



Title	去勢鶏生産を目的とする幼若雄鶏のX線処理
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The X-Ray Treatment of Cockerels Planned in the Production of Capons

By

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(With 2 tables and 16 figures)

While a number of papers have been published concerning the effect of x-radiation upon the sexual glands of mammals, for instance those by FRIEBEN 1903, PHILLIP 1904, BUSCHKE 1905, BROWN and OSGOOD 1905, BERFONNIE and TRIBONDEAU 1906, HOFFMANN 1908, REGAUD and DUBREUILLE 1908, SIMMONDS 1909, HIDA and KUGA 1911, BARRATT and ARNOLD 1911, GATENBY and WIGODER 1929, and SNELL 1933, etc., the investigations on this subject dealing with poultry are quite meagre up to the present time. So far as the author is aware, the papers published by HIDA and KUGA (1911), and ROLF, SCHROEDER and HIGGINS (1934) seem to be the important ones so far as concerned with the fowl. HIDA and KUGA (1911) studied the histological changes that occur in the testes following exposure to x-rays in the adult fowl. ROLF, SCHROEDER and HIGGINS (1934) treated the six-week cockerels with x-rays and examined the effect of x-rays upon the development of sexual characters.

Since it was known from the studies carried out on mammals that x-ray radiation has been often employed to arrest the cellular development of the gonad and to control the actions of the gland, there is a strong possibility that treating cockerels with x-rays might be used in the production of capons. With this view in mind the present author instituted an experimental inquiry to secure definite information on this subject. In the present paper observations on the testicular changes of the x-rayed cockerels are chiefly described.

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Method

All birds used in this study were White Leghorn cockerels of the same age. They were specially selected for uniformity in weight. Environment, feed and management were the same for all of them. At the commencement of treatment they were three weeks of age.

The cockerels, 32 birds in total, were irradiated at eight different ages from three weeks old to ten weeks old (cf. Table I). The factors governing the radiation have been kept constant for all experiments. Namely, a Coolidge's tube was used as the source of radiation, operating at 80000 volts and 4 milliamperes. The target-skin distance measured 25 cm. During all raying an aluminum filter, 3 mm thick, was used. The birds to be x-rayed were fixed on a desk without permitting much freedom of motion. The birds were exposed three times, at an interval of seven days, each time giving 15-minute exposure. Besides the treated birds, normal untreated specimens, reared under the same conditions, were provided for the sake of comparison. The majority of treated individuals did not become uninjured.

In every group of experiments, the birds, both treated and normal, were killed uniformly 7 weeks after exposure to x-rays. After dissection the testes were measured and then fixed in formalin for microscopical observations. At the same time the body weights of each bird were recorded. Subjected to the usual paraffin method, the testes were sectioned and stained with Delafield's haematoxylin.

Results of observations

No. 1. This group consists of five birds. They were irradiated at three weeks of age and killed 10 weeks old (Table I). At autopsy, it was found that

TABLE I. Experimental procedure

No.	Age of the time of X-radiation	Dose	Target-distance	Exposure time	Age at the time of killing	Number of birds treated
No. 1	3 weeks	80. Kv. 4 m. amp.	25 cm	45 min	10 weeks	5
No. 2	4 weeks	"	"	"	11 weeks	5
No. 3	5 weeks	"	"	"	12 weeks	4
No. 4	6 weeks	"	"	"	13 weeks	4
No. 5	7 weeks	"	"	"	14 weeks	4
No. 6	8 weeks	"	"	"	15 weeks	3
No. 7	9 weeks	"	"	"	16 weeks	3
No. 8	10 weeks	"	"	"	17 weeks	3

