CHAPTER IV

RESULTS

4.1. Effects of Gamma Radiation Applied to Parental Adult Males on Reproduction of P_1, F_1, F_2 and F_3:

Male adults (less than 24 hours) were irradiated with 10, 15 and 20 krad of gamma radiation and mated with normal females. The resulting males of each generation (male line) were used for mating normal females throughout three successive generations (F_1, F_2 and F_3).

The biological aspects studied were the number of eggs/mated female, % egg hatchability, mating frequency, % mated females with sperms and number of spermatophores/ mated female.

4.1.1. Number of eggs/mated female (Fecundity):

The effect of gamma dose on the female fecundity in the different generations is given in Table (1) and Figs. (1 and 2). The data show that the average number of deposited eggs per a parental female was reduced by increasing the dose of gamma radiation applied to P_1 males. However, the reduction was not significant when males were irradiated with 10 and 15 krad, whereas, it was significant at 20 krad.

The fecundity among F_1 generation was also reduced by increasing dosage applied to P_1 males. Statistical analysis showed that there were a significant differences between untreated control and all tested doses, however, the differences in egg production were not significant among

TABLE (1): Effects of irradiating parental male *Spodoptera littoralis* with substerilizing doses on the fecundity and hatchability of parents (P_1) and their F_1, F_2 and F_3 progeny. (18 pairs were used in each treatment).

Generation	Dose to P_1 male (krad)	No. of eggs/mated female	% Hatchability
P_1	0.0 Control	1561 a	80.3 a
	10.0	1291 a b	71.3 b
	15.0	1343 a b	66.2 b
	20.0	1101 b	62.2 b
F_1	0.0 Control	1340 a	80.7 a
	10.0	903 b	40.7 b
	15.0	803 b	38.1 b
	20.0	894 b	37.5 b
F_2	0.0 Control	1271 a	82.7 a
	10.0	1028 b	46.4 b
	15.0	923 b	34.9 b
	20.0	1148 a b	40.6 b
F_3	0.0 Control	1267 a	82.7 a
	10.0	1166 a b	80.2 a b
	15.0	1066 a b	77.6 b
	20.0	1125 a b	75.4 b

Means followed by the same letter in each column for each generation are not significantly different at 5% P.

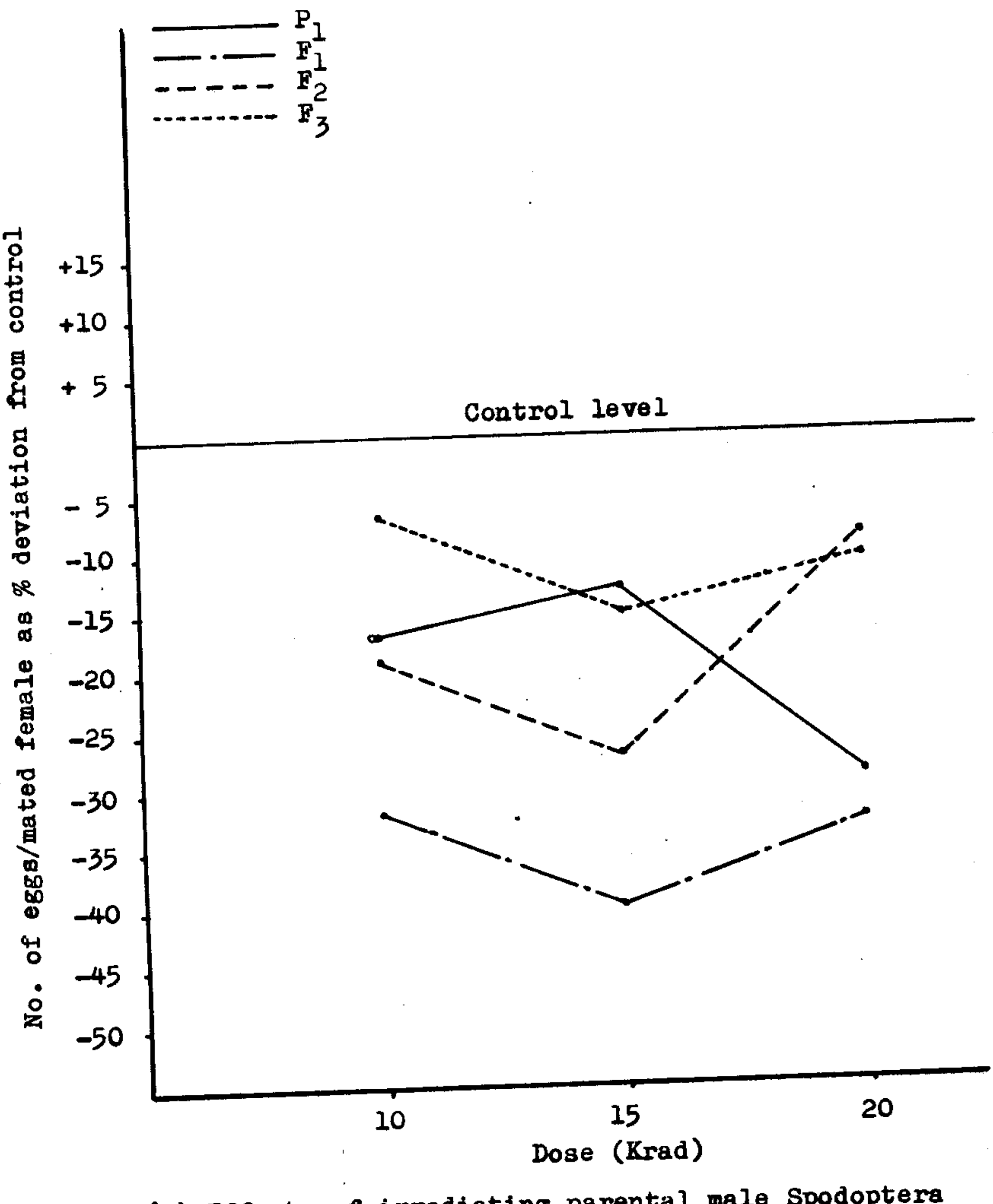


Fig.(1) Effects of irradiating parental male <u>Spodoptera littoralis</u> with substerilizing doses on the fecundity of parents and their F_1, F_2 and F_3 progeny.

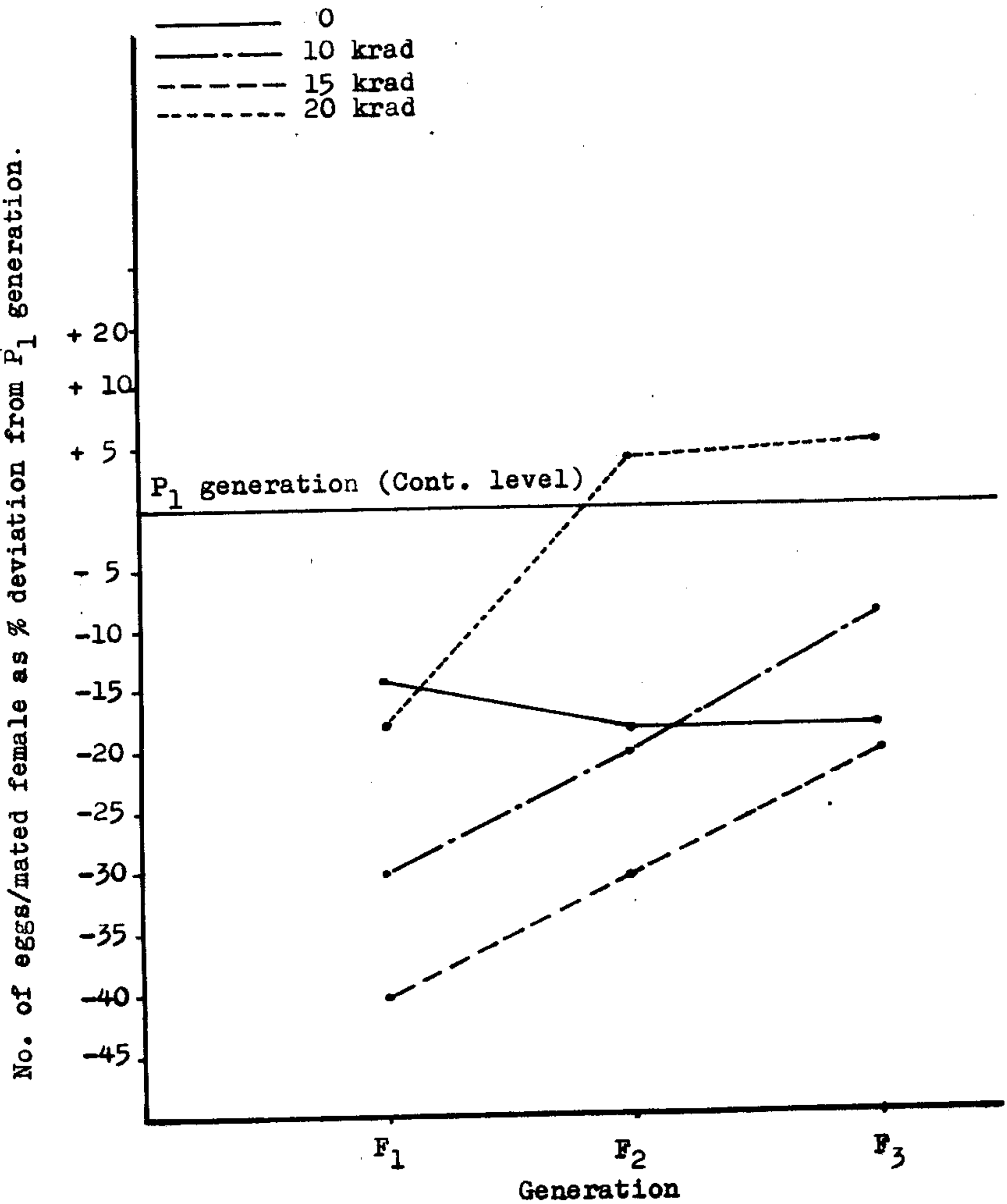


Fig.(2): Effects of irradiating parental male *Spodoptera littoralis* with substerilizing doses on the fecundity of F_1, F_2 and F_3 progeny related to their parents.

the three tested doses.

The number of eggs laid by normal females mated with F_2 males showed the same trend as in F_1 generation. The fecundity of F_3 generation was slightly affected at all tested doses, however, the differences were not significant when compared with the control.

The data also indicate that the number of deposited eggs per normal female among the successive generations was reduced when compared with P_1 generation. At 10 krad, level, the fecundity was significantly reduced through F_1 and F_2 generations. However, the reduction in F_3 generation was not significant. At the dose level 15 krad the number of eggs per female among F_1, F_2 and F_3 generationswas significantly different from the P_1 generation. However, at the dose level 20 krad the number of eggs per female did not show any appearant effect among the three successive generations F_1, F_2 and F_3.

Generally, the greatest reduction in number of eggs laid per female was observed in F_1 generation at the three tested doses applied to P_1 males. The reduction in fecundity increased as the dose applied to P_1 males was increased. However, the least reduction was shown in the F_3 generation.

4.1.2. Hatchability of eggs:

Table (1) presents the effect of 10, 15 and 20 krad applied to P_1 males on the viability of the eggs produced by normal females among the P_1 and the first three successive generations. These results are illustrated graphically in Fig. (3). The data indicate that the hatchability was reduced gradually by increasing the dose of radiation applied to the parental male. The reduction was significant at any dose level tested, compared to the control treatment. However, there were no significant differences among the tested doses.

Hatchability among F_1 was reduced than that of P_1 generation (Fig. 4). Viability of the eggs of F_1 was reduced to 40.7, 38.1 and 37.5 at 10, 15 and 20 krad, respectively. Again, the reduction in egg hatch of F_1 generation increased as the radiation dose applied to P_1 males was increased. However, there were no substantial differences at any dose level tested.

