EFFECT OF EXCESSIVE DOSAGES OF THYROID ON THE DOMESTIC FOWL.*

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In attempting an analysis of the character of barring in poultry its physiological basis was studied. Since barring is due to the rhythmic deposition of black pigment and since other workers who fed the thyroid gland of cattle to poultry found that the pigmentation of the feathers was affected, it was decided to study the effect of feeding thyroid to Barred Plymouth Rocks.

The thyroid, which is one of the endocrine or ductless glands, is located in the fowl on the ventral side of the common carotid artery at a point where it touches the jugular vein. It is a small, oval, red body with a fibrous capsule. There are two small parathyroid bodies attached to the lower pole of the thyroid.

OTHER WORK.

Much work has been done with the treatment of various species of animals with thyroid. However, the work with the domestic fowl is somewhat limited. The earliest work was done by C. J. and C. Parhon (1914), who fed dry thyroid powder every other day (.15 grams) to 6 pullets. Marked excitability resulted, with tremors and ischemia or local anemia of the comb. Five of the thyroid-fed pullets were at the end of a year exposed to cholera, 2 surviving (40 percent. survival). Of nine similar control pullets one survived (11.11 percent. survival). The authors were led to conclude that "this confirms the rôle of the thyroid gland in the production of immunity."

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Torrey and Horning (1925) suggested "a certain antagonism between ovary and thyroid in connection with pigment formation that has no counterpart in the male." Crew and Huxley (1923), with daily feeding of 2 grams of desiccated thyroid per chick from 3 months to 7 months of age, to R. I. Reds or Light Sussex males, failed to observe the assumption of hen-feathering noted by Horning and Torrey.

Giacomini (1924) fed raw ox thyroid to fowls, starting with pieces the size of a hemp seed, gradually increasing the dosages until in some cases as much as 5 grams was fed daily. He observed depigmentation and a "profound stimulating and accelerating action of the thyroid hormones" upon basal metabolism, especially catabolism. Zavadovsky (1925a) fed excessive dosages, which were highly toxic and caused a precipitous molt followed by striking depigmentation in the new feather growth. Zavadovsky (1925b) notes that with single dosages of 30 to 50 grams of desiccated thyroid gland there was a complete fall of the feathers by the seventh to fourteenth day, followed by a new growth of plumage by the 21st to 30th day. He attributed the striking change in plumage to the specific action of the thyroid on the pigment-forming mechanism. Horning and Torrey (1927) criticize this explanation and in referring to the excessive dosages as highly toxic state that the striking change in plumage is "induced by an excessive, essentially toxic dosage of thyroid rather than a specific action of the latter (thyroid) on the pigment-forming mechanism." In all their work they used non-toxic dosages, usually 1 gram of desiccated thyroid per 5,000 grams of body weight of the fowl. With such dosages they were able to maintain the health of the hens, which in turn also laid hatchable eggs.

Method of Procedure.

In order to study the effect of large dosages of desiccated thyroid on barred plumage, hens, cockerels and capons were fed single doses varying from 10 grams to 35 grams. On January 9, 1926, ten Barred Plymouth Rock hens (hatched April, 1925) from the production-bred strain kept at the University of Wisconsin, were penned separately and fed thyroid.[1] Since large dosages

[1] Armour's desiccated ox thyroid, U. S. P. 0.2 per cent. Iodine.

were fed it was thought best to add it to the mash. In several cases the hens did not eat all the mash so the remaining portion was weighed back and the approximate consumption of thyroid computed. The birds were weighed at the start of the test and observed for condition of molt. The feathers loosened and a molt occurred in all hens fed 10 or more grams.

General Results on Hens.

In all cases, thyroid administration was followed by an increased nervousness and activity. Plymouth Rock hens, normally of a rather gentle or phlegmatic disposition soon changed to a highly nervous condition. They resembled more the Leghorn in nervous temperament and activity, indicating the possibility of a breed difference in basal metabolism, having its seat in the thyroid gland. The thyroid-fed hens developed a high, shrill voice uncommon to Barred Plymouth Rocks.

