SEASONAL VARIATION IN THYROID GLAND ACTIVITY IN PHEASANTS[1, 2]

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ABSTRACT

Thyroid glands from 167 pheasants (Korean-*Phasianus colchicus karpowi*, Persian-*Phasianus colchicus persicus*, green-*Phasianus versicolor*, and Reeves-*Syrmaticus reevesii*) were examined to determine if there were a seasonal or sexual variation in (1) the weight of the thyroid gland and (2) thyroid activity as determined by histological techniques. A Thyroid Activity Index, which histologically rates thyroid activity from 1 to 5 (inactive to very active), was employed to evaluate the functional state of the gland. Five males and five females each of the pheasant groups were sacrificed in January, April, July, and October.

Generally, the thyroid glands were most active in January and April and least active in July and October. An inverse relationship seemed to exist: the lighter the gland, the more active it is, and the heavier the gland, the less active it is.

A great amount of data has been accumulated concerning seasonal variation in thyroid function in birds. Altered thyroid weight and morphology, as well as altered iodine metabolism, have been reported in several species of sparrows (Miller, 1939; Oakeson and Lilley, 1960), pigeons (Riddle, 1925, 1947), bob whites and Japanese quail (Kirkpatrick et al., 1962), mallard duck (Hohn, 1949), and the ringnecked pheasant (Greeley, 1953). There still remain, however, many unanswered questions regarding subtle differences in seasonal variation in organ function between closely related species and subspecies. It is becoming increasingly important in endocrinology to have information of this nature. As pointed out by Eleftheriou and Zarrow (1962), there are only a few studies which compare thyroid function in closely related species of animals.

Closely related species of pheasants belonging to the family *Phasianidae* were selected for this comparative study of thyroid activity. Although native to Asia, several species and subspecies of the genus *Phasianidae* and of the genus *Syrmaticus* have been introduced into America. Several states are currently considering introducing some of these pheasant species into those habitats of their state to which the ringnecked pheasant (*Phasianus colchicus*) has been unable to adapt. However, introduction of exotic species into regions where they are either ecologically or physiologically not suited almost always meets with failure. Before costly, large-scale, random introductions are made, it would be wise to determine whether these exotic species of pheasants are physiologically and ecologically adaptable to these new habitats.

The thyroid gland, which helps regulate energy metabolism, has an important role in the adaptation of the birds to a new environment. It is well known that thyroid activity in most species of birds varies continually throughout the year. Apparently this variation in thyroid activity functions to adjust metabolism to the changing seasons. Several studies already completed (Moore, 1961; Siebert, 1963) have indicated that Reeves and green pheasants exhibit differences in energy metabolism throughout the year.

The present study was designed to measure and compare differences in seasonal and sexual variation in thyroid gland activity in the Korean (*Phasianus*

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colchicus karpowi), Persian (*Phasianus colchicus persicus*), green (*Phasianus versicolor*), and Reeves (*Syrmaticus reevesii*) pheasants.

MATERIALS AND METHODS

A total of 167 pheasants was used in this study. All were raised at the Waterloo Wildlife Experiment Station, located in southeastern Ohio. They were housed in either flight or breeding pens and were exposed to the prevailing environmental conditions throughout the year.

Generally, five males and five females of each of the four pheasant groups were sacrificed in April, July, October, and January. The thyroid glands were removed, freed of adhering tissue, weighed on a torsion balance to the nearest milligram, and placed in Bouin's fixative. The parathyroids, which are not imbedded in the thyroid glands of birds, were not included in the thyroid weights. They were prepared for microscopic examination by the paraffin method, sectioned at 10 μ, and stained with Harris' hematoxylin and eosin.

