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The Growth of the Lymphoid Organs and the Gonads in the Japanese Quails (*Coturnix coturnix japonica*)

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ウズラ (*Coturnix coturnix japonica*) におけるリンパ器官および生殖腺の重量変化について

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Introduction

It has been recognized that lymphoid organs play an important role in immune responses. In the chicken, GLICK *et al.* (1956) described the role of the bursa of Fabricius, a hindgut epithelial lymphoid organ, in the development of humoral immunity. With a subsequent definition of the pivotal role of the manmalian thymus in the developmental immunobiology (ARCHER and PIERCE 1961; MILLER 1961, 1962; GOOD *et al.* 1962; MARTINEZ 1962), the chicken aroused the interest of many investigators because it is equipped with thymus as well as a bursa. It has been recognized that the bursa and the thymus are "central lymphoid organs" in the chickens, essential to the ontogenetic development of adaptive immunity (CHANG *et al.* 1957, 1959; MULLER *et al.* 1960, 1962; GRAETZER *et al.* 1963; ISAKOVIĆ and JANKOVIĆ 1964). A functional dissociation of the chicken immune system based on differences in thymic and bursal influence was originally suggested by WARNER *et al.* (WARNER *et al.* 1962; SZENBERG and WARNER 1962; WARNER and SZENBERG 1964). Experimental support for this hypothesis was forthcoming from several investigators (ASPINAL *et al.* 1963; GRAETZER *et al.* 1963; JANKOVIC *et al.* 1963; JANKOVIĆ and ISAKOVIC 1964; JANKOVIĆ and ISVANESKI 1963; ISAKOVIĆ and JANKOVIĆ 1964; COOPER *et al.* 1966).

The normal growth of these lymphoid organs was reported by a few investigators (JOLLY 1913; RIDDLE 1928; KÔNO 1933; BRADLEY 1950; GLICK 1956; WOLFE *et al.* 1962; YAMADA 1966). These reports were obtained solely from chickens with the exception of RIDDLE's report on pigeons.

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Recently the Japanese quails is attracting considerable attention as an experimental animal. However reports obtained from the Japanese quails are not available. Thus studies dealing with the growth of several lymphoid organs of the Japanese quails are reported in this paper. We have correlated the growth of these lymphoid organs with the body weight and the growth of the gonads. Moreover, we have compared data of chicken (WOLFE *et al.* 1962) against the data of Japanese quail.

Materials and Methods

The growth of the lymphoid organs and the gonads were studied using 393 Japanese quails (*Coturnix coturnix japonica*). Nine to eleven birds were sacrificed on the day of hatching and after 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18, 20, 22, 24, 26 and 30 weeks of age in both sexes by bloodletting. The birds were raised in a brooder for the first 4 weeks and then transferred to wire-separated cages. An electric light control was switched on at 4.00 am. and switched off at 8.00 pm.. The birds were fed on a water mixed regular mash for quail two times a day. The bursa of Fabricius, spleen, thymus and gonads were removed and weighted and the body weight was also recorded. The thymus and gonads were weighted separately and the weight of both sides were totalled. Statistical analysis was conducted based on the methods of SNEDECAR (1946).

Results

In Table 1 and Table 2 (each for male and female), the results of measurements for each age group and the mean value of organs and body weight together with the standard deviation are given Figure 1 shows the data of male and Figure 2 shows female's graphically. The body and organ weight relationships are showen in Table 3 for male and Table 4 also gives the results of female. Figure 3 (for male) and Figure 4 (for female) show Table 3 and Table 4 graphically. Table 5 and 6 give the results of statistical analysis of male and female.

Body weight: The mean body weight of the male quails show a steady increase up to 7 weeks of age. Thereafter, the body weight was maintained at approximately 100 grams throughtout the period of the experiments. On the other hand, in the female quails, the mean body weight showed a steady increase up till 8 weeks of age. Thereafter the body weight was maintained at approximately 120 grams throughout the observation period. The mean body weights as given above were close to the mean body weight of adult quails of both sexes, but the rate of the growth based on percentage increase was the greatest from the day of hatching to the fourth week. The body weight of the female was heavier than the male.

Bursa of Fabricius: The bursa of Fabricius on the day of hatching had a mean weight of $2.7+0.6$ mg in the male and 2.3 ± 0.8 mg in the female. The