Among the eight hens which survived thyroid administration seven showed a loosening of the feathers, which pulled out quite easily from 4 to 9 days later. A rather precipitous molt followed in these 7 hens in from 7 to 10 days (see figure 1). Careful

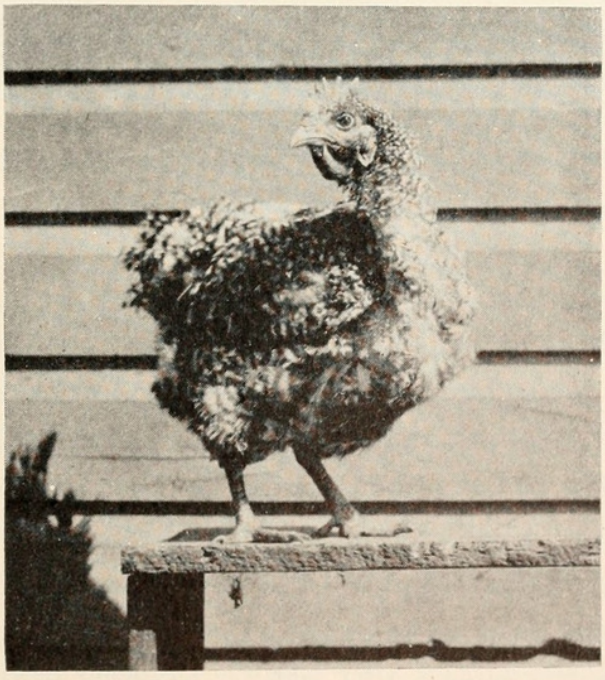

Fig. 1. Hen 4101 showing molt induced by single heavy dose of thyroid: fed 20–22 gms. thyroid Jan. 24, 1926; photographed Apr. 5, 1926.

records of the rate of molt were kept for hens 112 and 152. The feathers apparently loosen by the fourth day after thyroid administration and a molt follows by the seventh day, reaching its height by the eighth to eleventh day and then slackening rather abruptly by the fourteenth day, after which only a few occasional feathers fall. It is interesting to note that the incoming feather germs

TABLE I.

SHOWING DOSAGES FED HENS AND EFFECT ON FEATHERS.

Band Number.	Amount of Thyroid.	Days Elapsing Until		
		Feathers Loosen.	Body Molt.	White Appears.
57	8 to 9 Grams	No molt		None
2355	12 to 14 Grams	9	9	None
3670	10 Grams	8	10	None
4101	20 to 22 Grams	5	9	30
3930	23 to 25 Grams	Died Five Days Later		
47	15 Grams	No molt		
	15 Grams [1]	Died One Day Later		
110	20 to 25 Grams	Loose at start	9	30
119	15 to 18 Grams	8	10	44
152	8 to 9 Grams	No molt		None
	24 Grams [2]	4	7	40
112	0 Grams	Not loose	None	None
(Control)	30 Grams [2]	4	8	40

take several days longer to loosen the primary and secondary wing feathers than the body feathers. This precipitous type of molt is not uncommon to heavy layers which molt late (October and November).

The fact that such sudden and precipitous molts do occur in late-molting heavy-laying hens under normal conditions and that molt was not precipitated when 50 mg. of sodium arsenite was fed to 3 different Leghorn pullets (75 mg. proving lethal) tends to indicate that the striking molt was due to a hyperthyroid condition, speeding up abnormally the basal metabolism, rather than to the toxic effect of larger than physiological doses.

[1] Additional dose fed 7 days later.

[2] Fed in capsules 30 days after negative treatment noted above.

Feather Renewal.