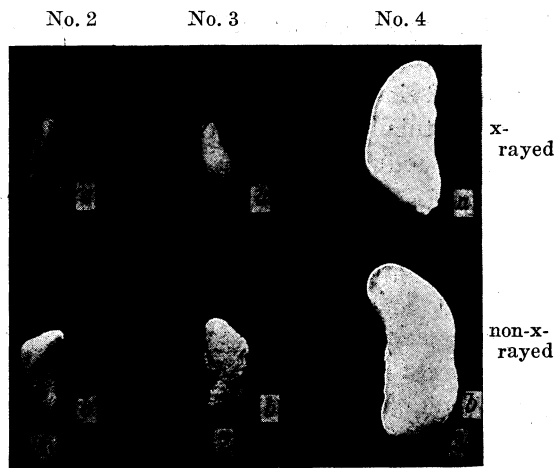
the testes of the x-rayed birds showed no marked difference, either in size or in weight, from those of normal cockerels of the same age (Table II).

TABLE II. Data from experiments

No.	Age at the time of radiation	Age at the time of killing	X-rayed				non-x-rayed			
			Size of testes (average, mm)		Weight of testes (average, gr)	Body weight (average, gr)	Size of testes (average, mm)		Weight of testes (average, gr)	Body weight (average, gr)
			Length	Width			Length	Width		
No. 1	21 days	56 days	9.35	3.15	0.06	488.3	9.33	3.95	0.09	508.3
No. 2	28 days	63 days	11.20	3.10	0.07	623.3	11.33	5.54	0.14	553.3
No. 3	35 days	70 days	12.05	4.08	0.12	593.3	13.52	6.72	0.20	656.7
No. 4	42 days	77 days	20.01	10.08	1.20	1005.1	22.50	9.82	1.47	1006.7
No. 5	49 days	84 days	21.12	9.82	1.32	941.7	21.30	10.01	1.48	931.7

Histological observations of the x-rayed testes showed that there had occurred no remarkable destructive changes, in parallel to the results of the anatomical study. In both of the treated and untreated animals, the seminiferous tubules contain spermatogonial cells which line the tubules in a single layer, as shown in Figs. 4 and 5. The only difference is seen in the fact that, in the control testes there are plenty of dividing spermatogonia which are quite rare in the treated testes.

No. 2. Five birds were exposed to x-rays at four weeks of age and killed 11 weeks old (Table I). On the anatomical observation the testes of the x-rayed birds were found to be a little reduced in size as compared with those of the normal birds (Fig. 1). Microscopical examination of the testes reveals that a marked histological change has occurred in the treated animals. In other words, there are encountered some degenerative



Figs. 1-3. Comparative size of testes of treated and normal cockerels. About natural size.

a: from x-rayed birds.

b: from non-x-rayed birds.

1, No. 2 specimens. 11 weeks old.

2, No. 3 specimens. 12 weeks old.

3, No. 4 specimens. 13 weeks old.

changes in the x-rayed testes. As compared with the condition found in the control testes, the seminiferous tubules of the radiated testes are reduced to about one-half normal size, decreasing also in number, and contain a few spermatogonia arranging in a single layer. There is entirely absent the division figure of the spermatogonia in every tubule. In contrary to the destructive structure of the seminiferous tubules in the radiated testes, a remarkable development of the interstitial tissues is observable surrounding every tubule, due to the great increase of the interstitial cells. The conditions as above described may be well understood by reference to Figs. 6, 7 and 8. From the above evidence it can be said that x-radiation prevents the normal development of the testes when irradiated at four weeks of age with the dose herein concerned.

In the control testes of the same age, on the contrary, the seminiferous tubules have undergone active development and contain many spermatogonial cells in the process of division, consisting of three or more layers (Fig. 9). Comparison of Fig. 9 with Figs. 6 and 7 will illustrate the fact more clearly.

It is noticeable here that combs and wattles of the x-rayed birds were remarkably smaller in size than those of the non-exposed birds of the same age.

