Bull. Inst. Zool., Academia Sinica 4: 65-71 (1965)

A STATISTICAL STUDY ON THE WEIGHTS OF ENDOCRINE ORGANS OF THE DOMESTIC SWINES IN TAIWAN[1]

CHANG-HWEI YANG[2]

Received for publication December 15, 1965

ABSTRACT

The essential endocrine organs, the pituitary, thyroid, adrenal and ovary of female domestic swines from 2 to 8 years old were used. The correlations between the glands themselves, between age and the glands and between body weight and the glands were studied statistically based on weights. The results showed a curvilinear correlation between age and the pituitary, adrenal and ovary but not the thyroid. A linear correlation was demonstrated between body weight and the endocrine glands except the adrenal. The correlations between the various glands were positive; the highest one was found between the pituitary and thyroid, the next between the adrenal and pituitary as well as between the adrenal and thyroid, and the least between the ovary and the other three glands.

It has been well understood that the function of endocrine organs are correlated with each other. Magsood found that large doses of thyroxine administered to rabbits increased the size of the adrenal, while thiouracil showed an opposite effect (1). Eskin *et al.* stated that exogenous estrogen interferred with goiter development and exogenous progesterone could enlarge the thyroid (2). Garter reported that higher level of ovarian hormone increased the weight of the adrenal (3). Kitay claimed that gonadectomy in rats led to increased pituitary weight and decreased adrenal weigth (4). Furthermore, Turner has comprehensively stated that all types of goiter, both hypofunctional and hyperfunctional, were directly or indirectly related to the functional disorder of the pituitary (5). Robbins reported that in hyperpituitarism, the sizes of thyroid and adrenal were enlarged to several times as those of the normal, and in hypopituitarism, the thyroid and adrenal became atrophid (6). According to these results of experimental and pathological studies, it may be presumed that an animal of normal physiological state is maintained by the developmental balance of various endocrine organs.

However, the endocrine glands usually vary individually in size and weight, and the range of variation is fairly wide (7). In order to investigate to what extent the endocrine organs of normal animals are correlated with each other, the author carried out a statistical study on Taiwan pigs. In addition, the weights of endocrine organs in correlation with age and body weight were also investigated.

MATERIALS AND METHODS

Ninety-two female pigs (*Sus domesticus*) of Taiwan native breed in healthy

1 This study was supported by a grant from the National Council on Science Development Taipei, Taiwan.

2 Associate professor, Department of Veterinary Medicine, College of Agriculture, National Taiwan University, Taipei, Taiwan.

condition were used in the present study. Their age ranged as follows:

No. of pigs (head)	6	19	22	25	12	6	2
Age (year)	2	3	4	5	6	7	8

The body weights noted below were obtained just before the animals were slaughterred:

No. of pigs (head)	3	5	9	13	12	5
	10	9	9	2	6	3
	2	3				
Body weight (kg)	60	66	72	78	84	90
	96	102	108	114	120	126
	132	128				

The pituitary, thyroid, adrenal and ovary were removed immediately after the animals were sacrificed and preserved in 10% formalin solution. The pituitary was weighed with Mettler's electric microbalance to the sensibility of 0.1 miligram, and the other organs weighed with torsion balance to the sensibility of 0.1 gram.

Data were analysed statistically (8). The mean values, standard errors and ratios of gland weight to body weight (gland, g/ body weight, kg×100) were calculated. The correlation coefficient (r) and the regression equation ($Y_e=a+bx$) were also obtained.

RESULTS AND DISCUSSION

*I. Correlation between age and weights of endocrine organs**

For the correlation of age with endocrine organs, the relationship between age and body weight of the animal must be discussed at first. In general, the body weight of an aniaml increases by age. The growth rate of body weight is rapid in young period, and gradually becomes retarded at maturity. After maturity, it is almost in standstill unless the animal is being fattened. In the physiological development of the domestic pig, puberty is reached approximately at the age of 5 months and the breeding period begins about at the 10th month. However, the completion of maturity may occur in the 18th month, because the third molar teeth erupt at that time. As shown in *Fig. 1*, there is a linear correlation between age and body weight of the domestic pigs with a significant correlation coefficient (r) of 0.5260 at 1% level. The result did not check well with the growth curve of body weight in general. But pig is a kind of meat animal, the fattening process of which usually occurs after maturity, therefore the body weight increases with age. However, from the aspect of dots distribution in the age gronps in *Fig. 1*, it ascended also very slightly after four-age group.

