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A. Bralis

The Effect of Hyperthyroidisation on the Plumage of Carnivorous Birds

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THE EFFECT OF HYPERTHYROIDISATION ON THE PLUMAGE OF CARNIVOROUS BIRDS

BY

A. BRALIS

With 12 figures in the text.

(Institute of Comparative Anatomy and Experimental Zoology of the Latvian University in Riga. Director: N. G. LEBEDINSKY.)

CONTENTS.

I. INTRODUCTION.

During the latter years a considerable amount of investigating work has been done on the influence of fresh thyroid gland and preparations of it on the growth and development of the feathers of birds. But all these researches with a few exceptions refer to granivorous birds, principally domestic fowls. The literature, however, on the influence of the thyroid gland on the organism of carnivorous birds is but very scanty. It is to contribute to the eludication of this question that the present investigations were undertaken.

As has been shown by the researches of B. M. ZAWADOWSKY (1925 a, b and 1926) and J. PODHRADSKY (1926) the hyperthyroidisation per os or per injectionem provokes in fowls a premature moulting and acts as a stimulant on the growth of feathers leading to a certain point to their depigmentation.

The minimum doses producing these phenomena were 1 to 2 gr. of a thyroid gland preparation in a single application, or 0,2 gr. daily during a prolonged feeding. The few specimens of carnivorous birds (two specimens of *Syrnium aluco* and one of *Tinnunculus cenchris*) on which B. ZAWADOWSKY (1926) experimented, received a single dose of 13 to 14 gr. of the thyroid gland preparation (*Syrnium aluco*) and 25 to 35 gr. of fresh gland (*Tinnunculus cenchris*). In my work I maintained the method of regular thyroidisation, i.e. every bird under experiment received regularly every day and during a certain period of time a fixed quantity of the thyroid gland preparation. As results from the works of B. ZAWADOWSKY and others this latter method is more effective as compared with the first, and this not only on the organism of granivorous but also of birds of mixed diet (Corvidæ). B. ZAWADOWSKY (1926) succeeded in receiving positive results only after employing the latter method.

Thyroidisation acts in the same stimulating way also on young birds wearing their juvenal plumage ("erstes Umrissgefieder" of B. BLANCKE, "plumage infantile" of PÉZARD, SAND and CARIDROIT, 1925).

Experimenting on young fowls of the races White-Leghorn and Brown-Leghorn B. HORNING and H. B. TORREY (1925) found that under the influence of thyroidisation an increased shedding of the "plumage infantile" takes place, and an acceleration of growth of the definitive feathers, the "plumage adulte" of PÉZARD, SAND and CARIDROIT (1925), or "zweites Umrissgefieder" of B. BLANCKE.

According to J. C. PARHON and C. PARHON fils (1924) the exstirpation of the thyroid gland produces in young geese a retarding influence on the formation of definitive feathers, the "plumage adulte", and in consequence the thyroid gland acted here also in a stimulating way on the formation of the said feathers.

In his experiments on chickens covered with down only (all previous experiments were carried on with birds in their juvenile plumage only) J. KRIŽENECKY (1926) found that thyroidisation acts stimulating also on the "plumage infantile". An exception made only the chickens on the partridge-plumed Italian race, on which thyroidisation was not influential. J. KRIŽENECKY explains this latter fact as resulting from the fastness of feathering and is of the opinion that thyroidisation cannot be of any influence at a maximal fastness of feathergrowth. The fastness of feathering is a property peculiar to certain varieties of birds, and, as has been shown by B. C. WARREN (1925), is inherited, slow feathering dominating over fast.

It must be pointed out, however, that thyroidisation does not in all cases act as a stimulant on the growth and development of bird-feathers. Thus, as has been observed by J. C. PARHON and C. PARHON (1923), feeding young ducks with thyroidine had a retarding influence on the formation of

definitive feathers. Thyroidisation does not influence also the regeneration of extracted feathers, as described by J. KRIŽENECKY, M. HEVALONNYJ and J. PETROV (1927).

The latter facts are so to say transitory between the stimulating influence of the thyroid gland on the organism of granivorous and the inferior efficiency of this gland on carnivorous birds.

I wish to express here my sincerest thanks to Prof. Dr. N. G. LEBEDINSKY for his amiable advises during the work.

II. MATERIALS AND METHODS.

As experimenting material served representatives of the families Strigidæ (*Syrnium aluco, Bubo bubo*), Falconidæ (*Buteo buteo*) and *Ardeidæ* (*Botaurus stellaris*). Each specimen under observation was placed into a large volery 2 m. high, 2,5 m. long and 1 m. wide, and owing to the spaciousness of it the bird was comparatively at ease. The food consisted of fresh meat and mice.

Every morning all shed feathers were collected and weighed. A regular collecting and weighing of the shed feathers was made also before the beginning of the thyroidisation. During a certain period of time the birds received daily per os a pulverised preparation of the thyroid gland, prepared by the chemical laboratory of G. GRÜBLER at Lipsic. As has been mentioned above the action of the preparation on the organism of birds used after the method of regular thyroidisation is stronger when compared with the method of a single dose of thyroid gland.

The maximal daily dose of the preparation thyreoidea sicc. used in the experiments was 15 gr., the minimal 0,25 gr. The dose of 15 gr. could not be increased for the reason that it was impossible to mix with the food a larger quantity of this exceedingly light dried and pulverised preparation. Fearing to give large doses from the beginning, they were gradually increased. In cases when the birds began to show signs of a toxic effect due to the preparation, the doses were for some days diminished or entirely suspended.

The particulars and results of the feeding are shown on table I.

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Table I.

Species	Duration of experiment	Doses of preparation		Time of moulting	Notes
		daily (gr.)	every other day (gr.)		
Syrnium aluco No. 1.	February			4 April — 25 June	died 26 June
	28	—	0,25		
	March				
	1—5	—	0,25		
	6—9	0,25			
	10	—			
	11—12	0,25			
	13—16	0,5			
	17	—			
	18—19	0,5			
	20—21	1,5			
	22—25	—			
	26—28	0,75			
	29	—			
	30	0,75			
	31	0,5			
	April				
	1—6	0,5			
	7	—			
	8—13	0,5			
	14	—			
	15—18	0,75			
	19	—			
	20	0,75			
	21	—			
	22—27	1,0			
	28	—			
	29—30	1,0			
	May				
	1	—			
	2—4	1,0			
	5	—			
	6—8	1,0			
	9	—			
	10	1,0			
	11—29	—			
	30—31	0,5			

THE EFFECT OF HYPERTHYROIDISATION

Table I (continuation).