Table 1. Body and Organ Growth of Male Japanese Quail

Age in weeks	Body weight (g)	Bursa (mg)	Spleen (mg)	Thymus (mg)	Testes (g)
H.D*	6.7± 0.58	2.7± 0.6	1.3± 0.6	4.0± 0.9	0.0011±0.0004
1	10.6± 1.12	8.2± 3.2	4.0± 0.1	15.8± 4.8	0.0015±0.0004
2	24.8± 5.17	25.4±12.7	9.4± 2.9	68.6±16.7	0.0062±0.0041
3	34.7± 7.84	35.4±14.3	13.8± 8.0	87.4±44.2	0.0145±0.0085
4	63.2± 7.81	61.7±18.6	31.4± 8.5	167.5±80.8	0.1421±0.1191
5	79.7± 3.91	86.9±20.4	28.7±10.1	305.2±64.2	0.4778±0.2315
6	83.4± 6.9	85.4±16.1	36.0± 4.5	195.3±71.1	0.0476±0.4992
7	92.2± 5.9	87.9±15.2	46.7±16.0	136.8±73.7	2.0431±0.5409
8	89.1± 6.0	78.5±28.4	32.5± 5.0	66.2±17.1	2.5413±0.4378
9	95.2± 6.9	57.8±25.9	31.6±10.7	45.8±28.1	3.0768±0.3732
10	94.9± 5.3	47.4±16.4	25.9± 8.5	29.7± 5.0	3.1414±0.7755
12	100.1± 7.3	48.6±25.5	36.4±23.8	48.5±19.7	3.1529±0.7414
14	100.5± 7.0	37.2± 9.9	35.0± 6.1	40.7±19.6	3.0113±0.9272
16	98.6± 7.7	32.3±10.0	25.2± 7.8	39.7±15.0	2.8965±0.3696
18	108.6±12.3	28.3±12.3	29.5± 6.5	41.6±23.5	3.0305±0.4150
20	103.7±14.2	19.1±11.7	30.7± 9.0	37.5±18.4	2.6173±0.4841
22	103.9± 7.5	21.5±11.4	27.6± 5.5	39.7±24.9	2.9870±0.4426
24	95.8± 6.0	21.1±17.9	28.0± 6.1	44.3±20.1	2.8801±0.4043
26	97.0± 6.8	19.1±11.3	23.4± 6.0	44.9±23.5	2.8575±0.4212
30	103.6± 6.3	17.1± 4.0	24.9± 7.7	41.3±18.4	3.0867±0.5941

* "H.D" is an abridgment of "Hatched day". This abridgment is used in the following tables and figures.

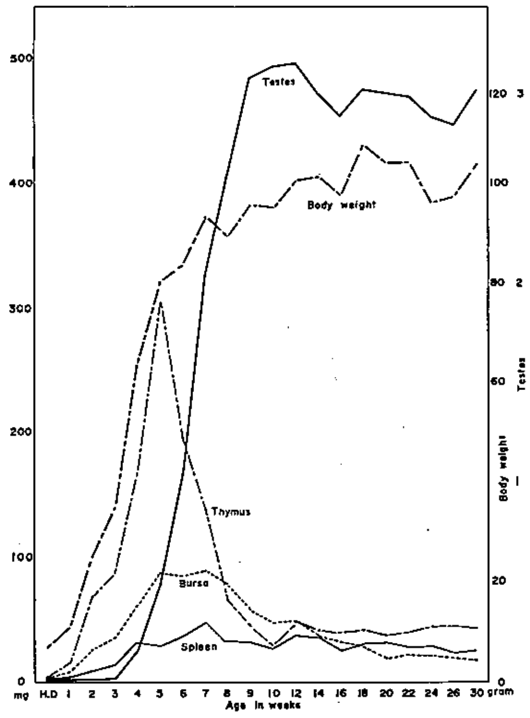

Fig. 1. Body and Organ Growth of Male Japanese Quail

Table 2. Body and Organ Growth of Female Japanese Quail

Age in weeks	Body weight (g)	Bursa (mg)	Spleen (mg)	Thymus (mg)	Testes (g)
H.D*	6.3 ± 0.5	2.3 ± 0.8	0.7 ± 0.3	4.0 ± 1.5	0.0015 ± 0.0003
1	10.8 ± 1.6	9.9 ± 2.9	3.9 ± 1.0	18.4 ± 7.0	0.0029 ± 0.0006
2	21.4 ± 4.1	20.6 ± 8.6	8.7 ± 2.7	45.4 ± 18.4	0.0080 ± 0.0038
3	43.7 ± 5.8	64.7 ± 19.7	27.1 ± 12.4	126.1 ± 32.4	0.0210 ± 0.0091
4	62.3 ± 8.2	75.5 ± 20.9	37.9 ± 18.0	198.1 ± 68.7	0.0417 ± 0.0176
5	78.3 ± 9.9	73.8 ± 22.6	46.2 ± 13.6	195.4 ± 95.8	0.0641 ± 0.0317
6	89.6 ± 14.3	90.0 ± 28.0	51.1 ± 34.2	197.5 ± 63.6	1.1794 ± 1.0007
7	111.3 ± 8.3	83.4 ± 23.0	80.6 ± 32.4	149.7 ± 83.9	2.2820 ± 2.0877
8	116.6 ± 8.6	67.3 ± 40.3	55.4 ± 22.6	81.2 ± 32.9	3.7221 ± 1.6573
9	102.8 ± 10.7	55.8 ± 27.5	71.7 ± 44.3	83.1 ± 39.3	4.4122 ± 1.3137
10	119.9 ± 5.2	44.2 ± 20.4	47.7 ± 16.5	62.6 ± 19.8	4.9452 ± 0.8754
12	114.2 ± 7.4	22.9 ± 15.9	42.6 ± 20.5	64.1 ± 32.7	4.4976 ± 0.7180
14	118.6 ± 11.5	24.5 ± 13.8	41.2 ± 8.1	55.7 ± 23.8	4.4312 ± 0.6343
16	128.1 ± 9.2	26.8 ± 10.5	49.5 ± 13.9	66.5 ± 33.8	4.8313 ± 0.5747
18	130.7 ± 11.0	22.6 ± 17.6	45.7 ± 12.6	56.2 ± 16.6	4.7460 ± 0.3923
20	128.4 ± 9.0	15.2 ± 8.0	40.5 ± 8.9	41.6 ± 16.5	4.7047 ± 0.3612
22	126.0 ± 4.4	9.2 ± 6.4	41.6 ± 9.0	37.0 ± 9.9	4.9009 ± 0.7584
24	124.8 ± 5.5	7.1 ± 1.8	52.7 ± 9.9	45.5 ± 19.9	5.4313 ± 0.8861
26	115.9 ± 9.8	10.5 ± 2.3	40.1 ± 14.3	44.7 ± 20.4	4.6794 ± 0.4625
30	118.3 ± 6.7	8.0 ± 4.0	41.8 ± 13.4	40.7 ± 19.0	4.6299 ± 0.5270