The viability of eggs laid by normal females mated with F_2 males showed the same trend which was noticed in F_1 generation. The results on hatchability in F_3 generation indicate that an obvious increase in egg hatch occurred at all tested doses, compared to F_1 and F_2 generations, where the % egg hatch of 0, 10, 15 and 20 krad treatments were 82.75, 80.21, 77.66 and 75.43, respectively. These results indicate that recessive lethals of irradiation continue in the population through F_1 and F_2 generations and to much less

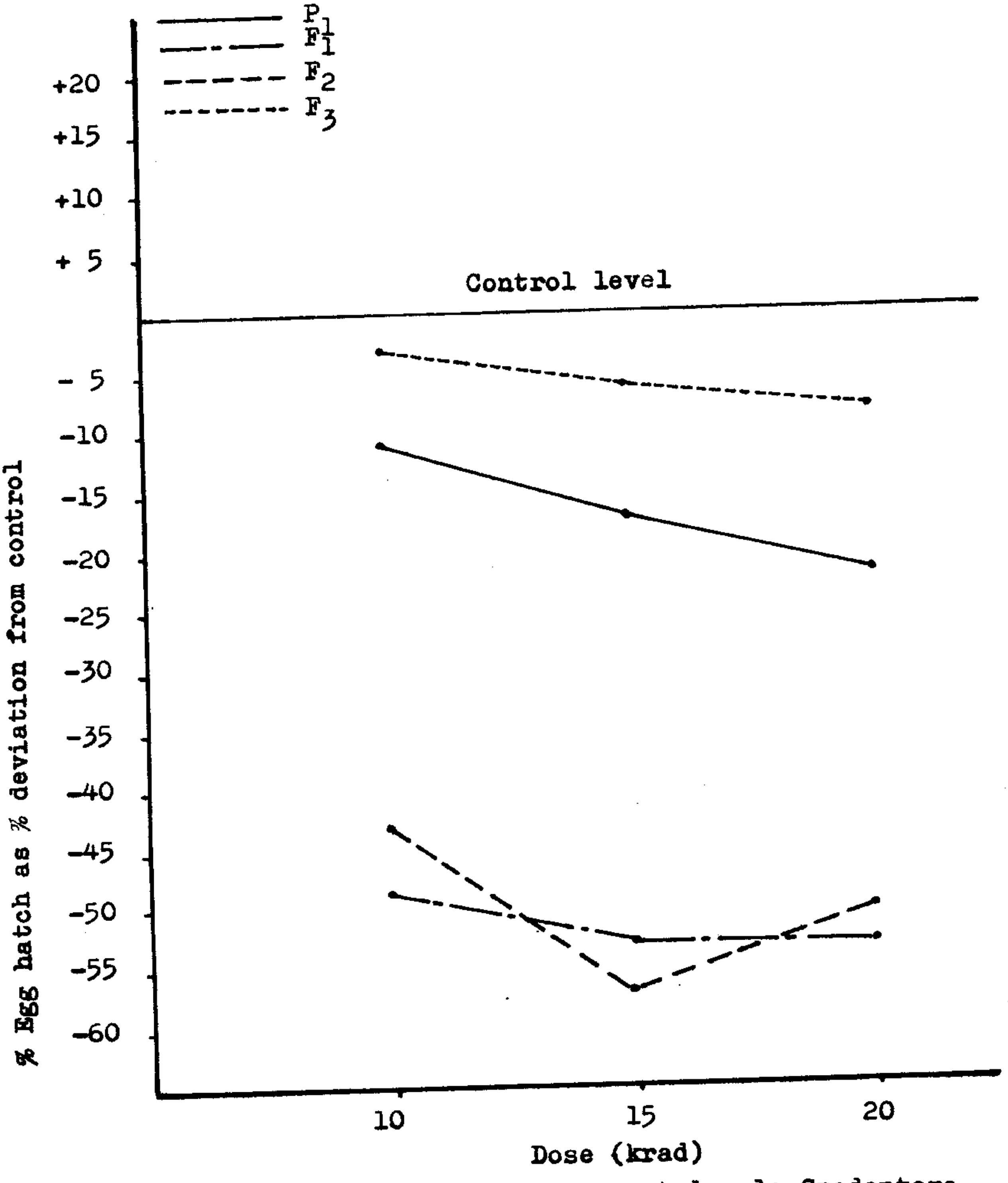


Fig.(3): Effects of irradiating parental male *Spodoptera littoralis* with substerilizing doses on the hatchability of parents (P_1) and their F_1, F_2 and F_3 progeny.

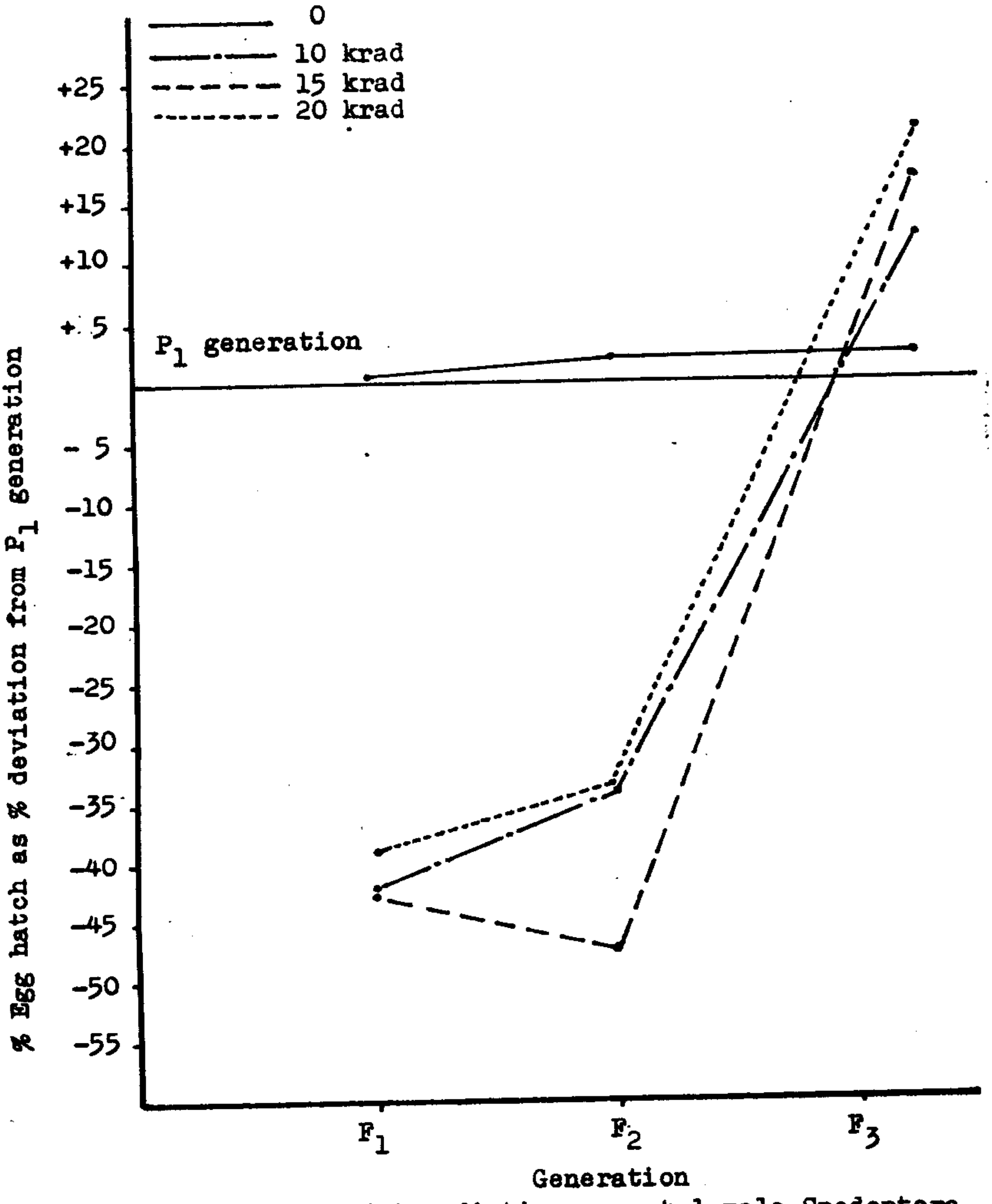


Fig.(4): Effects of irradiating parental male <u>Spodoptera littoralis</u> with substerilizing doses on the egg hatch in F_1, F_2 and F_3 progeny related to their parents.

extent through F_3 generation.

From the above results, it could be concluded that there was an adverse relationship between the dose applied to P_1 males and the percent egg hatch among the parental adults and their following three generations. Also, the greatest reduction in egg hatch occurred among F_1 and F_2 generations. However, F_3 generation demonstrated a high degree of recovery from the radiation treatment.

4.1.3. Mating frequency and sperm transfer:

The data on the mating frequency and sperm transfer are included in Table (2). The results indicate that no obvious reduction occured in mating ability of irradiated P_1 males. The data also indicate that there was no substantial difference in the percentage mated females among F_1, F_2 and F_3 generations at any dose level tested.

The success of sperms to reach spermathecae (estimated as percent of mated females with sperm) indicates that there was no obvious effect among the females of P_1, F_1, F_2 and F_3 at all tested doses (Table 2). The data in Table (2), also indicate that the average number of spermatophores per mated female was not significant between any dose level tested among P_1, F_1, F_2 and F_3 generations.

4.2 Effects on Immature Stages Through Three Successive Generations:

4.2.1 Larval-pupal survival:

TABLE (2): The treatment of male *Spodoptera littoralis* with substerilizing doses of gamma radiation, and its effect on mating activity of parents (P_1) and their F_1, F_2 and F_3 progeny.

Dose to P_1 male (krad)	% Mating				% Mated female with sperm				Average No. of spermatophores/mated female.			
	P_1	F_1	F_2	F_3	P_1	F_1	F_2	F_3	P_1	F_1	F_2	F_3
0	100.0	87.5	100.0	90	100	100.0	100.0	100	2.2	2.0	1.8	1.8
10	100.0	100.0	100.0	90	100	100.0	100.0	100	1.6	2.0	1.5	1.8
15	87.5	100.0	100.0	90	100	100.0	87.5	100	1.6	1.9	1.3	1.8
20	87.5	87.5	87.5	100	100	87.5	100.0	100	1.8	1.5	1.5	2.0

Eight pairs were used in each treatment in P_1 , F_1 and F_2

Ten pairs were used in each treatment in F_3

The data given in Table(3) and Fig.(5), presents the number of F_1, F_2 and F_3 larvae that reached the adult stage. The results indicate that the percentage of F_1 larvae survived to adult stage was significantly reduced at all dose levels tested when compared with the untreated control, where, the % larvae survived to adult stage were 74.33, 44.50, 32.0 and 38.8 when the male parent was exposed to 0, 10, 15 and 20 krad, respectively. Among F_2 larvae the reduction in surviving was obvious at all tested doses where it was 76.0, 56.0, 39.6 and 35.6 when male parents were irradiated with 0,10,15 and 20 krad, respectively. This indicates that there was a highly positive relationship existed between the dose given to P_1 males and the % larvae survived to adult stage among F_1 and F_2 generations. The mortality among F_3 larvae was reduced compared to that in the F_1 and F_2 generations.

The inherited deleterious effects had their greatest expression in F_1 and F_2 generations where the higher the dose applied to P_1 males, the lower was the % larvae survived to adult stage.

4.2.2. Developmental time:

The average developmental time, in days, required for egg hatch to adult emergence, (Table 3), seemed to be slightly affected among the progeny descendant of P_1 males irradiated with 10, 15 and 20 krad. The increase in developmental time for both males and females among the three successive generations was positively correlated with the dose given to P_1 males.

TABLE (3): The treatment of male *Spodoptera littoralis* with the substerilizing doses of gamma radiation and theireffects on survival, developmental, pupal weight and sex ratio of F_1, F_2 and F_3 generation.

Dose (krad)	% Larval surviving to adult	Larval + pupal duration (days)* ± S.E. ♂	Larval + pupal duration (days)* ± S.E. ♀	Av. pupal wt., g.** ♂	Av. pupal wt., g.** ♀	Sex Ratio ♂	Sex Ratio ♀
			F_1 generation				
0	74.33	31.7 ± 0.23	30.6 ± 0.23	0.287a	0.368a	1.12	1
10	44.50	33.5 ± 0.18	31.4 ± 0.19	0.239 b	0.279 b	1.17	1
15	32.00	34.1 ± 0.17	32.1 ± 0.19	0.230 b	0.279 b	1.00	1
20	38.8	34.5 ± 0.18	32.1 ± 0.17	0.227 b	0.255 c	0.94	1
			F_2 generation				
0	76.00	29.9 ± 0.22	28.8 ± 0.19	0.284a	0.340a	0.94	1
10	56.00	31.1 ± 0.20	30.7 ± 0.18	0.239 b	0.253 b	0.94	1
15	39.60	31.4 ± 0.21	30.9 ± 0.19	0.228 b	0.241 b	1.06	1
20	35.60	32.3 ± 0.16	31.9 ± 0.15	0.229 b	0.231 b	0.85	1
			F_3 generation				
0	77.00	28.3 ± 0.15	27.5 ± 0.14	0.255a	0.358a	0.90	1
10	67.00	29.1 ± 0.13	27.4 ± 0.15	0.253a	0.334a	0.71	1
15	63.00	30.0 ± 0.16	28.6 ± 0.14	0.263a	0.354a	0.71	1
20	56.60	30,6 ± 0.17	28.7 ± 0.19	0.245b	0.340a	0.86	1

* 90 larvae one-day-old were used per each treatment.

** 50 pupae two-day-old were used per each treatment.

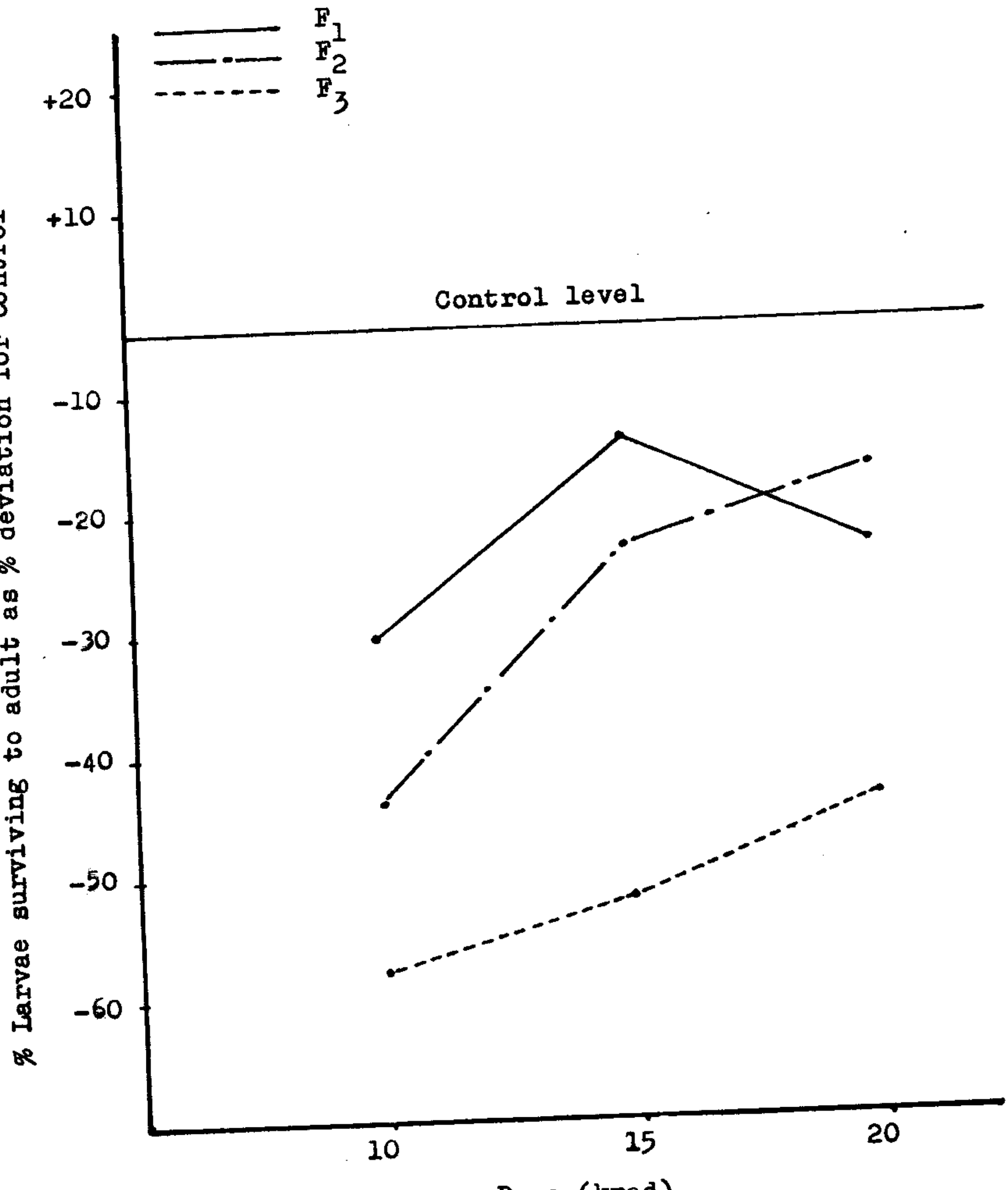


Fig.(5): The treatment of male Spodoptera littoralis with substerilizing doses of gamma radiation and their effect on survival to adult of F_1, F_2 and F_3 generation.