In five of the seven hens in which molt occurred there was noticeable depigmentation in the new feathers. All seven hens showed a silky nature of the feathers growing in after thyroid feeding. Horning and Torrey (1923) noted "a corresponding in-

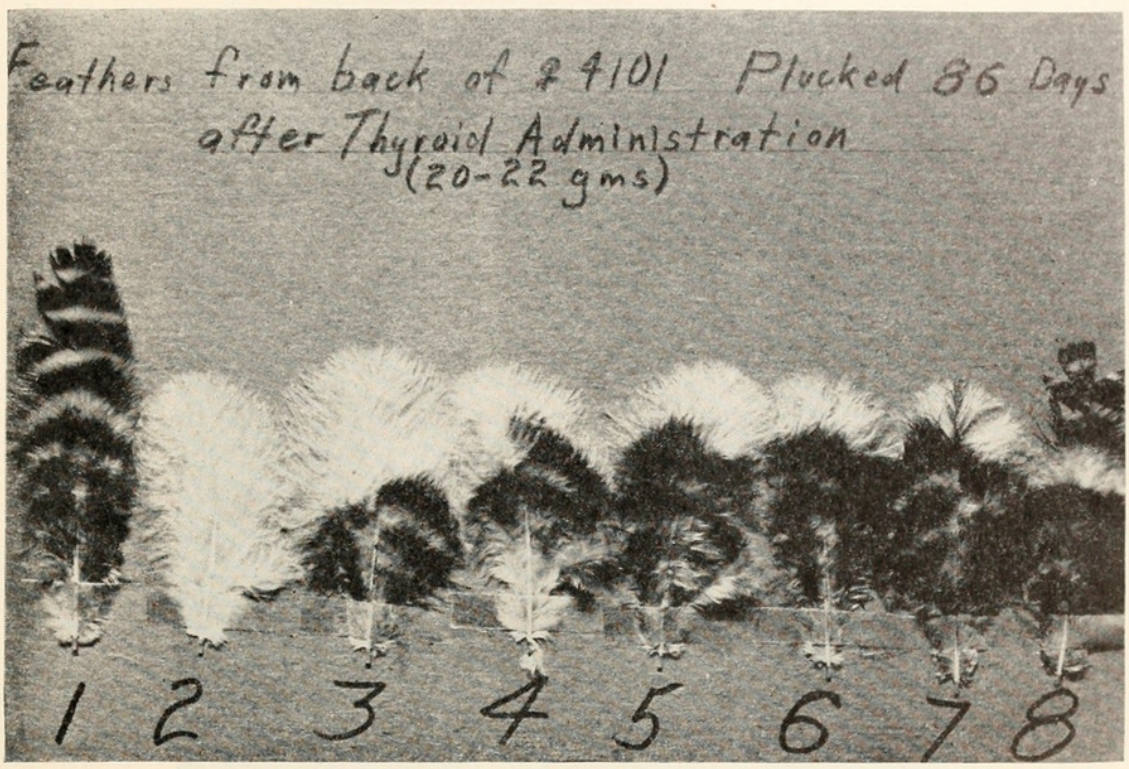

Fig. 2. Effect of thyroid administration on feather structure and pigmentation.

crease in the number and distribution of the barbules on the barbs" following thyroid feeding. Later, these authors (Horning and Torrey, 1927) report that "as a rule, this pigment is carried by the barbules and limited by their distribution."

Figure 2 shows feathers taken hen 4101 (fed 20 to 22 grams) after renewal of the feathers subsequent to thyroid feeding. Feather No. 1 shows the normal plumage, since it is a feather that was not molted. Feathers 2 to 7 show increasing amounts of pigmentation. All 8 feathers were taken from the back of Hen 4101, illustrated in Fig. 1. The heavy condition of molt of the hen is noticeable in Fig. 1 (Note the similarity to a rapid molting high producer). The photographs of the hen were taken 70 days

after thyroid administration. Feathers 2 to 5 (Fig. 2) are completely silky in appearance, there being on observation with the naked eye no apparent interlocking of barbules on adjacent barbs as illustrated and described by Lloyd-Jones (1915). Feathers 6 and 7 show a slight interlocking close to the shaft at its distal end.