The functional state of the thyroid gland was evaluated by means of a Thyroid Activity Index (table 1) modified from Davis and Davis (1954), Heyle and Laqueur (1934), and Saint-Girons and Duguy (1962) according to the following procedure: Three representative central cross sections of each thyroid gland were traversed along two diagonals at right angles to each other. Each cell lying along a diagonal was assigned to one of the five categories shown in table 1. For the majority of

TABLE 1
Thyroid activity index

Stage	Cell	Nucleus	Follicles	Vacuolation	State of gland
1	Very flat (2–3 μ)	Flat or crescentric	Very large and spherical	Without vacuoles	Inactive
2	Flat (4–6 μ)	Flat	Larger follicles on the periphery and smaller follicles towards the center	Few vacuoles	Fairly active
3	Cuboidal (7–10 μ)	Oval Touching cell membrane	Small and large throughout the gland	Many vacuoles	Moderately active
4	Columnar (11–15 μ)	Round In center of cell	Small and large throughout the gland	Very many vacuoles	Strongly active
5	Columnar (16–20 μ)	Round Located at base of cell away from lumen	Greatly shrunken	Very little if any colloid and greatly vacuolated	Very active

specimens, this involved classifying between 100 and 200 cells in each thyroid gland. The slides were numbered nonconsecutively so that the investigator would not know which species he was evaluating. This reduced bias to a minimum.

The interpretation of the figures for the Thyroid Activity Index (TAI) is based on the assumption that a thyroid gland with relatively high, columnar epithelium and highly vacuolated colloid is more active than one with low, flattened epithelium and nonvacuolated colloid. There is experimental evidence to justify these assumptions (Dempsey, 1949; Hoffman and Shaffner, 1950; Lever, 1948; Lever et al., 1949; and DeRobertis, 1949).

RESULTS

Histological examination of the thyroid glands revealed that the female Korean and female green pheasants possessed their most active thyroids in April; male Persian, male Korean, and male green pheasants in April and January; and female Persian pheasants in January (fig. 1).

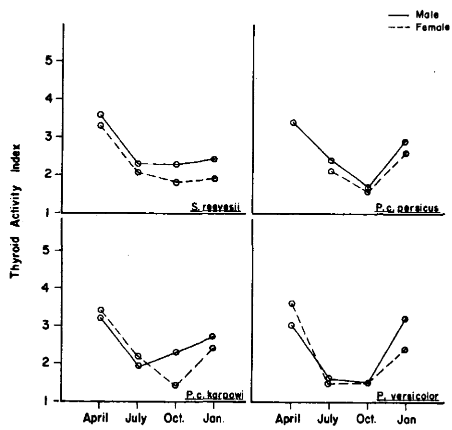

FIGURE 1. Seasonal variation in thyroid activity index in pheasants.

The thyroid glands of female Persian and male Korean pheasants were least active in July; those from male and female green pheasants least active in July and October; and those from female Korean pheasants least active in October. In both the male and female Reeves pheasants, the thyroid glands were active in April and inactive throughout the remainder of the year.

No difference in thyroid gland activity was found to exist between the sexes in July. Female green pheasants possessed significantly (P = 0.05) more active

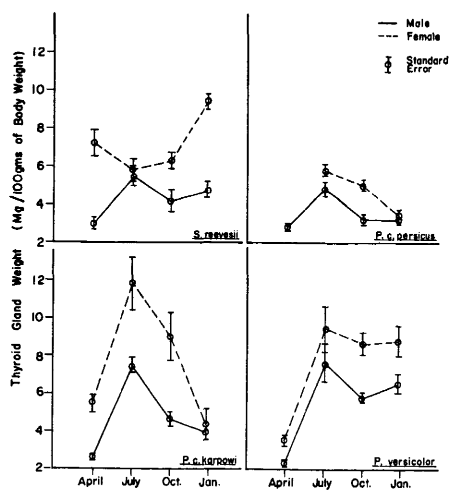

FIGURE 2. Seasonal variation in thyroid gland weight in pheasants.
S. reevesii—Reeves pheasants
P. c. persicus—Persian pheasants
P. c. karpowi—Korean pheasants
P. versicolor—green pheasants

thyroid glands than male green pheasants in April. Male Korean pheasants possessed more active thyroid glands (P = 0.05) than female Korean pheasants in October. In January, the thyroid glands of male green pheasants were more active (P = 0.05) than female green pheasants, and in October and January, male Reeves' pheasants possessed more active (P = 0.05) thyroid glands than female Reeves' pheasants.

