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EFFECT OF IRRADIATION ON THE INCIDENCE OF MATING IN *CACTOBLASTIS CACTORUM*

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In the Sterile Insect Technique (SIT) (Carpenter et al. 2001; Hight et al. 2005) used against the cactus moth, *Cactoblastis cactorum* Berg (Lepidoptera: Pyralidae), an invasive species threatening native *Opuntia* in the US Southwest and Mexico, large numbers of laboratory-reared adult moths are sterilized with ionizing radiation at 200 Gy (Tate et al. 2007) and released to mate with wild adults. The radiation dosage used is sufficient to render the females completely sterile but leave the males partially fertile. Progeny of irradiated males are few, predominantly male, and completely sterile (Carpenter et al. 2001; Tate et al. 2007). Success of the SIT depends on several variables, including the competitiveness of irradiated moths and the mating frequency of each gender. Our objectives were to determine whether irradiation compromised the mating ability of the males and whether adults would mate more than once.

Two separate experiments were conducted to provide answers to these questions. In both experiments, adult males were irradiated with ^{60}Co in a Gammacell 220 irradiator at a dose of 200 Gy <24 hr after eclosion. All insects were held in 400 cc ventilated cardboard cages at 25°C, 14:10 D:N, and 70-80% RH, with a small piece of cactus cladode and were unmated and <24 h old when placed on test.

In the first experiment, to determine mating frequency in normal females, we conducted 2 tests with female *C. cactorum* resulting in a total of 41 females mated to control males and 39 mated to irradiated males. Females were caged individually with either 5 irradiated or 5 control males until they died. They were then dissected and the spermatophores in the bursa copulatrix were counted as an indicator of mating frequency. No significant differences were detected between the 2 tests in the first experiment and we combined the results.

In the second experiment, to determine mating frequency in the male, 3 or 4 virgin *C. cactorum* females were placed in a cage with 1 irradiated or 1 control male. Females were removed daily, dissected to count spermatophores, and replaced with virgin females until death of the male. A total of 17 control and 18 treated males were used.

In the first experiment, to determine mating frequency of individual females caged with multiple males, the 41 females mated to control males lived a mean of 5.80 ± 2.15 (mean ± SD) d and produced a mean of 0.90 ± 0.80 spermatophore. The 39 females mated to irradiated males lived a mean of 6.87 ± 2.36 d and produced a mean of 1.18 ± 0.79 spermatophores. Females caged with irradiated males lived longer than those paired with controls (t =-2.11, df = 78, P = 0.038) but numbers of spermatophores did not differ between the 2 groups (t =-1.56, df = 78, P = 0.12). In both groups, the range of spermatophores was 0 to 3, with modal values of 1. The distribution of spermatophores in the 41 females caged with control males was 14, 18, 8, and 1 females with 0, 1, 2, or 3 spermatophores, respectively. In the 39 females caged with treated males, the distribution was 6, 23, 7, and 3 females with 0, 1, 2, or 3 spermatophores. The most conspicuous difference in the distribution of spermatophores in the 2 groups was in the number that failed to mate (spermatophores = 0), however this difference was not significant (χ^2 = 2.27, df = 1, P = 0.13).

In the second experiment, to determine the mating frequency of males, 16 control and 16 irradiated males lived 6.45 ± 2.62 and 6.19 ± 2.07 d, respectively. These means were not different (t =-0.342, df = 31, P = 0.73). The number of spermatophores found in the bursa copulatrix of the females were 1.76 ± 1.52 and 1.25 ± 1.39, respectively. These means were not different (t = -1.101, df = 31, P = 0.32).

Control males lived from 2 to 11 d and irradiated males lived from 2 to 9 d. Number of spermatophores ranged from 0 to 5 in the controls and 0 to 4 in the irradiated males. Five matings appear to be the maximum for *C. cactorum* males, an observation also noted by McLean et. al. (2007). Three control and 1 irradiated male produced 2 spermatophores in each of 2 consecutive days, with 1 male of each treatment repeating this productivity after 2 d. Four controls and 2 irradiated males produced single spermatophores in each of 3 consecutive days, with 1 control male producing an additional 2 spermatophores after 1 d of rest. Two control males and 1 irradiated male produced single spermatophores in consecutive days, with 1 male from each treatment producing 1 more spermatophore on each of 2 consecutive days following 2 d with no spermatophores. Nine males, 3 control and 6 irradiated, produced no spermatophores.

No significant or consistent differences from controls were found in the mating ability of irradiated male *C. cactorum* or of normal females mated to irradiated males. Females were found to mate up to 3 times in a mean lifetime of 6 d (maximum of 10 d in females mated to controls and 13

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d in females mated to irradiated males), although a single mating was the mode in both groups. Males also lived about 6 d (maximum of 11 d in the controls and 9 d for the irradiated males). One irradiated male mated 5 times, though not on 5 consecutive days. Mating on 2 or 3 consecutive days was common, as was failure to mate at all. Low mating frequency in laboratory-reared *C. cactorum* has been a troublesome phenomenon (Dodd 1940; Marti & Carpenter 2008), but is evidently unrelated to radiation exposure.

Summary

No deleterious effects due to irradiation of male *C. cactorum* at 200 Gy were found, and no differences in mating frequency or longevity of irradiated male moths or of female moths mated to irradiated males were detected in our laboratory tests. Although many factors may influence the overall competitiveness of sterile insects released in a SIT program, we conclude that the irradiation (200Gy) of *C. cactorum* males used in the current SIT program does not adversely affect mating ability or frequency.

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