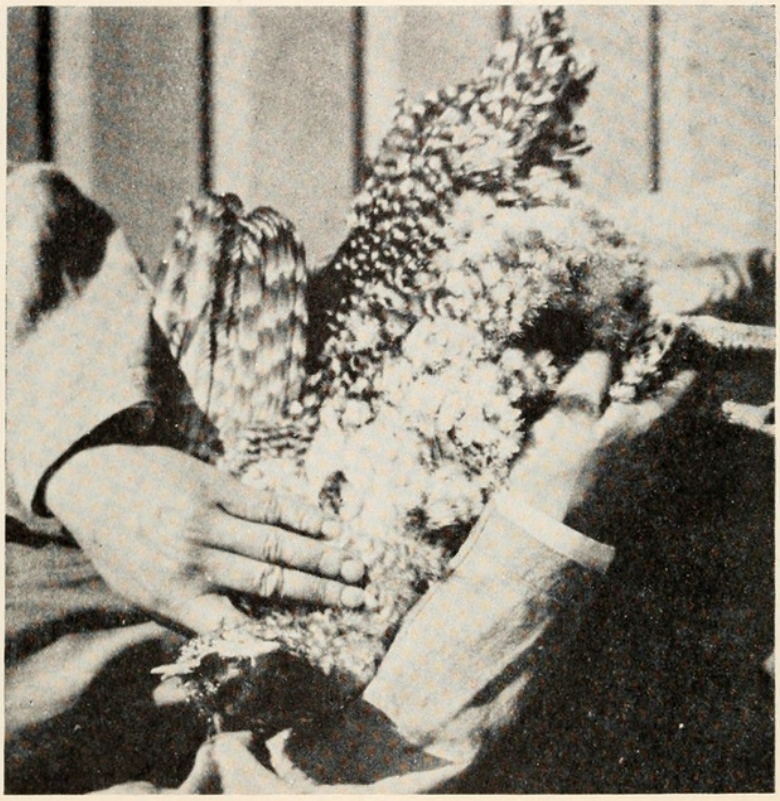

FIG. 3. Hen 4101 showing depigmented feathers under left wing (also abundant under right wing and on back). After subsequent molt, feathers in these same areas were normally barred when observed, Aug. 30, 1926.

Feather 8 had obviously commenced its growth prior to thyroid feeding as the distal end, including the first three black bars and two white bars, is normal in every respect (the portions missing in feathers 1 and 8 were removed for microscopical examination). The abnormally wide white bar in feather 8 resulted from thyroid feeding. This white bar and the remaining proximal portion of the feather are of the silky nature indicating the absence of interlocking barbules. A microscopical examination reveals the absence of the hooked hæmules of the barbules in the lower silky-

appearing portion of the feather and their presence in the distal (normal appearing) end. This is illustrated in Fig. 4. The "silky" barbule has essentially the same appearance as in the silky fowl. This similarity indicates the possibility that the mechanism causing the presence of silky feathers in the silky fowl has its seat