Species	Duration of experiment	Doses of preparation		Time of moulting	Notes
		daily (gr.)	every other day (gr.)		
Syrnium aluco No. 1.	June				
	1	—			
	2	0,5			
	3—4	—			
	5	0,5			
	6	—			
	7—8	0,5			
	9	—			
	10	0,5			
	11	—			
	12—14	0,5			
	15—25	—			
Syrnium aluco No. 2.	May				
	30—31	1,0			
	June				
	1	1,0			
	2	—			
	3—8	1,0			
	9	—			
	10—11	1,0		3 June — 19 June	
	12—14	1,5			
	15—16	—			died 20 June
	17—18	2,0			
	19	2,5			
Bubo bubo	May			18 May — 25 July	
	18—27	1,5			
	28—29	—			chloroformed 28 October
	30—31	1,5			
	June				
	1	1,5			
	2	—			
	3—6	2,0			
	7—8	2,5			
	9	—			
	10—11	2,5			
	12—14	3,5			

Table I (continuation).

Species	Duration of experiment	Doses of preparation		Time of moulting	Notes
		daily (gr.)	every other day (gr.)		
Bubo bubo	June				
	15—16	—			
	17	4,0			
	18—20	5,0			
	21—30	—			
	July				
	1—13	3,0			
	14—23	—			
	24—25	4,0			
	26—27	—			
	28—31	4,0			
	August				
	1—6	4,0			
	7—16	—			
	17—31	5,0			
	September				
	1—10	—			
	11—20	1,5			
	21—25	—			
	26—30	2,0			
	October				
	1—5	2,5			
	6—15	—			
	16—20	10			
	21—30	—			
Buteo buteo	August			no moulting	set free 24 October
	11—21	1,0			
	22—31	—			
	September				
	1—10	5,0			
	11—20	—			
	21—30	10			
	October				
	1—5	—			
	6—8	15			
	9—20	—			

Table I (continuation).

Species	Duration of experiment	Doses of preparation		Time of moulting	Notes
		daily (gr.)	every other day (gr.)		
Botaurus stellaris . .	February			no moulting	died 23 March
	28		0,25		
	March				
	1—5		0,25		
	6—9	0,25			
	10	—			
	11—12	0,25			
	13—19	0,5			
	20—21	1,5			
Syrnium aluco No. 3	July			no moulting	died 6 August
	16—25	—	0,5		
	26—31	0,5			
	August				
	1—4	0,5			
Syrnium aluco No. 4.	August			no moulting	experiment terminated 14 October
	11—15	0,5			
	16—25	—			
	26—31	0,5			
	September				
	1—8	0,5			
	9—16	—			
	17—30	1,0			
	October				
	1—4	1,0			
	5	—			
	6—12	1,0			
	13	—			
	14	1,0			

III. DESCRIPTION OF THE EXPERIMENTS.

1. Syrnium aluco No. 1.

The experiment was begun on the 28. II. 1929 and ended on the 25. VI. of the same year. From the beginning up to the 10. V., i.e. during 72 days the bird was under an almost uninterrupted influence of thyroidisation. As shown on table I the bird under experiment received during the first six days

0,25 gr. of the preparation every other day, then the same dose daily, and afterwards the dose was augmented first to 1,0 gr. a day and on the 20. and 21. III. to 1,5 gr.

This latter dose had a bad effect on the bird, which became irritable and lost appetite, so that it was necessary to give it up. After an interruption of 4 days the thyroidisation was continued and the bird received from that time on daily 0,75 gr. of the preparation.

On the 26. VI. the bird died in convulsions. The section showed it to be a male. No depigmentation or any change in colour were observed (fig. 1). The weight was 350 gr. Feathers were shed continuously during the whole period of the thyroidisation. A short interruption in moulting is seen only in the curve of flag- and rudder-feathers (fig. 2). In general the feathers of

Fig. 1. *Syrnium aluco* No. 1 after the hyperthyroidisation.

this bird were very loose during the thyroidisation, and when touched some of them fell out. Before the experiment the bird was not shedding feathers. Between the 28. II. and the 3. IV. the feathers were not collected every day but for the whole time at once. Altogether the bird lost 1,12 gr. of feathers, viz. 0,82 gr. of tectrices and downs and 0,3 gr. of flag- and rudder-feathers. The general curve of feathers (fig. 3) shed from the 4. IV., can be divided after the three highest points (11. IV.—1,4 gr., 13. V.—2,82 gr. and 14. VI.—1,34 gr.) into two periods, viz.: the first from the 11. IV. to the 13. V., and the second from the 13. V. to the 14. VI. Every period can in its turn be subdivided into two half-periods, of which one may be called the half-period of decline, the other of rise. The duration of each period is 32 days.

The curve of tectrices and downs (fig. 4) can also be divided into two periods of a duration of 36 days, by three points (11. IV.—1,4 gr., 17. V.—1,192 gr. and 22. VI.—0,61 gr.) not to count, of course, the insignificant declinations between these points. As to the curve of flag- and rudder-feathers

(fig. 2) it must be pointed out that here the length of the periods is abbreviated as compared with those of the tectrices and downs, i.e. every period lasts only 16 and even less days.

In the replacement of shed feathers by new-growing ones the following peculiarity was observed. The new feather gradually dislodges the old one, remaining in touch with it, forming thus two feathers one placed on the top of the other and joined by their middles (fig. 5). Similar cases have been observed in young hyperthyroidised specimens of fowls changing their juvenal feathers for definitives, as has been described by HORNING (1925), or during the change of downs for juvenile feathers as recorded by KRIŽENECKY (1926) and observed by this author in chickens of the Plymouth-Rock race. The same was noticed by RICE, NIXTON and ROGERS (1908) in normal not hyperthyroidised specimens.