No. 3. Four individuals were irradiated at five weeks of age and killed 12 weeks old. The comparative size of the testes of the treated and the non-treated birds can be seen from Fig. 2 and Table II, showing that the treated testes are smaller as well in size as weight than in the untreated testes. On the microscopical observation it was found that the treated testes show a pronounced similarity in condition, as those observed in No. 2. Namely, the seminiferous tubules of these testes are apparently degenerative in structure and greatly reduced in size, as shown in Fig. 10. The tubules consist of a single layer of cells, and sometimes they lack the germ-cells entirely, their lumens being filled with debris (Fig. 11). There are found well developed interstitial tissues in these testes surrounding the tubules (Figs. 10-11). The increase of the interstitial cells is quite remarkable in this case. A control testis is shown in Fig. 12 for the sake of comparison. Thus above noted, the x-radiation at the stage of five weeks old proved to be effective in arresting the development of the testes, so far as the dose herein used is concerned.

The birds subjected to x-rays had conspicuously smaller combs and wattles than the normal cockerels. Particularly some of them had the smallest combs and wattles and resembled in general appearance closely a true capon. But none of the exposed birds developed the plumage typical of a capon.

No. 4. Four birds were exposed to x-rays at six weeks of age and killed 13 weeks old for examination of the testes.

From the anatomical examinations it was ascertained that the testes of the radiated birds show no noticeable difference in their growth from those of the

non-radiated birds. As is clear from Fig. 3 and Table II, the radiated birds had well developed testes which are quite comparable in their size and weight to those of the untreated birds.

It was found in the microscopical study that there exists no slight evidence for the destructive change in the x-rayed testes. In the seminiferous tubules of the radiated testes the germ-cells have undergone active spermatogenetic development, showing normal divisions of both spermatogonial and spermatocyte stages (Fig. 13). And, a number of spermatozoa are found produced in the lumens of the tubules. There is never present unusual development of the interstitial tissue in these x-rayed testes. Fig. 13 shows a piece of section of a normal testis taken from a cockerel of the same age. The comparison of the x-rayed (Fig. 13) and non-x-rayed testes (Fig. 14) reveals no significant difference in their structural feature.

From the above evidence it is highly probable that x-rays are no more effective to prevent the development of the testes of six-weeks old cockerels, so far as the dose employed here is concerned.

No. 5 to No. 8. So far as the observations go, there was not found any kind of injurious effect of x-rays upon the development of the testes in these groups. The radiated testes showed quite normal growth which was apparently analogous to the non-radiated testes. Fig. 15 is a part of a testis taken from the cockerel No. 5, and Fig. 16 from the cockerel No. 6, in both of which spermatogenesis has proceeded in normal manner, and there is present no sign of destructive change. But, as an exceptional case, the mosaic testis which consists of well developed seminiferous tubules containing spermatozoa and degenerative sterile tubules, as shown in Fig. 16, was found in one of the cockerels of No. 6.

It may be inferred from these histological observations that x-rays exert no effect to arrest the growth of the testes in the groups, No. 5, No. 6, No. 7 and No. 8, so far as the scope of the present investigation is concerned.

Conclusion and consideration

The results of observations attained in the present study may be summarized as follows: the x-ray radiation with 80 kv., 4 m amp. and 45 min.-exposure-time has a noticeable effect in reducing or arresting the development of the testes, when the treatment is operated upon birds at the age of four and five weeks. When the birds are six weeks old and older than the latter, the x-ray treatment is not responsible at all for the development of the testes, so far as the dose of x-rays used in this study is dealt with. It can be stated, therefore, that the extent in age at which individual birds react to the x-ray treatment is from four to five weeks of age. Though there are present some variations in results, the birds subjected to x-rays at the age of four to five weeks had generally testes of