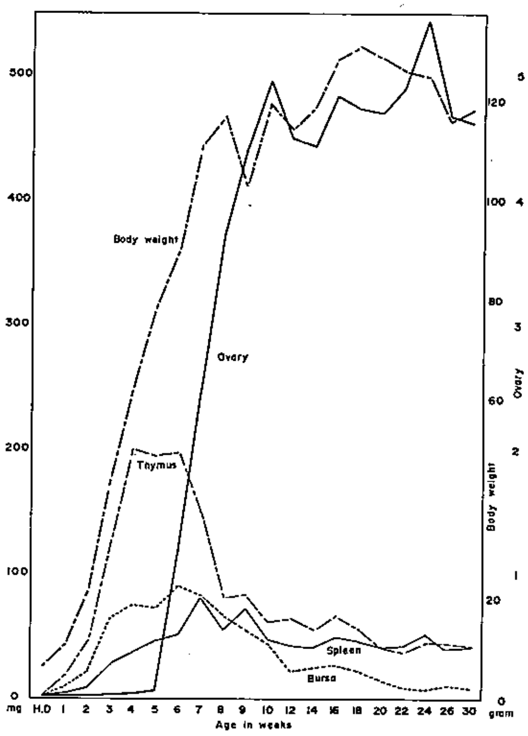

Fig. 2. Body and Organ Growth of Female Japanese Quail

Table 3. Organ Weight Percentage of Body Weight in Male

Age in weeks	Bursa (%)	Spleen (%)	Thymus (%)	Testes (%)
H.D*	0.040	0.019	0.060	0.016
1	0.077	0.038	0.149	0.014
2	0.102	0.038	0.277	0.025
3	0.102	0.040	0.252	0.042
4	0.098	0.050	0.265	0.255
5	0.109	0.036	0.383	0.599
6	0.102	0.043	0.234	1.256
7	0.095	0.051	0.143	2.216
8	0.088	0.036	0.074	2.852
9	0.061	0.033	0.048	3.232
10	0.050	0.027	0.031	3.310
12	0.049	0.036	0.048	3.150
14	0.037	0.035	0.040	3.000
16	0.033	0.026	0.040	2.937
18	0.026	0.027	0.038	2.790
20	0.018	0.030	0.036	2.524
22	0.021	0.027	0.038	2.875
24	0.022	0.029	0.046	3.006
26	0.020	0.024	0.046	2.946
30	0.016	0.024	0.040	2.979

