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EFFECT OF UV RADIATION ON THE UZI-FLY, *EXORISTA SORBILLANS* WIEDEMANN, AN ENDOPARASITOID OF THE SILKWORM, *BOMBYX MORI* L.

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Abstract—In laboratory experiments, pupae of the uzi fly, *Exorista sorbillans* Wiedemann (Diptera: Tachinidae), an endoparasitoid of the silkworm, *Bombyx mori* L. (Lepidoptera: Bombycidae) were subjected to UV-irradiation for different durations. Upon adult emergence, irradiated and control flies were crossed in all possible combinations and allowed to parasitise healthy silkworms. Adult emergence, fecundity and longevity of the resulting progeny were recorded. Progeny of irradiated *E. sorbillans* showed significantly reduced adult emergence, oviposition period and hatchability. The reduction in fecundity was negatively correlated with the duration of exposure to UV radiation. The longevity of uzi flies of both the sexes was also significantly reduced.

Key Words: UV-irradiation, uzi fly, *Exorista sorbillans*, silkworm, *Bombyx mori* L., endoparasitoid

Résumé—Au cours des essais en laboratoire, des pupes de la mouche *Exorista sorbillans* (Diptera: Tachinidae), un endoparasitoïde du ver à soie, *Bombyx mori* L. (Lepidoptera: Bombycidae), ont été soumises à une irradiation aux rayons ultra-violets (UV) pour des durées différentes d'exposition. A leur émergence, les adultes des mouches irradiées et ceux du témoin étaient croisés par toutes les combinaisons possibles, puis laissés parasiter les vers à soie bien portants. On a pris note du taux d'émergence des adultes, de la fécondité et de la longévité des descendants issus des croisements. Il a été constaté que les descendants nés des sujets irradiés de *E. sorbillans* montraient une réduction significative du taux d'émergence des adultes, de la durée de ponte et du taux d'éclosion d'oeufs. La réduction de fécondité était négativement corrélée avec la durée d'irradiation aux rayons ultra-violets. La longévité était aussi significativement réduite chez les deux sexes.

Mots Clés: irradiation aux rayons ultra-violets, mouche, *Exorista sorbillans*, ver à soie *Bombyx mori* L., endoparasitoïde

INTRODUCTION

The ultra violet (UV) portion of the spectrum is generally used to kill germs and to attract insects (Bruce, 1975). Recently, investigators have considered the possibility of using UV rays to control or suppress various species of insects (Calderon et al., 1985; Islam et al. 1992; Faruki and Khan, 1993). Ultraviolet irradiation has been used successfully in Bangladesh to control the uzi-fly, *Exorista sorbillans* Wiedemann (Diptera: Tachinidae), a serious endoparasitoid of the mulberry silkworm, *Bombyx mori* L. (Lepidoptera: Bombycidae) (Jahan, 1993).This approach is preferable to using insecticides or chemosterilants, which are known to have some toxic effects on silkworms (Rahman, 1989; Kumar et al., 1990). UV-rays are generally less harmful to living organisms than the ionising radiations as they penetrate only the surface layer of cells (Islam et al., 1992).

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According to Bahari (1994), the selection of radiation dose is crucial to the success of insect control either by inducing sterility or mortality. A high dose of radiation affects an insect's competitiveness by reducing its ability to seek a native mate, and its sexual aggressiveness and vigour by affecting its longevity or disrupting the synchrony of its biological rhythms (Barlett et al., 1968; North and Holt, 1968; Proverbs, 1969; Van Streenyk et al., 1979; LaChance, 1985; Tsubaki and Bunroongsook, 1990; Hasan, 1995).

The present study was conducted to determine the effect of UV radiation on the reproductive ability and life cycle of *E. sorbillans* irradiated as pupae.

Materials and Methods

Healthy pupae of *E. sorbillans* were collected from the stock culture maintained at the Entomology Laboratory, Institute of Biological Sciences, University of Rajshahi. A 15W germicidal lamp, GE15T8 measuring 20 x 4 cm, was the source of radiation, emitting at a wavelength of 254 nm. Three-day-old pupae were irradiated with UV rays for different periods, viz 2, 4, 8 and 10 minutes. Forty-five *E. sorbillans* pupae in 7-cm diameter Petri dishes placed 12 cm from the lamp were used for each treatment with three replications. Equal numbers of untreated males and females of similar age as those of treated batches were maintained at the laboratory as controls and for crossing.