4.2.3. Pupal weight:

Table (3) gives the average pupal weights of fifty individuals (2 days old pupae) for both males and females among F_1, F_2 and F_3 generations. It is clear that the weight of male pupae is always less than the weight of female pupae. The data indicate that the average pupal weight for both males and females of F_1 generation was significantly reduced at all dose levels tested when compared with the untreated controls. This reduction was directly related to the dose given to P_1 male. The same trend was observed among F_2 generation. The results on pupal weights for both males and females of F_3 generation indicate that there was not significant reduction between untreated control and all tested treatments.

4.2.4. Sex ratio:

The results given in Table (3) show that the sex ratio among the progeny of irradiated males seemed about normal. It was nearly 1 : 1 which was normally obtained in the control treatment.

4.3. Effect of Substerilizing Doses on the Mating Competitiveness of Irradiated Parent Males and Their F_1, F_2 and F_3 Progeny:

One of the most important requirements for the successful application of the sterile insect-release method, is the ability to sterilize the pest without any serious damage to mating competitiveness or other behaviour.

The following experiments were conducted to investigate the effects of substerilizing doses of 10, 15 and 20 krad on mating competitiveness of the parental males of cotton leaf worm and their F_1, F_2 and F_3 male progeny.

4.3.1. Mating competitiveness of parental males:

Table (4) and Fig. (6) show the data on competitiveness of irradiated cotton leaf worm male parents in comparison with untreated moths. The observed, expected egg hatch and competitiveness values (C.V.) at two ratios are illustrated on the figure. The results indicate a significant reduction in egg hatching within the two ratios at the three tested doses when compared with the untreated control. Comparison of means indicate that the 5 treated: 1 untreated male ratio consistently gave greater reduction in egg hatch than the 1 : 1 ratio. Within the 1 : 1 : 1 combinations, the reduction in egg hatch at 15 and 20 krad treatments was significantly greater than 10 krad. The same was also true for 5 : 1 : 1 combinations.

TABLE (4): Effect of substerilizing doses on competitiveness of parental male cotton leaf worm, *Spodoptera littoralis* (18 rep.).

Cross Ratio Ι♂ : U♂ : U♀	Dose (krad)	% Egg hatch Observed	Expected	C.V.
0 : 1 : 1	0	80.4	-----	----
1 : 0 : 1	10	54.5 a	-----	----
1 : 1 : 1		66.5 b	67.43	1.1
5 : 1 : 1		60.3 a b	58.78	0.97
1 : 0 : 1	15	45.3 a	-----	----
1 : 1 : 1		55.0 b	62.87*	1.14
5 : 1 : 1		49.6 a b	51.19	1.03
1 : 0 : 1	20	39.6 a	-----	----
1 : 1 : 1		52.5 b	60.01*	1.14
5 : 1 : 1		44.8 a	46.42	1.03

* Significantly different, from observed, at 5% P.

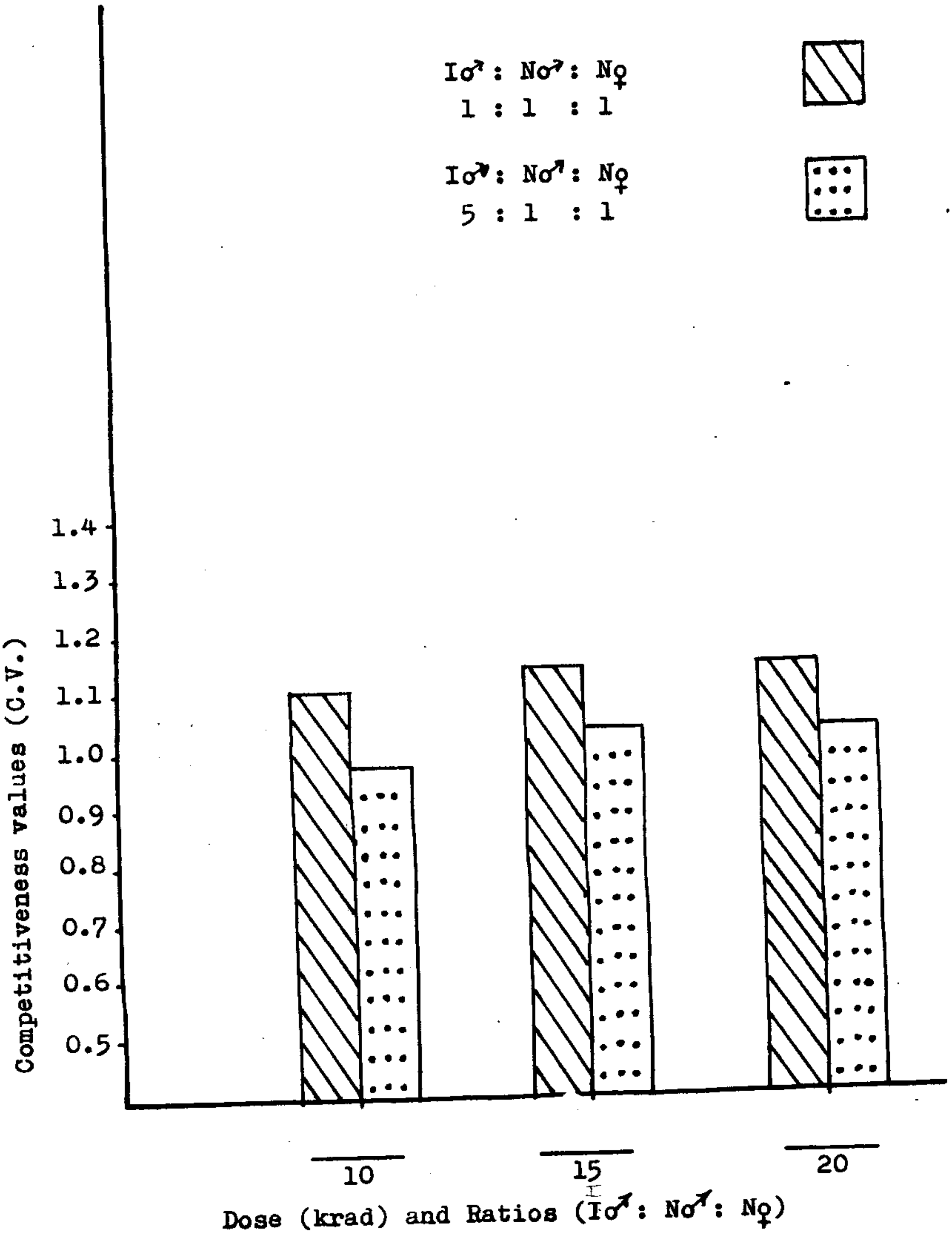


Fig.(6): Effect of substerilizing doses on mating competitiveness of parental male cotton leaf worm, S. littoralis.

The data in Table (4) also indicate that the competitiveness values among the treated males for the two tested ratios were not affected by irradiation with low doses. The above results lead to the conclusion that cotton leaf worm males irradiated by low doses of 10, 15 and 20 krad were fully competitive.

4.3.2. <u>Mating competitiveness of F_1 males</u>:

Table(5) and Fig.(7) show the data on competitiveness of F_1 males descendant of irradiated males. The results indicate that significant reduction in observed egg hatch occurred with the two tested ratios among all doses as compared with the untreated controls. Increasing the ratios of F_1 males from 1 : 1 to 5 : 1 gave more reduction in egg hatch, however, it was significant only at 10 krad level.

There was a significant difference between observed and expected egg hatch at the 1 : 1 ratio with 10, 15 and 20 krad. That difference was not significant at the 5 : 1 ratio.

Table (5) shows also the competitiveness values (C.V.) among the F_1 males for the two tested ratios. The data indicate that the (C.V.) of F_1 males were not affected when parent males were irradiated with the tested low doses. In general, the competitiveness values for the 1 : 1 ratio were greater than the 5 : 1 ratio at any dose level tested. Again it could be concluded that the F_1 males were fully competitive against untreated males in mating with normal females.

TABLE (5): Effect of substerilizing doses on competitiveness of F_1 male cotton leaf worm <u>Spodoptera littoralis</u> (18 rep.)

Cross Ratio	Dose	% Egg hatch		C.V.
I♂ : U♂ : U♀	(krad)	Observed	Expected	
0 : 1 : 1	0	82.07	-----	----
1 : 0 : 1	10	45.99 a	-----	----
1 : 1 : 1		55.85 b	64.03*	1.15
5 : 1 : 1		48.81 a	52.00	1.06
1 : 0 : 1	15	37.35 a	------	----
1 : 1 : 1		45.28 b	59.71*	1.32
5 : 1 : 1		39.24 a b	44.98	1.14
1 : 0 : 1	20	32.77 a	-----	----
1 : 1 : 1		41.95 b	57.32*	1.36
5 : 1 : 1		35.44 a b	40.98	1.15

* Significantly different, from observed, at 5% P.

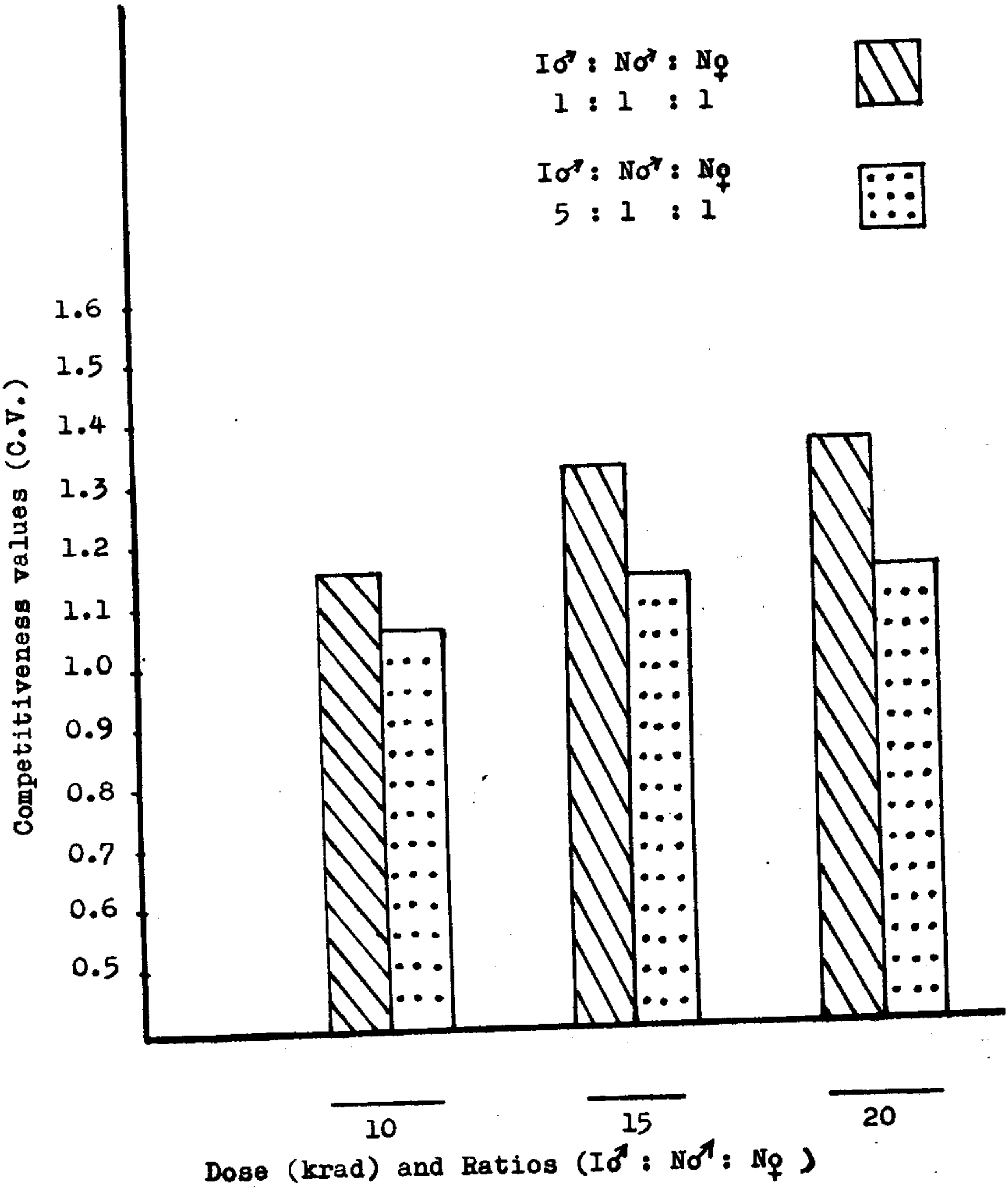


Fig. (7): **Effect of substerilizing doses on mating competitiveness of F_1 male cotton leaf worm, *Spodoptera littoralis*.**

4.3.3. Mating competitiveness of F_2 males:

Table (6) and Fig. (8) show the data on the competitiveness of F_2 males descendant of irradiated cotton leaf worm males. The results indicate that a significant reduction in observed egg hatch occurred within the two tested ratios among all doses as compared with the untreated control. It also appears from the results that the reductions in the observed egg hatch were not significant between the 1 : 1 and 5 : 1 ratios among the tested doses. Also, the results indicate that the competitiveness values of F_2 males were not affected at any treatment.

