PHYSIOLOGICAL DIFFERENCES BETWEEN FAST AND SLOW GROWING CHICKENS

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PREFACE

The author wishes to express his appreciation to the following staff members of the Poultry Department of the Oklahoma Agricultural and Mechanical College:

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INTRODUCTION

Two lines of Silver Oklabar chickens, called the Fast and Slow Growth lines, have been developed at the Oklahoma Agricultural Experiment Station. The Fast Line has been selected for rapid growth to twelve weeks of age, while the Slow Line has been selected for slow growth to twelve weeks of age. Selection for several generations has produced two lines of birds which differ in six and twelve-week body weight.

Although strain and breed differences in growth rate have been observed by many workers, little information is available indicating through what mechanism or physiological manner these differences operate. A study of some of the endocrine differences, if any, between the Fast and Slow growing Silver Oklabar lines might help us understand growth patterns in poultry. It is believed that phenotypic differences among strains of poultry are, at least partially, caused by differences in endocrine activity.

The objective of this investigation is to find any physiological differences between fast and slow growing chickens, with special attention directed to any differences in thyroid activity.

REVIEW OF LITERATURE

Inasmuch as the main object of this thesis is to discover differences, if any, between the thyroid function of Fast and Slow Growth lines of Silver Oklabars, it seems desirable to review the anatomy and physiology of the thyroid gland in the chicken. Differences in secretion rates of the thyroid gland reported between strains, breeds and species, as well as the assay methods used to detect these differences, will also be reviewed.

Thyroid Anatomy

Gross Anatomy -- In birds, the two lobes of the thyroid gland are completely separate. These lobes are located on each side of the trachea at the entrance to the thoracic cavity, as shown by Cruickshank (1930). These glands are oval-shaped and vary from a light to a very dark red in color.

The size of the thyroid glands, which is very variable, depends upon many factors such as season, environmental temperature, age, and diet.

The blood is supplied to the glands by a branch of the carotid artery called the thyroid artery. The blood is drained from the glands by veins which empty into the jugular vein. With the possible exception of the adrenal gland, probably more blood flows through the thyroid gland than any other gland in the body, Turner (1948).

It is doubtful that the abundant vasomotor nerves, which are located in the walls of the thyroidal blood vessels, cause the secretion of thyroid hormone as was shown by Uotila (1939). The function of the sympathetic nerves, however, is to regulate the flow of blood through the gland. The fact that thyroxine is secreted when its normal nerve supply is cut, or when the gland is transplanted to other parts of the body, indicated that thyroid secretion is not under nervous control.

Microscopic Anatomy -- The microscopic appearance of the thyroid gland shows an aggregate of spherical shaped follicles which may vary in size. These follicles may or may not contain colloid as was found by Larson, et al (1945). The colloid contains the specific thyroid hormone, thyroxine. The follicles are lined by entodermal epithelium which are the secretory cells. These epithelial cells are surrounded by interfollicular connective tissue as stated by Turner (1948).

Thyroid Physiology

General -- The secretion rate of the thyroid gland is generally believed to be governed by the balance between the thyroid hormone and the thyrotropic hormone of the anterior pituitary as shown by Payne (1944). A lowered thyroid hormone output causes the anterior pituitary to release more thyrotropin (TSH). This process takes place to keep the balance between the TSH and thyroid hormone normal, which in turn, holds the basal metabolic rate within a normal range. Other factors could possibly affect the release of thyroxine directly, as was stated by Monroe and Turner (1949), but they have not yet been demonstrated.

Dvoskin (1947) showed that it was evident that TSH is concerned with both the synthesis and release of the thyroid hormone from the thyroid gland. This is in accord with numerous other investigators.

To demonstrate the effects of the thyroid, it is necessary to induce hypothyroidism and hyperthyroidism. Hypothyroidism is generally produced in two ways: 1 -- by surgically removing the thyroid gland (thyroidectomy), and 2 -- by feeding an antithyroid substance. The two antithyroid substances most widely used are thiouracil and thiourea. Thiourea is the more toxic of the two, therefore, thiouracil is the most widely used. Hyperthyroidism is produced by feeding compounds containing thyroidal activity.

Effects on Growth -- Since the TSH and thyroid hormone balance holds the basal metabolic rate within a normal range, it could be expected that the thyroid hormone exerts as important influence upon growth in chickens. Many investigators have studied thyroid function as it pertains to growth in chickens.

Hypothyroidism -- Blivaiss (1947b) showed that totally thyroidectomized Brown Leghorn males did not attain normal growth. They were small and squatty when compared to the controls.

Thiouracil fed for 16 days to ten-day-old chicks did not improve feed consumption or gain in weight as was reported by Kempster and Turner (1945). However, in the second trial of eight-week-old chicks fed for 5 weeks, there was a marked improvement in carcass quality.

Andrews and Schnetzler (1946) fed thiouracil at levels of 0.025, 0.05, 0.10 and 0.2 per cent to six-week-old Barred Plymouth Rock chicks for a period of 8 weeks. Their results showed that the treated birds required less feed per pound of gain than the controls. They also showed an improvement in market quality of the carcasses.

Not all thiouracil-fed birds showed favorable results, however, as shown by Glazener and Jull (1946a). They reported that thiouracil decreased both growth rate and feed consumption of broilers. They also reported that the market quality of the carcass was not improved.

Hyperthyroidism -- Parker (1943) fed thyroactive iodocasein to Rhode Island Red day-old-chicks for a period of twelve weeks. The diets contained from 0.025 to 0.2 per cent of iodocasein. The chicks which received the lower levels, 0.025 and 0.050 per cent, made greater gains and required less feed per gram of gain than did the controls. Chicks fed higher levels of iodocasein, 0.1 and 0.2 per cent, gained more than the controls. The chicks fed iodocasein utilized their feed more efficiently than the controls only during the more rapid growing period.

The results of Irwin, Reineke and Turner (1943) also showed that iodocasein at the 0.08 per cent level produced the most satisfactory results from the standpoint of growth.

Wheeler and Hoffmann (1948) reported that feeding 0.02 per cent thyroprotein, continuously between twelve and twenty-four weeks of age to Rhode Island Red cockerels and pullets, resulted in no significant improvement in growth.

