SEASONAL CHANGES IN THYMUS WEIGHTS IN RING-NECKED PHEASANTS

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The thymus, a paired lymphoid gland located in the neck region or upper abdominal cavity in birds and mammals, has been the subject of considerable attention in recent years. This gland plays a major role in the immunological system, being indispensable for the development of lymphoid cells in the lymph nodes, spleen, and other lymphoid organs; the thymus, itself, does not form antibodies (Haurowitz 1965:19–20). It is commonly stated that the thymus attains its largest size in young animals and involutes with increase in age (Kirkpatrick 1944:184; Bradley 1950:74; Quiring 1950:478; Weichert 1951:290; Sturkie 1965:656). However, this lymphoid gland also undergoes a period of enlargement and subsequent regression in postbreeding adult birds (Höhn 1947:187, 1956). Data are presented in this report to demonstrate seasonal and age-associated changes in weights of thymus glands in Ring-necked Pheasants (*Phasianus colchicus*).

MATERIALS AND METHODS

Weights of pheasant thymuses were obtained during an investigation of seasonal changes in metabolic reserves and organ weights. Wild pheasants were collected throughout 1966 and 1967 in east-central Illinois, primarily in Ford and Livingston Counties, by nightlighting (Labisky 1959), shooting, and salvaging birds killed by hay mowers and automobiles. Most birds were sacrificed between sunrise and 09:00.

Sex, age, and body weight were recorded for each pheasant. If the birds were molting, the last primary dropped was also recorded. Juveniles (birds less than 10 months old) were separated from adults by measuring (probing) the depth of the bursa. Young juveniles (those collected during July–October) were aged to the nearest week according to advancement of molt of the primary flight feathers (Labisky 1968:465).

During dissection, the full length of the neck region and the upper abdominal cavity were searched with the aid of low-power magnification (2×) for thymus tissue. After being excised, the thymus tissue was freed from extraneous material and weighed to the nearest mg. In 1966, only the left thymus was excised from most birds; weights of these glands were doubled. In 1967, both the right and left thymuses were excised and weighed. In no instance was the mean weight of right thymuses significantly different from that of left thymuses in pheasants collected in 1967.

RESULTS

Weights of thymuses from pheasants collected during various periods in the life cycle of the species are summarized in table 1. When expressed as per cent of body weight, thymuses in both sexes were more than twice as large in young, growing pheasants as in older birds. In actual weight the largest thymuses examined were from October-collected juveniles which were, on the average, 17 weeks old. However, calculations resulting from curvilinear regression indicated that thymuses probably attained their largest size in juvenile hens concomitantly with the molting of primary 8 (fig. 1), which occurs when pheasants are 11–12 weeks old (Labisky 1968:465).

Thymuses regressed greatly in juvenile pheasants from October to January and February, and remained small through the following June, i.e., for hens, through the winter, prenesting, laying, and incubating periods, and into the brooding period. However, all adult pheasants collected during the molting period (in process of molting primary flight feathers) had enlarged thymuses, with the mean weights approaching those of thymuses from October-collected juveniles. The thymuses remained somewhat enlarged in adults into the following October, when the new primaries were in final stages of growth.

In most sex-age classes and periods in the life cycle listed in table 1, weights of thymuses varied greatly; the coefficients of variation averaged 81 per cent. Thymus tissue was not found in 32 of the 105 pheasants collected during January through June. Thymuses appeared more variable in hens than in cocks, as evidenced by differences in the respective coefficients of variation: 46–188 per cent compared with 12–114 per cent.

Curves representing curvilinear regression indicate that the enlargement and subsequent regression of thymuses in both juvenile and adult pheasants were closely related to the progression of molt of primary flight feathers (figs. 1, 2). The relationships were highly significant ($P < 0.01$). Thymuses rapidly enlarged during the time primaries 1–6 were being replaced, and attained their largest size concomitantly with the emergence of primary 7 or 8. The glands regressed in size during the remainder of the molt, i.e., during replacement of primaries 8 or 9 through 10 and sub-

TABLE 1. Weights of both thymuses from pheasants, 1966 and 1967, east-central Illinois.

