Radiobiology of the Sheep Biting Louse (Mallophaga: Trichodectidae)[1]

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ABSTRACT

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The LD_{50} for variously aged eggs of *Bovicola ovis* (Shrank) exposed to gamma irradiation ranged from 0.34 to 51.23 krad. The eggs were progressively more resistant with increasing age. Treatments also resulted in reduced egg production by subsequent females and malformed testes in subsequent males.

Wolfenbarger and Mangum (1972) observed that both sexes of the pink bollworm, *Pectinophora gossypiella* (Saunders) were sexually sterilized when the young eggs were exposed to gamma irradiation (4–8 krads). Blusat (1974) found that gamma irradiation (0.96–1.12 krads) at the beginning of segmentation of the egg of the Colorado potato beetle, *Leptinotarsa decemlineata* (Say), had little effect, but that similar irradiation after segmentation resulted in larval mortality and sterile imagos. Geigy (1931) observed that fruit flies, *Drosophila melanogaster* Meigen, developing from eggs exposed to certain doses of ultraviolet radiation, had grossly underdeveloped sex glands.

We, too, observed that eggs of *Bovicola ovis* (Shrank) could give rise to adult males without testes if they were treated with gamma irradiation. We therefore extended our investigation of the radiation biology of the sheep biting louse by irradiating eggs and observing the effects on egg mortality, on egg productivity, and on the testes development of subsequent adults.

Materials and Methods

Eggs were collected from an in vitro laboratory colony of *B. ovis* reared at 37°±1.5°C and 74±3% RH. Lice were fed a diet of organosoluble extract of raw wool and dehydrated veal (Hopkins et al. 1976), and bundles of mohair were provided as oviposition sites. Since the bundles were changed every 24 h, all indicated ages of eggs reported herein were ±0.5 day. For tests, duplicate groups of 25 eggs were placed in plastic cups and irradiated when 0.5–8.5 days old with 0.93–70 krad from a ^{137}Cs gamma source (rate of 1.85±1% krad/min). Unirradiated eggs (eggs began hatching when 9 days old) were used as controls. After irradiation, the groups of eggs were placed with diet in 0.5-dr glass shell vials and held at the rearing conditions. Attempts were made to rear all resulting nymphs to the adult stage.

In the tests of mortality of eggs, the numbers of eggs that hatched in each vial were recorded, and the percentage inhibition of hatch (100 − (% hatch in test ÷ % hatch in control × 100)) was determined. In colonies of *B. ovis*, we found sex ratios are not consistent and are usually unbalanced in favor of females (unpublished data); therefore, we did not evaluate the data on mortality on the basis of sex. Data were subjected to probit analysis to determine the LD_{50}'s for eggs of particular ages. At least 3 dosages of irradiation were tested with each age of eggs, and 48–50 eggs were irradiated at all dosages that resulted in inhibition. Values resulting from probit analyses were significant at the 5% level.

In the tests of damage to testes, we dissected from 4th-instar males that developed from irradiated eggs and classified the testes as follows (see Fig. 1): Type I = control, i.e., 1 bilobed pair (sometimes with 3 lobes instead of 4), Type II = 2–4 enlarged lobes of atypical conformation, Type III = lobes reduced in size and of atypical conformation, and Type IV = vas deferens only slight enlarged at the typical location of the testes.

Six- to 8-day-old females from treated eggs were placed with untreated males at a ratio of at least 1 male/female. After 7–12 days, the numbers of live lice were recorded, and eggs were collected, counted, and held at least 10 more days. The number of hatched eggs was then recorded. From these data, reductions in productivity and hatchability of the eggs was determined.

Results and Discussion

Results (Table 1) show that eggs of *B. ovis* became increasingly resistant to lethal effects of gamma rays with increasing age. Eggs irradiated just prior to hatching (8.5 days old) were ca. 150× more resistant to the treatment than those irradiated when they were 0.5 days old.

Development of testes was also affected by irradiation (Table 2). When eggs 3.5 days old or less were irradiated, testes of type I or II (see Fig. 1) generally resulted. When eggs 4.5 days old or more were irradiated, testes of types III or IV generally resulted (see Fig. 1).

