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MATING COMPETITIVENESS OF IRRADIATED MALES OF *CULEX TARSALIS* IN A FIELD CAGE STUDY[1]

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ABSTRACT. Adult male *Culex tarsalis* irradiated and released into large outdoor field cages at ratios (irradiated: unirradiated) of 1:1, 2:1, and 9:1 were expected to "sire" egg rafts with hatch rates (low hatch/high hatch) of 1:1, 2:1, and 9:1 based on a competitiveness value of 1.0. Male to female sex ratios were 2:1, 3:1, and 2:1, respectively, for each field cage release. The observed hatch rate ratios did not differ significantly from the expected values at each ratio, but the overall reduction in hatch was greater at higher ratios.

Gamma radiation has been used to sterilize male mosquitoes (Morlan et al. 1962, Davis et al. 1959, Ramakrishnan et al. 1962). Darrow (1968) exposed eggs, larvae and pupae of *Culex tarsalis* to gamma radiation to determine its effect on life span and relative fertility. Ainsley et al. (1980) determined that a dose of 5.0 kilorentgens (kR) from a 60-cobalt source achieved a sterility rate of more than 95% in adult male *Cx. tarsalis* and had little effect on survival or mating behavior. Ainsley and Asman (1979) found that the mating competitiveness of irradiated males in small laboratory cages was not significantly affected if the ratios of sterile to fertile males were increased. The present study evaluated the ability of irradiated male *Cx. tarsalis* to compete in large outdoor field cages at various ratios with unsterilized males from the same field population.

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METHODS

All mosquitoes were reared from wild pupae collected at Poso West, a study area near Bakersfield, CA (Nelson et al. 1978). A portion of adult males less than 24 hr old was exposed to gamma radiation produced by a Mevatron® linear accelerator at a rate of 250 R/min. The remaining males and females were separated within 24 hr of emergence to prevent mating prior to release. Releases of 3 to 4 day old individuals were made at Bakersfield in large outdoor field cages (Terwedow et al. 1977). Egg rafts were collected daily from pools in each cage, and held individually in 5 dram vials (72 hr) for determination of percent hatch and embryonation rate (McDonald et al. 1979).

The initial experiments had either a 1:1 ratio or a 2:1 ratio of males irradiated at 5.0kR to unirradiated males. In one cage, 800 irradiated males and 800 unirradiated males were released with 800 virgin females. In a 2nd cage, 1600 irradiated males and 800 unirradiated males were released with 800 virgin females. A 3rd cage contained 800 irradiated males and 800 virgin females.

The 2nd experiment had a 9:1 ratio of males irradiated at 6.0kR to unirradiated males. In one cage, 1800 irradiated males and 200 unirradiated males were released with 1000 virgin females. A 2nd cage contained 1500 irradiated males and 1500 virgin females.

Mating competitiveness was estimated by determining the ratio of the number of egg rafts "sired" by irradiated males (those with less than 50% hatch = low hatch) to that sired by unirradiated males (those with greater than 50% hatch = high hatch) after compensating for the release ratio (Ainsley et al. 1980). The chi-square statistic was used to compare the number of high hatch and low hatch rafts obtained with the number expected at the specified release ratio in the competition cages.

RESULTS

1:1 ratio. An equal number of low hatch egg rafts and high hatch egg rafts was obtained when equal number of irradiated and unirradiated males were released into a field cage. Low hatch rafts comprised 20 of the 45 collected (Table 1); this does not differ significantly from the expected ratio ($X_1^2 = 0.556$; $P = 0.46$). This represented a mating competitiveness value of 0.80 for the irradiated males.

2:1 ratio. When the number of irradiated males released was double that of unirradiated males, 67% of the egg rafts were expected to be low hatch. The results (Table 1) showed no significant difference ($X_1^2 = 0.010$; $P = 0.92$) between the numbers observed and the expected values. The estimated mating competitiveness of the irradiated males was 1.04.

9:1 ratio. Ninety percent of the egg rafts were expected to be of low hatch with a release ratio of 9 irradiated males to 1 unirradiated male. In the field cage, 36 of 39 rafts exhibited low hatch (Table 1). Again, the observed data did not differ significantly ($X_1^2 = 0.046$; $P = 0.83$) from the expected ratio, and the estimated male mating competitiveness was 1.33.

Irradiated controls. Males irradiated at 5.0kR had a mean hatch rate of 8.687 ± 7.557 (n = 156). Males irradiated at 6.0kR had a mean hatch rate of 20.514 ± 5.612 (n = 34), however 5 of the 34 rafts collected had hatch rates of 88 – 100%.

DISCUSSION

The observed ratios of high to low hatch egg rafts did not differ significantly from the expected values when release ratios of irradiated to unirradiated male

Table 1. Observed hatch rate and mating competitiveness of irradiated male *Culex tarsalis* at specific release ratios.

Release Ratio (1♂♂:U♂♂:U♀♀)	Irradiation Dose (kR)	Number of rafts Collected	No. of Egg Rafts with Hatch: Observed High	Observed Low	Expected High	Expected Low	Mating Competitiveness	Mean Hatch Rate
1:1:1	5.0	45	25.0	20.0	22.5	22.5	0.80	58%
2:1:1	5.0	40	13.0	27.0	13.3	26.7	1.04	37%
1:0:1	5.0	156	1.0	155.0	0.0	156.0	—	9%
9:1:5	6.0	39	3.0	36.0	3.9	35.1	1.33	13%
1:0:1	6.0	34	5.0	29.0	0.0	34.0	—	21%

Cx. tarsalis were 1:1, 2:1 or 9:1, but the overall reduction in hatch was greater at higher ratios. The estimated mating competitiveness of the 3 release ratios were 0.80, 1.04, and 1.33, respectively. Patterson et al. (1977) recorded a 50% reduction at a higher radiation dose in a 9:1 release ratio of *Cx. pipiens quinquefasciatus*. Our observations support the theory that the sterile male release technique becomes more effective as the ratio of sterile to fertile insects increases (Knipling et al. 1968).

The high hatch rafts present in the irradiated control cage of the 9:1 release might have been the result of incomplete irradiation of the males. The occurrence of an almost equal proportion of high hatch rafts in the irradiated control cage might tend to confirm this. It is also possible that a few inseminated females from a previous experiment were present in the cage at the time of the release. The only 2 rafts collected on the 1st day of sampling had 100% hatch which could reflect the presence of a few older, previously inseminated females.

Our results indicated that wild *Cx. tarsalis* males irradiated at the optimum dosage can compete successfully with unirradiated males for wild females in outdoor cages. It is also apparent that higher release ratios increase the proportion of low hatch egg rafts, enabling a greater potential for population reduction at higher release ratios.

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