Effects on Feathering -- The effect of the thyroid gland upon the plumage of the fowl has been studied by many investigators.

Hypothyroidism -- Blivaiss (1947a and 1947b) reported that following complete thyroidectomy, all plumage stages of Brown Leghorns exhibited a replacement of normal pigmentation by reddish-brown pigment. There was a decrease in barbulation, and the feather growth rates were reduced.

Chu (1940) reported that in Barred and White Rocks thyroidectomy did not show any alteration in the color of the plumage, but did show, however, a reduction of barbules.

Juhn (1946) fed thiouracil in the proportion of 0.5 per cent feed, dry weight, in tap water to male and female Brown Leghorn chicks, commencing at seven weeks of age. When the controls were in full adult plumage, test males showed red feathered pigments and reduced barbulation. Test females developed feathers similar to the males, but with little altered pigmentation. These results are about the same as shown for feather changes as observed after thyroidectomy.

Hyperthyroidism -- Crew (1925) reported that the administrated of desiccated thyroid to cock-feathered cocks produced a plumage that was distinctly henny in structure and coloration. These results were similar to those obtained by Cole and Hutt (1928). Hutt (1930) also reported hen feathering in males after males were fed thyroid iodine. He reported that depigmentation was quite marked in the case of the heavy doses, but less evident than when smaller doses were administered.

Emmens and Parkes (1940) reported that thyroxine stimulates melanin formation in most breeds. However, excess dosages with thyroxine may cause depigmentation. The more rapidly growing feathers are the most sensitive to the specific effects of thyroxine.

Chu (1940) reported that under conditions of hyperthyroidism, the plumage changes which resulted were the opposite to those obtained with hypothyroidism. In the Barred and White Rocks there was a full development of barbules.

When thyroactive iodocasein was fed in the diet in the amount of 0.08 to 0.2 per cent to day-old-chicks for a period of twelve weeks, the chicks were more fully feathered than were the controls, Parker (1943), and Irwin, _et al_ (1943).

Effects on Egg Production -- Many investigations have been made on effects of the thyroid on egg production in an effort to increase egg production during normally low periods of fecundity.

Hypothyroidism -- Winchester (1939) reported that in a group of seven White Leghorn hens, thyroidectomy resulted in a decrease in egg production from 3.77 to 0.42 eggs per hen per week. Taylor and Burmester (1940) also reported that egg production was reduced approximately one-third to one-fourth of that of normal hens after complete thyroidectomy.

Glazener and Jull (1946b) reported that the use of thiouracil to depress the thyroid did not appreciably lower egg production.

Hyperthyroidism -- Turner, et al (1945) reported that egg production was maintained at a more uniform level during the seasonal cycle of egg production by maintaining a uniform level of thyroid hormone in the feed. Turner, et al (1945) fed three lots with increasing amounts of iodinated casein which had high thyroidal activity. In all three lots, the average percentage egg production for one year was very definitely higher than that of the control lot. It was determined that the optimum level of iodinated casein in the feed was between 5 and 10 grams per 100 pounds of feed.

Turner and Kempster (1947) fed thyroprotein in the amount of 10 grams per 100 pounds of feed to a group of White Leghorn hens in their fifth laying year. These hens laid an average of 93.8 eggs each during the year, while similar control hens laid an average of 58.9 eggs each. Hens fed thyroprotein during a three-year period produced 11.2 per cent more eggs during the third year, 25.7 per cent more during the fourth year, and 52.5 per cent more eggs during the fifth year than the control group. This would indicate that hens kept in a mild degree of hyperthyroidism continuously, with advancing age, tended to lay at a higher rate than normal hens. This mild hyperthyroidism did not cause any increase in mortality.

Hutt and Gowe (1948) reported that White leghorn females when given iodinated casein, at a level of approximately 10 grams per 100 pounds of feed, did not show any increase in egg production over a period of seven months. The treatment was started in January, and for the first three months the treated birds actually produced less eggs than did the controls. After the first three months, there was no significant or consistent effect.

Comparative Secretion Rates -- Differences in secretion rate of the thyroid gland reported between strains, breeds and species, as well as secretion rates under certain environmental conditions, will be reviewed. Induced thyroid enlargements will also be discussed.

Chickens -- Schultze and Turner (1945) reported that there was a definite difference between the thyroxine secretion rate of White Leghorn cockerels and White Plymouth Rock cockerels. The secretion rate of the White Leghorn cockerels was about 10 per cent higher, per unit of body weight, than the White Plymouth Rock cockerels. Glazener, et al (1949) used females from rapid growing and slow growing strains of New Hampshires and of Barred Plymouth Rocks to compare the strains for thyroxine secretion. The females of the rapid growing strains had a higher level of secretion than did the females of slow growing strains. Boone, et al (1950) compared the thyroid secretion rate of two strains of Rhode Island Red chicks which were characterized by fast and slow feathering. No evidence was found that the slow feathering trait was due to an inherently low thyroid secretion rate; however, in both cases the secretion rate of the males was slightly higher than that of the females.

The thyroxine secretion rates of hybrid "double cross" chicks of Rhode Island Red and Single Comb White Leghorn inbred stocks were determined by Mixner and Upp (1947). The hybrid chicks had a much higher thyroxine secretion rate as compared to the single cross chicks. These hybrid chicks were also markedly superior in their level of thyroxine secretion to chicks of a New Hampshire X Barred Plymouth Rock crosses.

It was shown by Mixner, et al (1944), that maximum thyroid enlargement was secured in about 11 to 12 days when White Plymouth Rock chicks were fed 0.1 per cent thiouracil in the diet. The females showed a greater thyroid enlargement than did the males. The females also required greater amounts of thyroxine to depress the thyroid weights to any given weight level, or to the normal level for their sex. The thyroids of lighter breeds of chickens produced larger thyroids than heavier breeds.

El-Ibiary and Shaffner (1950) showed that it was possible to select lines of chickens that show a wide variation in the enlargement of the thyroid gland. With this type of selection, under conditions of induced hypothyroidism, it was shown that variation in the enlargement of the thyroid gland is under genetic control. Shaklee and Shaffner (1952) developed lines of New Hampshire chickens differing widely in thyroidal response to thiouracil feeding. Day-old-chicks were fed a mash containing 0.2 per cent thiouracil to four weeks of age, at which time they were selected for large thyroid glands and for small thyroid glands. After one generation of selection, a highly significant difference was observed between the thyroid glands of the two lines when fed thiouracil.