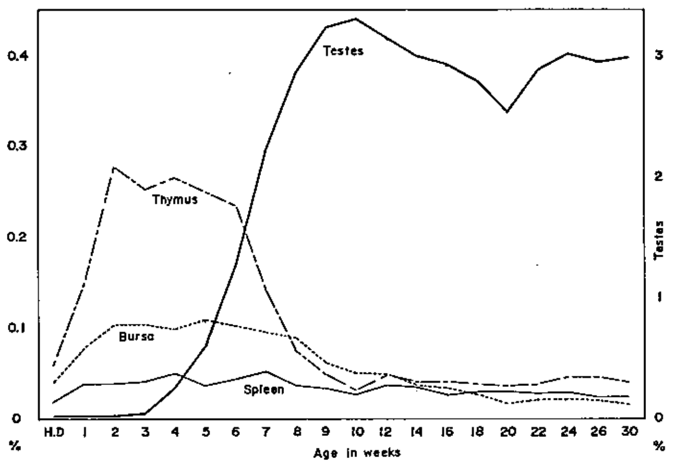

Fig. 3. Organ Weight Percentage of Body Weight in Male

Table 4. Organ Weight Percentage of Body Weight in Female

Age in weeks	Bursa (%)	Spleen (%)	Thymus (%)	Testes (%)
H.D*	0.037	0.012	0.063	0.024
1	0.092	0.036	0.070	0.027
2	0.096	0.041	0.212	0.037
3	0.148	0.062	0.289	0.048
4	0.121	0.061	0.318	0.067
5	0.094	0.059	0.250	0.082
6	0.100	0.057	0.220	1.316
7	0.075	0.072	0.135	2.050
8	0.058	0.048	0.070	3.192
9	0.055	0.070	0.082	4.334
10	0.037	0.040	0.052	4.124
12	0.020	0.037	0.056	3.938
14	0.020	0.035	0.047	3.736
16	0.021	0.039	0.052	3.772
18	0.017	0.035	0.043	3.631
20	0.012	0.032	0.032	3.664
22	0.007	0.033	0.029	3.889
24	0.006	0.042	0.036	4.352
26	0.009	0.035	0.039	4.038
30	0.007	0.035	0.034	3.914

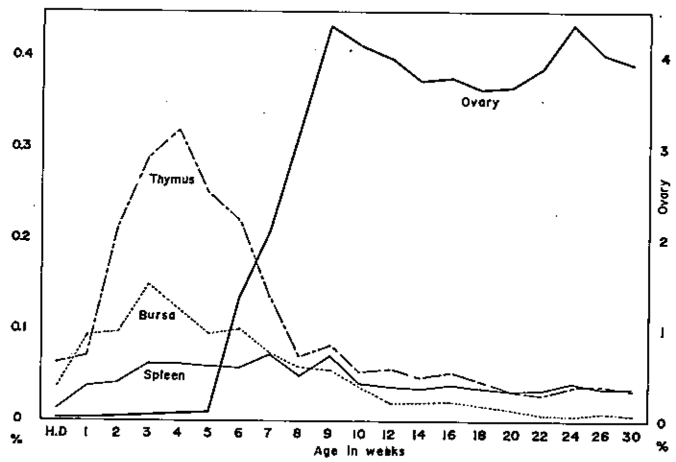

Fig. 4. Organ Weight Percentage of Body Weight in Female

Table 5. Correlations in Male

Treatments	H.D*	Age in weeks 1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	22	24	26	30
B and F	−	⧺	+	+	⧺	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
B and S	−	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
B and T	−	−	+	+	+	−	−	−	+	−	−	−	−	−	−	−	−	−	−	−
B and G	−	−	⧺	+	−	−	−	−	−	+	−	−	−	−	−	−	−	−	−	−
F and S	−	−	−	+	−	−	−	−	−	+	−	−	−	−	+	−	−	−	−	−
F and T	−	−	⧺	⧺	−	−	−	−	−	−	−	−	−	−	−	−	⧺	−	−	−
F and G	−	−	−	⧺	−	−	+	−	−	−	−	−	−	−	−	−	−	+	+	−
S and T	−	−	−	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
S and G	⧺	−	⧺	⧺	−	−	−	−	−	−	⧺	−	−	−	−	−	−	−	−	−
T and G	−	−	−	⧺	−	−	+	−	−	−	−	−	−	−	−	−	−	−	−	+

B=Body weight; F=Bursa of Fabricius; S=Spleen; T=Thymus; G=Testes;
− are less than 0.95 acceptance level. + are 0.95 acceptance level. ⧺ are 0.99 acceptance level.

Table 6. Correlations in Female

Treatments	H.D*	Age in weeks 1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	22	24	26	30
B and F	−	⧺	+	+	+	−	−	−	+	−	−	−	−	−	−	−	−	−	−	−
B and S	+	−	+	⧺	+	−	−	−	−	−	−	+	−	−	−	−	−	−	−	−
B and T	−	⧺	−	⧺	−	+	−	−	−	−	−	+	−	−	−	−	−	−	−	−
B and G	−	−	+	⧺	+	−	⧺	−	−	−	−	−	⧺	−	−	+	−	−	−	−
F and S	⧺	−	⧺	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
F and T	−	+	−	+	−	−	−	−	⧺	⧺	−	−	−	−	−	−	−	−	−	−
F and F	−	−	⧺	⧺	+	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
S and T	−	−	−	⧺	−	−	−	−	−	−	−	+	−	−	−	−	−	−	−	−
S and G	−	+	⧺	+	−	−	−	−	−	−	−	+	−	−	−	−	−	⧺	−	−
T and G	−	−	−	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+

B=Body weight; F=Bursa of Fabricius; S=Spleen; T=Thymus; G=Ovary;
− are less than 0.95 acceptance level. + are 0.95 acceptance level. ⧺ are 0.99 acceptance level.

above mean weight in the male and female represented 0.040% and 0.037% of the gross body weight respectively. The bursa reached its maximum weight relationship (0.109% of the body weight at 5 weeks in male and 0.148% at 3 weeks in the female) and thereafter grew at a slower rate than the body. The bursa attained its maximum mean weight of 87.7±15.2 mg at 7 weeks of age in the male and 90.0±28.0 mg at 6 weeks of age in the female. At that time, they represented 0.095% of body weight in the male and 0.100% in the female respectively. The bursa of the male decreased to about 9.4 mg in mean weight between 7 and 8 weeks of age. The female bursa decreased to about 6.6 mg in mean weight between 6 and 7 weeks. At times a small increase in the mean weight occurred between 8 and 30 weeks of age, but generally the bursa continued to decline in mean weight. The initial bursa regression for the male is probably at 8 weeks of age and for the female is probably at 9 weeks of age. At 30 weeks of age, namely the last weeks of age of this experiment, the mean weight of the bursa reached 17.1±4.0 mg in the male quails and 8.0±4.0 mg in the female.