Table 3 shows the egg production of females that survived well (> 79% survival at 6 days). Egg production of females that developed from eggs treated at 2.5 days old or less was not affected though fertility was sometimes reduced. Females did not produce eggs when they developed from eggs treated at 3.5 days of age or older.

A review of the literature strongly suggests that polar bodies and their functions are involved, but from our observations we do not have proof that they are; therefore, we are reporting only gross effects of the treatments. Indepth studies at the cellular level would perhaps reveal the physiology involved.

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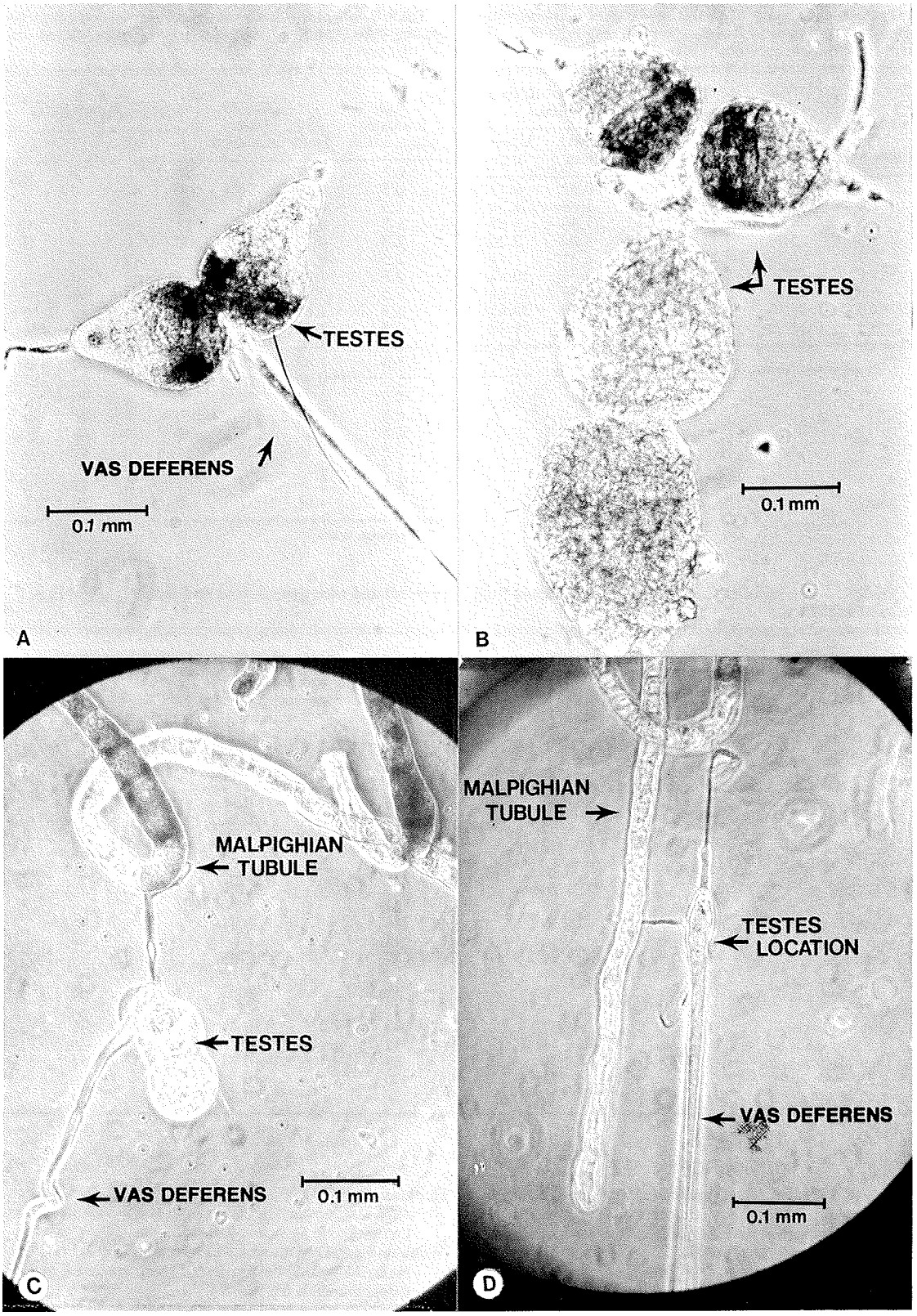

FIG. 1.—Types of testes resulting in 4th-instar *B. ovis* after irradiation of the egg. Descriptions in text.