Reineke and Turner (1945b) measured the hormone secretion rate in groups of two-week-old White Plymouth Rock chicks at intervals during one year. It was found that the maximum secretion rate was obtained during the fall (Oct. and Nov.). The thyroid secretion rate decreased thereafter, and reached a low during the latter part of March, and remained at this low level until August. During October, the thyroid secretion rose again toward the normal winter level observed the previous year.

Kleinpeter and Mixner (1947) showed that the thyroxine secretion rate of day-old-chicks was not affected by the quality of light, but was influenced by the quantity of light. Chicks which received light for a period of 24 hours had a higher secretion rate than chicks which only received 12 hours of light.

Ducks -- The thyroxine secretion rate of three-week-old White Pekin ducklings was determined by Hoffmann (1950). The secretion rate of the ducklings was shown to be approximately double the thyroxine secretion rate of chickens of comparable weight. This is evidence that a normally high thyroxine secretion rate is responsible for a faster growth pattern. Biellier and Turner (1950) determined that the thyroxine secretion rate of White Pekin females was slightly greater than that of the males. The feeding of 0.1 per cent thiouracil in the diet of the duck produced a greater hypertrophy of the thyroid gland than of any other species reported. Also, the normal thyroid weight of the duck is greater in relation to body weight than that of any fowl studied.

Turkeys -- Smyth, Jr., and Fox (1951) found that the thyroxine secretion rate of three-week-old poults was intermediate between previously recorded rates for chicks and ducks for similar weight and age. Sex differences in secretion rate of thyroxine were inconsistant. However, a marked sex difference was observed in regard to the compensatory hypertrophy of the thyroid gland following thiouracil administration at a 0.1 per cent level in the feed. The females responded by a greater thyroid enlargement than the males. Crossbred offspring were found to have a higher thyroxine secretion rate than purebreds. This is in accord with the thyroxine secretion rate of hybrid "double cross" chicks as was shown by Mixner and Upp (1947).

Swine -- Baird, et al (1952) showed that pigs belonging to two genetically different lines, selected for rapid and slow rates of gain, did not show any significant differences in thyroid weights in relation to body weight. There were also no significant differences between sexes. Reineke, et al (1948) stated that thyroid weight alone is a very poor index of thyroid gland activity. They stated that the thyroid secretion rate for pigs is at a maximum in young, rapidly growing animals. The administration of thyroprotein will cause some increase in growth rate if the dosages are in the proper amount.

Rats -- The thyroxine secretion rate of young male albino rats was determined by Reineke, et al (1945). The rats were given 0.1 per cent thiouracil in their drinking water for a period of two weeks. The effect of the thiouracil alone doubled the thyroid weight, and depressed the metabolic rate 23.7 per cent. Dempsey and Astwood (1943) reported that the rate of thyroid enlargement, in response to thiouracil administration, was low in hot environments and high when the rats were maintained in the cold. The average thyroxine secretion rate of rats is greater than that for chickens but is slightly less than the secretion rate for turkey poults.

Assay Methods

The review of literature upon the assay methods used for the experimental work conducted on the Fast and Slow Growth lines of Silver Oklabar chickens for this thesis include: Gland weight, closed vessel technique and thiouracil - thyroprotein assay.

Gland Weight -- Juhn and Mitchell, Jr., (1929) found that the gland weights between male and female Brown Leghorns were very variable, and that thyroid weights were the most variable. However, the thyroids did show a sex difference, the male thyroids being heavier than those of females.

Aberle and Landauer (1935) working with day-old-chicks, reported a statistically significant difference between the thyroid weight of males and females. They concluded that there was an actual sexual difference in thyroid weight of newly hatched chicks in that the females showed a greater thyroid weight than did the males.

A study was made by Hoffmann, et al (1953) to determine whether or not breed or strain differences exist with regard to gland size, and if such differences can be accounted for by relative body weights. Data was secured on the pituitary, thyroid, adrenal, gonad and comb weights of 16 males and 16 female chickens from each of seven different breeds or strains. Statistically significant strain and variety differences were obtained for all weights; and in only one case, comb weight of females, did these differences become non-significant when the values were adjusted for differences in body weight. However, in most cases strain differences were reduced considerably by adjustment for body weight. The thyroid gland was not significantly larger in males, and when adjusted for weight differences between the sexes, this gland was relatively heavier in the females.

Closed Vessel Technique -- Animals which have a high thyroidal activity also have a high metabolic rate. Therefore, animals, in a sealed vessel, with a higher metabolic rate would die more rapidly than those with a lower rate. This is basically the closed vessel technique.

Smith, et al (1947) reported that mice treated with large doses of dried thyroid preparations, or with iodinated casein, survived in closed vessels only about half as long as normal mice. The dried thyroid preparation, when fed to the mice, increased the thyroid activity which, in turn, produced a higher metabolic rate causing the mice to die much more rapidly than the normal mice. Reisfield and Leathem (1950) also showed that the survival time of mice in a closed vessel was reduced by oral administration of thyroglobulin.

McCartney and Shaffner (1949) used the closed vessel technique to determine the survival time of chicks hatched from thyroprotein-fed and thiouracil-fed females. Their results indicate that the thyroidal activity of the chicks hatched from the thyroprotein and thiouracil-fed females was lower than in normal chicks, suggesting a lowered metabolic rate and a functional hypothyroid condition.

Thiouracil - Thyroprotein Assay -- Dempsey and Astwood (1943) first used the thiouracil - thyroprotein assay as a means of determining the rate of thyroid hormone secretion at various environmental temperatures for rats. Schultze and Turner (1945) used the thiouracil - thyroprotein assay to determine the difference between the thyroxine secretion between White Leghorn cockerels and White Plymouth Rock cockerels. The general procedure used was to divide the chicks into seven different lots. Lot 1 was designated as control, Lot 2 as thiouracil only, and Lots 3 through 7 were thiouracil plus increasing amounts of daily injections of d,l-thyroxine. The chicks were killed at the end of 12 days, and the thyroid glands were weighed. The average weights of the thyroid for each lot were plotted on a graph. From these graphs the relative secretion rates were obtained.