4.3.4. Mating competitiveness of F_3 males:

The results from Table (7) and Fig. (9) indicate a significant reduction in egg hatching within all tested ratios among F_3 when compared with the untreated controls. Also, the results indicate that the reduction in egg hatch was significant among the 1 : 1 ratio at 10 and 20 krad treatments. The results on observed, expected percent egg hatch and competitiveness values of F_3 males among all treatments took the same trend as observed in F_1 and F_2 generations.

TABLE (6): Effect of substerilizing doses on Competitiveness of F_2 male cotton leaf worm, <u>Spodoptera littoralis</u> (18 rep.).

Cross Ratio	Dose	% Egg hatch		C.V.
I♂ : U♂ : U♀	(krad)	Observed	Expected	
0 : 1 : 1	0	78.52	-----	----
1 : 0 : 1	10	47.49 a	-----	----
1 : 1 : 1		56.43 b	63.00*	1.11
5 : 1 : 1		50.06 ab	52.66	1.05
1 : 0 : 1	15	40.99 a	-----	----
1 : 1 : 1		43.5 a	59.75*	1.37
5 : 1 : 1		42.99 a	47.24	1.09
1 : 0 : 1	20	37.51 a	-----	----
1 : 1 : 1		42.88 a	58.01*	1.35
5 : 1 : 1		35.09 a	44.34	1.26

* Significantly different from observed, at 5% P.

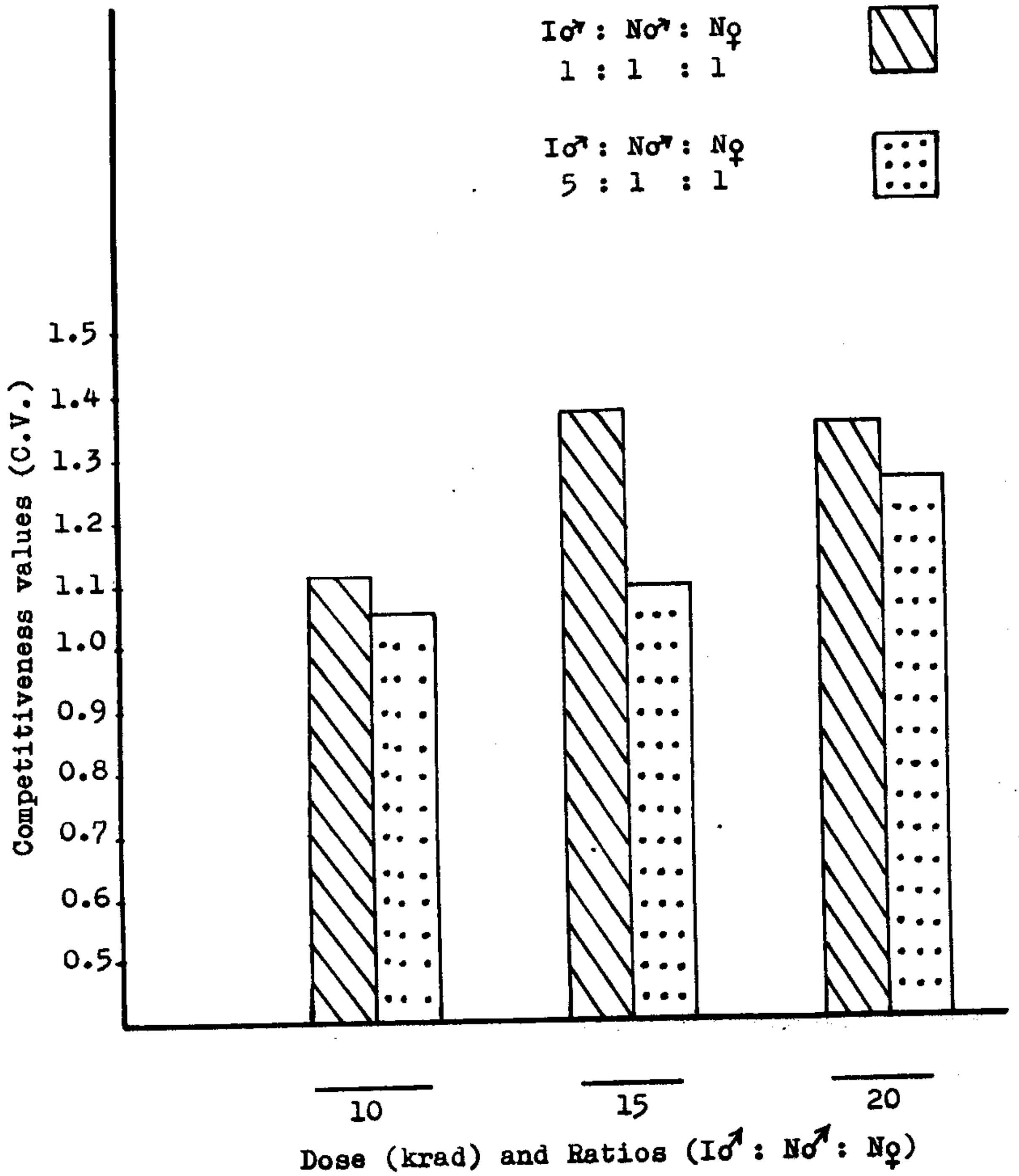


Fig. (8): Effect of substerilizing doses on mating competitiveness of F_2 male cotton leaf worm, *Spodoptera littoralis*.

TABLE (7): Effect of substerilizing doses on competitiveness of F_3 male cotton leaf worm, *Spodoptera littoralis* (18 rep.).

Cross Ratio Iσ : Uσ : U♀	Dose (krad)	% Egg hatch Observed	% Egg hatch Expected	C.V.
0 : 1 : 1	0	78.06	-----	----
1 : 0 : 1	10	50.19 a	-----	----
1 : 1 : 1		60.64 b	64.12	1.05
5 : 1 : 1		55.07 ab	54.83	0.99
1 : 0 : 1	15	48.06 ab	-----	----
1 : 1 : 1		52.99 a	63.06*	1.19
5 : 1 : 1		45.73 b	53.06*	1.16
1 : 0 : 1	20	40.8 a	-----	----
1 : 1 : 1		48.26 b	59.43*	1.23
5 : 1 : 1		40.52 a	47.01*	1.13

* Significantly different from observed, at 5% P.

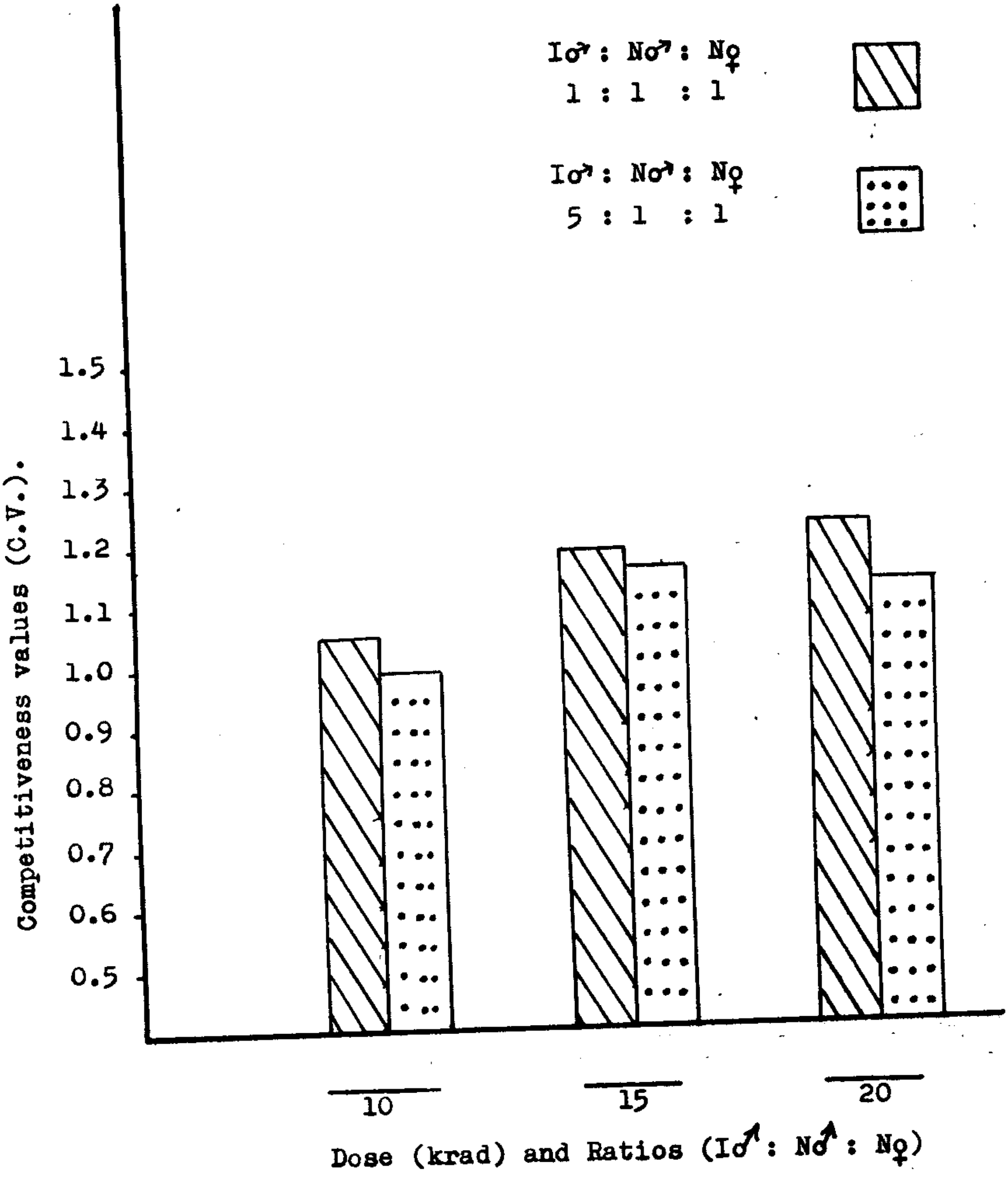


Fig. (9): Effect of substerilizing doses on mating competitiveness of F_3 male cotton leaf worm, Spodoptera littoralis.

4.4. Effect of Gamma Irradiation on the Internal Anatomy of Reproductive System of *Spodoptera littoralis*:

4.4.1. Effect of gamma-radiation on the testes and ovaries measurements of treated moths:

In the present research, trials were done to study the effects of gamma-irradiation on testes and ovaries of the first, second and third generations of newly emerged adults resulted from irradiated P_1 males at different gamma doses.

Dissection of adult male parents immediately after irradiation showed no histological effects on testes with 10, 15 and 20 krad.

Results in Table (8) indicate that the volumes of testes of the first, second and third generations of *S. littoralis* moths resulted from irradiated P_1 adult males were significantly affected by gamma radiation doses of 10, 15 and 20 krad. There are a positive relationship between the dose applied to P_1 males and the reduction among the volumes of the testes of the three successive generations.

Data in Table (9) show the effect of different gamma-irradiation doses on the average length of the right and left ovarioles. It could be concluded that there was a negative relationship between treatments and ovariole length where the length of the ovarioles decreased as the dose was increased.

The length of the ovariole was greatly reduced at the first and second generation especially at 15 and 20 krad. At 20 krad the average length of the ovariole decreased in both ovaries to 5.81 & 5.87 cm. for the first and second generation, respectively, compared to 8.84 and 8.63 cm in the control ovarioles.

TABLE (8): **Effect of gamma irradiation on the volume of F_1, F_2 and F_3 of *Spodoptera littoralis* male testes irradiated as P_1 adult males.**

Dose (Krad)	Average testis volume (mm)*		
	F_1	F_2	F_3
0	5.91 a	5.76 a	5.28 a
10	4.43 b	3.78 b	4.18 b
15	2.54 c	2.40 c	3.67 c
20	2.45 c	2.11 c	3.43 c

Testis volume was calculated assuming the spherical shape of the testis by the formula:

$$V = 4/3 \pi r^3$$

*20 adult males one-day-old were used per each treatment.

TABLE (9): Effect of gamma irradiation on the measurements of F_1, F_2 and F_3 of *Spodoptera littoralis* female ovaries irradiated as P_1 adult males.

Dose	Average length of ovarioles (cm)*					
	F_1		F_2		F_3	
(krad)	Right	Left	Right	Left	Right	Left
0	8.84	8.84	8.62	8.63	8.83	8.84
10	7.32	7.32	6.93	6.93	8.37	8.37
15	6.13	6.16	6.25	6.26	7.59	7.60
20	5.81	5.81	5.87	5.87	7.17	7.15

* 20 adult females one-day-old were used per each treatment.

The results in Table (9) show that the ovarioles of the third generation was not greatly affected.