The irradiated pupae were kept separately in wire- mesh cages (25 x 25 x 25 cm). When the adult flies emerged, they were sexed using sexually dimorphic characters. For crossing, five pairs of males and females were introduced into 500 ml beakers covered with fine mosquito net secured with rubber bands.

The flies were crossed as follows:

- Untreated male (UM) x Untreated female (UF);
- Irradiated male (IM) x Irradiated female (IF);
- Irradiated male (IM) x Untreated female (UF); and
- Untreated male (UM) x Irradiated female (IF).

The flies were supplied with a 10% glucose solution soaked in cottonwool placed on the mosquito net (Kumar et al., 1990). Thirty fifth-instar silkworms were provided in the beakers as hosts. Silkworm larvae were replaced every 24 h until all *E. sorbillans* females died. The parasitised *B. mori* larvae were examined daily and the number of eggs laid by *E. sorbillans* females recorded. The infested larvae were reared in separate rearing trays in a wire-netted rearing cabinet to avoid further parasitisation. Hatching of the eggs was recorded daily by counting the black scars on the host's body. Observations were also made on oviposition period, reproductive potential, adult emergence and longevity of *E. sorbillans*. All experiments were conducted at 30 ± 3° C and 75% RH.

Data were analysed and plotted using the software packages *Minitab Inc.* and *Fig-P*, respectively. To investigate whether there were differences in the mating performance of treated and untreated flies the null hypothesis, H_0: $(T_1 + T_2)/2 = T_3$, where T_1= mean of untreated batch (UM x UF), T_2= mean of irradiated batch (IM x IF) and T_3= mean of crossing group, i.e. UM x IF or IM x UF) was tested (Ray, 1982).

Results and Discussion

Adult emergence of UV-irradiated uzi-fly pupae decreased significantly ($P < 0.001$) as the period of exposure increased (Fig. 1). Similar reduction in adult emergence of gamma- irradiated pupae of *E. sorbillans* has been reported by Kumar et al. (1990). The failure to emerge is usually used to record overall pupal mortality. Irradiation of the pupal stage often disrupts important physiological processes, causing gross physical malformations (Tilton and Brower, 1983).

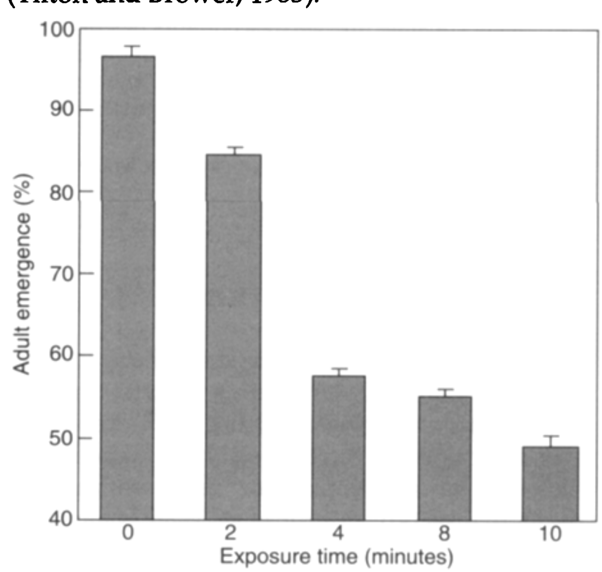

Fig. 1. Recovery (%) of *Exorista sorbillans* adults from 3-day old UV-irradiated pupae

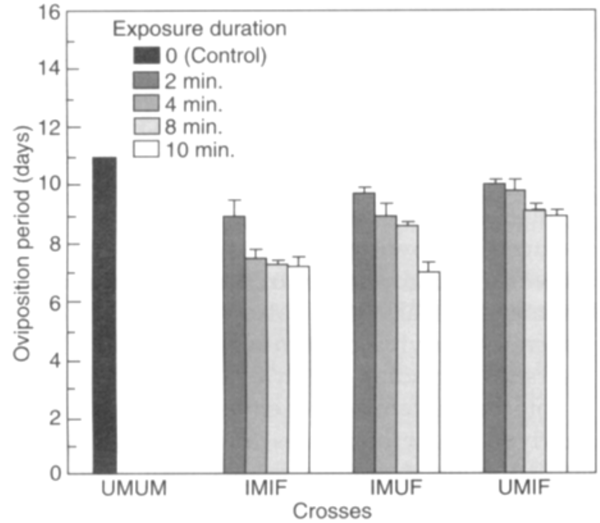

Fig. 2. Oviposition duration of progeny of UV-irradiated *Exorista sorbillans*. Bars within different crosses followed by the same letters are not significantly different by Tukey's multiple comparison procedure.
UM, UF, IM, IF = untreated male, untreated female, irradiated male, irradiated female, respectively.