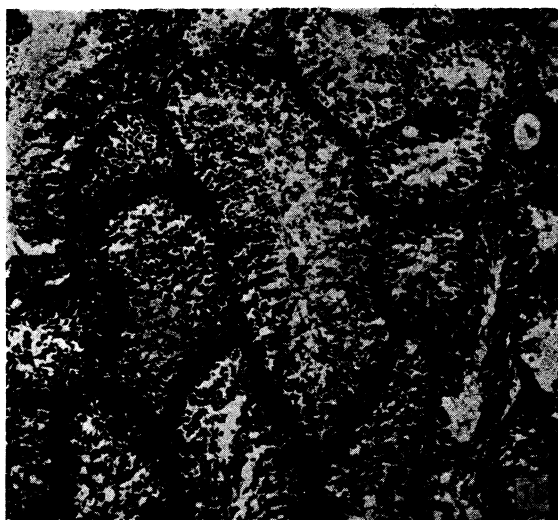
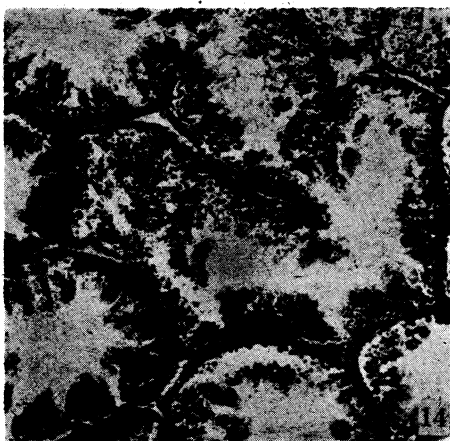
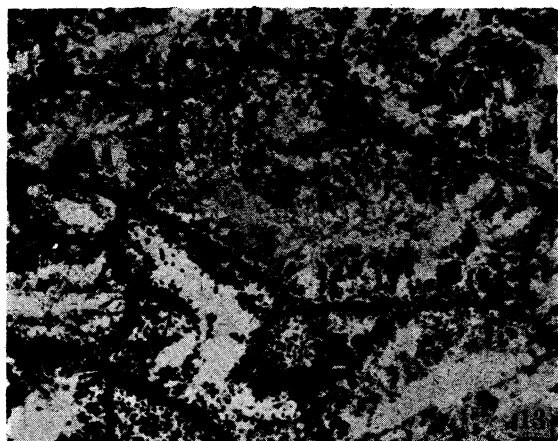
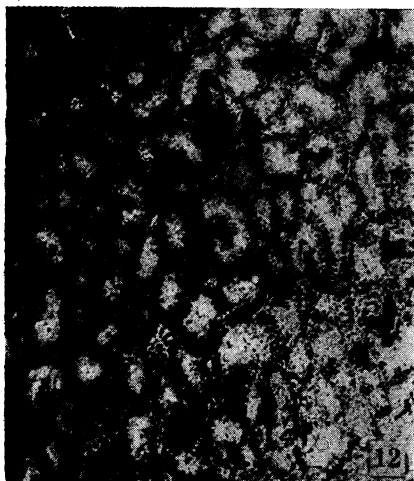
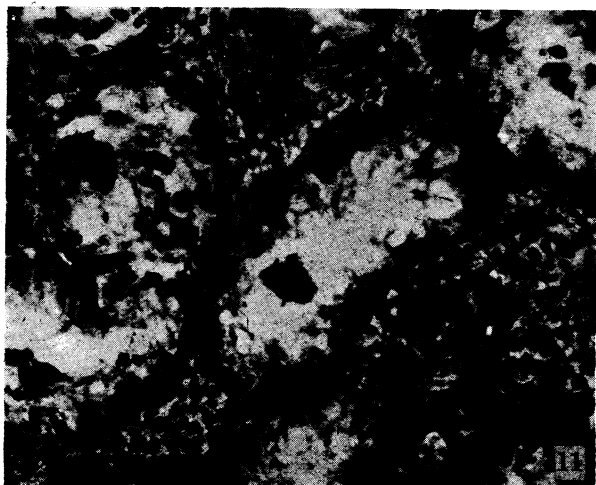
rudimentary structure, being smaller in size and weight than those of the normal cockerels of the same age.