A seasonal variation in the relative (fig. 2) and absolute (tables 2 and 3) weights of the thyroid glands was found to occur in all four species studied, except in the female Persian pheasants where no significant seasonal variation in the absolute weights of the thyroid glands existed.

TABLE 2

Thyroid and body weights of male pheasants at various seasons of the year

Month	Group	N	Mean weights ± standard error	
			Thyroid (mg)	Body (g)
April	Reeves	5	46 ± 5	1327 ± 14
	Persian	5	30 ± 2	1059 ± 27
	Korean	5	28 ± 1	1098 ± 68
	Versicolor	5	22 ± 2	1058 ± 87
July	Reeves	5	84 ± 12	1520 ± 35
	Persian	5	44 ± 5	922 ± 29
	Korean	5	76 ± 10	1057 ± 17
	Versicolor	4	70 ± 10	986 ± 24
October	Reeves	5	64 ± 6	1554 ± 30
	Persian	5	40 ± 6	1187 ± 54
	Korean	5	60 ± 3	1332 ± 49
	Versicolor	4	72 ± 2	1251 ± 55
January	Reeves	5	72 ± 8	1548 ± 65
	Persian	5	32 ± 2	1016 ± 25
	Korean	5	44 ± 3	1080 ± 55
	Versicolor	2	72 ± 4	1140 ± 0

TABLE 3

Thyroid and body weights of female pheasants at various seasons of the year

Month	Group	N	Mean weights ± standard error	
			Thyroid (mg)	Body (g)
April	Reeves	5	86 ± 10	1174 ± 25
	Persian	0	—	—
	Korean	5	38 ± 4	714 ± 40
	Versicolor	5	28 ± 2	840 ± 51
July	Reeves	5	60 ± 10	901 ± 33
	Persian	5	38 ± 2	678 ± 17
	Korean	5	100 ± 16	823 ± 97
	Versicolor	4	67 ± 6	738 ± 12
October	Reeves	5	66 ± 8	1031 ± 30
	Persian	5	40 ± 6	720 ± 15
	Korean	5	78 ± 12	818 ± 31
	Versicolor	5	68 ± 4	765 ± 21
January	Reeves	4	90 ± 5	1032 ± 28
	Persian	5	24 ± 2	704 ± 25
	Korean	5	32 ± 6	764 ± 54
	Versicolor	5	76 ± 10	858 ± 23

All of the pheasants except the female Reeves pheasants were found to have their smallest thyroid glands in April. The largest thyroid glands in male Persian and Male Korean pheasants occurred in July and October, while male green pheasants had their largest thyroids in July, October, and January. The heaviest thyroid glands from female Korean and female green pheasants came from those sampled in January. Female Reeves pheasants possessed their heaviest thyroid glands in April and January; the glands were small throughout the remainder of the year.

Seasonal variation in the relative weights of the thyroid glands is shown in figure 2. Male Reeves, male Korean, and both male and female green pheasants possessed their heaviest thyroids in April. However, male Persian pheasants had their heaviest thyroids in April, October, and January; female Korean pheasants had heaviest thyroids in April and January; and female Persian pheasants had heaviest thyroids in January. The heaviest thyroid glands in male and female Persian pheasants and male and female Korean pheasants came from those sampled in July. Female Reeves pheasants possessed their heaviest thyroid glands in April and male and female green and male Reeves pheasants possessed their heaviest thyroids in July, October, and January. The females of all four pheasant groups possessed heavier thyroid glands than the males in all seasons, studied on a relative basis, with the exception of green and Reeves pheasants in July and Persian and Korean pheasants in January. The females had heavier thyroids than did the males when compared on a milligrams thyroid/100 gram body weight basis ($P = 0.05$). The absolute thyroid weights did not show such significant variations (tables 2 and 3).

DISCUSSION

The thyroid hormones of birds, as in mammals, produce a great stimulation of metabolism and are required for normal growth and development (Gorbman and Bern, 1962). In temperate climates, thyroid gland activity is increased during the colder periods of the year when an increase of metabolic rate, brought about by increased titers of thyroid hormones, is needed to counteract the increased heat loss. Marked seasonal changes in the histology of the thyroid gland have been observed in many mammals and birds during this period of the year. Moreover, Miller (1939) showed that exposure of house sparrows to low temperatures can cause stimulation of thyroxin secretion and an increased metabolic rate.