Spleen: The spleen on the day of hatching had a mean weight of 1.3±0.6 mg in the male and 0.7±0.3 mg in the female. These mean weights represented 0.019% in the male and 0.012% in the female. There was a constant increase in mean weight of these organs from the day of hatching to 7 weeks of age except for the period between 4 and 5 weeks of age in the male. At 7 weeks of age, the spleen reached its maximum mean weight of 46.0±16.0 mg in the male and 80.6±32.4 mg in the female. At this time, they represented 0.051% of the gross body weight in the male and 0.072% in the female. These values were showed a maximum percentage of the gross body weight in both sexes. The spleen of the female was significantly heavier than that of the male. After 7 weeks of age the spleen decreased its mean weight and thereafter continued between 40 to 50 mg in the female and approximately 30 mg in the male while showing a small increase or decrease. At 30 weeks of age, the mean weight of the spleen reached 2.49±7.7 mg in the male and 41.8±13.4 mg in the female which represented about 0.024% of the body weight in the male and 0.035% in the female.

Thymus: The thymus at the day of hatching had a mean weight of 4.0±0.9 mg in the male and 4.0±1.5 mg in the female. The mean weight represented 0.040% of the body weight in the male and 0.084% in the female. There was a continuous increase in the mean weight of the male thymus up to the 5th week of age, and at this time the male thymus reached its maximum mean weight of 305.2±64.2 mg. On the other hand, there was a continuous increase in the mean weight of the female thymus up to the 4th week of age and this organ reached its maximum mean weight of 198.1±68.7 mg at 4 weeks of age. The thymus attained its maximum weight relationship, 0.383%, of the body weight at 5 weeks of age in the male and 0.318% at 4 weeks of age in the female. Thereafter the mean weight of the thymus and relationship to the body decreased rapidly up to the 10 weeks of age in the male. In the female, practically no change occurred between 4 and 6 weeks, and 6 and 8 weeks a rapid decrease was seen. Thereafter this organ exhibited slight fluctuations in mean weight of 41.3±18.4 mg in the male and 40.7±19.0 mg in the female.

Testes: The testes at the day of hatching had a mean weight of 0.0011±0.0004 g, representing 0.016% of the body weight. The testes were very small until 3 weeks of age, at which time the mean weight of the organs were 0.0145±0.0085 g. This mean weight represented 0.042% of the body weight. Thereafter, there was a conciderable increase in the mean weight of the testes up to 6 weeks of age. Although the testes grew steadily from the day of hatching to 3 weeks, they increased in weight slowly. They began to grow at a much more rapid rate than the body weight between 3 and 9 weeks of age. At 9 weeks, the testes reached its mean weight of 3.0768±0.0768 g, representing 0.323% of the body weight. This weight may be regarded to be the equivalent of the adult quail. Between 9 and 30 weeks, there were small decreases, but the testes remained approximately at 3 grams.

Ovary: The ovary at the day of hatching had a mean weight of 0.0015±0.0003 g, representing 0.016% of the body weight. The ovary was very small until 5 weeks of age, at which time the mean weight of the organ was 0.0641 ±0.0317 g, representing 0.082% of the body weight. This mean weight represented a 0.062 g increase over the mean weight of the day of hatching. Although the ovaries grew constantly during the first 5 weeks of age, they increased in weight slowly. However, between 5 and 9 weeks of age there was a considerable increase of 0.0641 to 4.4122 g in the mean weight. This rapid increase of the ovaries from 5 to 9 weeks was evident not only from actual mean weight but also from the ovary to body ratio, in which an increase from 0.0082 to 4.334% was seen. Aftre the 9th week of age, the ovaries remained above 4 grams in weight.

Statistical analysis: The statistical analysis of the data included calculations of coeficients of the linear correlation between different samples vareties within each age group. The experimental results which were obtained in the manner described above were shown in Tables 5 and 6. As indicated in these tables, the correlations between weight of organs paired in various combinations were infrequent. The positive correlations were found frequently for almost all combinations at 2 and 3 weeks of age, especially at 3 weeks of age every combination showed positive correlations in both sexes.