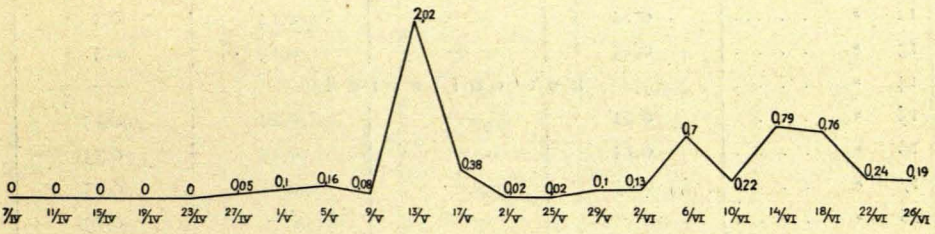

Fig. 2. *Syrnium aluco* No. 1. Flag- and rudder-feathers.

2. Syrnium aluco No. 2.

The thyroidisation of *Syrnium aluco* No. 2 (fig. 6) can be divided into three periods. The first lasted from the 30. V. to the 11. VI., the second from the 12. VI. to the 14. VI., and the third from the 17. VI. to the 18. VI. The bird received daily during the first period 1 gr. of the thyroid gland-preparation, during the second period 1,5 gr., and during the last period of 2 days 2 gr. A dropping of feathers before the thyroidisation was hardly noticed, and during the time between the 25. V. and the 30. V. only one rudder-feather was found. The tectrices and dawns began to fall out on the tenth day of thyroidisation, whereas shedding of flag- and rudder-feathers began already on the fifth day. In general the bird lost but few, to the greater part flag- and rudder-feathers. The curves (figs. 7, 8, 9) show that there can be recognised only one period for the whole time of thyroidisation (30. V.—19. VI.). It can be divided into the half-period of rise of the curve to the maximal hight on the 13. VI. (0,51, 0,63 and 1,14 gr.), and the half-period of decline from the maximal point towards the end of the period. The half-period of rise

Table II. SYRNIUM ALUCO No. I.

Date	Tectrices and downs in gr.	Flag- and rudder-feathers in gr.	Tectrices, downs + flag- and rudder-feathers in gr.	Thyreoidea sicc. per day in gr.
4 April	0,55	—	0,55	0,5
5 »	0,3	—	0,3	0,5
6 »	0,45	—	0,45	0,5
7 » . . .	not collected			—
8 »	0,7	—	0,7	0,5
9 »	0,3	—	0,3	0,5
10 »	0,2	—	0,2	0,5
11 »	0,2	—	0,2	0,5
12 »	0,14	—	0,14	0,5
13 »	0,15	—	0,15	0,5
14 »	not collected			—
15 »	0,24	—	0,24	0,75
16 »	0,15	—	0,15	0,75
17 »	0,15	—	0,15	0,75
18 »	—	—	—	0,75
19 »	0,04	—	0,04	—
20 »	0,1	—	0,1	0,75
21 »	not collected			—
22 »	0,1	—	0,1	1,0
23 »	0,04	—	0,04	1,0
24 »	0,05	—	0,05	1,0
25 »	0,05	—	0,05	1,0
26 »	0,15	—	0,15	1,0
27 »	0,05	0,05	0,1	1,0
28 »	not collected			—
29 »	0,27	0,1	0,37	1,0
30 »	0,25	—	0,25	1,0
1 May	not collected			—
2 »	0,35	—	0,35	1,0
3 »	0,22	0,08	0,3	1,0
4 »	0,2	0,08	0,28	1,0
5 »	not collected			—
6 »	0,35	0,04	0,39	1,0
7 »	0,17	0,04	0,21	1,0
8 »	0,19	—	0,19	1,0
9 »	not collected			—

Table II (continuation).

Date	Tectrices and downs in gr.	Flag- and rudder-feathers in gr.	Tectrices, downs + flag- and rudder-feathers in gr.	Thyreoidea sicc. per day in gr.
10 May . . .	0,2	0,8	1,0	1,0
11 » . . .	0,1	0,4	0,5	—
12 » . . .	not collected			—
13 » . . .	0,5	0,82	1,32	—
14 » . . .	0,4	0,32	0,72	—
15 » . . .	0,32	0,05	0,37	—
16—27 » . . .	2,84	0,08	2,92	—
28 » . . .	0,35	0,09	0,44	—
29 » . . .	0,2	—	0,2	—
30 » . . .	0,11	—	0,11	0,5
31 » . . .	0,14	0,05	0,19	0,5
1 June . . .	0,02	0,08	0,1	—
2 » . . .	—	—	—	0,5
3 » . . .	0,11	0,57	0,68	—
4 » . . .	0,03	—	0,03	—
5 » . . .	0,03	—	0,03	0,5
6 » . . .	0,05	0,13	0,18	—
7 » . . .	0,05	—	0,05	0,5
8 » . . .	0,1	—	0,1	0,5
9 » . . .	not collected			—
10 » . . .	0,09	0,22	0,31	0,5
11 » . . .	0,09	0,18	0,27	—
12 » . . .	0,2	—	0,2	0,5
13 » . . .	0,1	0,52	0,62	0,5
14 » . . .	0,16	0,09	0,25	0,5
15 » . . .	0,16	0,35	0,51	—
16 » . . .	not collected			—
17 » . . .	0,22	0,22	0,44	—
18 » . . .	0,06	0,19	0,25	—
19 » . . .	0,19	0,06	0,25	—
20 » . . .	0,16	0,07	0,23	—
21 » . . .	0,19	0,11	0,3	—
22 » . . .	0,07	—	0,07	—
23 » . . .	0,02	—	0,02	—
24 » . . .	not collected			—
25 » . . .	0,05	0,19	0,24	—

lasted 12 days, that of decline 6 days. All these curves are similar to each other.

No change in the coloration of the feathers was observed. The bird was a male weighing 415 gr.

Table III. SYRNIUM ALUCO No. 2.