4.4.2. Effect of gamma irradiation on the histology of the treated male testes:

The male reproductive organs of Spodoptera littoralis are composed of two yelliwish testes enclosed in a common sheath or scrotum, so they form a single structure 2.57 mm and 1.78 mm in length and width, respectively. Two vasa deferentia each composed of upper and lower parts, two vesicula seminalis and two distinguished accessory glands. Distally, the two separate coiled long accessory gland are fused longitudinally but their lumina are separate. The ejaculatory duct is also composed of a paired primary duct and cuticular unpaired ejaculatory ducts (simplex).(Fig.10).

Examination of transverse sectionsthrough the testis showed that a testis consisted of a mass of gonial cells in all stages of development. Spermatogonia occurred near the outer periphery farther inside cystes of primary spermatocyts and secondary spermatocyts were evident (Fig. 11). Areas of spermatids occurred still nearer the center. Most of the central area was filled with sperm bundles (Fig.11).

Two types of sperms were produced normally in Lepidopteran males, nucleated eupyrene sperm and anucleated apyrene sperm. Cells in which meiosis occurs before pupation

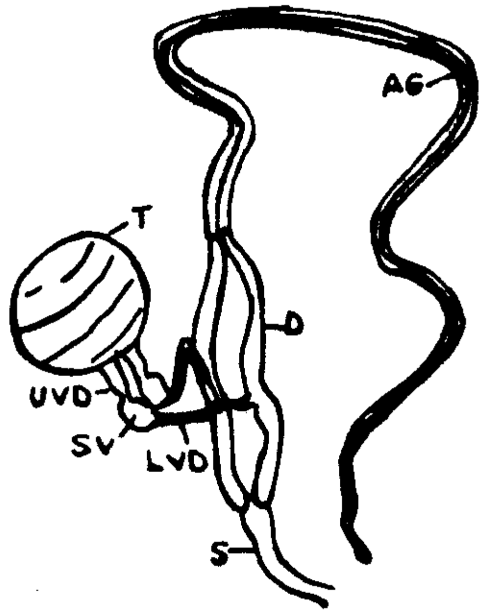


Fig. (10)

Diagrammatic drawing of the internal reproductive system of *Spodoptera littoralis* male showing accessory glands (AG), Duplex (D), lower vas deferens (L.V.D.), seminal vesicle (S.V;), simplex (S), testis (T), upper vas deferens (U.V.D.)

produce eupyrene sperm. Apyrene sperm are produced after pupation (Meves, 1903).

In the present study the two types of sperm bundles are easily differentiated in thin sections because the fully developed eupyrene bundles are characterized by large densely staining sperm tails elements, apyrene bundles are relatively small and faintly staining. Also, the eupyrene sperm bundles were long, sinuous and has distinct nuclei at the anterior end. Apyrene sperm bundles were shorter and occurred nearer the opening to the seminal vesicle than the eupyrene sperm bundles. The shorter apyrene sperms had less distinct nuclei located mid way along their length (Fig.11).

Examination of transverse sections through the testes of treated and untreated adults showed that most of the morphological changes occurred during sperm maturation process and at sperm bundles formation. These findings agree with those of Ashrafi and Roppel (1973a),who detailed that radiation induced partial sterility related to structurally abnormal sperms of Plodia interpunctella.

Examination of transverse sections through a testis of F_1 generation resulted from irradiated P_1 males with 10 krad shows a minute effect on the structure of testis contents. Most of sperm bundles appeared normal and individual sperm was fully formed indicating normal metamorphosis (Figs.12 and 13).

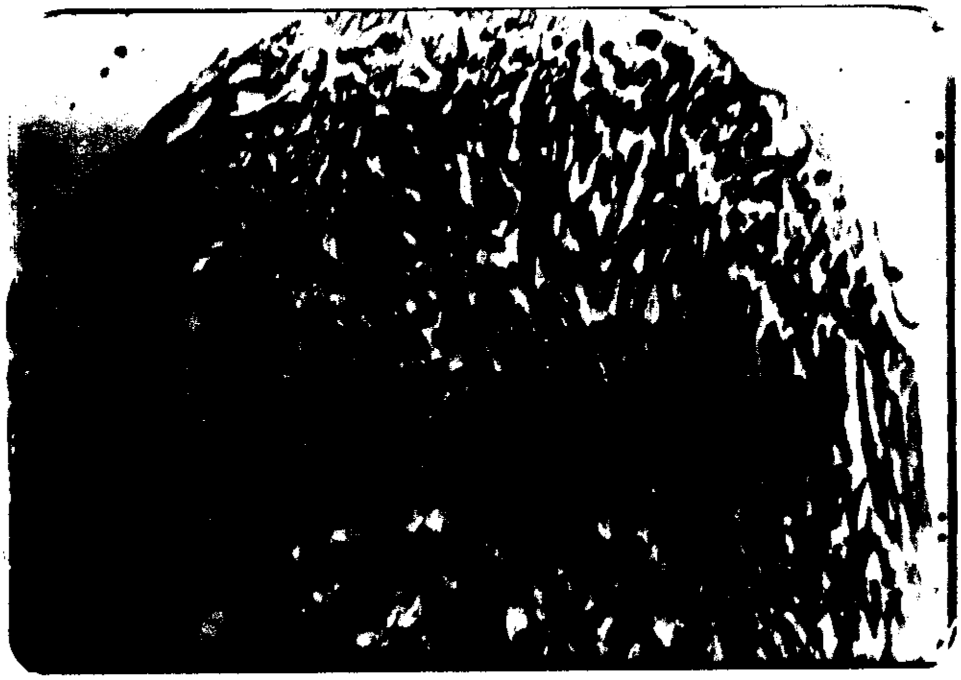


Fig. 11): Cross section in the testis of 1-day-old *Spodoptera littoralis* unirradiated male

(25.2 X.)

Figs. 12 &13): Cross sections in the testes of F_1 male 1-day-old of cotton leaf worm treated as P_1 male with 10 krad showing most of sperm bundles appeared normal.

(25.2 X. , 40 X.)

A dose of 15 krad showed morphological abnormalities and retardation in sperm maturation in comparison to the maturation in the untreated male. Both types of sperm bundles showed different degrees of shortage (Fig. 14). Although some germinal area appeared normal in some sections (Fig. 15) it was affected in others.

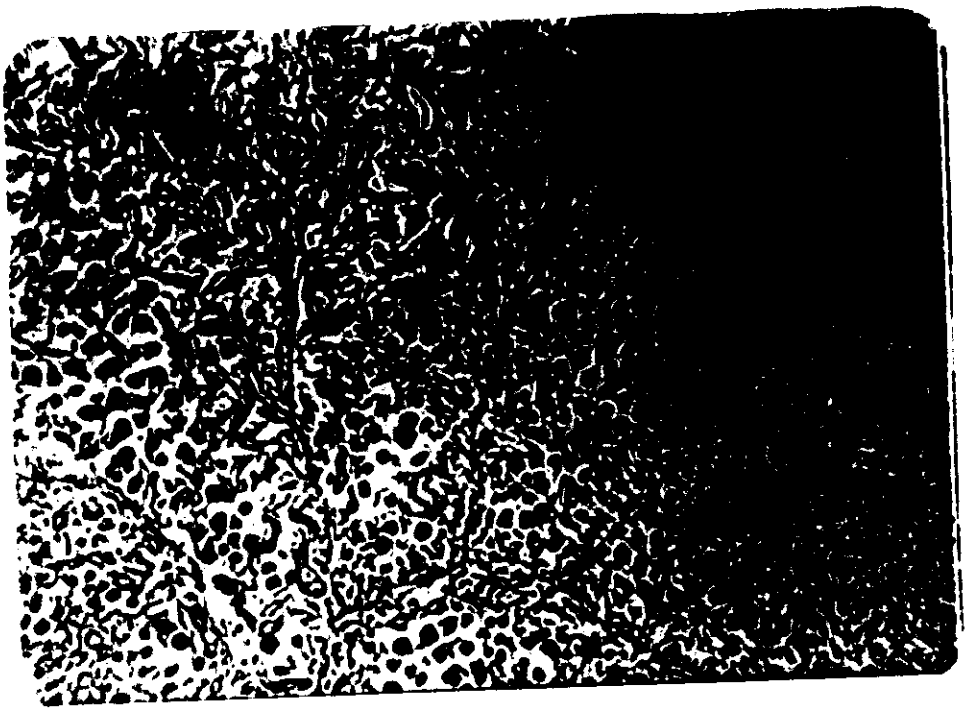
Spermatogonia, spermatocytes and spermatids in transverse section through testes of F_1 generation resulted from P_1 males were severely affected by 20 krad exposure (Figs. 16 & 17). The most obvious effects were the decrease in spermatocyte numbers, the breakage of the sperm bundles and the loose of the sperms (Fig. 16). Shrinkage of follicular tissues and vacuoles in spermatogonial region also were observed. (Fig. 17).

In the testes of F_2 males resulted from parents irradiated with 10 krad, thickness and shrinkage of follicular tissues was observed. Besides, the vacuoles became more obvious in the spermatogonial region (Figs. 18 & 19). Also, many spermatocytes appeared normal in structure while their numbers were decreased.

The F_2 progeny of P_1 adult, S. littoralis given 15 and 20 krad showed a wide range of morphological abnormalities (Figs. 20 & 21). Germinal tissues were completely damaged. Primary and secondary spermatocyte were absent (Figs. 21 & 22). The spermatid bundles were no longer distinguishable and spermatids showed signs of liquifaction and large vacuolated areas appeared (Figs. 20 - 22). In many bundles

Figs. 14 &15): Cross sectionsin the testis of F_1 male 1-day-old of cotton leaf worm treated as P_1 male with 15 krad showed abnormalities in sperm bundles.

(12.8 X., 25.2 X.)

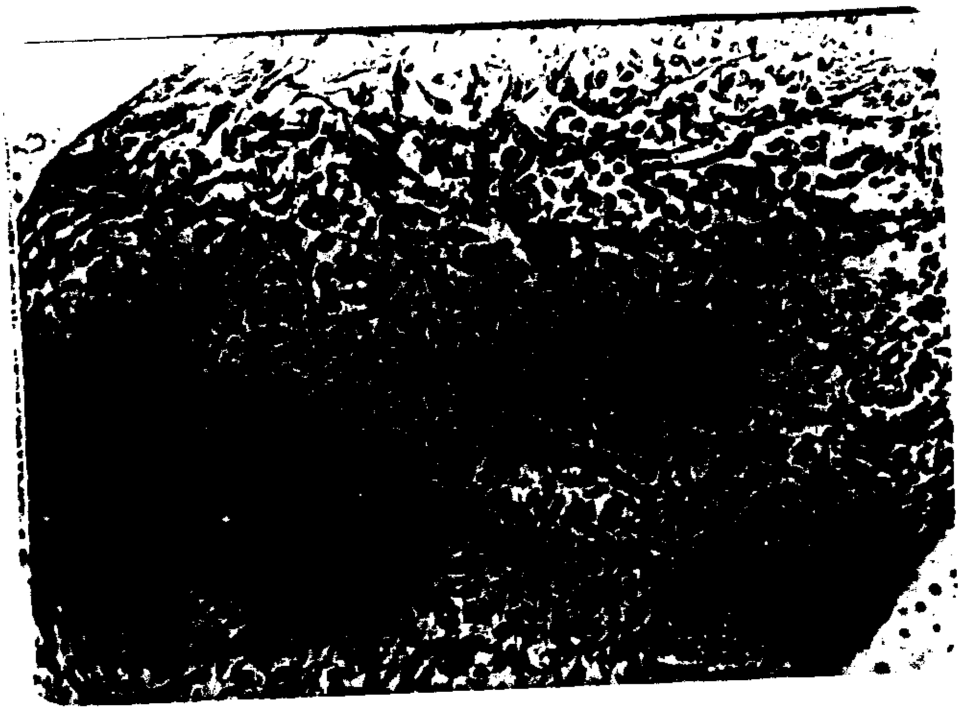


Figs. 16 &17): Sections of the testis of 1-day-old F_1 males irradiated as P_1 male with 20 krad showing the breakage of sperm bundles, loose of sperms, shrinkage of follicular tissue and vacuoles.

(25.2 X. , 25.2 X.)

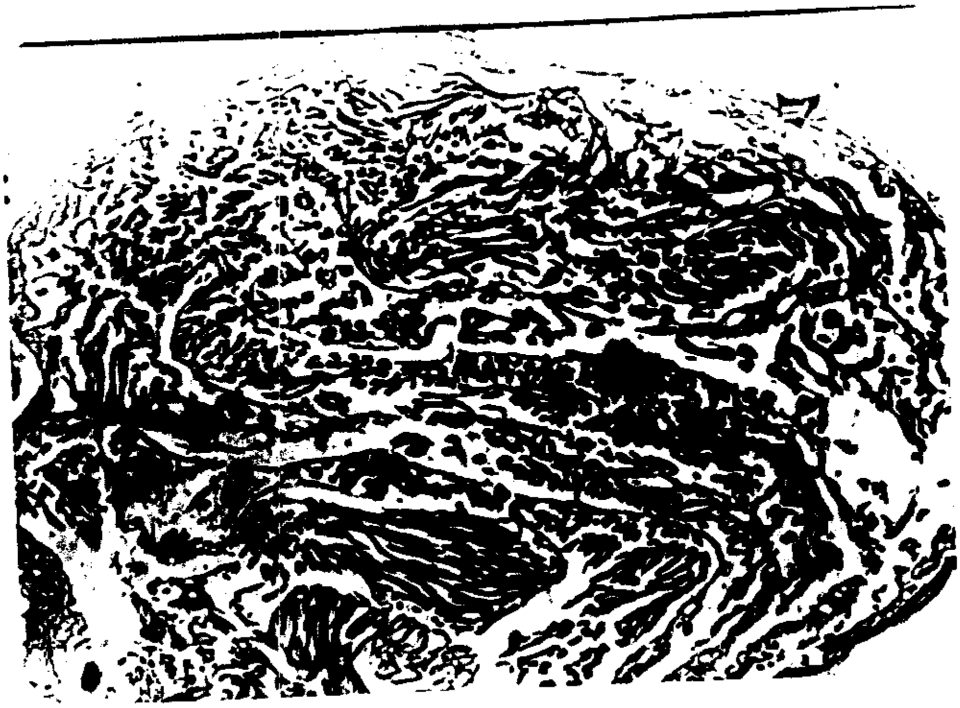
Figs. 18 &19): Sectionsof the testis of 1-day-old F_2 males irradiated as P_1 male showing abnormalities in follicular tissues, occurrence of vacuoles in the spermatogonial region and reduction in number of spermatocytes.