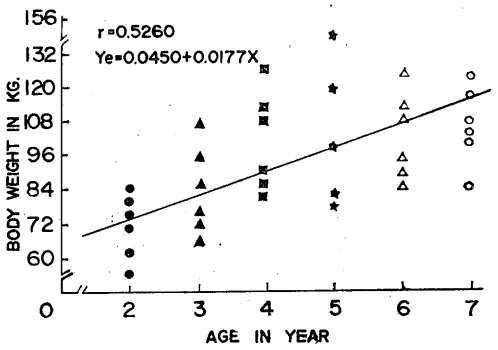

Fig. 1. Correlation between age and body weight of female Taiwan native pigs. Representation of dots in the figures, ●=2 yr, ▲=3 yr, ■=4yr, ★=5 yr, △=6 yr, ○=7 yr and □=8 yr.

The relationships between age and the pituitary, adrenal and ovary were all in the tendency of curvilinear correlation as shown in *Fig. 2*, with ratios (ηyx) of 0.6984, 0.5692 and 0.5369 respecctively, significant at 1% level. However, the relation between the thyroid and age did not reach the level of statistical significance. The peaks of the curves are about at the fourth year of age. After that age, the weights of the glands showed the tendency of decrease, and the declination slope of the adrenal weight (middle diagram) was more remarked than the other two. The deferred declination in weights of the three glands may be due to the fact that the colloidal substance usually accumulates in the aged pituitary tissues (9, 10), folliculosis occurs in the ovary of the aged prolific animal (6, 11) and the atrophic alteration is often seen

* In the study of the relationship between age and glands, only 6 animals were taken in each group by random sampling in order to have the same number of animals in each age group.

in the adrenal tissues of the adult animal (12, 13).

II. Correlation between body weight and weights of endocrine organs

TABLE I shows that the weights of endocrine organs of the pigs were fairly variable, and so the values of correlation coefficients (r) between gland weights and body weight were small and the dots do not distribute closely along the regression lines.

The weights of the pituitary, thyroid and ovary were in linear regression to the body weight with the respective rs of 0.3532, 0.2410 and 0.2932, significant at 1% level as shown in *Fig. 3.* The distribution of the correlative dots reveals that there was a higher correlationship in the lighter weight area than in the heavier weight area, and that there is also a large number of correlative dots with heavier body weight and lighter gland weight distributed at the upper left side of the diagrams. In the thyroid gland (middle diagram), there are numerous dots which situate further away from the line; in the ovary (right diagram), the distant dots are less, while in the pituitary (left diagram) are the least. The results support the suggestion

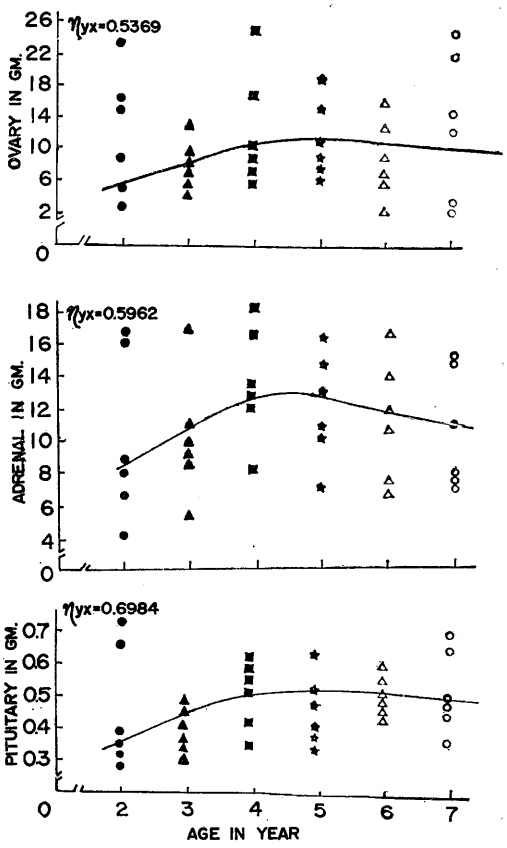

Fig. 2. Correlation between age and the weights of endocrine glands of female Taiwan native pigs.