Date	Tectrices and downs in gr.	Flag- and rudder-feathers in gr.	Tectrices, downs + flag- and rudder-feathers in gr.	Thyreoidea sicc. per day in gr.
30 May	—	—	—	1,0
31 »	—	—	—	1,0
1 June	—	—	—	1,0
2 »	—	—	—	—
3 »	—	0,1	0,1	1,0
4 »	—	0,1	0,1	1,0
5 »	—	—	—	1,0
6 »	—	—	—	1,0
7 »	—	0,1	0,1	1,0
8 »	0,04	—	0,04	1,0
9 »	not collected			—
10 »	0,11	0,4	0,51	1,0
11 »	0,1	0,3	0,4	1,0
12 »	0,14	0,15	0,29	1,5
13 »	0,27	0,18	0,45	1,5
14 »	0,15	0,18	0,33	1,5
15 »	0,1	0,12	0,22	—
16 »	not collected			—
17 »	0,12	0,03	0,15	2,0
18 »	0,02	—	0,02	2,0
19 »	0,12	—	0,12	2,5

3. Syrnium aluco No. 3 and No. 4.

Under experiment were two young owls, *Syrnium aluco* No. 3 and No. 4. Both were received on the 6. VII. 1929 and were in their juvenal feathering ("plumage infantile" of PÉZARD, SAND and CARIDROIT, 1925, "erstes Umrissgefieder" of BLANCKE), with exception of the flag- and rudder-feathers. *Syrnium aluco* No. 1 was under experiment only from the 16. VII. to the 4. VIII. The first 10 days the bird was given every other day 0,5 gr. of the thyroid gland-preparation, and the following 10 days the same dose daily.

After a lapse of 20 days it perished by accident, being wounded by *Syrnium aluco* No. 4, which had been temporarily been placed into the same cage. A loss of definitive feathers did not take place. The bird shed only its juvenal feathers which were gradually replaced by the definitive ones. Pigmental changes were not observed.

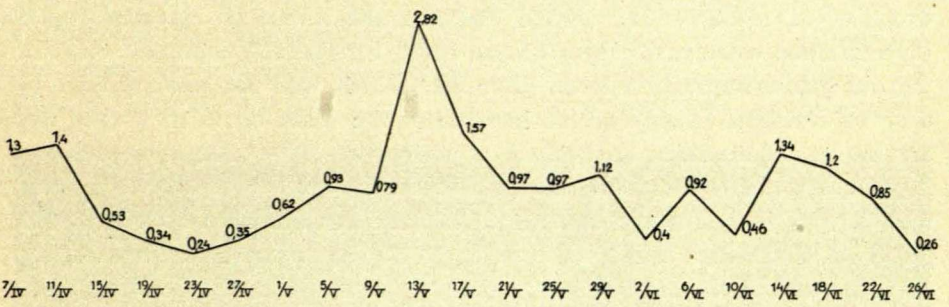

Fig. 3. *Syrnium aluco* No. 1. Tectrices, downs, flag- and rudder-feathers.

The period of the thyroidisation of *Syrnium aluco* No. 4 lasted from the 1. VIII. to the 14. X. In the beginning the bird was given 0,5 gr. of the preparation daily. After an interruption of 10 days the thyroidisation was renewed and during 14 days 0,5 gr. were given daily.

The last period of the thyroidisation was the most prolonged and the dose the most elevated. During 26 days the bird was given 1 gr. daily of the preparation. Subsequently the dose was not augmented, as a further increase would have resulted in the death of the object. In the preceding experiments *Syrnium aluco* No. 2 could stand doses exceeding 1 gr. for a very few days only. *Syrnium aluco* No. 1 likewise felt bad after a two-days treatment with 1,5 gr., so that it was necessary to interrupt the thyroidisation for several days.

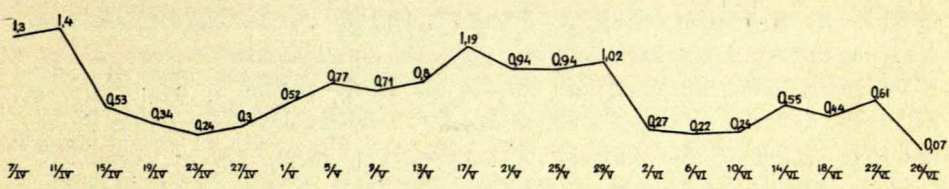

Fig. 4. *Syrnium aluco* No. 1. Tectrices and downs.

Evidently the maximal dose of dried gland is 1 gr. for this species of birds, and, of course, a prolonged treatment with this dose also produces a toxic effect. Thus towards the termination of the experiment the bird began to show signs of empoisonment, as loss of appetite, abatement of movableness etc.

No shedding of feathers took place and no pigmental changes were observed. It was found that (as has been observed also by J. Křiženecky, 1926, in newly feathered fowls) thyroidisation does not evoke the shedding of new-grown definitive feathers in young owls.

4. Bubo bubo.

The entire period of the thyroidisation of the eagle-owl can be divided into two parts. The first comprises the period from the beginning of the treatment, i.e. from the 18. V. to the 31. VIII. inclusively, and is characterised by the dropping of feathers. The second embraces the period of repeated hyperthyroidisation when partly the previous, partly considerably increased doses of thyroid gland-preparation were given but which was not accompanied by drop of feathers. Despite of the increase of the doses up to 10 gr. per day and the use of the latter during 5 days, positive results could not be obtained.

During the first period the doses were increased gradually, beginning with 1,5 gr. to 5 gr. a day. At the outset, i.e. from the 28. V., the bird was given during 11 days a daily dose of 1,5 gr. of the preparation. Subsequently this dose was increased to 2, 2,5, 3,5, 4 and 5 gr. a day, each dose being given during 4 days.