Period	Date	No. birds	Mean age (weeks)	Weight (mg) $\bar{x} \pm$ SE	Mean % body wt (× 10,000)
Juvenile ♀♀					
Growth	21 Jul.–17 Aug.	11	6.9 ± 0.6	837 ± 135	2870 ± 302
Fall	24 Oct.–1 Nov.	15	17.5 ± 0.5	1024 ± 122	1203 ± 139
Winter	12 Jan.–23 Feb.	8	ca. 33	102 ± 24	88 ± 27
Adult ♀♀					
Prenesting	6–8 Apr.	12		59 ± 29	57 ± 28
Laying	21 Apr.–7 June	25		26 ± 10	25 ± 10
Incubating	5 June–6 July	26		70 ± 23	83 ± 27
Brooding	17 June–7 July	4		62 ± 33	82 ± 44
Molting[a]	18 July–13 Sept.	16		980 ± 137	1181 ± 155
Fall	24–27 Oct.	11		545 ± 100	597 ± 96
Winter	12 Jan.–23 Feb.	12		35 ± 16	38 ± 17
Juvenile ♂♂					
Growth	23 July–17 Aug.	10	6.3 ± 1.6	795 ± 92	2564 ± 190
Fall	10 Oct.–2 Nov.	5	17.2 ± 0.6	1504 ± 88	1240 ± 219
Winter	14–15 Feb.[b]	5	ca. 35	313 ± 26	267 ± 20
Adult ♂♂					
Prebreeding	8–18 Apr.	3		81 ± 11	62 ± 8
Breeding	25 Apr.–9 June	9		84 ± 32	70 ± 26
Molting	21 July–17 Aug.	7		1025 ± 45	908 ± 44
Fall		0			
Winter	23 Feb.	1		91	69

[a] All except three of the hens collected during molting period were accompanied by chicks, and hence might be considered brooding as well as molting.
[b] 1968.

sequent growth of these feathers. The curve depicting change in size of thymuses in juveniles, when compared with the curve for adults, attained a higher apex (1326 mg vs. 1125 mg) and remained at correspondingly higher levels during later stages of the molt. These findings are somewhat in contrast with those of Höhn (1956:100), who found no close relationship between beginning of thymus enlargement and onset of molt in adult Mallards (*Anas platyrhynchos*), House Sparrows (*Passer domesticus*), and Robins (*Turdus migratorius*).

As it is common knowledge that thymuses enlarge in young, growing animals—occurring in pheasants concurrently with molting—and begin to regress as the body approaches adult proportions or sexual maturity, the relationship between changes in size of thymuses and replacement of primaries in juvenile pheasants is not particularly surprising. It is of interest, however, that the patterns of enlargement and regression of thymuses in juvenile and adult pheasants are similar.

DISCUSSION

The seasonal dynamics of thymus weight in avian forms are apparently influenced to a large extent by shifts in hormone activities. The thymus is suppressed by adrenal cortical hormones (Garren and Satterfield 1957:716; Hublé 1958:299; Höhn 1959:284), mixtures of estrogen and progesterone, and the antithyroid drug aminothiazol (Hublé 1958:298–299). Conversely, thyroxine increases thymus weight (Höhn 1959:284), and, according to Höhn (1956:101, 1959:286), increased secretion of this hormone is probably responsible for the summer recrudescence of thymuses in adult birds.

It seems reasonably certain that enlargement of the thymus, molting, and thyroid activity, and hence metabolic rate, are interrelated. Administration of large dosages of thyroxine or desiccated thyroid induces molting (Van der Meulen 1939:109; Höhn 1959:286) as well as enlargement of the thymus. The metabolic rate increases during the molting period (Koch and de Bont 1944:83–84; Perek and Sulman 1945:242; Wallgren 1954:59–60), and enlargement and subsequent regression of the thymus are closely related to the molt in at least one species (figs. 1, 2).

The abrupt shift in the thymus from increase to decrease in size in molting pheasants (figs. 1, 2) can be further correlated with the rate of molt. In captive adult hens, the mean interval between replacement of successive primaries increased from 8–10 days for primaries 1–6 to 12–13 days for primaries 6–10 (W. L. Anderson, unpublished data). Hence, the rate of molt *decreased* markedly about the time primary 6 emerged, which corresponds