TABLE I

The direct and relative weights of endocrine organs, Mean±SE

Organ	Pituitary	Thyroid	Adrenal	Ovary
Weight, g	0.458±0.13	19.28±1.23	11.28±0.46	10.22±0.68
Ratio of gland wt./body wt., g/kg×100	0.30 ±0.10	12.64±0.98	6.64±0.33	7.61±0.38

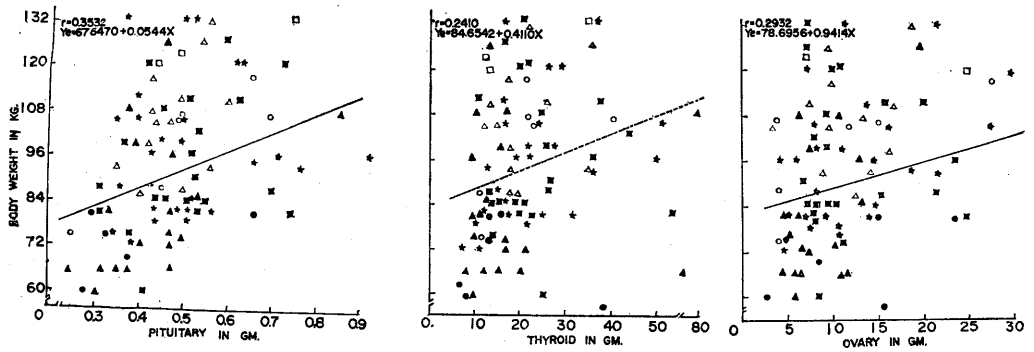

Fig. 3. Correlation between the weights of endocrine glands and body weight of Taiwan native pigs.

that the fatter animal usually has a lower function in the thyroid and ovary (13, 14 and 15).

The relationship between body weight and adrenal weight did not reach a statistically significant level. This result agrees in the reports of Antopoi and Atkinson (16, 17).

III. Correlation of weights between different endocrine organs

A. The pituitary weight and those of the thyroid, adrenal and ovary:

Fig. 4 shows that the weights of the pituitary and those of the thyroid, adrenal and ovary were of positive linear correlation, and the *r*s were 0.7590, 0.3312 and 0.2961 respectively at 1% level. From the values of *r*s, it is clear that there was a closer relationship between the pituitary and thyroid than between the pituitary and adrenal and between the pituitary and ovary. In the scatter diagram of the correlation between the pituitary and thyroid (upper diagram), the dots below the average level distribute closely along the line of regression. However, in the diagrams of the correlation between the pituitary and adrenal (middle diagram), and between the pituitary and ovary (lower diagram), there is a large number of dots scattered about the area of the average. Moreover, the dots with ovary are more dispersed than those with the adrenal. These results confirm that the pituitary has more intimate functional relationship with the thyroid than with the other glands (5, 18 and 19).

Fig. 5 shows the correlation between the ratio of the pituitary weight to body weight (P/BW) and the ratios of the other 3 glands to body weight (T/BW, A/BW and O/BW). From the relative analysis, 3 *r*s were obtained. A compaison of the *r* values between relative (*Fig. 5*) and direct (*Fig. 4*) analyses is presented as follows:

TABLE II

Comparison of relative and direct r values between the pituitary and the other 3 glands

	Pituitary and thyroid	Pituitary and adrenal	Pituitary and ovary
Relative *r*	0.5707	0.4752	0.3176
Direct *r*	0.7590	0.3312	0.2961
Difference	−0.1883	+0.1440	+0.0215

Therefore it is clear that by relative analysis the correlation was decreased between the pituitary and the thyroid but increased between the pituitary and adrenal and between the pituitary and ovary. The result can also be seen by comparing the scatter diagrams in *Figs. 4* and *5*.

B. The thyroid weight and those of the adrenal and ovary:

By direct measurement, the *r* between thyroid and adrenal was 0.3520 and that between thyroid and ovary was 0.3025, both revealing the significantly positive correlationship at 1% level as shown in *Fis. 6*. The scatter diagrams show that the dots in well correlated were limited below the average; while above the average, the dots were almost in the dispersed distribution. And far away from the line of regression are distributed some dots with the relationship of the heavier-adrenal and lighter-thyroid (upper diagram) as well as that of the heavier-ovary and median-thyroid (lower diagram). For the explanation of this two groups of unbalanced development, it may be suggested that some animals might posses well developed adrenals but atrophied thyroids (19), while in others the heavier ovary was supported by the favorable thyroid function (10).