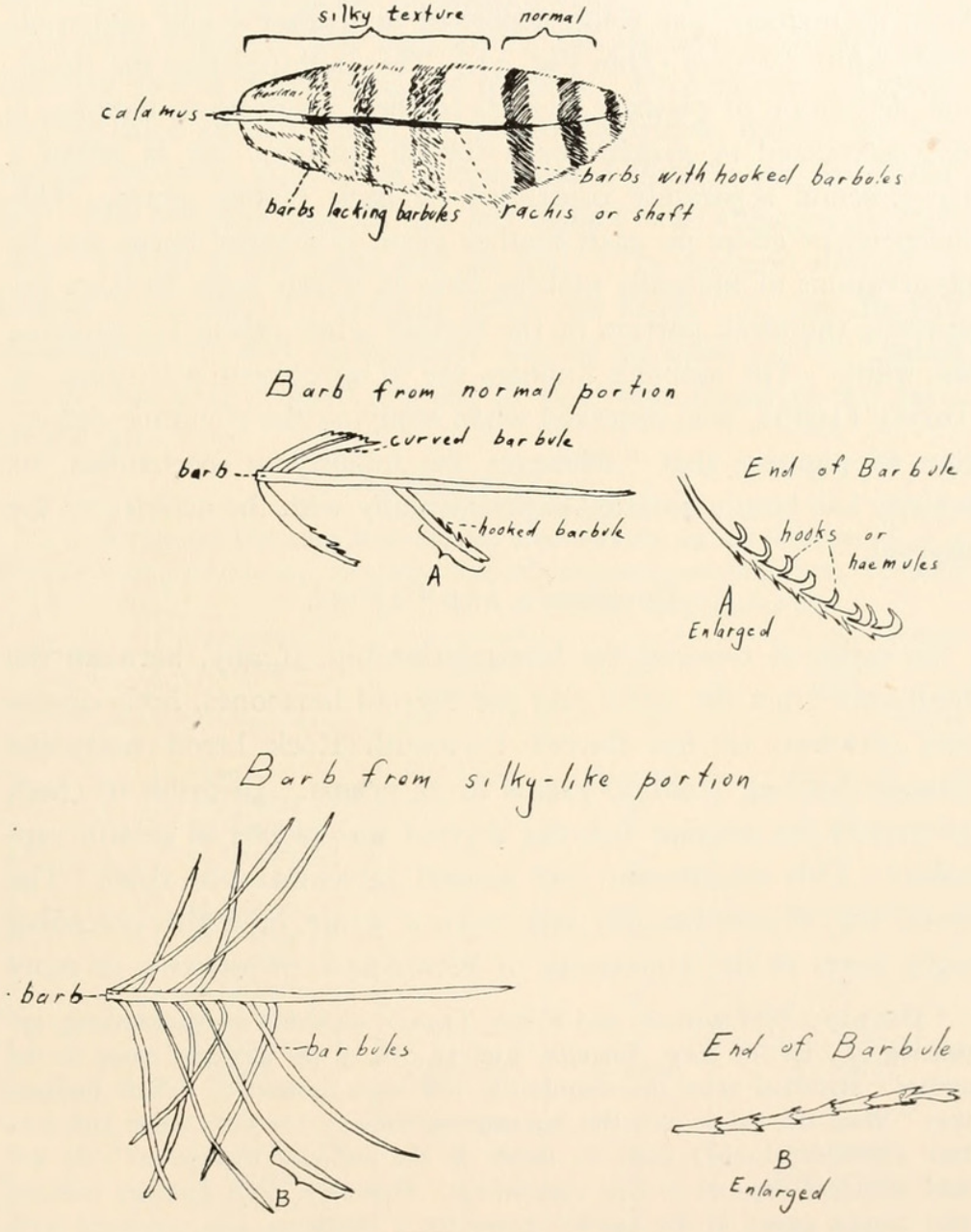

FIG. 4. Feather No. 8 from ♀ 4101. (See Fig. 2.)

in the thyroid gland. Perhaps a hormone from the thyroid gland in this breed, transmitted to each feather germ through the blood

stream, has an inhibitory effect on the barbules thereby preventing the development of hooks (hæmules).[1]

It is noticeable from a glance at Figs. 2 and 3 that feathers being renewed at the same time have black pigment (melanin) deposited in differing amounts. While pigment was being deposited in rhythmic waves in feathers 5, 6 and 7, resulting in well-defined bars, no pigment was being deposited in feather 2 and numerous other white feathers (note Fig. 3). This indicates that the rhythmic deposition of pigment in each feather, resulting in barring, is not centralized or synchronized for all feathers, but is rather a phenomenon separately controlled by each feather germ. This independent effect on each feather germ is further borne out by observations of normally molting hens in which some feathers are growing the black portion of the feather while others are growing the white. The author's findings are in agreement with those of Torrey (1926), who observed when studying the rhythmic deposition of pigment that "whatever the underlying mechanism, its activity has been associated experimentally with the activity of the thyroid."