Discussion

In Japanese quails, it was observed that the bursa attained a peak of average weight at 7 weeks in the male and at 8 weeks in the female. The report of JOLLY (1913) indicated that in chickens the bursa reached its maximum mean weight after 4 to 5 months of hatching. BRADLEY (1950) showed that the maximum weight of the bursa in fowls was reached in the fourth month. Also, GLICK's data (1956), using three different breeds of chickens, showed that the peak of mean bursal weight was attained at 8 weeks of age for male Rhode Island Red, 4 to 4.5 weeks for male White Leghorns and 8 to 14 weeks for male hatched from a cross between Barred Plymouth Rocks and Dominant White Rocks. WOLFE *et al.* (1962) and YAMADA (1966) indicated that the maximum bursal weight was reached at 10 weeks of age in the male Albor Aire White Rocks and in the male White Leghorns, respectively. Therefor, in the Japanese quails, it was concidered that the maximum mean weight of the bursa would be attained sooner than that in the stage reported previously in the chickens, except for GLICK's data (1956) for male White Leghorns.

The factors involved in bursa regression have not been clearly ascertained. The rate of involution of the bursa in Pheasants was increased with exogenous male hormone (KIRKPATRICK and ANDREWS 1944). In some trials GLICK (1957) caused the bursa regression to increase with testosterone propionate in the chickens. Afterwards GLICK (1959) published data indicating that cortisone acetate suppressed the growth of the bursa in chickens. MEYER *et al.* (1959) observed that the development of the bursa of Fabricius was inhibited by injection of 19-nortestosterone in 5 day old embryos. These investigations suggest that the bursa involution may be caused by the combined action of the hormone from the testes and the adrenals. The regression of the coinciding with the marked enlargement of the testes was found by JOLLY (1913), GLICK (1956) and WOLFE *et al.* (1962) in the chickens. The data presented in this paper indicated that bursa involution is accompanied by an increase in rate of the testes in quails, likewise. In the female quails, a similar relationship was found between the bursa and the ovary.

The difference in weight of the bursa between male and female chickens was reported by GLICK (1956), but apparent sexual difference was not observed in the present study. GLICK (1956) demonstrated that a high degree correlation existed between the bursa and the body weight during the growing period of the bursa in the chickens. Furthermore, WOLFE *et al.* (1962) showed that a similar correlation exists between the bursa and the body weight during 1 to 3 weeks of age in the chickens. The data of the present study demonstrated that a similar correlation exists between the bursa and the body weight during 1 to 4 weeks of age in both sexes.

It was observed in the present study that the quail thymus continues its conspicuous growth until 5 weeks of age in the male and until 4 weeks in the female. Actual decrease in the mean weight and percentage of the body weight began at 6 weeks in the male and at 7 weeks in the female. Our data showed that the thymus involution was accompanied by a rapid growth of the gonads in the quails. In the report of WOLFE *et al.* (1962), the thymus attained its maximum mean weight 7 weeks later than the bursa in chickens. But our data indicated that the quail thymus attained its maximum mean weight 2 weeks earlier than the bursa. WOLFE *et al.* (1962) demonstrated that a high degree correlation existed between the thymus and the body weight except for 3, 14 and 23 weeks of age. On the contrary, the weight of the thymus and the body weight have a high degree correlation only at 2, 3, 4, and 8 weeks of age in male quails.

The spleen, which plays a role in antibody formation, showed continuous growth until 7 weeks (except for 5 weeks in the male) and then decreased with small fluctuation from 8 weeks of age in the quails. But this decrease was small, and after 10 weeks of age the mean weight of the spleen showed nearly a constant weight by 30 weeks at which time the experiment was terminated. The spleen of the female quail was generally heavier than that of the male between 3 and 30 weeks of age. The maximum mean weight of the spleen was reached in the quails at 7 weeks of age in both sexes. In male chickens, on the otherhand, the spleen attained its maximum mean weight at 20 weeks of age. It may be clearly seen from the above mentioned evidence that the maximum weight of the spleen in the quail was reached earlier than that of the male chickens.

The quail data is not to be compared with chicken data by actual weight alone. Therefor when comparing our data with data of WOLFE *et al.* (1962) by a body weight percentage of organs at the peak of growth curve, the species difference became evident. Since the data of WOLFE *et al.* involved only male chickens, male quails used in this comparison yielded the data shown in Table 7.

Table 7. Comparison Between Japanese Quail and Chicken in Body Weight Percentage of Maximum Organ Weight

Organs	Quail (%)	Chicken* (%)	Quail : Chicken (ratio)
Bursa	0.11	0.43	1 : 4
Spleen	0.05	0.26	1 : 5
Thymus	0.38	0.63	1 : 1.7
Testes	3.31	0.70	4.7 : 1

* This is data of WOLFE *et al.* (1962).

The bursa of chicken was 4 times as heavy as that of quail. The spleen of chicken was 5 times as heavy as that of quail. The thymus of chicken was 1.7 times as heavy as that of quail. However, the testes of the quail was 1.7 times as heavy as that of chickes.

Whereas Japanese quail and chicken are involved in the same order, the species difference between the quail and chicken became evident.

Summary

This paper deals with the comparative growth of major lymphoid organs, gonads and body of the Japanese quail. The growth or involution was measured in terms of the changes of organs and body weight of the birds.