This effect is undoubtedly mediated by changes in the TSH release from the pituitary. Winchester (1940) has demonstrated a seasonal variation in heat production in chickens. At the time of greatest heat production, the TSH content of the pituitary glands was at a maximum. These studies imply that the thyroid gland, through the secretion and release of thyroid hormones, has a direct effect on heat production in birds.

A period of increased thyroid gland activity occurs preceding molt. This has been observed in the house sparrow, tree sparrow, and robin, and is also indicated in chickens by increased oxygen consumption before the molt (Marshall, 1961). According to Gorbman and Bern (1962), there is much specific variation in the degree of sensitivity of the molting mechanism to changes in the thyroid state. Domestic fowl, pigeons, and pheasants are examples of thyroid-sensitive forms.

Normal gonadal function in birds has been shown to be dependent on normal thyroid gland activity. Marshall (1961) states that gonadal atrophy and a reduction in comb and wattle size resulted after thyroidectomy in mature chickens, and testicular development was stimulated by the addition of thyroid hormones in ducks and mallards. Exogenous thyroid hormones also caused increased egg production in hens (Magsood, 1952).

Pheasants are most physically active during the breeding period. According to Long (1948), crowing, flying, running, and fighting all increase during the period from March to June. This period is the breeding season for the Reeves, Persian, Korean, and green pheasants. Histological examination of the thyroid glands during this period (April) showed them to be quite active in appearance in all four species studied, indicating that the thyroid gland is activated during the reproductive period and, probably, plays an important role in normal gonadal function in view of the role of the thyroid hormone in reproduction of birds (Gorbman and Bern, 1962).

The absolute weight of the thyroid glands of male Reeves pheasants, male Persian pheasants, and both male and female Korean and green pheasants, however, was smallest in April. In April, the thyroid glands of female Reeves pheasants were heaviest. Greeley (1953) found that male game farm ringnecks (*P. colchicus*) had their smallest thyroid glands in April, while female game farm ringnecks had their heaviest thyroids in April.

Histological examination of the thyroid glands of all of the species studied in July revealed them to be low in activity and, except for the female Reeves pheasants, at their heaviest. These data agree with the observations of Greeley (1953), that male and female game farm ringnecks (*P. colchicus*) have thyroid glands that are inactive in appearance at this time of the year. Breitenbach et al. (1963)

TABLE 4

Mean maximum and mean minimum temperatures during the months that thyroid activity in pheasants was measured

Month	Year	Mean maximum temperature	Mean minimum temperature
April	1963	57.5°F	34.6°F
July	1963	79.8°F	53.9°F
October	1963	66.7°F	33.6°F
January	1964	35.6°F	14.6°F

also found that thyroids of female ringnecks (*P. colchicus*) were heaviest in July.

Greeley (1953) showed that both male and female ringnecks had glands which were active in appearance in October. In October, the thyroid glands in all four species used in this study were inactive in appearance, except for the male Korean pheasants which possessed thyroids which appeared to be fairly active. This thyroid inactivity in October could be due to the unusual hot, dry conditions which prevailed in southeastern Ohio during this and the preceding month (table 4). The high environmental temperatures would have depressed metabolism and this would have been reflected in thyroid gland inactivity.

In January, probably due to the increased heat demands, all of the thyroid glands were active in appearance except for the male and female Reeves pheasants, which possessed thyroids which were histologically inactive. An explanation of these latter observations is not apparent.

It is of interest to note that an inverse relationship between thyroid gland activity and weight was found to occur; this was most apparent in male Korean pheasants. In April and January, when the thyroids were lightest, the glands were moderately active in appearance, and in October, when the glands were intermediate in weight, the thyroids were fairly active in appearance. Galpin (1938) and Podhradsky (1933) have also postulated an inverse relationship between the weight and activity of the thyroid gland in certain species of pigeons. The data presented here lend support to their conclusions.

These findings point out that, regarding thyroid gland activity, emphasis should be placed on histological and physiological tests rather than on weight data alone.

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