In order to ascertain the influence on the bird of a given quantity of the thyroid gland-preparation, from June 20th, each period of thyroidisation was made to be followed by an interruption of 10 days. Thus the quantity of feathers dropped after the given portion of the preparation could be made out. The interruption lasting from the 21. VI. to the 30. VI. was followed by three periods of thyroidisation. From the 1. VII. to the 13. VII, i.e. during 13 days the bird was given 3 gr. daily, from the 28. VII. to the 6. VIII. 4 gr. every other day, and from the 17. VIII. to the 31. VIII. 5 gr. daily. Further, after a 10-days' interruption, i.e. on the 10. XI. begins the period of repeated hyperthyroidisation, during which the bird was given, beginning with the smallest dose and up to 10 gr. a day. As can be seen on table I, the bird received between the 11. IX. and the 20. IX. daily 1,5 gr., and from the 26. IX. to the 30. IX. 2 gr. respectively 2,5 gr. daily. During the last period, from the 16. X. to the 20. X. the eagle-owl was given the maximal dose of 10 gr. per day. No feathers were dropped, and during the entire period of hyperthyroidisation the bird did not loose a single feather. The shedding of feathers during the first period of thyroidisation is expressed by the curves on figs. 10, 11 and 12. A slight shedding of feathers was observed before the treatment with thyreoidea sicc., viz.: between the 10. V. and the 17. V. there were shed 0,41 gr. of tectrices and downs and 0,09 gr. flag- and rudder-feathers, in all 0,5 gr., which makes an average of 0,062 gr. per day. The dropping of feathers in this bird can be divided into two periods. In each the maximum is reached on the 21st day and followed by a decline attaining the minimum also on the 21st day, the whole period thus lasting 42 days.

The first period lasts from the 10. V. to the 21. VI., the second from the 21. VI. to the 2. VIII. Each period has two minimal and one maximal point of feather-dropping. In the first period it reaches the maximal point

on the 31. V. (7,3 gr. and 11,02 gr.); in the second on the 12. VII. (6,05 gr. and 6,6 gr.), i.e. after 42 days (figs. 10 and 11). The minima of the first period are on the 10. V. (0,051 gr. and 0,062 gr.) and on the 21. VI. (0,03 gr. and 0,08 gr.), of the second period on the 21. VI. and 2. VIII. (0). Here also the interval between each two points is 42 days. The curve of the flag- and rudder-feathers (fig. 12) is distinguished by the maximum points of feather-dropping falling not on the 31. V. and on the 12. VII., as indicates the general curve and that of the flag- and rudder-feathers, but on the 7. VI. (3,93 gr.) and on the 19. VII. (1,7 gr.). The interval between these points

Fig. 5. *Syrnium aluco* No. 1. The right wing, one feather placed on the top of the other and joined by its middle.

is also 42 days, but each half-period of the decline of the curve is 14 days, whereas the rising half-period is 28 days, i.e. the curve declines from the highest points on the 7. VI. (3,93 gr.) and on the 19. VII. (1,7 gr.), to the minimal points on the 21.VI. (0,05 gr.) and on the 2. VIII. (0) during 14 days. The half-period of the rise of the curve from the minimal points on the 10. V. (0,011 gr.) and on the 21. VI. (0,05 gr.), to the maximal points on the 7. VI. (3,93 gr.) and on the 19. VII. (1,7 gr.) is 28 days, not to count, of course, the small oscillations of the curve between the 21. VI. and the 5. VII.

It is remarkable that the dropping of feathers was at its maximum at the very beginning of the thyroidisation, when the smallest dose of the preparation was given, viz. 1,5 gr. daily. Subsequently the dropping declines in spite of the increase of the doses to 2, respectively 2,5, 3,3 and 5 gr. daily. At the dose of 5 gr. the dropping ceases altogether, later to increase again

Table IV. BUBO BUBO.

Date	Tectrices and downs in gr.	Flag- and rudder-feathers in gr.	Tectrices, downs + flag- and rudder-feathers in gr.	Thyreoidea sicc. per day in gr.
18—27 May . . .	2,9	1,4	4,3	1,5
28 » . . .	1,2	0,55	1,75	—
29 » . . .	1,85	1,0	2,85	—
30 » . . .	1,28	0,5	1,78	1,5
31 » . . .	2,1	1,25	3,35	1,5
1 June . . .	1,85	1,55	3,40	1,5
2 » . . .	not collected			—
3 » . . .	2,32	1,58	3,9	2,0
4 » . . .	0,55	0,4	0,95	2,0
5 » . . .	0,25	0,1	0,35	2,0
6 » . . .	0,2	0,3	0,5	2,0
7 » . . .	0,35	—	0,35	2,5
8 » . . .	0,2	0,2	0,4	2,5
9 » . . .	not collected			—
10 » . . .	0,2	—	0,2	2,5
11 » . . .	0,05	0,1	0,15	2,5
12 » . . .	0,01	—	0,01	3,5
13 » . . .	0,07	—	0,07	3,5
14 » . . .	0,02	—	0,02	3,5
15 » . . .	0,02	—	0,02	—
16 » . . .	not collected			—
17 » . . .	0,01	0,05	0,06	4,0
18 » . . .	—	—	—	5,0
19 » . . .	—	—	—	5,0
20 » . . .	—	—	—	5,0
21 » . . .	—	—	—	—
22 » . . .	—	—	—	—
23 » . . .	0,2	—	0,2	—
24 » . . .	not collected			—
25 » . . .	0,3	0,05	0,35	—
26 » . . .	0,15	—	0,15	—
27 » . . .	0,2	—	0,2	—
28 » . . .	0,1	0,25	0,35	—
29 » . . .	not collected			—
30 » . . .	0,1	—	0,1	—
1 July . . .	0,1	—	0,1	3,0

Table IV (continuation).

Date	Tectrices and downs in gr.	Flag- and rudder-feathers in gr.	Tectrices, downs + flag- and rudder-feathers in gr.	Thyreoidea sicc. per day in gr.
2 June	0,05	0,1	0,15	3,0
3 »	0,1	—	0,1	3,0
4 »	0,1	—	0,1	3,0
5 »	0,1	—	0,1	3,0
6 »	0,1	—	0,1	3,0
7 »	0,1	—	0,1	3,0
8 »	not collected			3,0
9 »	0,6	—	0,6	3,0
10 »	1,6	—	1,6	3,0
11 »	2,15	0,35	2,5	3,0
12 »	1,5	0,2	1,7	3,0
13 »	0,65	0,4	1,05	3,0
14 »	not collected			—
15 »	0,4	—	0,4	—
16 »	0,2	1,0	1,2	—
17 »	0,15	0,1	0,25	—
18 »	0,1	0,1	0,2	—
19 »	0,05	0,1	0,15	—
20 »	0,05	0,05	0,1	—
21 »	0,05	—	0,05	—
22 »	—	—	—	—
23 »	0,02	—	0,02	—
24 »	—	—	—	4,0
25 »	—	0,07	0,07	4,0

in spite of the cessation of the thyroidisation. At the dose of 3 gr. daily the dropping again reaches the maximum. The diminuation of the dropping coincidences in this case with the period of interruption of the thyroidisation between the 14. VII. and the 23. VII. The subsequent thyroidisation did in no way influence the shedding of feathers.