MATERIALS AND METHODS

Thyroid assays were run and endocrine gland weights were obtained on Fast and Slow Growth lines of Silver Oklabars in order to determine differences in endocrine activity of fast and slow growing chickens.

The Slow and Fast Growth lines of the Silver Oklabar chickens were originated in January, 1950, from flock matings. From this original population of about 700 chicks, the heaviest and lightest chicks at six and twelve weeks of age were selected as parents for the Fast and Slow Growth lines. Selection for body weight was subsequently practiced within each line; that is, selection for low body weight was practiced within the Slow Growth line, and selection for high body weight was practiced in the Fast Growth line. Chicks of the fourth and fifth generations were used in this study to determine physiological differences between fast and slow growing birds. It is interesting to note that the differences in body weight at six weeks, between the two lines, were 0.44 and 0.60 pounds for the fourth and fifth generations. Similar differences at twelve weeks of age were 0.94 and 1.24 pounds.

<u>Closed Vessel Technique</u> -- Chicks of the fourth and fifth generations were used to determine thyroid activity by the closed vessel technique. The number of fourth generation chicks used were: Slow Line males, 78; Slow Line

females, 99; Fast Line males, 113; and Fast Line females, 88. The number of fifth generation chicks were: Slow Line males, 41; Slow Line females, 56; Fast Line males, 60; and Fast Line females, 61.

The chicks were weighed and placed in one-half pint Kerr fruit jars. Suffocation time was recorded after the chicks stopped all gasping. A simple, but effective, test to see if the chick was dead, was to tap the lid of the jar with the eraser end of a pencil. The sound would disturb the chick, and if any life was left, the chick would almost always give a final gasp. If the jar was tapped at least three times, and no gasping was observed, it was assumed the chick was dead.

The time to die was recorded in minutes per 100 grams body weight. The "t" test (Snedecor, 1950) was used to test the differences between the Fast and Slow Growth lines for thyroid activity.

<u>Thiouracil</u> - <u>Thyroprotein</u> <u>Assay</u> -- Chicks of the fifth generation were used to determine differences in thyroid activity between the Fast and Slow Growth lines as measured by this assay method. The general procedure was to divide the chicks into six different lots. Lot 1 was designated as control, and fed a standard chick ration as shown in Table 1. Lot 2 was designated the thiouracil control lot. To obtain the thiouracil lot, 0.1 per cent thiouracil was added to the standard chick ration. Lots 3 through 6 also contained 0.1 per cent thiouracil, and in addition contained thyroprotein

(Protamone) in increasing amounts. The thiouracil was mixed with the standard chick ration for Lots 2 through 6 at one time, while the Protamone was mixed separately. Protamone was added to Lots 3 through 6 so that daily feed intake would be equal to 1.0, 1.5, 2.0 and 2.5 micrograms daily of d,l-thyroxine. The amount of Protamone added was: Lot 3, 38.88 milligrams; Lot 4, 78.30 milligrams; Lot 5, 117.18 milligrams; and Lot 6, 157.68 milligrams. These rations were fed for a period of eleven days. It was determined the chicks would eat approximately 0.3 pounds feed per chick in eleven days. Since each lot was divided into equal numbers, the Protamone for each lot could be added for the eleven days at one time. The chicks were kept in electric battery brooders. The room temperature was 70° to 80° F., and temperature under the hover was 95°F.

The thiouracil used in this project was obtained from Lederle Laboratories, Pearl River, N. Y., and the thyroprotein (trade name "Protamone") from Cerophyl Laboratories, Inc., Kansas City, Mo. Cerophyl Laboratories stated that "Protamone" contained 1.13 per cent thyroxine, and that the thyroxine present was in the l-isomer form. The l-isomer has twice the activity of d,l-thyroxine (Reineke and Turner, 1945).

At the end of eleven days, the chicks were killed by suffocation, and the thyroid glands were removed and weighed. The number of chicks used were: 23 chicks per lot in the first trial; 20 per lot in the second trial; and 45 chicks per lot in the third trial. Results of the three trials were averaged together, and graphs were drawn from these results to show the relative secretion rate between the Fast and Slow Growth lines.

Thyroid Weight of Day-Old-Chicks -- Chicks used for the thyroid weight assay were the same chicks as those used for the closed vessel technique. The thyroid weight assay was used as a measure for thyroid activity between the Fast and Slow Growth lines.

Pedigreed eggs from both Slow and Fast Growth lines were randomized in the hatching trays. All chicks were killed within 24 hours after hatching by suffocation, and weighed to the nearest tenth of a gram. The thyroid glands were removed, and the chicks were sexed. The room temperature in which the chicks were killed was between 75° and 85° F.

To excise the thyroids, the chick was placed on its back. The ribs were cut from the posterior to the anterior end, approximately half way between the dorsal and ventral line. Then the breast bone and ribs were folded toward the anterior end of the chick exposing the thyroid glands. The glands were separated from the surrounding tissue with a pair of pointed tweezers. After their removal, they were placed on an absorbent towel. Fat and extraneous tissue were removed from the thyroid glands with a sharp scalpel. The thyroids were then weighed on a milligram scale.

Thyroid weights of the day-old-chicks were converted to thyroid weight in milligrams per 100 grams body weight. The "t" test (Snedecor, 1950) was used to test the differences between Fast and Slow Growth lines for thyroid weight.

Gland Weights of Twelve-Week-Old Chicks -- Since the Fast Line grows much more rapidly than the Slow Line, information on gland weights of twelve-week-old chicks might indicate differences in physiological activity between the two lines. Therefore, forty chicks of the fourth generation were raised to twelve weeks of age under uniform environmental conditions. They were killed by severing the jugular vein, after which the feathers were removed. After dressing, the gonads, adrenals, comb, thyroids and pituitary gland were removed from each bird and weighed on a milligram scale.

In the analysis, gland weights of the twelve-week-old chicks were converted to gland weight in milligrams, or grams, per 100 grams body weight. The "t" test (Snedecor, 1950) was used for testing the differences between the Fast and Slow Growth lines for twelve-week-old gland weights.

