y. KANESHIRO. 1997. Acquisition of female-attracting fragrance by males of the oriental fruit fly from a Hawaiian lei flower, *Fagraea berteriana*. J. Chem. Ecol. 23: 2275-2285.

SHELLY, T. E. 1994. Consumption of methyl eugenol by male *Bactrocera dorsalis* (Diptera: Tephritidae): low incidence of repeat feeding. Florida Entomol. 77: 201-208.

SHELLY, T. E. 1997. Selection for non-responsiveness to methyl eugenol in male oriental fruit flies (Diptera: Tephritidae). Florida Entomol. 80: 248-253.

STEINER, L. F., W. C. MITCHELL E. J. HARRIS, T. T. KOZUMA, AND M. S. FUJIMOTO. 1965. Oriental fruit fly eradication by male annihilation. J. Econ. Entomol. 58: 961-964.

TAN, K. H., AND R. NISHIDA. 1996. Sex pheromone and mating competition after methyl eugenol consumption in the *Bactrocera dorsalis* complex, pp. 147-153 *in* B. A. McPheron and G. J. Steck (eds.). Fruit fly pests: a world wide assessment of their biology and management. St. Lucie Press, Delray Beach, FL.

ZAR, J. H. 1996. Biostatistical analysis. Prentice-Hall, Upper Saddle River, NJ.