After the termination of the experiment the bird was chloroformed. Pigmental reactions were not observed. The bird was a male weighing 1,600 gr.

5. Buteo buteo.

The representative of the Falconid family was not in the least influenced by the thyroidisation despite of the gradual increase of the dose which went

up to 15 gr. a day. The bird felt evidently well, as no alterations in its conduct could be observed. A diminution of appetite was noticed only on the sixth day after a daily dose of 10 gr. The observations which began on the 11. VIII. and were terminated on the 20. X., can be divided into four periods of 10 days each, with exception of the last, which lasted only 3 days. During the first period the bird was given 1 gr., during the second 5 gr., during the third 10 gr., and during the fourth 15 gr. daily. The intervals between the said periods were 10 and 5 days. To raise the dose above 15 gr. was impracticable, as it proved impossible to mix more of the very light powder with the small daily ration of food, taken by the comparatively small bird.

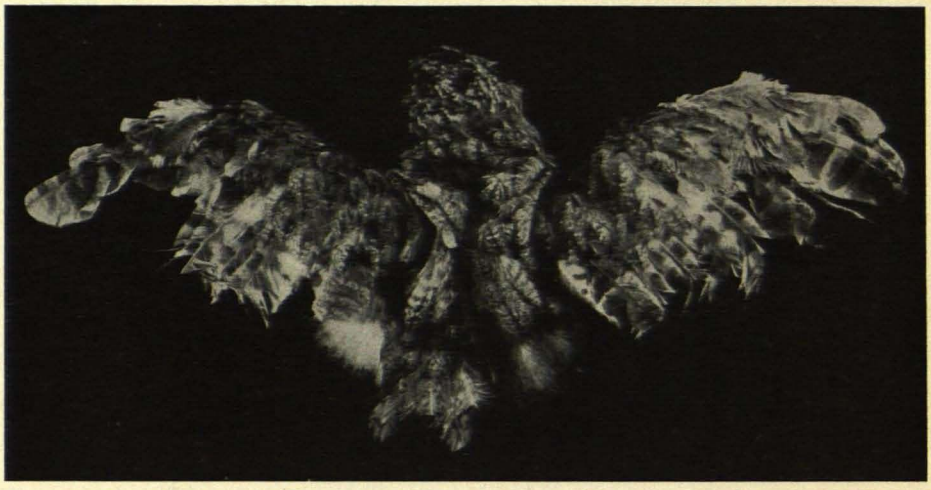

Fig. 6. *Syrnium aluco* No. 2 after the hyperthyroidisation.

In spite of the rather large dose of thyreoidea sicc. it was impossible to obtain a loss of feathers or any pigmental reactions.

After the termination of the experiment the bird was vigorous and enjoyed an excellent appetite, and without having to suffer from any noxious effects due to thyroidisation. It was therefore set free. Its weight was 360 gr.

6. Botaurus stellaris.

To the representative of the Ardeid family comparatively small doses of the thyroid gland-preparation proved to be toxic. Supportable to this bird were daily doses of 0,25 gr. and 0,5 gr. The augmentation of the dose to 1,5 gr. caused the death of the bird on the third day. It was under experiment 22 days only. During the first 6 days it was given 0,25 gr. every other day, and the following 6 days the same quantity daily. Beginning with the 13. III. the dose was raised to 0,5 gr. a day. There was no shedding of feathers at all.

During the entire time from the 28. II. to the 22. III. the bird did not loose a single feather, and neither did the pigmentation undergo any change. The weight of the bird was 370 gr.

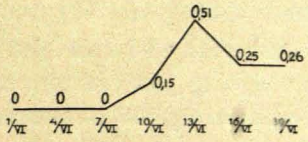

Fig. 7. *Syrnium aluco* No. 2. Tectrices and downs.

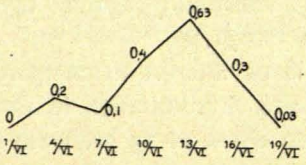

Fig. 8. *Syrnium aluco* No. 2. Flag- and rudder-feathers.

IV. GENERAL RESULTS AND THEORETIC CONCLUSIONS.

The experiments described above show that carnivorous birds are endowed with great resistibility towards thyroidisation, especially this comes true in *Buteo buteo*. Notwithstanding a rise of the daily dose to 15 gr. this bird remained in good health and did neither shed feathers, nor undergo any pigmental changes. In all probability this fact stands in relation with its faculty to feed occasionally and a prolonged time on carrion. KÖNIG, for instance, observed on Teneriffa that the buzzard—for want of rats and mice—became a true carrion-eater. *Bubo bubo* also withstood a prolonged regular thyroidisation in which the dose went up to 10 gr. daily. The shedding of feathers of this bird took place, as may be seen on table IV, only during the first period of treatment, i.e. from the 18. V. to the 25. VII., whereafter the shedding ceased and did not renew even after the raise of the dose to 10 gr. a day. The entire period of repeated hyperthyroidisation was characterised by the want of feather-shedding (table I). There arises the question how such a resistibility of the feathers might be explained in *Bubo bubo* during the repeated hyperthyroidisation. At that time the bird was given the same dose (1,5 gr.) of the preparation at which the maximal shedding took place during the first period of thyroidisation, and also a much increased dose, i.e. 10 gr. daily. It is possible that the first period coincided with the period of moulting, in favour of which presumption speaks the (though not copious) falling out of feathers before the beginning of thyroidisation. This possibility admitted, it still remains obscure why the loss of feathers had been so limited. But it is possible that here, as was the case with the two other representatives of the Strigid family—*Syrnium aluco* No. 1 and No. 2—the thyroidisation itself caused a, though insignificant, loss of feathers, which subsequently ceased, when the organism became used to it. The loss of feathers in this bird, as well as in *Syrnium aluco* No. 1 began with the tectrices and downs (tables II and IV). In *Syrnium aluco*

No. 2 (table III), however, it was characterised by the fact that the flag- and rudder-feathers were the first to fall out, not the tectrices and downs, as was the case with the two first-named birds. Of all birds under experiment the least resistibility against thyroidisation was found in *Botaurus stellaris* (weight 370 gr.).