By relative measurement, the *r* between the thyroid and adrenal was 0.3492, and that between the thyroid and ovary was 0.3036 both at the significant level of 1% (*Fig. 7*). The values were similar to

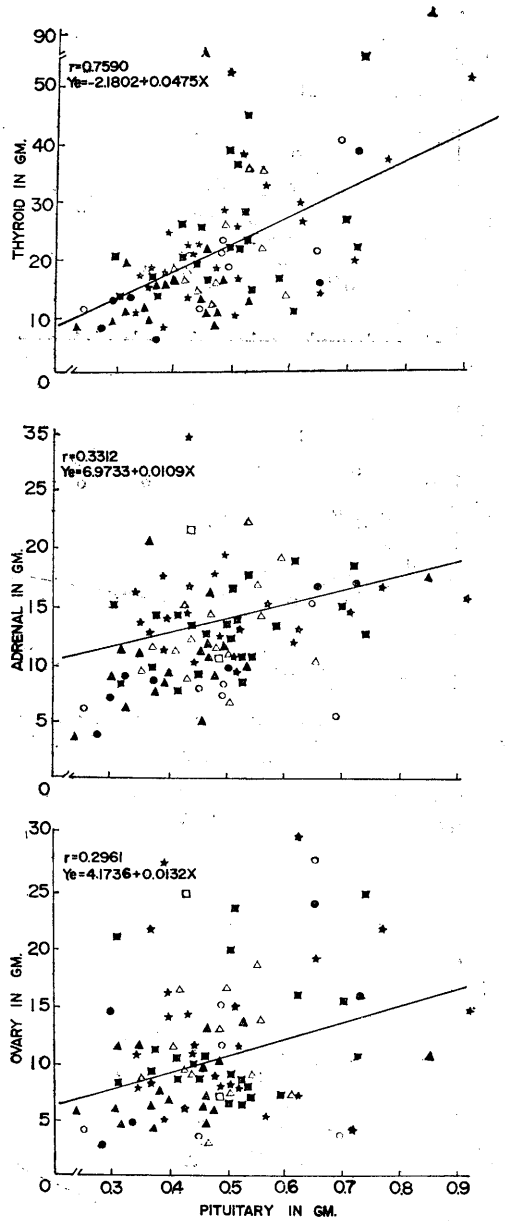

Fig. 4. Correlation of weights between the pituitary and the thyroid, adrenal and ovary of Taiwan native pigs respectively.

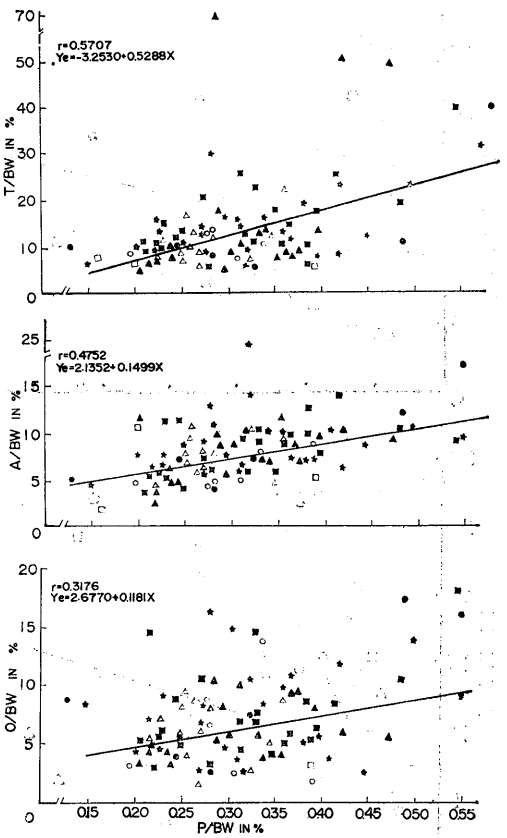

Fig. 5. Correlation between P/BW and T/BW, A/BW, O/BW respectively. P/BW =ratio of pituitary weight to body weight. T/BW=ratio of thyroid weight to body weight. A/BW=ratio of adrenal weight to body weight. O/BW=ratio of ovary weight to body weight.

those of the direct measurement (*Fig. 6*). Thus, the appearance of scatter diagrams of *Fig. 7* was similar to that of *Fig. 6*.

C. *The adrenal weight and that of the ovary:*

The *r* between the adrenal and ovary by direct measurement was 0.3050 at 1% level as shown in *Fig. 8*. The diagram shows a distinctive feature different from other diagrams, in that the dots of the heavier adrenal and ovary were more numerous than those in the lighter weight area. The result agrees with that of Garter who stated that high level of ovarian hormone increased the adrenal weight (3). McKeeve also reported that the weight of adrenal was heavier in the breeding season than in non-breeding season in *Microtus motamus*. Besides, the unbalanced development of the heavier-adrenal and lighter-ovary is also a particular feature in *Fig. 8*.