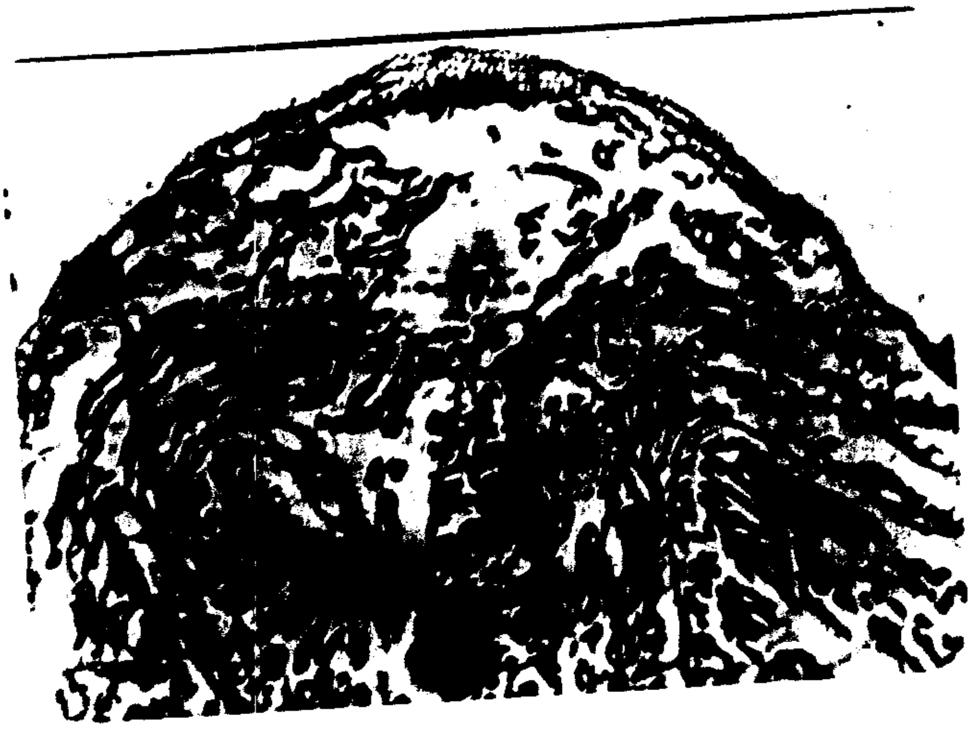
(25.2 X. , 40 X.)



Figs. (20 & 21): Sections in the testis of 1-day-old F_2 males irradiated as P_1 male with 15 krad showing absence of germinal tissue, occurrence of large vacuoles and degenerated sperm bundles.

(12.8 X. , 25.2 X.)





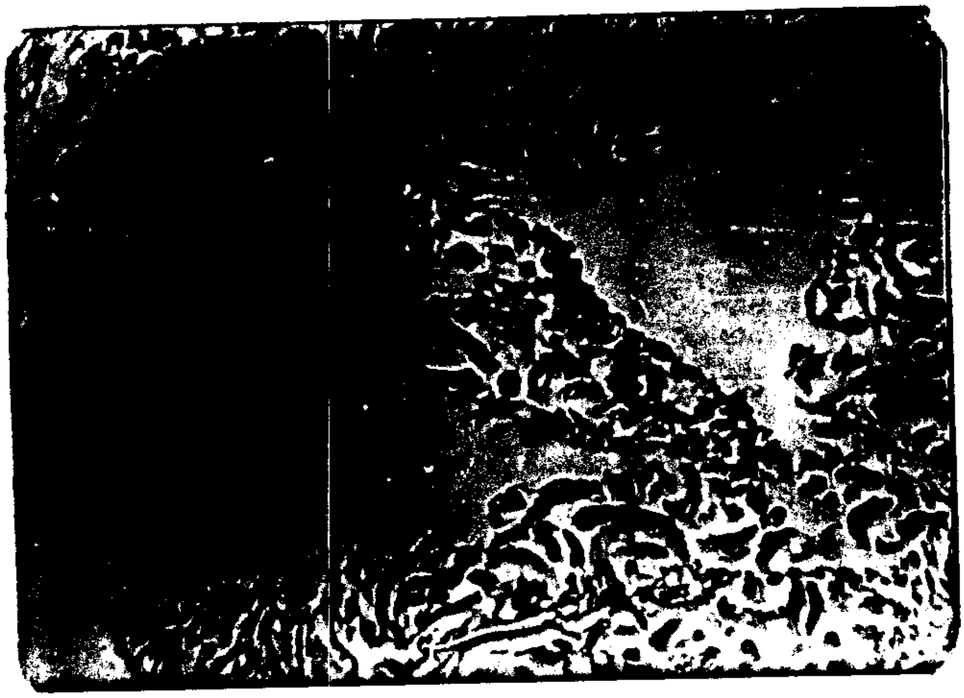


Fig. (22): Section in the testis of 1-day-old F_2 males irradiated as P_1 male with 15 krad showing absence of germinal tissue, occurrence of large vacuoles and degenerated sperm bundles.

(40 X.)

the sperms were degenerated (Figs. 20 - 24). Also, Figs. (23 & 24) showed cavities and vacuoles beneath the follicular tissues and large gaps also appeared in it. So, we noticed that the effects were more pronounced with the increase in dose. This results agree with those obtained by Riemann and Flint, (1967), who studied the irradiation histological effects on testes of the adult boll weevil, *Anthonomus grandis*.

Sections of the testes of F_3 progeny descended from parental males irradiated with 10 krad showed significant damage. Although spermatogonia were fewer in number than normal, vacuoles in the spermatogonial region were present. Also, spermatocyte and younger spermatid groups were abnormal in its appearance (Figs. 25 & 26).

At the dose 15 krad, the effects were more pronounced, the spermatocyte cysts contained nondifferentiated spermatocyts at the periphery of the testis but at its center the spermatocyte cysts were ruptured, cells were scattered and nuclei were darkly stained (Figs. 27 - 29).

At the dose 20 krad, showed that the spermatid bundles were no longer distinguishable, spermatocytes were degenerating and cytoplasm was often lacking leaving almost empty cysts. Many cystes were small and deeply stained. Sometimes, the cysts were completely lost and large vacuoles appeared instead of them (Figs. 30 - 32).

Figs. (23 & 24): Sectionsin the testis of 1-day-old F_2 males irradiated as P_1 male with 20 krad showing cavities and vacuoles beneath the follicular tissues and large gaps appeared in it.

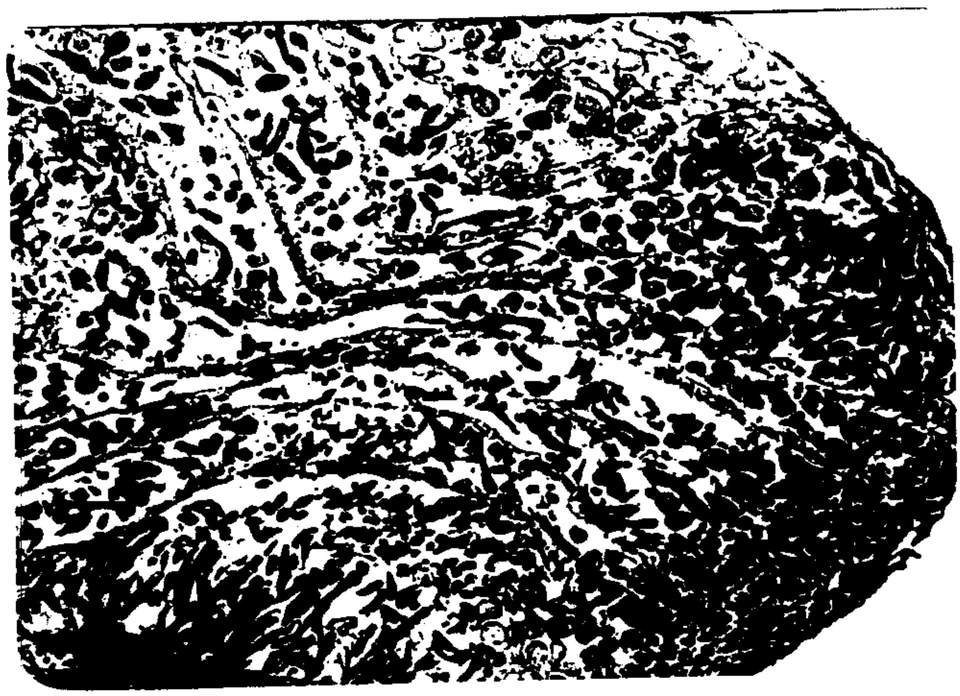
(25.2 X., 25.2 X.)

Figs. (25 & 26): Sectionsin the testis of 1-day-old F_3 males irradiated as P_1 male with 10 krad showing abnormalities in the region of development and maturation.

(25.2 X. , 40 X.)

Figs. (27 & 28): Sections of the testis of 1-day-old F_3 males irradiated as P_1 male with 15 krad showing undifferentiated spermatocytes and scattered & ruptured spermatocytes.

(12.8 X. , 25.2 X.)



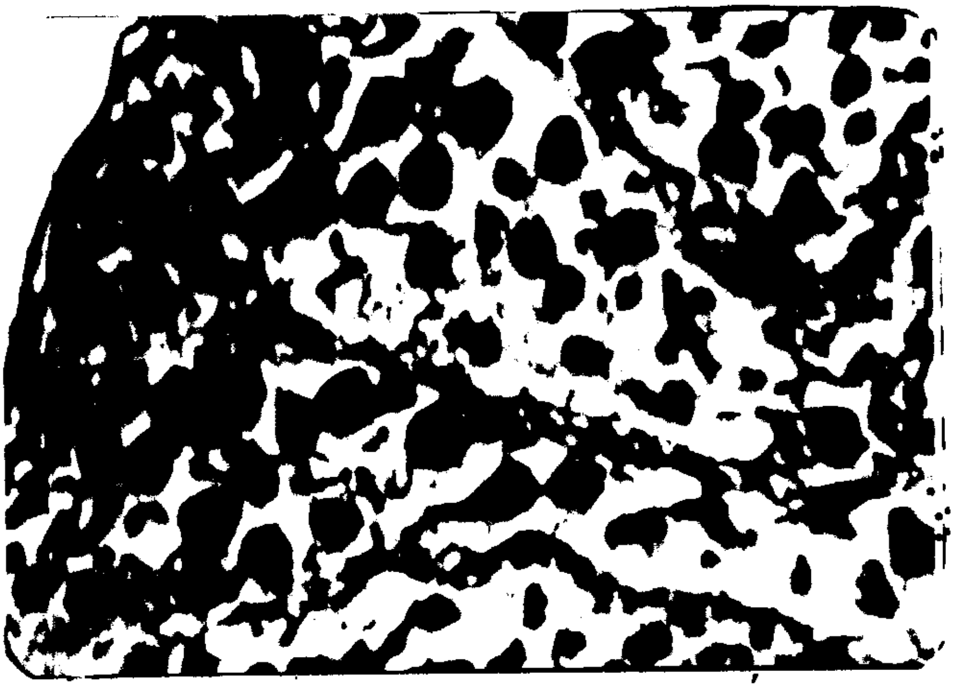
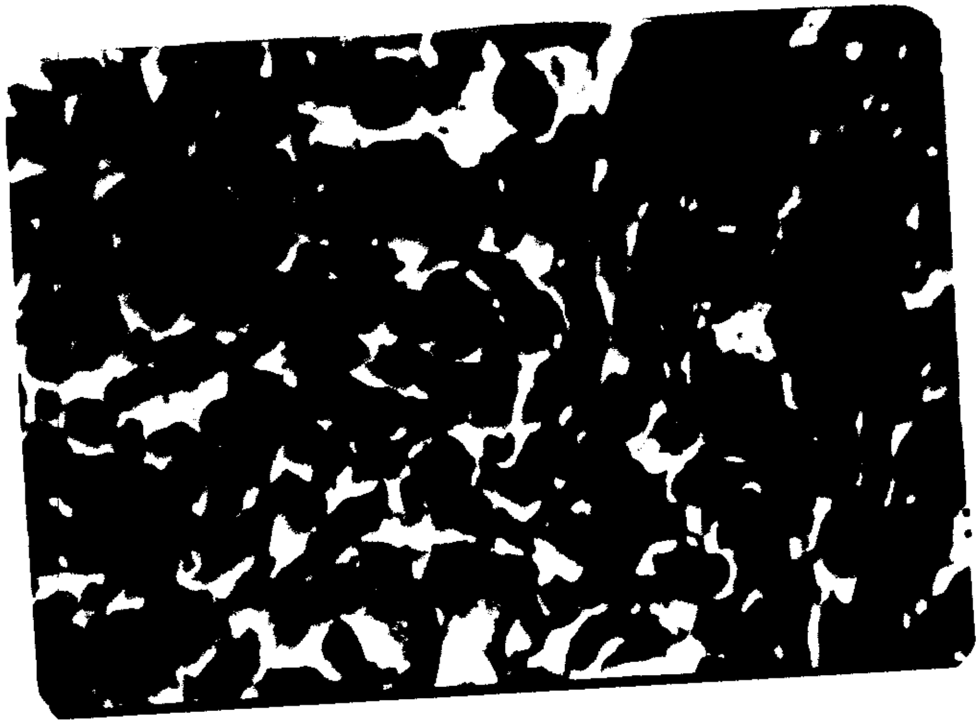


Fig. (29): Section of the testis of 1-day-old F_3 males irradiated as P_1 males with 15 krad showing undifferentiated spermatocytes.