Cockerels and Capons.

In order to observe the interrelationship, if any, between the hormones from the testes and the thyroid hormones, both capons and cockerels of the Barred Plymouth Rock breed were fed dosages varying from 10 grams to 35 grams. In order to check accurately the amount fed, the thyroid was placed in gelatin capsules.[1] This experiment was started December 22, 1926. The stock was March hatched and from a strain bred the preceding eight years at the University of Kentucky. When two or more

[1] The paper by Danforth and Foster (1929), on skin transplantations, appearing in *Jour. of Exp. Zoology,* Vol. 52, No. 3, pp. 443–470, came to the author's attention after this manuscript had been submitted. Their findings that "With the Silkie . . . the determining factors for both color and texture (hookless barbs) seem to reside in the follicles themselves" do not lend apparent support to this supposition. However, both findings indicate that certain genes in the feather germ for a character are expressed with the aid of hormones circulating through the blood stream to the feather during its development.

[1] Quarter-ounce capsules, each containing 5 grams of thyroid, were used. The large end of the capsule was dipped in cod liver oil before administration to aid in the passage through the gullet and the crop.

doses were fed they were administered on succeeding days. Ten cockerels and ten capons were given doses as indicated in Table II. Two controls were kept of both capons and cockerels.

It should be noted that 2 capons and 1 cockerel died after administration of thyroid. The temperature of the capons was extremely high just prior to death (111½° and 116° F.) The birds were down on their legs, giving the appearance of paralysis, and they died in convulsions and tremors. Post-mortem examination revealed in both cases contracted ventricles, dilated auricles and an excessive amount of straw-colored fluid in the pericardial sac. The anterior lobe of the left kidney was enlarged in each case. Edema of the lungs was marked. The cockerel showed no adverse symptoms the evening before his death. A post-mortem examination showed appearances similar to those of the capons except that only a small amount of fluid was found in the pericardial sac.

TABLE II.

SHOWING DOSAGES FED MALES AND EFFECT ON FEATHERS.

Coop.	Amount of Thyroid.	Days Elapsing Until		
		Feathers Loosen.	Slight Molt.	Heavy Molt.
Capons				
1	Control	Not loose	No molt	No molt
2	10 Grams (1) [1]	9	9	23
3	15 Grams (1)	6	9	10
4	15 Grams (1)	6	10	23
5	20 Grams (1)	3	3	9
6	20 Grams (2)	6	10	Not heavy
7	25 Grams (2)	6	9	10
8	25 Grams (5)	6	9	10
9	30 Grams (2)	3	9	10
10	30 Grams (3)	3		(Died—5 days)
11	35 Grams (2)	3	3	(Died—5 days)
12	Control	Not loose	No molt	No molt
Cockerels				
21	Control	Not loose	No molt	No molt
22	10 Grams (1)	10	10	Not heavy
23	15 Grams (1)	6	9	Not heavy
24	15 Grams (1)	9	10	10
25	20 Grams (1)	6	10	Not heavy
26	20 Grams (2)	6	10	Not heavy
27	25 Grams (2)	6	7	10
28	25 Grams (5)	6		(Died—7 days)
29	30 Grams (2)	6	10	13
30	30 Grams (3)	6	9	10
31	35 Grams (2)	6	9	10
32	Control	Not loose	No molt	No molt

[1] Total amount divided into number of doses indicated in parenthesis.

Feather Changes.