The bursa attained its maximum mean weight of 87.9±15.2 mg at 7 weeks of age in the male and 90.0±28.0 mg at 6 weeks of age in the female. The bursa of the quail reached its maximum mean weight at a period earlier than that previously reported in chicken, except for GLICK's data (1956) for male White Leghorns. The spleen reached its maximum mean weight of 46.0±16.0 mg in the male and 80.0±32.4 mg in the female at 7 weeks of age. The female spleen was significantly heavier than the male. The thymus attained its maximum mean

weight of 305.2±64.2 mg in the male at 5 weeks of age and 198.1±68.7 mg in the female at 4 weeks. The involution of these lymphoid organs were accompanied by a rapid increase in the rate of growth of the gonads in quail.

The gonads reached its adult value of about 3 grams in the male and above 4 grams in the female in the female at 9 weeks of age.

When comparing our data with data of WOLFE *et al.* (1962) by a body weigth percentage of organs at the peak of the growth curve in the male birds, the bursa, the spleen and the thymus of the chicken were 4, 5 and 1.7 times hevier than the equivalent quail organ, respectively. In contrast, the testes of quail was 4.7 times as heavy as that of the chicken.

Whereas Japanese quail and chicken are involved in the same order, the species difference between the quail and the chicken became evident. (This work was partly supported by a Grant for Scientific Research from the Ministry of Education.)

References

1) ARCHER, O. and PIERCE, J. C. (1961): Role of thymus in development of the immune response. Fed. Proc., **20**: 26.
2) ASPINALL, R. L., MEYER, R. K. GRAETZER, M. A. and WOLFE, H. R. (1963): Effect of thymectomy and bursectomy on the survival of skin homograft in chickens. J. Immunol., **90**: 872-877.
3) BRADLEY, O. C. (1950): The structure of the fowl. London, Oliver and boyd, 76 p.
4) CHANG, T. S., RHEING, M. S. and WINTER, A. R. (1957): The significance of the bursa of Fabricius in antibody production in chickens. 1. Age of chickens. Poultly Sci., **36**: 735-738.
5) CHANG, T. S., RHEING, M. S. and WINTER, A. R. (1959): The significance of the bursa of Fabricius in antibody production in chickens. 3. Resistance to *Sal. typhimurium* infection. Poultly Sci., **38**: 174-176.
6) COOPER, M. D., PETERSON, R. D. A., SOUTH, M. A. and GOOD, R. A. (1966): The functions of the thymus system and the bursa system in the chicken. J. Exp. Med., **123**: 75-102.
7) GLICK, B. (1956): Growth of the bursa of Fabricius in chickens. Poultly Sci., **35**: 843-851.
8) GLICK, B., CHANG, T. S. and JAAP. R. G. (1956): The bursa of Fabricius and antibody formation. Poultly Sci., **35**: 224-225.
9) GLICK, B. (1957): Experimental modification of the growth of the bursa of Fabricius. Poultly Sci., **36**: 18-23.
10) GLICK, B. (1960): Growth of the bursa of Fabricius and its relationship to the adrenal gland in the White Pekin Duck, White Leghorn, outbred and inbred New Hampshire. Poultly Sci., **39**: 130-139.
11) GRAETZER, M. A., WOLFE, H. R., ASPINALL, R. L. and MEYER, R. K. (1963): Effect of thymectomy and bursectomy on precipitin and natural hemagglutinin production in the chicken. J. Immunol., **90**: 878-887.
12) ISAKOVIĆ, K. and JANKOVIĆ, B. D. (1964): Role of thymus and bursa of Fabricius in immune reactions in chickens. II. Cellular changes in lymphoid tissues of thymectomized and normal chickens in the caurse of first antibody response. Internat. Arch. Allergy

Appl. Immunol., **24**: 296-310.

13) JANKOVIĆ, B. C., WAKSMAN, B. H. and ARNASON, B. G. (1962): Role of the thymus in immune reactions in rats. I. The immunologic response to bovine serum albumin (antibody formation, Arthus reactivity and delayed hypersensitivity) in rats thymectomized or spleenectomized at various time after birth. J. Exp. Med., **116**; 159-176.

14) JANKOVIĆ, B. D. and ISVANESKI, M. (1963): Experimental allergic encephalomyelitis in thymectomized, bursectomized, and normal chicken. Internat. Arch. Allergy Appl. Immunol., **23**: 188-206.

15) JANKOVIĆ, B. D., ISVANESKI, M., MILOSEVIĆ, D. and POPESKOVIĆ, L. (1963): Delayed hypersensitive reactions in bursectomized chickens. Nature, **198**: 298-299.

16) JANKOVIĆ, B. D. and ISAKOVIĆ, K. (1964): Role of the thymus and the bursa of Fabricius in immune reactions in chickens. I. Changes in lymphoid tissues of chickens surgically thymectomized at hatching. Internat. Arch. Allergy Appl. Immunl., **24**: 278-295.

17) JOLLY, J. (1913): L'involution physiologique de la bourse de Fabricius et ses relations avec l'appartion de la maturité sexuelle. C. R. Soc. Biol., **75**: 638-648.