RESULTS

Physiological differences in thyroid activity were demonstrated between fast and slow growing chickens. These differences were found on the basis of the closed vessel technique and the thiouracil - thyroprotein assay. However, there were no differences in gland weights between the two lines.

Closed Vessel Technique -- This assay method measures difference in metabolic rate, and thus measures thyroid activity because this endocrine gland affects metabolic rate. The results of the closed vessel technique, as used with the day-old-chicks, are shown in Table 2.

The Fast Line males required an average of 258.4 minutes per 100 grams body weight to die, while the Slow Line males required 327.2 minutes per 100 grams body weight to die. This difference was highly significant which would indicate a definite thyroidal activity difference between the Fast and Slow Line males. Since the Slow Line males required more time to die than the Fast Line males, the Fast Line males have a higher metabolic rate or thyroid activity than the Slow Line males. The difference between the Fast and Slow Growth females was also highly significant except in generation 5a. This was probably due to chance sampling since the total probability level of the difference was 0.001 for females. Fast Line females required an average of 261.7

minutes per 100 grams body weight to die and the Slow Line females required 330.0 minutes per 100 grams body weight to die, showing again that the Fast Line has a higher metabolic rate than the Slow Line.

The females required slightly more time to die than did the males for both Slow and Fast Growth lines. Therefore, the males have a higher metabolic rate than do the females. The closed vessel technique, for thyroid activity, shows a definite difference between the Fast and Slow Growth lines.

Thiouracil - Thyroprotein Assay -- This assay method measures the difference in secretion rates of the thyroid gland between the Fast and Slow Growth lines. In addition, induced thyroid enlargements by feeding thiouracil can be obtained. The results from feeding thiouracil and thiouracil plus thyroprotein are plotted on a graph. The graphs made from this study are shown in Figure 1. The ordinate of the graph is micrograms of d,l-thyroxine and the abscissa is thyroid weight in milligrams. The thiouracil is fed to depress the action of the thyroid gland, thus causing an increase in the size of the gland. The thyroprotein is fed to reduce the size of the thyroid gland by supplying thyroxine. Therefore, thiouracil alone will give maximum thyroid enlargement, while increasing amounts of thyroprotein will decrease the size gradually to a size smaller than that of the control group. Where the line plotted for decreasing thyroid weight and the line plotted for the control group cross on the graph, the secretion rate can be determined.

The secretion rate of the Fast Line males, 1.70 micrograms d,l-thyroxine daily, was slightly higher than the secretion rate of the Slow Line males, 1.63 micrograms d,l-thyroxine daily. The secretion rate of the Fast Line females, 1.80 micrograms d,l-thyroxine daily, was greater than the secretion rate of the Slow Line females, 1.50 micrograms d,l-thyroxine daily. This is further evidence that a difference between Fast and Slow Growth lines does exist for thyroid activity or metabolic rate. The Fast Line has a higher metabolic rate than the Slow Line. However, this study did not show any difference between secretion rates of males and females.

Induced thyroid enlargements were greater in the Slow Line than in the Fast Line. The females exhibited greater induced thyroid enlargement than the males. The Fast Line has a greater thyroidal activity than the Slow Line since thiouracil depressed the action of the thyroid gland of the Fast Line more than that of the Slow Line. Similarly, the males have a higher thyroidal activity than the females since the male thyroid glands were depressed more than the females.

To further show physiological differences between the Fast and Slow Growth lines, when the thiouracil - thyroprotein assay was used, the chicks were killed by the closed vessel technique. These results were plotted on a graph as shown in Figure 2. However, the ordinate is now recorded as time to die instead of thyroid weight.

The Fast Line males had a higher secretion rate than the Slow Line. In the case of the females, however, the Slow Line had the highest secretion rate. From these results no difference was shown between the secretion rates of the Fast and Slow Growth lines when the closed vessel technique was used. The vessel used to suffocate the chicks was a half-pint jar. Since these chicks were considerably larger than day-old-chicks, the time required to die was very short, and the end point between groups was very difficult to determine. This was probably the reason these results did not show any difference between the Fast and Slow Growth lines when the closed vessel technique was used with the thiouracil - thyroprotein assay. This also explains why no difference was shown between the secretion rates of males and females. However, in the thiouracil control lot, which causes maximum thyroid enlargement, the Slow Line of both male and female required more time to die than did the Fast Line. Therefore, the Fast Line has a higher thyroid activity than the Slow Line. Also, the males have a higher thyroidal activity than the females, as the males required less time to die in the thiouracil control than did the females.

The results of the thiouracil - thyroprotein assay do show definite physiological differences between the Fast and Slow Growth lines as was shown by the secretion rates from this study.

Thyroid Weight of Day-Old-Chicks -- Since the growth rate of the Fast and Slow Lines vary considerably, it seemed desirable to see if any differences did exist between thyroid weights of day-old-chicks. The results of the thyroid weight assay are shown in Table 3. Significance was shown at the 1 per cent level in both generations, 5a and 5b, for males. In generation 5a, the Slow Line has the smallest thyroid weight; while in generation 5b, the Fast Line has the smallest thyroid weight. This was probably due to chance sampling since the results were opposite. Significance was shown for the females in generation 4b. This was probably due to chance sampling also. Therefore, no difference was shown for thyroid weights of day-old-chicks between the Fast and Slow Growth lines.

The average thyroid weight of the females was slightly more than the thyroid weight of the males in both the Slow and Fast Growth lines.

<u>Gland Weights of Twelve-Week-Old Chicks</u> -- Gland weights were used as a method to determine if physiological differences between Fast and Slow Growth lines did exist at twelve weeks of age. The results of gland weights of twelve-week-old chicks are shown in Table 4. Significance was shown between comb and adrenal gland in males. This could probably be attributed to chance sampling, since in the case of the females, significance was not shown between any glands. The results definitely show no difference for gland weight between Fast and Slow Growth twelve-week-old chicks. Also, no difference was shown between males and females.

DISCUSSION

From the results of this study, it has been shown there is a difference between fast and slow growing chickens in endocrine gland function. These differences were demonstrated by the closed vessel technique, for thyroid activity, and the thiouracil - thyroprotein assay, for secretion rates and maximum thyroid enlargement. The gland weights of day-old-chicks and twelve-week-old chicks did not show any significant difference. However, larger sample numbers of chicks could possibly show a difference. The body weights of the six and twelve-week-old Fast and Slow Growth lines overlap. Thus, it is possible that the samples used for this study could have come from this overlap which would give no difference between Fast and Slow Growth lines for gland weights. This is why it is assumed that larger sample numbers of chicks might give a significant difference between gland weights.