Areas of the saddle and back were plucked at the time of thyroid administration in order to check on the new feathers grown. In addition to the growth of feathers in the plucked areas, new feathers grew to replace those molted. In structure and depigmentation the new feathers resembled those discussed in detail in the case of the hens. However, the depigmentation was not nearly so marked in the males.

Effect on Weight.

All the males were weighed at the time of thyroid administration and at stated intervals thereafter. At the same time, body temperature was taken by inserting the bulb of a clinical thermometer well into the vent. Work of Fronda (1921) shows that the body temperature of the fowl is nearest the average or normal from 4 to 6 P.M. and 8 to 10 A.M., hence the temperatures were

Table III.

Body Weight of Males.

Coop.	Weight at Start.	Gain [1] at 48 hrs.	Gain [1] at 5 days.	Gain [1] at 7 days.	Gain [1] at 12 days.	Gain [1] at 31 days.
Capons						
1 (Control)	6 lbs. 12 oz.	0 oz.	−2 oz.	−4 oz.	+1 oz.	+4 oz.
2	6 lbs. 15 oz.	−3	−9	−9	−4	+5
3	7 lbs. 12 oz.	−11	−15	−12	−11	−3
4	7 lbs. 8 oz.	−8	−9	−4	0	+2
5	7 lbs. 15 oz.	−6	−10	−11	−3	+1
6	8 lbs. 15 oz.	−9	−14	−7	−5	+5
7	7 lbs. 2 oz.	−4	−18	−21	−9	−2
8	7 lbs. 2 oz.	−1	−6	−14	−11	+3
9	8 lbs. 8 oz.	−6	−12	−15	−9	−3
10	6 lbs. 12 oz.	−8	−12	Dead		
11	8 lbs. 4 oz.	−4	−13	Dead		
12 (Control)	7 lbs. 0 oz.	+4	+4	+2	+7	+8
Cockerels						
21 (Control)	7 lbs. 12 oz.	+5	+1	+3	+8	+9
22	8 lbs. 12 oz.	−4	−7	−4	+1	+8
23	8 lbs. 0 oz.	−1	−1	0	+4	+16
24	7 lbs. 8 oz.	−4	−11	−17	−8	+3
25	7 lbs. 10 oz.	−2	−5	−1	+2	+17
26	8 lbs. 8 oz.	−1	−11	−19	−11	−3
27	7 lbs. 14 oz.	−3	−18	−9	−7	+2
28	8 lbs. 6 oz.	−1	−6	−20	Dead	
29	7 lbs. 15 oz.	−3	−11	−14	−13	+1
30	8 lbs. 9 oz.	−3	−5	−7	−4	+1
31	7 lbs. 11 oz.	−3	−11	−7	−3	+5
32 (Control)	7 lbs. 9 oz.	+8	+7	+9	+11	+19

[1] Based on weight at start.

taken at those times. Table III. shows the effect of thyroid administration on weight and Table IV. the effect on temperature. The average weight of the four controls was 7.26 pounds, while

TABLE IV.

TEMPERATURE OF MALES.