18) KIRKPATRICK, C. M. and ANDREW, F. N. (1944): The influence of the hormones on the bursa of Fabricius and pelvis in the Ring-necked Phesaut. Endocrinol., **34**: 340-345.

19) KÔNO, S. (1933): On the extirpation of Bursa Fabricii of the young fowls. Jap. J. Zootech. Sci., **6**: 109-118.

20) MARTINETZ, C., KERSEY, J., PAPERMASTER, B. W. and GOOD, R. A. (1962): Skin homograft survival in thymectomized mice. Proc. Soc. Exp. Biol. and Med., **109**: 193-196.

21) MEYER, R. K., RAO, M. A. and SPINALL, R. L. (1959): Inhibition of the development of the bursa of Fabricius in the embryos of the common fowl by 19-Nortestosterone. Endocrinol., **64**: 890-897.

22) MILLER, J. F. A. P. (1961): Immunological function of the thymus. Lancet, **2**: 748-749.

23) MILLER, J. F. A. P. (1962): Role of the thymus in transplantation immunity. Ann. N. Y. Acad. Sci., **99**: 340-354.

24) MULLER., A. P., WOLFE, H. R. and MEYER, R. K. (1960): Precipitin production in chickens. XXI. Antibody production in bursectomized chickens and chickens injected with 19-nortestosterone on the fifth day of incubation. J. Immunol., **85**: 172-179.

25) MULLER, A. P., WOLFE, H. R., SPINALL, R. K. and MEYER, R. K. (1962): Further studies on the role of the bursa of Fabricius in antibody production. J. Immunol., **88**: 354-360.

26) RIDDLE, O. (1928): Growth of gonads and bursa of Fabricius in doves and pigeons with data for body growth and age at maturity. Amer. J. Physiol., **86**: 243-265.

27) SNEDECOR, G. W. (1964): Statistical Methods, Iowa, Iowa State College Press.

28) SZENBERG, A. and WARNER, N. L. (1962): Dissociation of immunological responsiveness in fowls with a hormonally arrested development lymphoid tissue. Nature, **194**: 146-147.

29) YAMADA, J. (1966): The weight and the Histological changes with age of the bursa of Fabricius in chickens. Jap. J, Vet. Res., **14**: 136.

30) WARNER, N. L., SZENBERG, A. and BURNET, F. M. (1962): The immunological role of different lymphoid organs in the chicken. I. Dissociation of immunological responsiveness. Australian J. Exp. Biol. and Med. Sci., **40**: 373-388.

31) WARNER, N. L. and SZENBERG, A. (1964): Immunologic studies on hormonally bursectomized and surgically thymectomized chickens: Dissociation of immunologic responsiveness. The thymus in immunobiology (Good and Gabrielsen editors), New York,

Hoeber-Harper, 395 p.
32) WOLFE, H. R., SHERIDAN, S. A., BILSTAD, N. M. and JOHNSON, M. A. (1962): The growth of lymphoidal organs and the testes of chickens. Anat. Rec., **142**: 485–492.

摘　　要

著者らはウズラ (*Coturnix coturnix japonica*) を393羽用い，そのリンパ器官および生殖腺の重量変化を孵化日から30週齢まで観察し，次の所見を得た。

ファブリシウス嚢 (以下 BF) は孵化日に♂で2.7±0.6 mg，♀で2.3±0.8 mgであり，最高重量は♂で7週齢に87.9±15.2 mg，♀で6週齢に90.0±28.0 mgであった。この最高重量到達時期はニワトリのそれと比較すると，GLICK (1956) の♂白色レグホンにおける報告を除き，これまでのどの報告よりも早期であった。その後BFは加齢とともに重さを減じ，30週齢には♂で17.1±4.0 mg，♀で8.0±4.0 mgを示した。

脾臓は孵化日に♂で1.3±0.6 mg，♀で0.7±0.3 mgであり，最高重量は♂で7週齢に46.7±16.0 mg，♀で7週齢に80.6±32.4 mgであった。脾臓は最高重量到達後，若干重さを減じるが10週齢から30週齢まではほぼ一定の値を持続した。♀の脾臓は♂のそれより一般に重かった。

胸腺は孵化日に♂で4.0±0.9 mg，♀で4.0±1.5 mg，♀で4週齢に198.1±6.87 mgであった。胸腺はその後，若干の変動を示しつつも加齢とともにその重さを減じた。

生殖腺は両性において4週齢までは非常に小さく，かつ軽いままであるが，その後9週齢にかけて急激に重さを増し，成熟値と思われる値に達し，以後ほぼ一定の値を持続した。

各週齢群での各種臓器間の相互関係は2および3週齢群において高い相関を示したが，他の週齢群では一般に高い相関は示さなかった。

このウズラの成績とWOLFEら (1962) の♂のニワトリにおける成績とをそれぞれの各種臓器の最高重量の体重%で比較してみると，ウズラのBF，脾臓，胸腺はそれぞれニワトリの約1/4, 1/5, 3/5を示したが，精巣は約4.7倍もニワトリのそれよりも大であった。ウズラとニワトリとは同じ“目”に属していながら上記のような種差が存在することが明らかになった。