It has been shown that the balance between the thyroid hormone and the thyrotropic hormone of the anterior pituitary govern the secretion rate of the thyroid gland (Payne, 1944). A lower basal metabolic rate causes the anterior pituitary to release more thyrotropin which, in turn, holds the basal metabolic rate within a normal range. The thyroid hormone acts directly upon the basal metabolic rate of the chicken, and a functioning thyroid is essential for normal somatic growth. There is good agreement upon the fact that males have a higher basal metabolic rate than do females (Boone, <u>et al</u>, 1950). Since males grow more rapidly than females, similarly fast growing chickens have a higher basal metabolic rate than slower growing chickens (Glazener, <u>et al</u>, 1949). Therefore, the thyroid activity of males is greater than the females, and the thyroid activity of the fast growing chickens is greater than the slow growing chickens. The results from this study show that the Fast Line has a higher thyroidal activity than the Slow Line. Also, the males have a higher thyroidal activity than the females of both the Fast and Slow Growth lines.

Growth rate is inherited by multiple factors, and when selection for traits, which are controlled by many pairs of genes is practiced, there is a lot of variability. Faster growing chickens have a higher metabolic rate when selected for fast growth than slower growing chickens of the same strain. Therefore, genes which control growth may also control the activity of the thyroid which, in turn, controls basal metabolic rate. Selection for thyroid activity to produce a faster growth rate in chickens has not been practiced. However, selection for maximum thyroid enlargement, when fed thiouracil, has shown that maximum thyroid enlargement is under genetic control (El-Ibiary and Shaffner, 1950). It has also been shown that hybrid double cross chicks had a much higher thyroxine secretion rate when compared to the single cross chicks (Mixner and Upp, 1947). It would be interesting to observe growth rates and body weights if selection for thyroidal activity were used. The results from this study show that selection for growth rate does not alter gland size but does alter the gland activity.

The assay methods used in this study were gland weights, closed vessel technique and thiouracil - thyroprotein assay. The gland weights are not a reliable assay of thyroidal activity of day-old-chicks as shown by this study. When gland weights are used a large number of individuals are needed, especially when differences in groups tend to overlap. The closed vessel technique is a reliable measure of thyroidal activity, particularly of day-old-chicks. This technique will show differences in thyroidal activity when gland weights for the same chicks will show no difference. When the closed vessel technique was used on eleven-day-old chicks of this study, the results were not as conclusive as gland weight. This could partially be attributed to the vessel size. The vessels, in which the eleven-day-old chicks were suffocated, were too small causing the end point for the different groups to be too close together. If larger vessels had been used, it is possible the end point would have been much easier to distinguish. The thiouracil - thyroprotein is an assay for showing secretion rates. This assay has been used for many different animals with good results. It would seem that more accurate secretion rates can be obtained by giving daily injections of d,l-thyroxine instead of feeding thyroprotein. The reason for this is that daily intake of feed may vary per chick, while daily injection of d,l-thyroxine would be the same each day. However, in this study the feeding of thyroprotein in the ration to determine secretion rates for the Fast and Slow Growth lines did give good results.

Table 1.--Grower mash for chickens

Ingredients	Percent/100 lbs. feed
Ground Yellow Corn	46.7
Wheat Shorts	20.0
Alfalfa Leaf Meal	5.0
Fish Meal	6.0
Soybean Meal	5.0
Cottonseed Meal	10.0
Meat and Bone Scrap	5.0
Di Calcium Phosphate	1.0
Salt	0.5
Vitamin Concentrate No. 11	0.8

Table 2.--Closed vessel technique of day-old-chicks of Fast and Slow Growth lines

Generation	Sex	SLOW LINE No.	SLOW LINE Average Time*	SLOW LINE Standard Error	FAST LINE No.	FAST LINE Average Time*	FAST LINE Standard Error	(Fast-Slow) Difference of Means	Probability Level of Diff.
4a	M	7	360.9	17.76	12	249.6	18.38	111.3	0.001
4b	M	24	329.8	12.10	46	287.6	9.61	42.2	0.010
	F	39	340.9	11.95	32	287.7	14.29	53.2	0.001
4c	M	47	357.1	10.42	55	310.2	7.18	46.9	0.001
	F	60	345.0	9.94	56	319.2	7.30	25.8	0.040
5a	M	27	257.2	16.10	34	195.3	10.74	61.9	0.010
	F	37	294.9	12.96	36	192.8	8.55	102.1	0.060
5b	M	14	340.5	22.56	26	183.9	12.22	156.6	0.001
	F	19	328.6	15.55	25	199.0	13.04	129.6	0.001
Total & Average	M	119	327.2	7.28	173	258.4	6.05	68.8	0.001
	F	155	330.0	6.22	149	261.7	6.86	68.3	0.001

* Average time in minutes per 100 grams body weight for day-old-chicks to die

Table 3.--Thyroid weight assay of day-old-chicks of Fast and Slow Growth lines

Generation	Sex	SLOW LINE No.	SLOW LINE Average Weight*	SLOW LINE Standard Error	FAST LINE No.	FAST LINE Average Weight*	FAST LINE Standard Error	(Fast-Slow) Difference of Means	Probability Level of Diff
4a	M	13	21.5	1.57	21	19.1	1.40	2.4	0.35
	F	17	19.4	0.94	9	19.1	1.64	0.3	0.87
4b	M	24	15.8	0.65	46	16.8	0.59	-1.0	0.30
	F	39	17.5	0.63	32	20.2	0.86	-2.7	0.02
4c	M	47	16.0	0.57	55	14.8	0.43	1.2	0.14
	F	60	17.2	0.42	56	17.4	0.51	-0.2	0.85
5a	M	27	15.4	0.72	34	12.3	0.47	3.1	0.01
	F	37	14.3	0.48	36	14.2	0.55	0.1	0.30
5b	M	14	10.3	0.47	26	12.4	0.31	-4.7	0.01
	F	19	12.4	0.43	25	13.1	0.46	-0.7	0.25
Total &	M	125	15.8	0.41	182	15.0	0.32	0.8	0.08
Average	F	172	16.4	0.09	158	16.6	0.10	-0.2	0.15