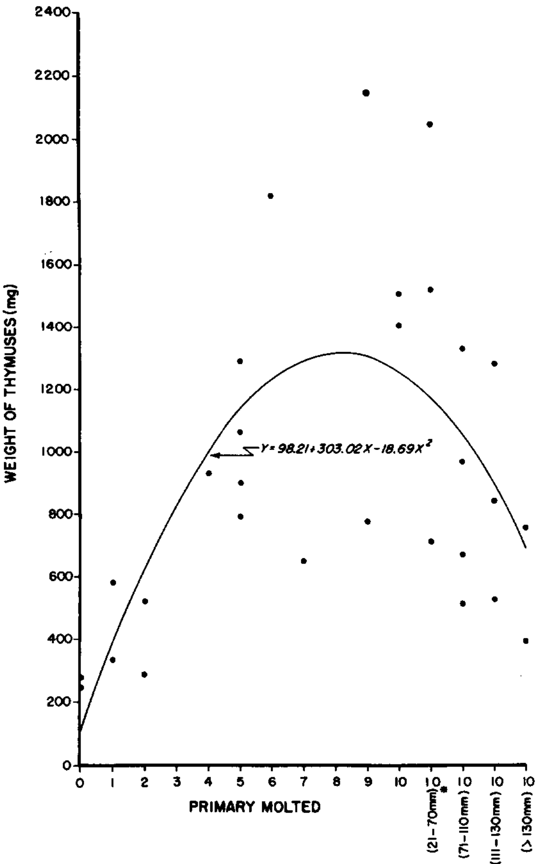

FIGURE 1. Relationship, as described by curvilinear regression (Snedecor 1956:452), between weight of both thymuses and progression of molt of primary flight feathers in 29 juvenile hens pheasants, 1966 and 1967, east-central Illinois (* length of primary 10).

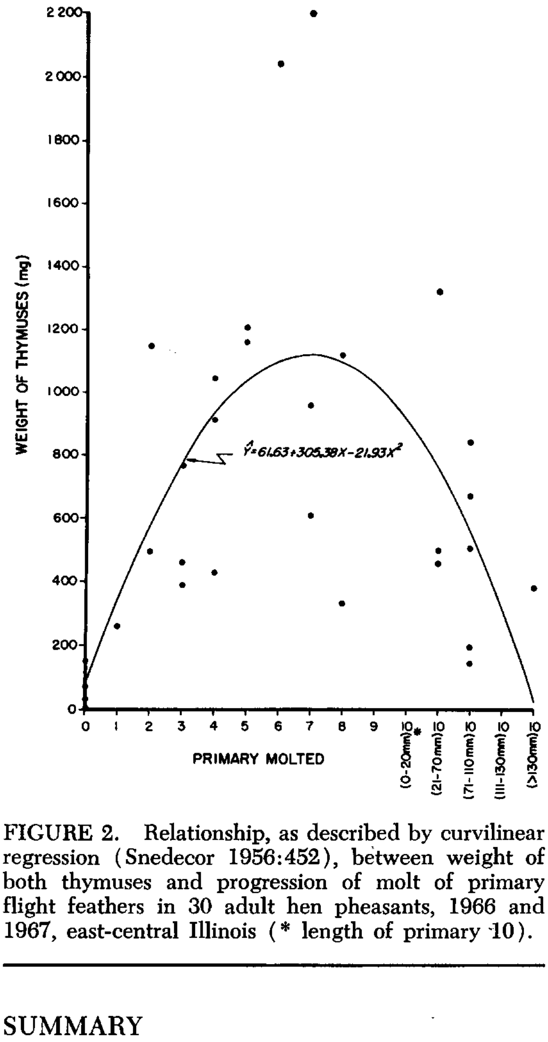

FIGURE 2. Relationship, as described by curvilinear regression (Snedecor 1956:452), between weight of both thymuses and progression of molt of primary flight feathers in 30 adult hen pheasants, 1966 and 1967, east-central Illinois (* length of primary 10).

with a pronounced decline in the rate of increase of thymus weight in adult hens (fig. 2).

Whether an enlarged thymus in adult birds during the molting period has some function contributing to their well-being is unknown. It seems logical that the role of the thymus in the immune process would have its greatest value in young animals. Nevertheless, Good et al. (1966:466) believe that the gland is functional into old age. Pertinent in this respect is Höhn's (1956:97) finding that enlarged thymuses in adults are histologically indistinguishable from those of juveniles in Mallards, House Sparrows, and Robins. Perhaps an increased supply of lymphoid cells has survival value for adult birds subjected to the rigors of developing new plumage. Pheasants are reportedly at their annual low ebb in body weight and stress resistance during early stages of molting (Kabat et al. 1956:33). Investigations of possible survival mechanisms associated with enlargement of the thymus gland in adult birds might prove highly rewarding.

SUMMARY

Thymuses in Ring-necked Pheasants attained their largest size in young, growing birds, after which they regressed and remained small through the following June. However, all adult pheasants collected during the molting period (July–October) had greatly enlarged thymuses. The enlargement and regression of thymuses in both juvenile and adult pheasants were closely related to the progression of molt of primary flight feathers. Interrelationships among thymus enlargement, molting, hormone secretion, and metabolic rate are discussed.

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