It is of interest to compare the non-resistibility of this bird with the response to thyroidisation in *Buteo buteo* weighing 360 gr., to which latter bird even doses of 15 gr. were not toxic. Comparing the influence of 1 gr. of thyroidine given to adult fowls by B. ZAWADOWSKY and D. PODHRADSKY with the effect of 0,1 gr. supported by chickens in his own experiments, J. KRIŽENECKY (1926) comes to the conclusion that the toxic effect of this substance diminishes in proportion with the body-weight (and age) of the animal. J. KRIŽENECKY and B. ZAWADOWSKY in their experiments on fowls, take as a base 1 gr. of dried thyroid gland-preparation to 1 kg. of the body-weight of the animal. This proposition being applied to carnivorous birds, 1 gr. of the preparation ought to have acted on *Botaurus stellaris,* a bird somewhat heavier than *Buteo buteo,* in a similar way as in the latter, but this has not been the case.

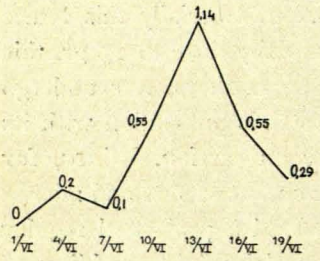

Fig. 9. *Syrnium aluco* No. 2. Tectrices, downs, flag- and rudder-feathers.

The question arises why *Botaurus stellaris* is less resistant to thyroidisation. Comparing the character of the food of both birds we see that *Botaurus stellaris* feeds in the main on live fishes and other small animals but never on carrion, as is the case with *Buteo buteo.* Possibly this circumstance is the cause of the above fact.

The resistibility to thyroidisation in carnivorous birds who, being themselves of comparatively small weight (even 360 gr.) can support without any noxious consequences doses of 10 gr. and even 15 gr. daily during 10, respectively 3 days. On the other hand the sensitiveness of granivorous birds who can support 1 gr. only to 1 kg. of their body-weight, induces to take a nearer view of the possible causes of the phenomenon.

The results of my experiments on carnivorous birds lead thus to the conclusion that there exists some dependence of the toxic properties of thyreoidea sicc. on the mode of nutrition of birds who can resist the toxic action of rather large doses during a prolonged time. Some light on this dependence is thrown, as I believe, by the works of B. ZAWADOWSKY and Z. PERELMUTTER (1926), E. KENDALL (1919), and B. ZAWADOWSKY and G. ASIMOV (1927).

ZAWADOWSKY and PERELMUTTER (1926) investigated the distribution of thyroxine in the different organs and tissues of hyperthyroidised fowls, and

also the time during which the thyroxine remains in the blood and tissues after a single application. This was atteined by implantation of tissues taken from hyperthyroidised fowls into the body-cavity of axolotls. The implanted tissues and organs called forth a more or less rapid metamorphosis of the animals into the amblystoma form, and it was found that the blood, liver and kidneys constitute a group of tissues having a straight and specific relation to the hormone of the thyroid gland. To the next group belong the brain, the pancreas gland and the milt. To the third group refer indifferent organs as the muscles, fat-tissue and thymus. Consequently the course of the blood, and such organs as are closely connected with it, as the liver and the kidneys, constitute the direct way of thyroxine when experimentally introduced into the organism. Thyroxine introduced per os into the alimentary canal of birds is retained by the liver, after having been absorbed from the small intestine into the blood and filtered by the liver with its portal system.

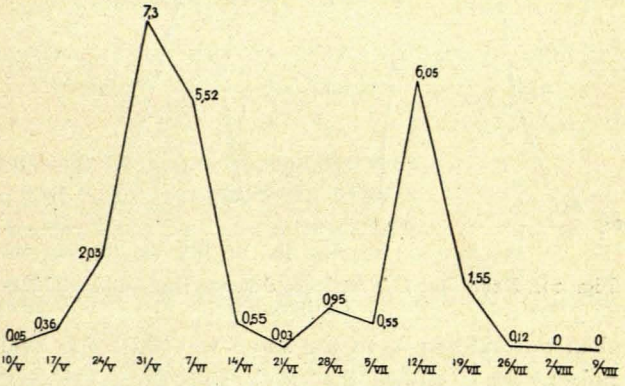

Fig. 10. *Bubo bubo.* Tectrices and downs.

In a further work of B. ZAWADOWSKY and G. ASIMOV (1927) on porpoises and dogs, the liver and kidneys are also pointed out as the principal ways of deliverance of the organism of mammalia from an excess of that hormone. The difference in relation to birds lies in the more rapid destruction of the hormone by the organism of mammals. Thus, for instance, material taken from these animals and implanted into the body-cavity of an axolotl does not produce any effect after an elapse of 24 hours, whereas taken from the blood of hyperthyroidised fowls the hormone is deposited in certain organs on the second and third day. When a porpoise is killed 3 to 5 hours after the thyroidisation the implanted liver acts more vigorously than the blood of that animal. After 5 hours the kidneys also acted in a positive sense.