* Average weight in mgs. per 100 grams body weight

Table 4.--Gland weights of twelve-week-old chicks

		SLOW LINE		FAST LINE			
Gland	Sex	No.	Average Weight	No.	Average Weight	(Fast-Slow) Difference of Means	Probability Level of Diff.
Gonad*	M	19	22.1	19	20.4	1.7	0.670
	F	21	1461.0	19	1342.0	119.0	0.15
Adrenal**	M	20	298.6	19	395.5	-96.9	0.005
	F	21	279.6	19	271.8	7.8	0.69
Comb*	M	20	6.3	19	11.6	-5.3	0.001
	F	21	1.9	19	1.7	0.2	0.67
Thyroid**	M	19	332.0	19	311.8	20.2	0.400
	F	21	327.9	18	369.0	-41.1	0.55
Pituitary**	M	20	103.9	18	72.5	31.4	0.008
	F	21	108.4	19	97.4	11.0	0.35

* Average weight expressed in grams per 100 grams body weight
** Average weight expressed in milligrams per 100 grams body

FIGURE 1

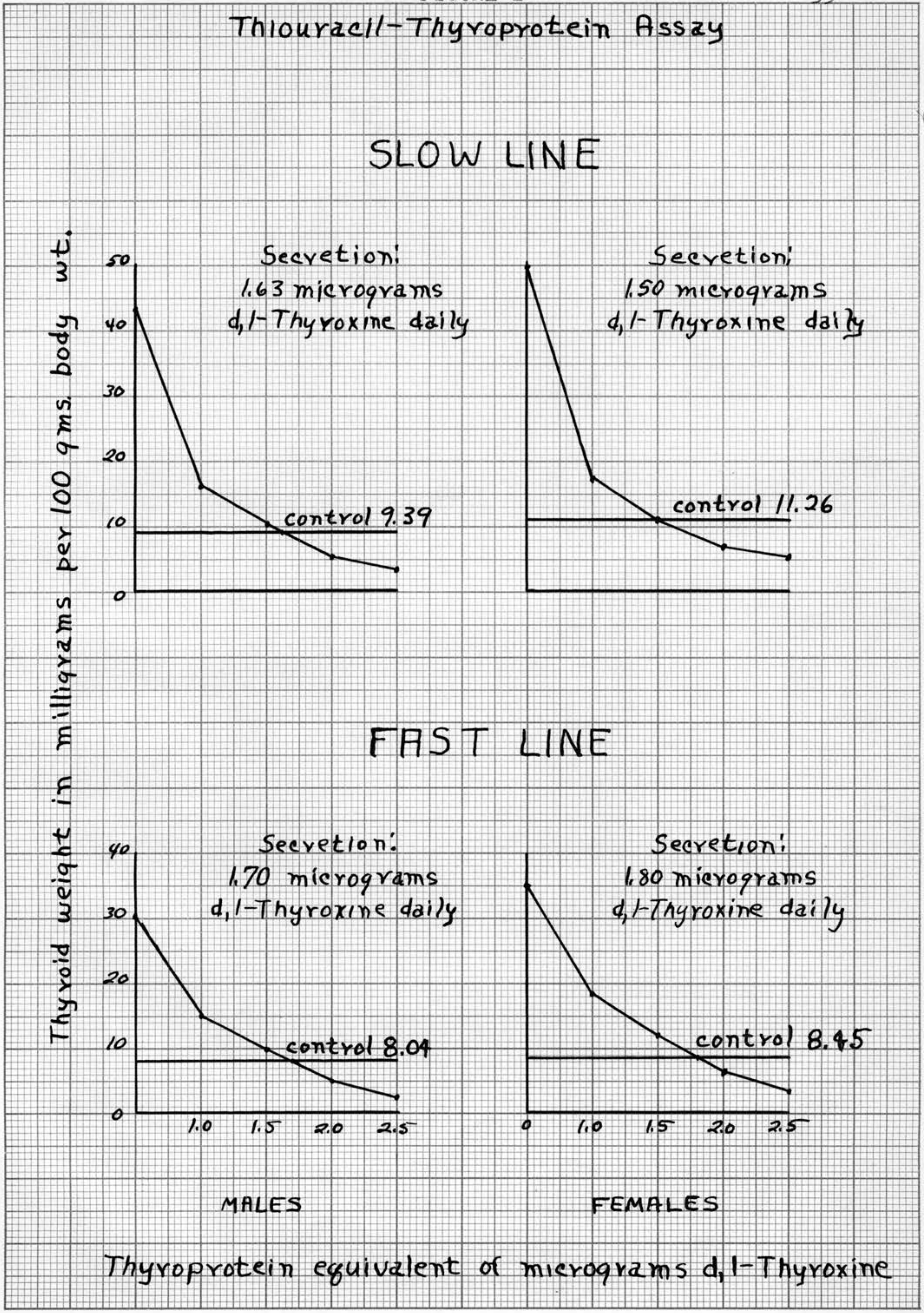
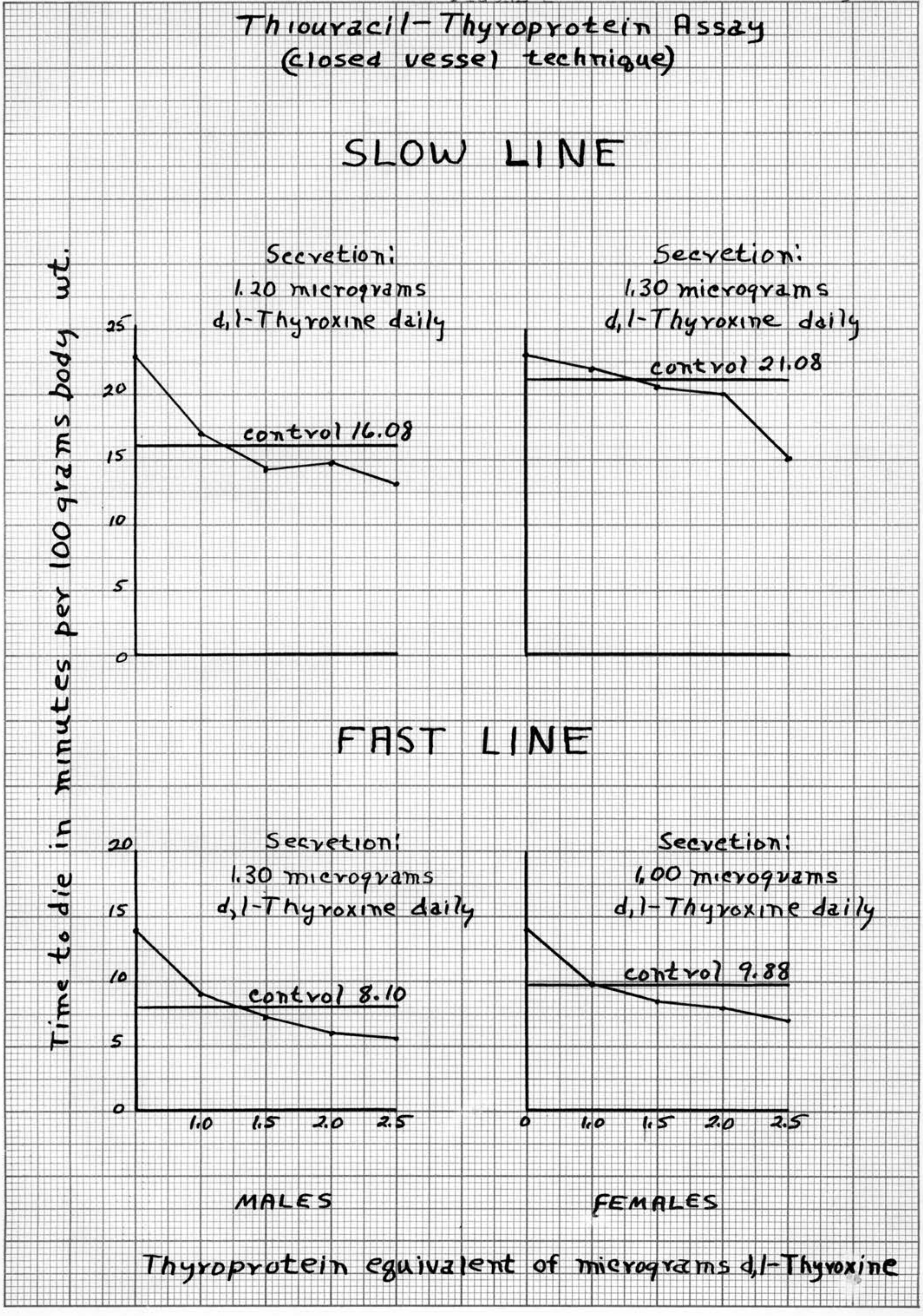