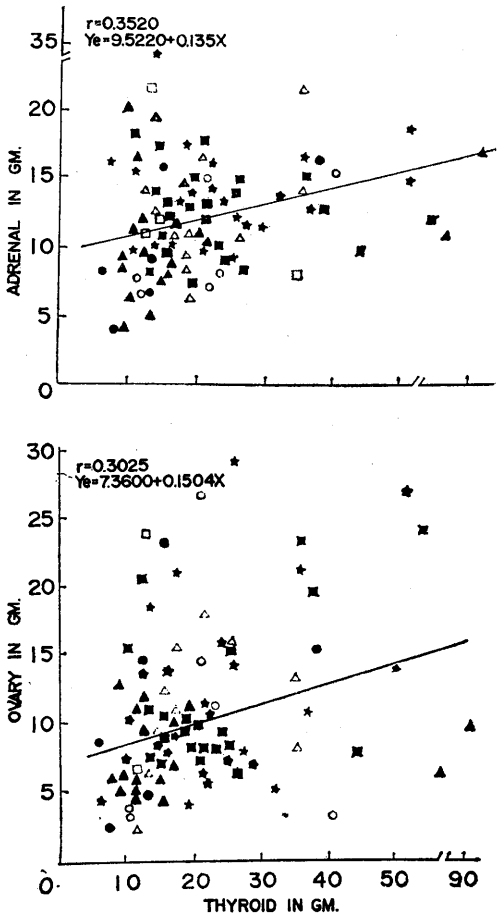

Fig. 6. Correlation of weights between the thyroid and the adrenal, ovary of Taiwan native pigs respectively.

The *r* between these two glands by relative measurement was 0.3085 at the level of 1%. The scatter diagram of *Fig. 9* was also similar to that of *Fig. 8.*

Acknowledgements The author is indebted to Mr. Hwa-fun Hsieh for his help in measuring the specimens, and to Professor Su-fang Yeh, Mr. Hong-pan Wu for their valuable advice on the statistic studies.

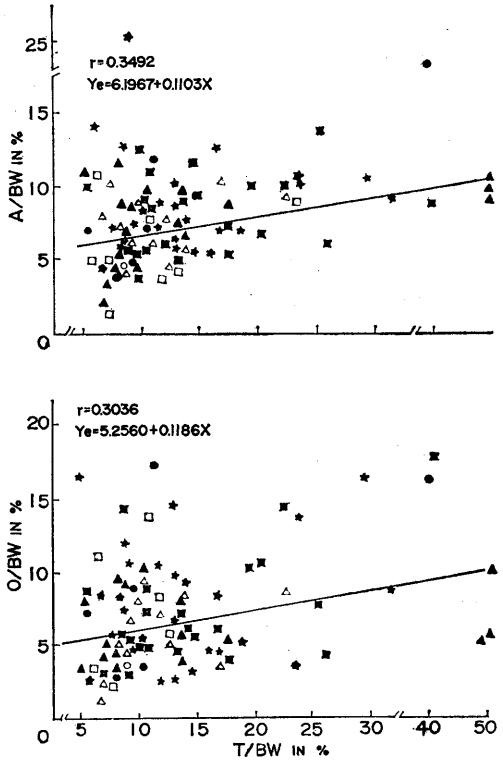

Fig. 7. Correlation between T/BW and A/BW, O/BW respectively.

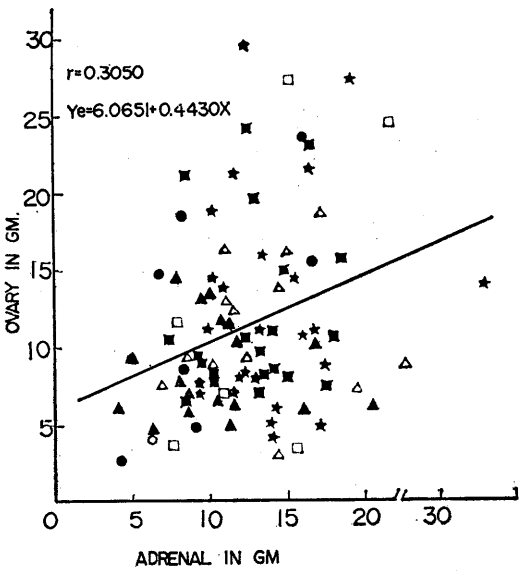

Fig. 8. Correlation of weight between the adrenal and ovary of Taiwan native pigs.