Table 1—Summary of probit analyses of mortality data resulting from gamma irradiation of *B. ovis* eggs of particular ages (48–50 eggs/treatment).

Irradiated at age (days ±0.5)	LD_{50} krad	Slope	Intercept	95% confidence level	
				Lower limit	Upper limit
0.5	0.34	3.00	6.41	0.31	0.37
1.5	1.54	10.69	3.01	1.48	1.58
2.5	1.57	5.75	3.87	1.48	1.65
3.5	3.13	7.45	1.31	3.00	3.26
4.5	6.73	6.11	- 0.06	6.31	7.14
5.5	10.2	5.29	- 0.34	9.55	10.87
6.5	18.2	9.04	- 6.39	17.53	18.84
7.5	29.16	8.05	- 6.79	27.76	30.61
8.5	51.23	9.64	-11.47	49.43	52.99

Table 2.—Types of testes (descriptions in text) observed among 4th-instar *B. ovis* arising from eggs irradiated with gamma rays.

Age irradiated (days ±0.5)	Avg krads	No. 4th instars examined	% with indicated type[a] testes			
			I	II	III	IV
0.5	0.27	17	100	0	0	0
0.5	0.43	20	60	40	0	0
1.5	0.48	33	42	55	3	0
1.5	0.77	18	17	78	5	0
2.5	0.17	18	100	0	0	0
2.5	0.85	15	53	47	0	0
2.5	1.30	2	0	0	0	100
3.5	0.93	54	46	4	50	0
3.5	1.67	16	44	56	0	0
4.5	2.12	25	4	0	72	24
4.5	3.76	7	0	0	71	29
5.5	1.58	25	0	0	100	0
5.5	2.99	25	0	4	76	20
5.5	4.77	24	0	0	96	4
6.5	3.44	38	0	0	100	0
6.5	6.17	9	0	0	89	11
7.5	2.15	28	4	0	96	0
7.5	4.12	10	0	0	90	10
8.5	2.18	12	25	0	67	8
8.5	4.01	7	0	0	29	71

[a] Descriptions in text.

Table 3.—Egg production of female *B. ovis* arising from eggs irradiated with gamma rays and hatchability of eggs the females deposited.

Age eggs irradiated (days ±0.5)	Tests in which > 79% of adult ♀ survived > 6 days	At the end of test		
	Dosage (krad)	No. ♀ in test	No. live ♀	Avg no. eggs/live ♀/day	% hatchability
0.5	0.5	6	6	0.38	62
control	0	15	14	0.32	68
1.5	0.84	4	4	0.32	22
control	0	15	13	0.28	65
2.5	0.90	10	8	0.34	21
control	0	20	19	0.40	52
3.5	1.85	4	4	0	—
control	0	19	19	0.41	50
4.5	2.59	13	12	0	—
control	0	20	19	0.36	60
5.5	3.25	7	7	0	—
control	0	52	51	0.53	68
6.5	2.59	18	17	0	—
control	0	51	49	0.47	61
7.5	3.85	13	12	0	—
control	0	39	39	0.37	67
8.5	3.52	11	10	0	—
control	0	29	28	0.42	63

REFERENCES CITED

Blusat, R. 1974. Effets de l'irradiation γ des oeufs de *Leptinotarsa decemlineata* Say (Coleoptera, Chrysomelidae) sur le développement larvaire et la fécondité des adultes. Ann. d'Embryol. Morph. 7: 395–406.

Geigy, R. 1931. Action de l'ultra violet sur le pole germinal dans l'oeuf de *Drosophila melanogaster*. Rev. Suisse Zool. 38: 187–288.

Hopkins, D. E., W. F. Chamberlain, and A. R. Gingrich. 1976. Mallophaga: In vitro testing of artificial diets. Ann. Entomol. Soc. Am. 69: 538–40.

Wolfenbarger, D. A., and C. L. Mangum. 1972. Fertility of moths of pink bollworm reared from irradiated eggs. J. Econ. Entomol. 65: 919–21.