The oviposition period of *E. sorbillans* was significantly ($P < 0.001$) shortened as the period of irradiation was increased in all the crosses as compared to the control batch (Fig. 2). However, the cross between irradiated male and untreated female showed a longer oviposition period in all the exposure times compared to some crosses (Fig. 2). Such changes in the synchrony of biological rhythms between irradiated and untreated insects may be disadvantageous if the F_1 sterility technique were to be used (Bahari, 1994). Genetic damage, such as radiation-induced translocations, probably also decreased the reproductive rate among the progeny of irradiated males. Such gene and chromosomal mutations would probably account for the observed heterogeneity of the percent egg hatch of F_1 progeny. Progeny unaffected by such mutations have normal reproductive rates whereas genes and chromosome mutations are transmitted to progeny that die or that have reduced fertility, resulting in their rapid elimination (Amoako-Atta et al., 1978).

Table 1 shows the effect of UV irradiation on the reproductive potential of *E. sorbillans*. Fecundity was gradually suppressed with increased duration of exposure ($P < 0.001$) (Table 1). Female progeny of IM x IF produced fewer eggs than that of UM x UF. LaChance et al. (1975) reported similar results for adults of the pink bollworm. Reduced fecundity in *E. sorbillans* was probably due to both reduced transfer of active sperms by irradiated males to untreated females and limited production of oocytes in the irradiated females. Irradiation may also influence the quality and transfer of sperm. The highest and lowest fecundity was recorded for the offspring of IM x UF and UM x IF at the exposure time of 2- and 10-minutes respectively.

Table 1. Effect of UV radiation on the fecundity and hatchability of *Exorista sorbillans*

Exposure duration (minutes)	Crossing schedule	Oviposition[1]			Percent hatchability		
		Mean ± SE	% reduction[2]	CPV*	Mean ± SE	% reduction[2]	CPV*
2	UM x UF	373.55 ± 23.80 a	–	–	96.97 ± 2.37 a	–	–
	IM x IF	263.61 ± 12.97 b	29.43	–	66.77 ± 9.55 b	31.14	–
	IM x UF	307.79 ± 10.50 c	17.60	5.17	58.44 ± 5.87 b	39.73	66.96***
	UM x IF	292.26 ± 11.70 c	21.76	11.64***	63.97 ± 5.10 b	34.03	58.53***
4	UM x UF	373.55 ± 23.80 a	–	-	96.97 ± 2.37 a	–	–
	IM x IF	234.92 ± 12.70 b	37.11	–	60.80 ± 5.52 b	37.30	–
	IM x UF	285.70 ± 8.08 c	23.32	10.74***	54.51 ± 4.19 b	45.89	148.15***
	UM x IF	296.90 ± 14.95 c	20.52	2.67***	58.02 ± 5.32 b	40.17	97.36***
8	UM x UF	373.55 ± 23.80 a	-	-	96.97 ± 2.37 a	-	-
	IM x IF	228.79 ± 23.05 b	38.75	-	50.08 ± 4.03 b	48.36	-
	IM x UF	277.57 ± 9.88 c	25.69	8.52***	43.92 ± 3.25 c	54.70	284.69***
	UM x IF	245.66 ± 18.88 b	34.23	12.42***	47.24 ± 4.76 bc	51.28	165.97***
10	UM x UF	373.55 ± 23.80 a	-	-	96.97 ± 2.37 a	-	-
	IM x IF	219.90 ± 17.86 b	41.13	-	46.40 ± 4.14 b	52.15	-
	IM x UF	278.28 ± 16.46 c	25.50	5.31	40.89 ± 2.72 c	57.83	345.09***
	UM x IF	169.92 ± 11.08 d	54.51	49.90***	36.78 ± 2.21 c	62.07	491.29***

UM-Untreated male, UF-Untreated female, IM-Irradiated male, IF-Irradiated female; *CPV—Contrast Probability Values (Ray, 1982); ***= $P < 0.001$. Means in a column within an exposure duration followed by the same letter are not significantly different by Tukey's multiple comparison procedure (Hintz, 1990). [1] No. of eggs per female per day. [2]% reduction in eggs relative to control.