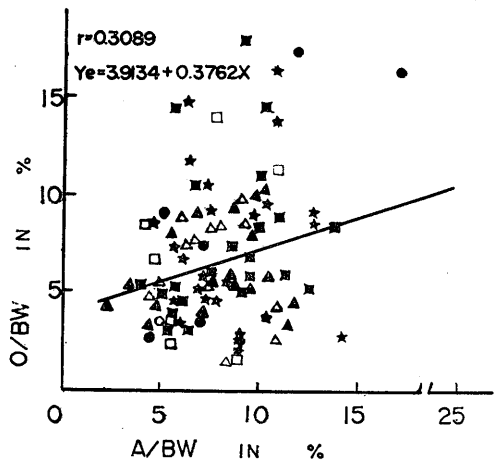

Fig. 9. Correlation between A/BW, and O/BW.

LITERATURE CITED

1. MAGSOOD, M. 1954. Effects of the thyroid state, season and castration on the adrenal gland in male rabbits. *J. Endocrinology* **11**: 103-114.
2. ESKIN, B. A., M. D. PATTITE and M. B. DRATMAN. 1963. The influence of ovarian hormones on goitrogenesis. *J. Endocrinology* **69**: 195-198.
3. GARTER, S. B. 1956. The influence of the sex hormone on the adrenal weight in the rat. *J. Endocrinology* **13**: 150-160.
4. KITAY, J. I. 1963. Adrenal function in rat after gonadectomy and gonadal hormones replacement. *J. Endocrinology* **73**: 253-264.
5. TURNER, C. D. 1955. *The relationship of physiology to goiter* in *General Endocrinology*, Saunders Books Co., Philadelphia, U. S. A. p 55.
6. ROBBINS, S. L. 1963. *The endocrine system* in *Textbook of Pathology*, 2nd ed., Saunders Books Co., Philadelphia, U.S.A. pp 959-1015.
7. YANG, C. H. 1965. Morphological studies on the endocrine organs of wild and domestic animals. *Memoirs of Col. Agri., National Taiwan University* **8**: 2 (in press).
8. KUO, T. C. 1945. *Biometrics and medicine.* Cheng-chong Books Co., Taipei, Taiwan. pp 77-132 (in Chinese).
9. TRAUTMAN, A. 1956. *Endocrine organs* in *Histology of domestic animal.* Comstock Publishing Associates, New York, U. S. A. p 149.
10. FERRER, J. 1956. Histo-physiology of the pituitary cleft and colloid cyst after gonadectomy and adrenectomy. *J. Endocrinology* **13**: 349-354.
11. YAMAUCHI, S. 1963. A histological study on ovary of aged cow. *Jap. J. Vet. Sci.* **225**: 315-322.
12. KAWANABE, H. and H. NAGAE. 1964. On the effects and influences of advancing age upon the endocrine organ of domestic cat. *Acta Anatomica Nipponica* **39**: 6-7.
13. STANTISTERAN, G. A. 1960. The growth and involution of lymphatic tissue and its interrelationship to aging and sexual organ in mice. *Anat. Rec.* **136**: 117-126.
14. KUO, S. P. 1961. Goitrogenesis. *J. Formosan Med. Assoc.* **60**: 403-422.
15. FALCONER, I. J. and H. A. ROBERTSON. 1961. Changes in thyroid activity during growth in sheep. *J. Endocrinology* **22**: 23-30.
16. ANTOPOI, W. 1950. Anatomic change produced in mice, treated with excessive doses of cortisone. *Soc. Experi. Biol. Med.* **63**: 262-265.
17. ATKINSON, R. L. 1960. Influences of cortisone and dienesterol diacetate on the body weight and organ weight of the male chicken. *J. Poultry Sci.* **39**: 638-645.
18. ROBERTSON, H. A. and I. R. FALCONER. 1961. Reproduction and thyroid activity. *J. Endocrinology* **22**: 133-142.
19. HARRIE, G. W. and J. W. WOODS. 1957. Hypothalamus-pituitary-thyroid relationship. *Ciba Foundation Colloquia on Endocrinology* **10**: 3-14.
20. MCKEEVER, S. 1959. Effect of reproductive activity and the weight of adrenal gland in *Microtus motamus. Anat. Rec.* **135**: 1-7.