(40 X.)

Figs. (30 & 31): Sectionsof the testis of 1-day-old F_3 males irradiated as P_1 male with 20 krad showing distinguishable spermatid bundles, degenerated spermatocytes and large vacuoles.

(40 X. , 25.2 X.)



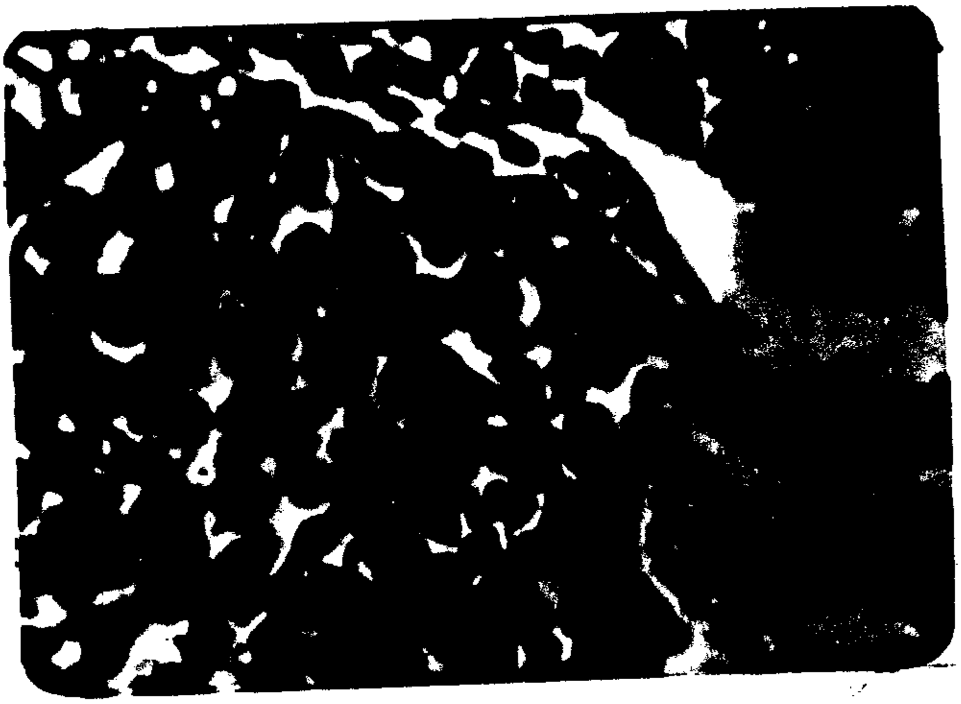


Fig. (32): Section of the testis of 1-day-old males irradiated as P_1 male with 20 krad showing deeply stained cysts, vacuoles inside in the spermatocytes cysts and large vacuoles.

(40 X.).

4.4.3. Effect of gamma irradiation on the histology of the ovaries of *Spodoptera littoralis*:

The female reproductive system (Fig. 33) is composed of two ovaries which lie in the body-cavity of the abdomen on either side of the alimentary canal. Each ovary consists of four polytrophic ovarioles which open into the lateral oviduct. The ovarioles are elongated tubes, about 8.7 cm in length, in which the developing eggs occur one after the other in a single chain.

Each ovariole consists of a terminal filament, a germarium and a vitellarium. The terminal filaments of the four ovarioles of each side are usually united to form a suspensory filament.

The germarium is always terminal and cotains the perimodial germ cells or oogonia which later become differentiated into oocytes and trophocytes (nurse cells). The size of the oocyte varies according to the phase of development till mature oogonia (eggs).

Germarium contains two kinds of cells, the oogonia and prefollicular cells. Differentiation of the oocyte and nurse cells from the oogonia does not take place in this region.

Previtellarium is the portion of the ovariole immediately following the germarium and constitutes the vitellarium. The growth and differentiation of the ovariole elements, such as the oocytes, nurse cells and follicular cells proceed in the vitellarium.

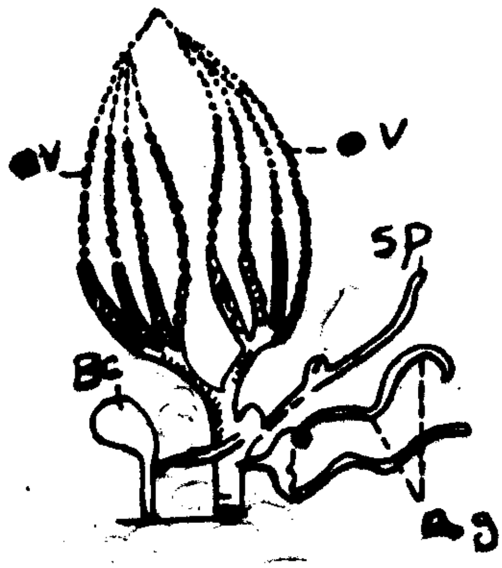


Fig. (33)

Diagrammatic drawing of reproductive system of *Spodoptera littoralis* showing ovarioles (OV), Bursa copulatrix (BC), Spermathecae (SP) and accessory glands (ag).

In the previtellarium the cyst cells begin to differentiate into the oocytes and nurse cells. The oocytes measure 3.2 x 2.0 µm, and the nurse cells 21 x 0.76 µm in size. No yolk spherules can be seen in the oocyte cytoplasm. Cytoplasmic bridges were rarely seen between the oocyte and the nurse cells.

Nurse cells were arranged in raws between the oocytes. Their size is the same as that of the nurse cells in the germarium.

Vitellarium is the region where the oocytes continue to develop . The vitellogenesis and chorion formation of the oocytes were completed in the vitellarium,the full grown oocytes were found. The oocytes are filled with numerous yolk spherules, increase in volume and move posteriorly in the vitellarium. Yolk synthesis began peripherally and proceeds centraly. When the oocytes were fully grown, they attain the size of about 4.6 x 3.1 µm, the oocytes were filled with numerous yold spherules and the germinal vesicle migrated from the center to the periphery in the oocyte. Each oocyte is surrounded with thin follicular layer composed of follicular cells with flat nuclei (Fig. 34).

The nurse cells were arranged in raws in the vitellarium but when the oocytes have finally matured the nurse cells decrease in size and began to degenerate (Fig. 34).

The ovary of <u>Spodoptera littoralis</u> is a polytrophic type, each oocyte has a number of nurse or nutritive cells

Fig (34): Longetudinal section in the ovariole of 1-day-old Spodoptera littoralis untreated female.

(12.8 X.)

enclosed in its follicle. Each oocyte composed of a layer of epithelial cells resting on a basement membrane, and the whole ovariole is enclosed in a connective-tissue membrane, (Fig. 34). The growth of the oocytes distends the ovariole into a series of follicles each lined by a definite follicular membrane . The oocytes and the nurse cells differ in size according to the stage of development (Figs 34).

The ovariole is covered with 2 sheaths, the non-cellular thin covering and the epithelial sheath composed of the flat cells (Fig. 34).

The histopathological effectsof radiation on the ovaries of treated virgin females,were evaluated on the base of the state of the follicle. Histological examination of the ovaries of the F_1 females resulted from 10 krad-irradiated P_1 males showed the degeneration of the nurse cells, the follicle epithelial cells appeared abnormal, separation of the follicular epithelium from the developing oocyte as a result of shrinkage of oocyte contents and the follicular epithelium was very thin if it compared with the control (Figs. 35 & 36).

By irradiation with 15 krad oocurred in addition to the forementioned effects, the oocytes became abnormal in shape (Figs. 37 & 38) and clumped together (Figs. 39 & 40). Vacules appeared in some ofthe cells and the noncellular thin covering was broken or absent in many areas (Figs. 37 & 38).

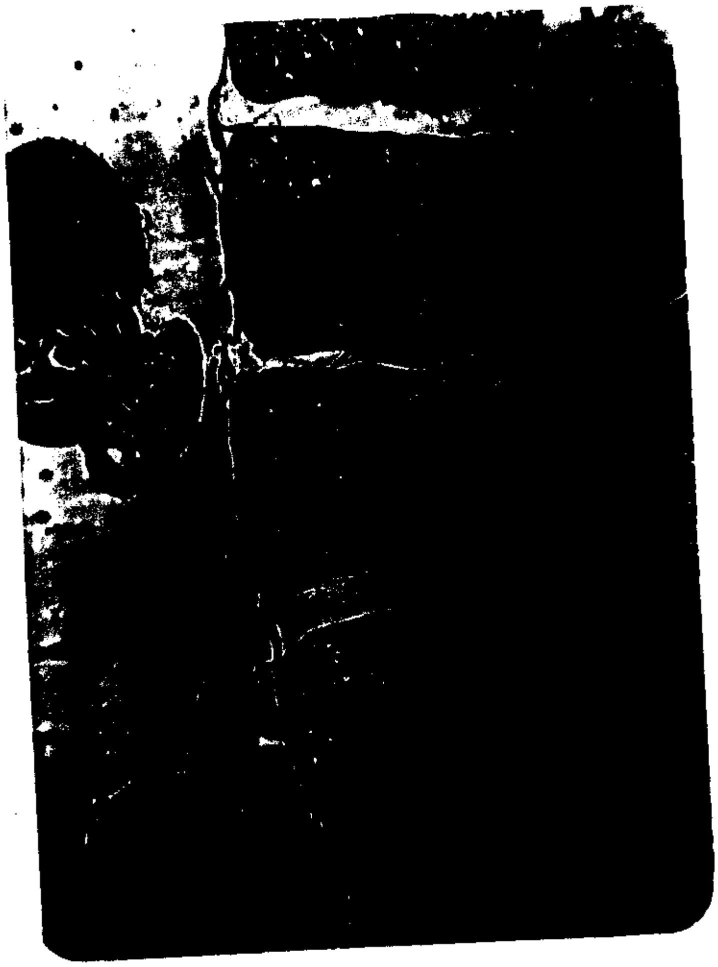
The effects at 20 krad were similar although the damage was more severe as the dose was increased. The oocyte

Figs. (35 & 36): Longetudinal sectionsin the ovariole of 1-day-old F_1 female irradiated as P_1 males with 10 krad showing abnormalities in oocyte, nurse cells and ovariole cover.

(12.8 X. , 12.8 X.)

Figs. (37 & 38): Longetudinal sectionsin the ovariole of 1-day-old F_1 female irradiated as P_1 males with 15 krad showing absence of follicular cell membrane.

(12.8 X. , 12.8 X.)



Figs. (39 & 40): Longetudinal sectionsin the ovariole of 1-day-old F_1 female irradiated as P_1 males with 15 krad showing the oocytes becoming abnormal, clumped together and vacuoles appeared in some of the cells.

(12.8 X. , 12.8 X.)

epithelium was not greately affected but vaculation was present in oocytes (Figs. 41 - 43).

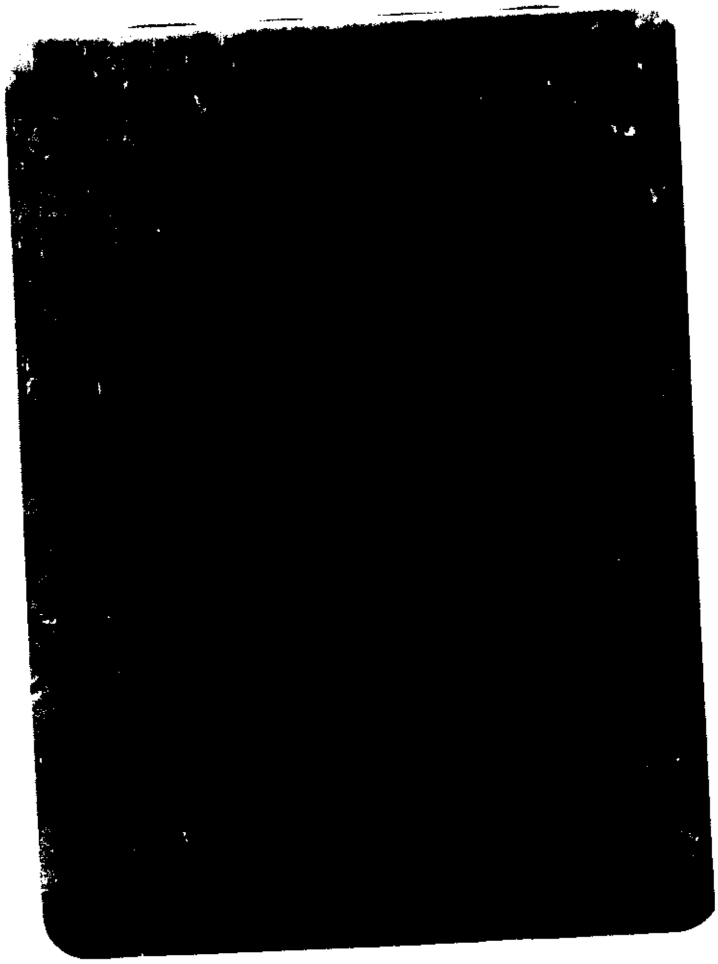
The F_2 females had more pronounced effect on the ovaries, at 10 krad separation of the follicular cells from developing oocyte also occurred as a result of shrinking and vacuolation of its contents (Fig. 44). The follicular epithelium appeared irregular around the oocyte, thus the oocytes became abnormal in shape. Nurse cells were absent (Fig. 44 and 45).