Coop.	Temperature at Start.	Decrease [1] at 48 hrs.	Decrease [1] at 5 Days.	Decrease [1] at 7 Days.
Capons				
1 (Control)	107 1/5° F.	0.2° F.	0.2° F.	0.2° F.
2	106 4/5°	1.4°	0.2°	0.4°
3	106 2/5°	1.2°	0.8°	0.0°
4	106 4/5°	2.4°	0.4°	0.4°
5	106 4/5°	1.4°	0.4°	0.4°
6	106 2/5°	0.8°	0.4°	0.4°
7	106 2/5°	1.4°	1.6°	0.4°
8	106 4/5°	1.2°	2.2°	2.0°
9	106°	0.8°	0.0°	0.6°
10	107 4/5°	2.4°	3.7°	Dead
11	106 4/5°	1.6°	9.2°	Dead
12 (Control)	106 3/5°	0.0°	0.6°	0.2°
Average of treated birds		1.46°	1.95°	0.57°
Average of controls		0.1°	0.4°	0.2°
Cockerels				
21 (Controls)	107 3/5°	0.6°	1.0°	0.2°
22	106 4/5°	1.8°	0.2°	0.2°
23	106 4/5°	1.0°	0.0°	0.4°
24	106 4/5°	1.2°	0.4°	0.4°
25	107°	0.8°	0.0°	0.4°
26	106 2/5°	0.2°	0.0°	0.2°
27	106 4/5	1.6°	0.0°	0.6°
28	106 3/5°	0.8°	0.4°	Dead
29	106 3/5°	0.8°	0.2°	0.4°
30	106 2/5°	1.0°	0.6°	0.0°
31	106 2/5°	0.6°	0.2°	0.4°
32 (Control)	106 2/5°	0.4°	0.4°	0.4°
Average of treated birds		0.82°	0.2°	0.33°
Average of controls		0.5°	0.7°	0.3°

that of the 20 thyroid-fed males was 7.88 pounds, hence it may be seen that the birds to be fed thyroid had a slight advantage in size at the start of the test. At the expiration of 48 hours after administration of the first dose, all thyroid-fed males had lost weight (varying from 1 to 11 ounces per bird) whereas no loss of weight appeared in the controls. In 19 of the 20 thyroid-fed males loss in weight increased from the 2d to the 5th day. By

[1] Based on temperature at start, capon temperatures taken from 4 to 6 P.M., and cockerel temperatures taken from 8 to 10 A.M.

the 7th day 9 of these had regained some of the loss in weight. The capons averaged a loss of 6 ounces each by the second day, whereas the cockerels lost only 2.5 ounces. By the 5th day the capons had lost an average of 11.8 ounces each and the cockerels 8.6 ounces each. When compared with the controls it may readily be seen that a decided loss in weight occurred subsequent to thyroid administration, the loss being more pronounced in the capons than in the cockerels. This loss in weight was found by Giacomini (1924) to follow thyroid administration in larger than physiological doses, and was attributed by him to the stimulus given to basal metabolism (especially catabolism), rendering such birds unable to utilize properly the carbohydrates in the feed. However, he reported no difference in the effect on capons and cocks, whereas the writer found indications of a greater disturbance, occurring more quickly, with the capons, substantiated by the greater drop in temperature. Perhaps this may be due to a lack of compensatory hormones from the testes.

Effect on Temperature.

The average temperature of the controls was 106.95° F., and of the birds to be fed thyroid 106.68° F. at the beginning of the test. Thyroid administration resulted in a significant decrease of the body temperature. Forty-eight hours after giving the first dose the average temperature of the controls was 106.65° F. whereas that of the 20 birds fed thyroid was 105.54° (1.11 degrees lower than controls). The average decrease for the capons was 1.46°, while for the cockerels it was only 0.82°.

Summary.

1. Single doses of desiccated thyroid ranging from 8 to 30 grams although producing physiological shock were not lethal to hens.

2. Single doses of 30 to 35 grams proved lethal to two out of three capons.

3. Cockerels are able to withstand single dosages as large as 35 grams.

4. Single doses varying from 8 to 35 grams cause a loosening

of the feathers in from 3 to 10 days. Molt commences in from 3 to 10 days.

5. Depigmentation occurs during feather renewal following the precipitous molt. It was quite noticeable in 30 days after feeding.

6. A silky texture to the feathers was noticeable following thyroid feeding.

7. The hooks or hæmules are absent from the barbs in the feathers growing in immediately following thyroid feeding in larger than physiological dosages.

8. Thyroid feeding in large doses causes a change in nervous temperament of the Plymouth Rock, making it highly excitable.

9. Loss in body weight follows feeding of thyroid in large dosages, more especially in capons.

10. Thyroid feeding has a depressing effect on body temperature when fed in large dosages, capons showing a greater depression than cockerels.

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