From these experiments results that the hormone of the thyroid gland is first retained by the liver and after entering the blood gets into the kidneys. Comparing the observations of KENDALL, and ZAWADOWSKY and PERELMUTTER, one is led to conclude that the liver does not only play the part of a resorbing organ but also as the chief place of destruction of the thyroid gland-hormone. In general the liver plays an important part as to substances which can produce noxious action, making them harmless by changing them

chemically, i.e. by its so-called antitoxic function. There are many substances that are very poisonous when introduced into the blood or subcutaneously, and having no toxic effect when taken internally. This is explained by the antitoxic function of the liver. It retains in its tissues a number of poisonous metallic salts (copper, arsen etc.) and at the same time it lessens the poisonous effect of vegetable alkaloids (HEEGER and SCHIFF). Thus the toxic properties of nicotine manifest in a much lesser degree when taken internally than when applied subcutaneously. After H. ROGERS frogs whose liver had been removed could be poisoned by much smaller quantities of different drugs (atropine, strichnine, morphine, nicotine etc.) than normal frogs. In the same way does the liver make harmless animalic poisons. It is known that toxic substances are continuously produced in the organism. Many products of the intestinal putrefaction are also poisonous, for instance phenol, indol, scatol, which are turned by the liver into inoffensive salts of paired sulphuric acids and are excreted by the kidneys. Consequently the principal part in this defence of the organism against the action of different poisonous substances lies on the liver. It is, so to say, an inoffensive-making filtre between the intestine and the tissues.

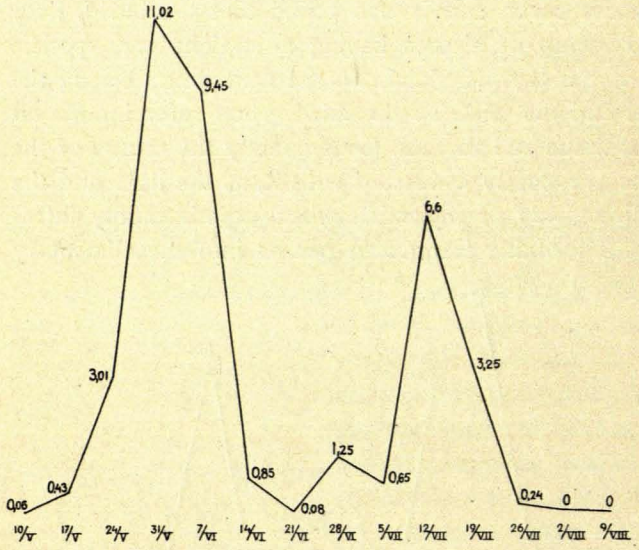

Fig. 11. *Bubo bubo.* Tectrices, downs, flag- and rudder-feathers.

The said defensive work of the liver is effectuated by its cells and the products of the re-making enter in a direct way into the blood course. But this is not all. The liver produces a series of products that are expelled in form of bile through a special system of ducts. KENDALL (1919), one of the above-cited authors, observed that thyroxine, introduced by injection into the organism of an animal at the quantity of 43 v. H. was excreted by the

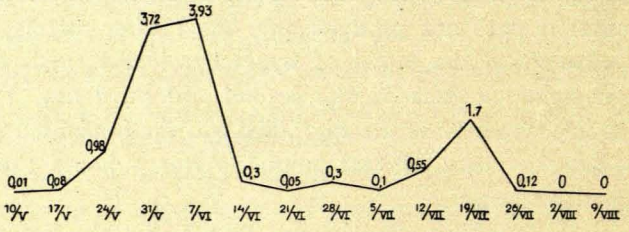

Fig. 12. *Bubo bubo.* Flag- and rudder-feathers.

bile 50 hours later. Most of the nitrogenous substances that can produce a noxious effect on the organism are formed in the body of animals feeding exclusively on albuminous matter. In the first line this may be said of animals feeding not only on fresh albuminous food but also on these substances in state of decomposition, as *Buteo buteo*. In this case it is evidently the liver that plays an important part in making harmless the poisons of albuminous substances. In all probability it is therefore the liver that being adapted to this protective function appears to be in our experiments the principal protector of the organism of carnivorous birds against the toxic action of large doses of thyroid gland-preparations.

V. SUMMARY.

I. In the present investigations were tried the effects on carnivorous birds of different doses of Thyreoidea sicc. (manufactured by the laboratory of G. GRÜBLER).

II. As results of the treatment the following was observed:
1. The endurance of the birds towards thyroidisation.
2. An insignificant feather-shedding in adult specimens of the Strigid family:
   a) Continuous feather-shedding during the whole time of thyroidisation (*Syrnium aluco* No. 1).
   b) Feather-shedding only at the beginning of the period of thyroidisation (*Bubo bubo*).
   c) Very insignificant loss of feathers beginning with the loss of flag- and rudder-feathers (*Syrnium aluco* No. 2).
3. Absence of feather-shedding in young owls (*Syrnium aluco* No. 3 and No. 4) newly covered with definitive feathers.
4. Absence of feather-shedding in *Buteo buteo* and *Botaurus stellaris*.
5. Absence of any pigmental changes in all the birds under experiment.

III. The largest dose of Thyreoidea sicc. could be endured by *Buteo buteo*, adapted to feed occasionally on carrion alone.

IV. The least endurance towards thyroidisation was shown by *Botaurus stellaris*.

V. It is possible that there is a certain interrelation between the mode of nutrition and the resistibility towards Thyreoidea, viz. carnivorous birds are in proportion to 1 kg. of live weight incomparably more enduring than granivorous birds, and *Buteo buteo*, often feeding on carrion, excels in this even over all other carnivorous birds.

Resistibility towards Thyreoidea sicc. on 1 kg. of body weight in carnivorous birds.

Table V.

Species	Weight of bird in gr.	Quantity of preparation on 1 kg. of body weight in gr.	Time of application of maximal doses		
			Daily dose in gr.	Days	One of maximal[1] doses given during the most prolonged time
Syrnium aluco No. 1.	350	2,9	1,5	2	1
			1	15	
» » No. 2.	415	2,4	2,5	1	1
			2	2	
			1,5	3	
			1	11	
Bubo bubo	1 600	3,1	10	5	5
			5	18	
Buteo buteo	360	27,8	15	3	10
			10	10	
Botaurus stellaris . .	370	1,4	1,5	2	0,5
			0,5	7	

VI. This resistibility of carnivorous birds is probably in relation with a general faculty of their liver to destroy noxious products of tissue-change, in particular during their digestive processes, when albuminous matter is decomposed in large quantities. In carrion feeders this faculty could be expected to be met with in the highest degree and this corresponds well with our experiences with the resistibility of *Buteo buteo*.

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[1] The relative figures are calculated on base of this dose.

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