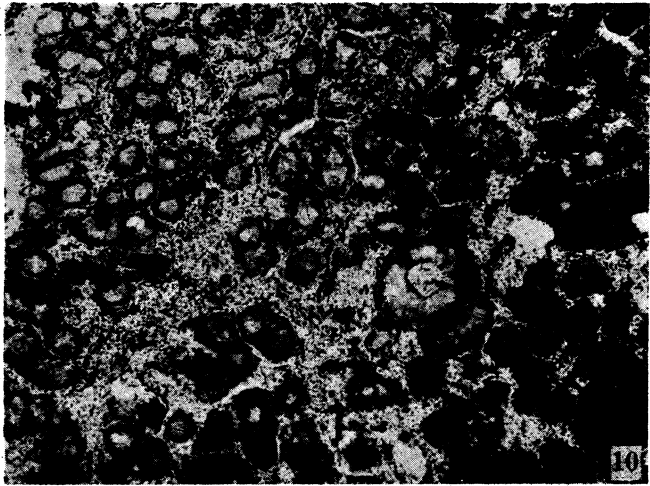
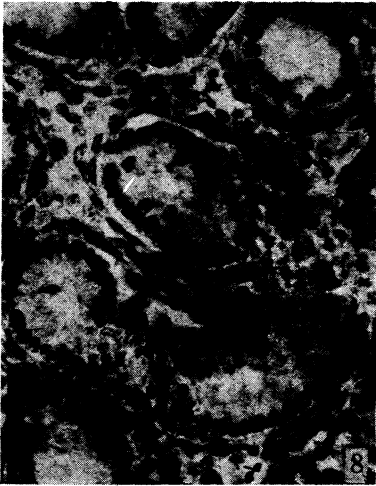
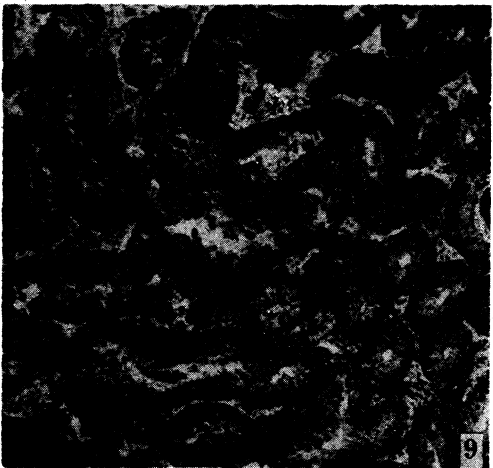
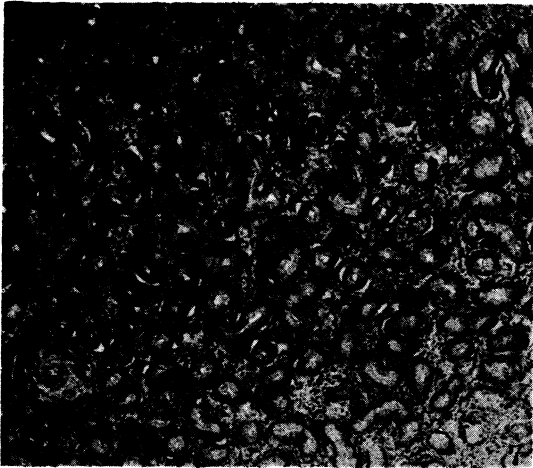
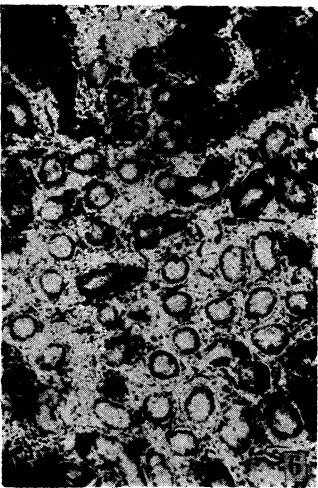
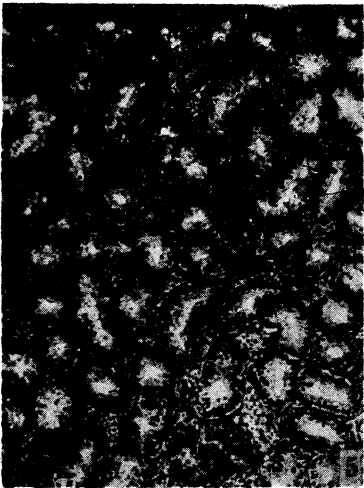
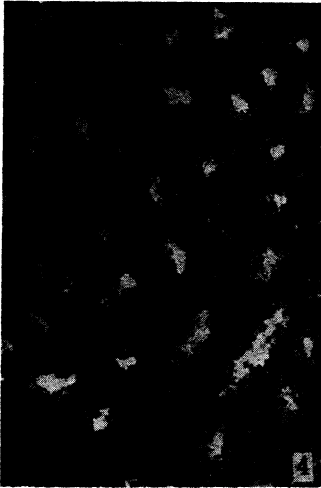
Histological observations of these testes proved them to be degenerative in structure (cf. Figs. 6, 7, 8, 10, 11). Considered from the facts ascertained in mammals with the similar subject (GATENBY and WIGODER '29, SNELL '33), it is evident that the shrinkage of the seminiferous tubules is due to the degeneration of germ-cells included, being occasioned by x-rays. HIDA and KUGA ('11) reported the degeneration of the germ-cells in the testes of adult fowl subjected to x-rays. Recently ROLF, SCHRÖDER and HIGGINS ('34) reported that the birds exposed to x-rays at six weeks of age, had conspicuously rudimentary testes, as well as combs and wattles which were smaller in size than those of the normal cockerels. These treated birds, according to them, lost their ability to crow.