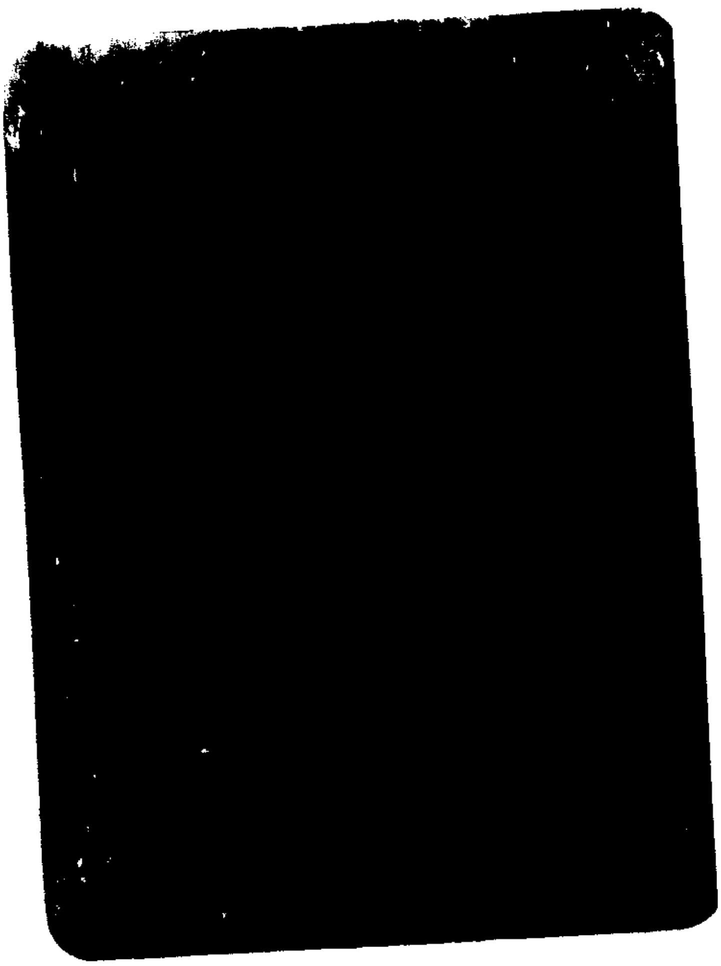
The F_2 females resulted from treatment P_1 males with 15 and 20 krad were more severely affected as additional effects were also noticed. Lack of young oocytes could be due to degeneration and interruption in their formation. Damage to epithelial cells was indicated by their abnormal appearance and deep staining (Figs. 46 - 48).

Histological examination on the ovaries of F_3 generation resulted from irradiated P_1 males showed that the damage was less than F_1 and F_2 generations but the damage was more clear as the dose increased.
The follicles were not greatly affected at 10 krad except that some vacuolation was present in the oocytes which became normal in shape, (as shown in Fig. 49). The nurse cells appeared again but in small sizes(Figs. 49 & 50). The effects at 15 krad was increased as the follicular epithelium appeared irregular arround the oocytes and the abnormalities in the structure of nurse cells were very clear (Figs. 51 & 52).

Figs. (41 & 42): Longetudinal sectionsin the ovariole of 1-day-old F_1 female irradiated as P_1 males with 20 krad showing absence of follicular membrane and presence of vacuoles in oocytes.

(12.8 X. , 12.8 X.)





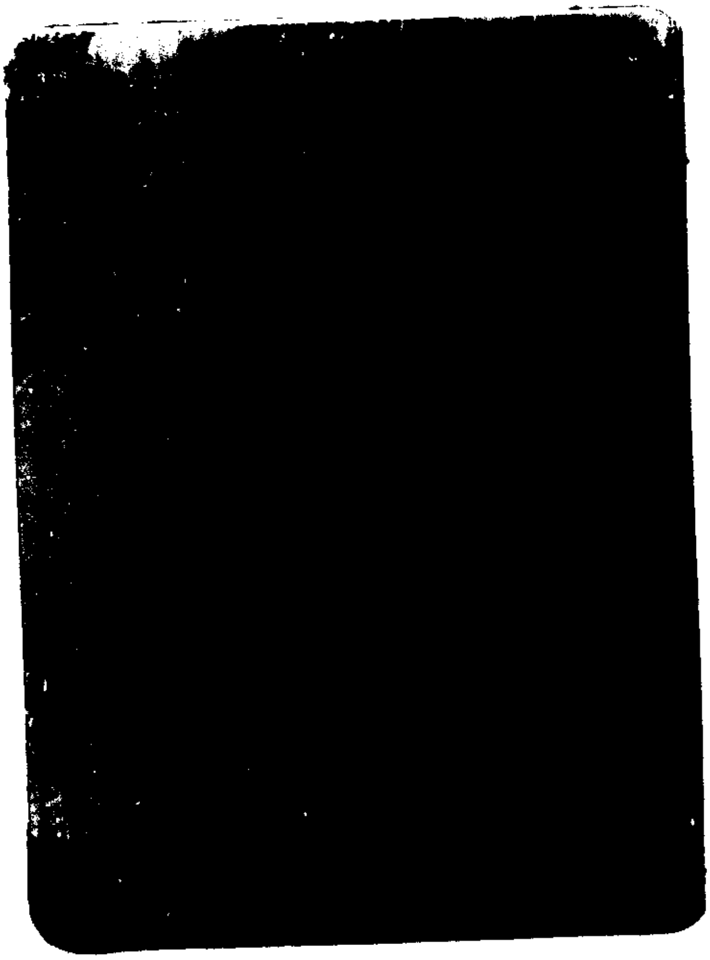
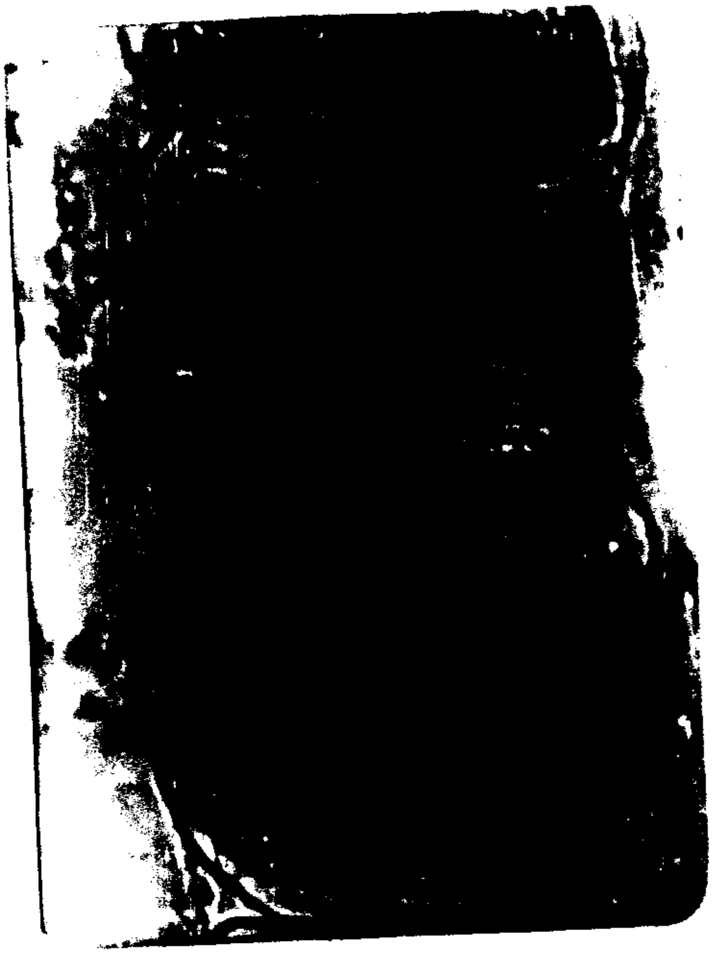


Fig. (43): Longetudinal section in the ovariole of 1-day-old F_1 female irradiated as P_1 males with 20 krad showing unaffected and affected oocyte epithelium.

(12.8 X.)

Figs. (44 & 45): Longetudinal sectionsin the ovariole of 1-day-old F_2 female irradiated as P_1 males with 20 krad showing separation of follicular cell, vacuolation in oocyte and the oocytes abnormal shape.

(12.8 X. , 12.8 X.)



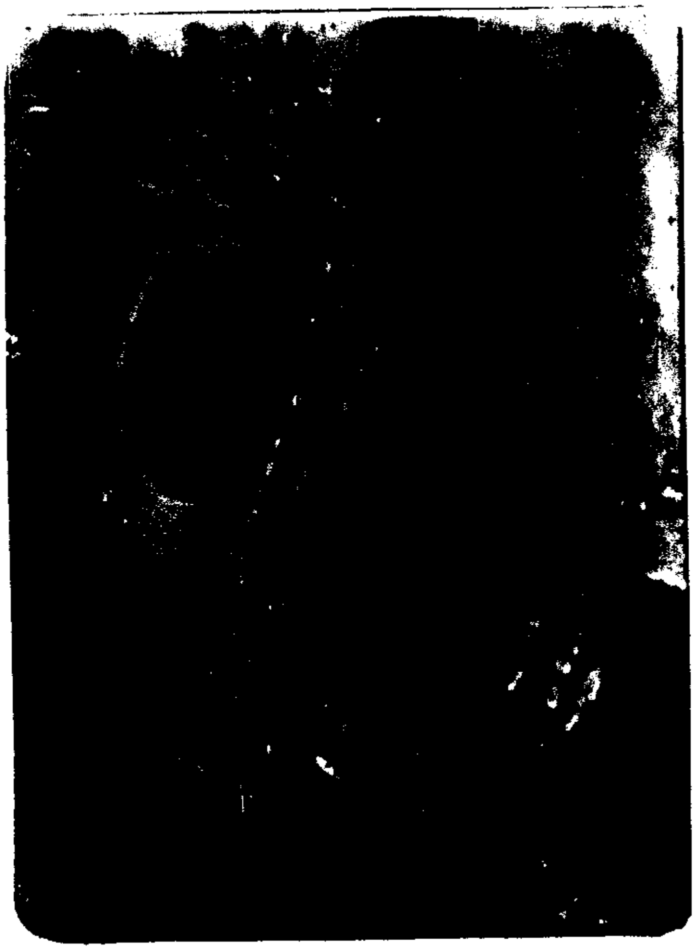


Fig. (46): Longetudinal section in the ovariole of 1-day-old F_2 female irradiated as P_1 male with 15 krad showing lack of young oocyte.

(12.8 X.)

Figs. (47 & 48): Longetudinal sections in the ovariole of 1-day-old F_2 female irradiated as P_1 male with 20 krad showing lack of young oocytes and damage to epithelial cells.

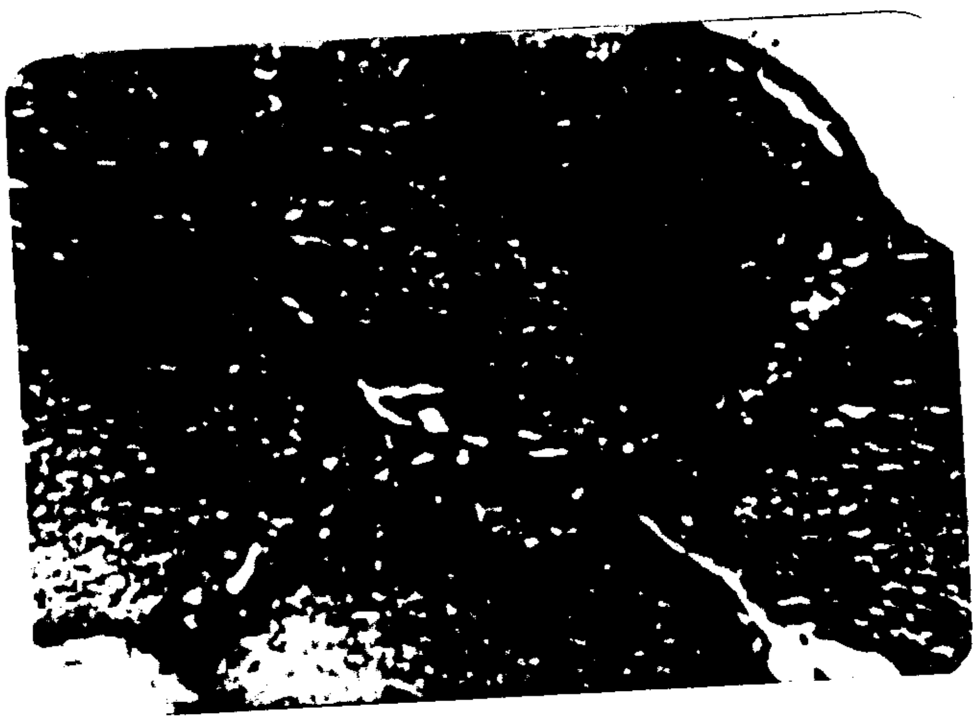
(12.8 X. , 12.8 X.)

Figs. (49 & 50): Longetudinal sectionsin the ovariole of 1-day-old F_3 female irradiated as P_1 males with 10 krad showing vacuolation in the oocytes and the nurse cells returnal to appear again but in small size.

(25.2 X. , 40 X.)

Figs. (51 & 52): Longetudinal sections in the ovariole of 1-day-old F_3 female irradiated as P_1 males with 15 krad showing the follicular epithelium appearing irregular arround the oocytes and the abnormalities in the structure of nurse cells.

(25.2 X. , 40 X.)



At 20 krad the effects were similar although the damage was more severe. Vacuoles appeared in some of the oocytes, and in some follicles the follicular epithelium separated from the developing oocytes (Figs. 53 & 54).

So, irradiation doses 10, 15 and 20 krad had a pronounced effects on the ovaries and the process of oocyte formation of generation resulted from irradiated P_1 males. Degenerative changes correlated with gamma dose and the effect of doses was more pronounced in the first and second generations.

Figs. (53 & 54): Longetudinal sections in the ovariole of 1-day-old F_3 female irradiated as P_1 males with 20 krad showing vacuoles in some of the oocytes and some follicles in the follicular epithelium seperating from the oocytes.

(25.2 X. , 25.2 X.)