Thiouracil-Thyroprotein Assay
SLOW LINE
Secretion:
1.63 micrograms
d,l-Thyroxine daily
Secretion:
1.50 micrograms
d,l-Thyroxine daily
control 9.39
control 11.26
FAST LINE
Secretion:
1.70 micrograms
d,l-Thyroxine daily
Secretion:
1.80 micrograms
d,l-Thyroxine daily
control 8.04
control 8.45
Thyroid weight in milligrams per 100 gms. body wt.
50
40
30
20
10
0
1.0
1.5
2.0
2.5
MALES
FEMALES
Thyroprotein equivalent of micrograms d,l-Thyroxine

FIGURE 2


Thiouracil-Thyroprotein Assay
(closed vessel technique)
SLOW LINE
Secretion:
1.20 micrograms
d,l-Thyroxine daily
Secretion:
1.30 micrograms
d,l-Thyroxine daily
control 16.08
control 21.08
FAST LINE
Secretion:
1.30 micrograms
d,l-Thyroxine daily
Secretion:
1.00 micrograms
d,l-Thyroxine daily
control 8.10
control 9.88
Time to die in minutes per 100 grams body wt.
0
5
10
15
20
25
1.0
1.5
2.0
2.5
MALES
FEMALES
Thyroprotein equivalent of micrograms d,l-Thyroxine

SUMMARY

Two lines of Silver Oklabar chickens -- the Fast and Slow Growth lines -- have been selected for rapid growth and for slow growth to six and twelve weeks of age, at the Oklahoma Agricultural Experiment Station. These lines were started in 1950, and have been selected continuously for six generations. As a result, the Fast Line grows much more rapidly than the Slow Line. This study was made to determine if there were any physiological differences between these two lines. The assay methods used to determine these differences were gland weights, closed vessel technique, and thiouracil - thyroprotein assay. The number of day-old-chicks, in both Fast and Slow Growth lines, assayed for thyroid activity were: fourth generation, 378; and fifth generation, 218. Forty chicks of the fourth generation were used to determine if there was any difference between the gonads, adrenals, comb, thyroids and pituitary gland of twelve-week-old chicks. Eighty-eight fifth generation chicks per lot were used for the thiouracil - thyroprotein assay to obtain secretion rates.

The results of these data on the physiological differences between fast and slow growing chickens can be summarized as follows:

1. A significant difference was shown for thyroid activity between the Fast and Slow Growth day-

old-chicks when the closed vessel was used, showing that the Fast Line has a higher thyroid activity than the Slow Line.

2. The thyroid secretion rate of the Fast Line was greater than that of the Slow Line. Fast Line males secreted 1.70 micrograms of d,l-thyroxine daily; Fast Line females secreted 1.80 micrograms of d,l-thyroxine daily. Comparable secretion rates for the Slow Line were 1.63 and 1.50 micrograms of d,l-thyroxine daily for the males and females respectively. This shows that the Fast Line has a higher thyroid activity than the Slow Line.
3. The induced thyroid enlargements were greater for the Slow Line than for the Fast Line, showing again that the thyroid activity of the Fast Line was greater than that of the Slow Line.
4. No difference was shown for thyroid weight of day-old-chicks between the Fast and Slow Growth lines, indicating that gland weight is not a reliable measure of activity.
5. No difference between the Fast and Slow Growth lines was shown for gonads, adrenals, comb, thyroids, and pituitary gland weights of twelve-week-old chicks.

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