The birds affected by x-rays applied in this study, had noticeably smaller combs and wattles than the normal cockerels of the same age. In general appearance they resembled closely the surgical capons, but none of them developed the characteristic plumage of a capon. From external characteristics they would be classified as "slips" rather than true capons. The evidence seems to indicate that the x-ray radiation concerned in this study did not completely inhibit the production and action of the testicular hormone responsible for the production of plumage characteristic of a capon. However, the results obtained in this study, and also those attained by ROLF, SCHROEDER, and HIGGINS ('34), are sufficient to suggest a possibility in the production of capons by means of the x-ray treatment of the cockerels, showing that more adequate amounts of radiation and more proper methods of treatment may produce a true capon.

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Explanation of Figs. 4 to 16

All are photomicrographs of the sections of testes which were taken with the aid of the Leitz-Makam.

4. Testes of No. 1 x-rayed specimen. $\times 100$.
5. Testes of No. 1 control specimen. $\times 100$.
6. Testes of No. 2 x-rayed specimen. $\times 100$.
7. Testes of No. 2 x-rayed specimen. $\times 100$.
8. Testes of No. 2 x-rayed specimen. Enlarged view ($\times 400$) showing the degenerative seminiferous tubules.
9. Testes of No. 2 control specimen. $\times 100$.
10. Testes of No. 3 x-rayed specimen. $\times 100$.
11. Testes of No. 3 x-rayed specimen, Enlarged view ($\times 400$) illustrating the degenerative seminiferous tubules.
12. Testes of No. 3 control specimen. $\times 100$.
13. Testes of No. 4 x-rayed specimen. $\times 100$.
14. Testes of No. 4 x-rayed specimen. $\times 100$.
15. Testes of No. 5 x-rayed specimen. $\times 100$.
16. Testes of No. 6 x-rayed specimen. The mosaic testes. $\times 100$.