For all exposure periods, UV irradiation significantly reduced the hatchability of *E. sorbillans* eggs. The lowest hatchability was observed at 10-minute exposure. None of the irradiation doses used in the present investigation induced complete sterility in the flies. However, the contrast probability values for both the fecundity and hatchability showed significant results which indicate differences in the mating performance of treated parents compared to untreated ones (Table 1). These results support the findings of Kumar et al. (1990) who observed reduced egg hatchability in adults of *E. sorbillans* resulting from gamma-irradiated pupae. Knipling (1970) suggested that reduced hatchability resulting from chromosomal translocations and other effects of ionising radiation could be used to control insects of economic importance. It is possible that UV radiation produces chromosomal translocation in the uzi-fly. Future work is suggested along these lines.

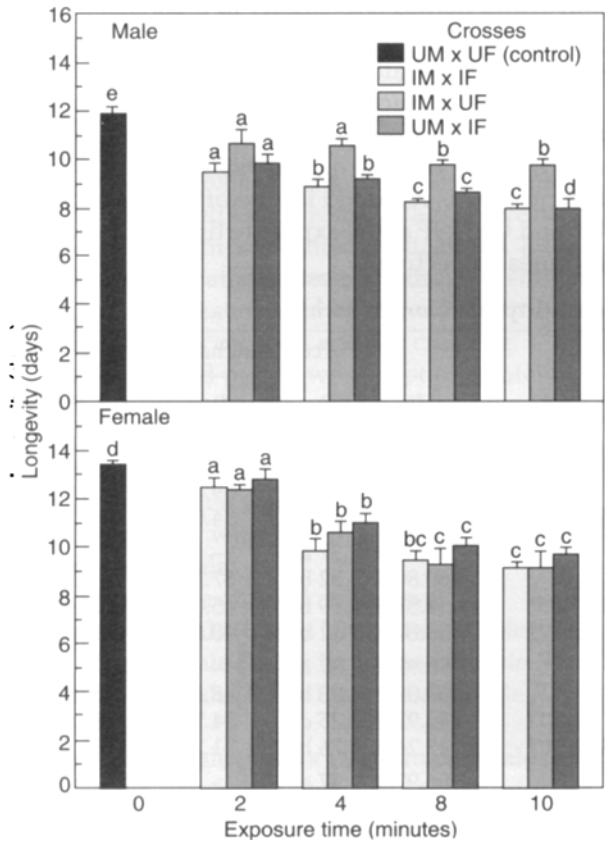

Fig. 3. Longevity of progeny of UV-irradiated *Exorista sorbillans*. Bars belonging to a particular cross followed by the same letters are not significantly different by Tukey's multiple comparison procedure.
UM, UF, IM, IF = untreated male, untreated female, irradiated male, irradiated female, respectively.

Insect longevity may affect competitiveness and indeed, longevity has been used to measure sexual aggressiveness (Baumhover, 1965). However, several factors may affect longevity and it is questionable whether it is a satisfactory measure of an insect's 'fitness'. The longevity of adult *E. sorbillans* was significantly ($P < 0.001$) reduced following UV irradiation (Fig. 3). However, no consistent trends were observed. Bhatnager et al. (1965) also observed a dose-dependent survival pattern in the house fly, *Musca domestica* L. irradiated with X-rays. It is interesting to note that the female progeny of irradiated pupae survived longer than males in all the crosses. Benz (1970) obtained similar results with *Zeiraphera diniana*.

The present findings also showed a relationship between the fecundity and longevity of adult *E. sorbillans* resulting from UV-irradiated pupae. Baumhover (1965) suggested that reduced longevity in irradiated male screwworm flies *Cochliomyia hominivorax* (Coquerel), may indicate that they were sexually more aggressive than unirradiated flies. If this hypothesis is correct, a reduction in the longevity of irradiated male *Stomoxys nigra* is compensated by an increase in their sexual efficiency (Ramsamy, 1977). A similar trend could be expected in the uzi fly.

The present results showed that none of the UV doses tested was able to induce complete sterility in *E. sorbillans*. The progeny of uzi flies subjected to UV-irradiation as pupae might be useful in the 'sterile insect' technique. However, further research under laboratory and field conditions is necessary.

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