Effect of Gamma Radiation on *Biosteres longicaudatus* (Ashmead) (Hymenoptera: Braconidae), a Larval Parasitoid of *Dacus dorsalis* Hendel (Diptera: Tephritidae)

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ABSTRACT

Pupae of the oriental fruit fly, *Dacus dorsalis* Hendel, which had been exposed as larvae to the parasitoid, *Biosteres longicaudatus* (Ashmead), were subjected to 10 krad gamma radiation in nitrogen atmosphere on the eleventh day after parasitization. The irradiation treatment caused sterility in the adult parasitoids of both sexes.

Gamma irradiation slightly enhanced longevity of treated females when compared with untreated parasitoids. However, longevity of treated males decreased significantly.

The sterile insect and the augmentative parasitoid release techniques are two ecologically acceptable methods for the suppression of tephritid fruit fly populations in Hawaii (Wong et al. 1984). The integration of both suppression methods is proposed to be more effective and less costly than the use of either of these methods alone, or the use of insecticide sprays (E. F. Knipling, personal communication).

During the laboratory rearing of tephritid fruit fly parasitoids, over 50% of the host larvae exposed to parasitoids were unparasitized and produced pupae that eclosed to normal adult flies. This surplus of pupae could be sterilized and released with the parasitoids. However, information on the effect of radiation on parasitized pupae was lacking.

Therefore, this test was conducted to determine the effect of gamma radiation on the fertility and longevity of adult parasitoids, using the oriental fruit fly, *Dacus dorsalis* Hendel, and its primary larval parasitoid, *Biosteres longicaudatus* (Ashmead).

MATERIALS AND METHODS

Mature third instar larvae of the oriental fruit fly were exposed to the parasitoid *B. longicaudatus* for oviposition (Greany et al. 1976). On the eleventh day after oviposition (1-2 days before host flies eclose at 26 ± 2°C and 60 ± 10% RH), samples (ca. 200 each) from mixed parasitized and unparasitized puparia were subjected to a dose of 10 krad gamma irradiation in nitrogen atmosphere (Burditt and Seo 1971, Ohinata et al. 1977). This

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dose induced 99% sterility for treated oriental fruit flies (Wong et al. 1982). Examination of pupae at 10X magnification with transmitted light for the presence of parasitoid ovipositional scars facilitated the segregation of parasitized and unparasitized puparia (Nakagawa 1969). Before mating took place, eclosed adult parasitoids were segregated individually into transparent plastic cages which had undiluted honey smeared on screens at the top. Fertility tests were conducted by using 15 cohorts of each of the following groups: 1) untreated females with untreated males (UF × UM); 2) untreated females with treated males (UF × TM); 3) treated females with untreated males (TF × UM); 4) treated females with treated males (TF × TM); and 5) treated females alone (TF). These parasitoids were allowed to oviposit individually into mature third instar oriental fruit fly larvae (ca. 100 per oviposition unit), and notes on their progeny, longevity, and fertility were recorded. Data were analyzed by Student's t-test and analysis of variance, and means were separated ($P > 0.05$) with Duncan's multiple range test (SAS Institute 1982).

RESULTS AND DISCUSSION

In our test, dissection of 100 random samples of parasitized puparia on the eleventh day after oviposition revealed that 65% of the parasitoids were still fourth larval instars or prepupal stages, and 35% were pupae.

Adult parasitoids from treated *D. dorsalis* puparia emerged in 16 to 19 days, as did the untreated parasitoids. Also, treated females were seen to parasitize host larvae, but without producing offspring. Longevity and fertility results from mating tests are summarized in Table 1. These results showed that gamma radiation exposure produced complete sterility in males, and a considerable harmful effect on the fertility of females.

It was expected that by preventing oogenesis with gamma radiation the life span of the adult females would be prolonged, at the expense of nutri-

TABLE 1. Differential effect of 10 krad gamma radiation on males and females of *Biosteres longicaudatus* (Ashmead).

Treatment[a]	Longevity (days) Females[b] $\bar{X}$ ± SEM	Males[b] $\bar{X}$ ± SEM	Progeny of females
UF × UM	18.4 ± 1.1 b[c]	16.5 ± 1.4 a[c]	Both sexes
UF × TM	19.9 ± 2.0 b	9.8 ± 0.9 b	Males only
TF × UM	18.2 ± 1.8 b	15.5 ± 0.9 a	No progeny
TF × TM	19.9 ± 1.9 b	11.7 ± 0.9 b	No progeny
TF (no males)	25.4 ± 1.8 a	—	No progeny
F value (DF)	2.71(4)	8.39(3)	

[a]U = untreated, T = treated, M = males, F = female.
[b]Fifteen replicates per treatment.
[c]Means within a column followed by a same letter are not significantly different ($P < 0.05$, ANOVA; Duncan's multiple range test [SAS Institute 1982]).

tive materials normally reserved for ovulation. This phenomenon has been reported in several insects which were subjected to radiation (Azarian et al. 1965). Katiyar (1965) reported that with *Ceratitis capitata* (Wiedemann) treated with 10 krad on the seventh day of the pupal stage, there was a slight increase in longevity of males, and a great enhancement to the longevity of females, compared with untreated pupae. However, dosages greater than 20 krad reduced the longevity of emerged adults. Higher eclosion rates have been reported in *D. dorsalis* parasitoids that were subject to gamma radiation of host puparia in air (Balock 1965). However, Balock did not test either longevity nor fertility of treated parasitoids. From Table 1, longevity of treated males was significantly ($t = 4.82$; d.f. $= 58$; $P = 0.0001$) shorter than that of the untreated males. T-test analysis of data on treated and untreated virgin females showed a significantly greater longevity for the treated females ($t = 3.27$; d.f. $= 28$; $P = 0.0028$). However, the difference in mean longevity of treated females which were confined with males was not significant ($t = 1.32$; d.f. $= 58$; $P = 0.193$).

In summary, gamma radiation doses which sterilize flies will also sterilize their parasitoids. Sterile females of *B. longicaudatus* are ineffective as the host is killed in the pupal stage by the developing parasitoid larva.

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