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**Studies on the Effect of the Alteration in the Internal
Environment of Poultry Egg on Embryonic Growth**
**IV. The Effect of Intergeneric Albumen Exchange
on Organ Weights and Metatarsal Bone
Length in Day-Old Chicks***

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Summary

A large quantity of quail egg albumen was supplied to chick embryos, to study the effect of foreign albumen as a nutritional environment on body conformation at hatching time.

Hatching weight and abdominal unassimilated yolk weight were significantly smaller in the experimental birds than in the control. Possible reasons for this were discussed.

None of the significant differences between the experimental and the control chicks were found in any organ weights investigated, their per cent weights of body weight, and the actual or relative metatarsal bone lengths.

Accordingly, it was evident that quail egg albumen supplied sufficient nutrients to chick embryos.

The subject of the study was to clarify whether chick embryo growth was influenced through a large quantity of foreign albumen, that is, *Coturnix* quail albumen, as a nutritional environment. This attempt would be interesting by such study that chick and quail was immunologically different in egg albumen each other (1).

At the onset of this experiment, we thought that body proportion introduced in the previous paper (2) might be beneficial in judging the effects of genotype or environment.

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Experimental Procedure

Hatching eggs layed by ten White Leghorns between the 29th of November and the 4th of December, 1965 were used in this experiment. Both groups, experimental and control eggs, were allocated on alternate days according to the date of laying. Unfertilized eggs for donors were obtained from fifty-two randomly selected quails. These birds belonging to two different genera were reared at the Laboratory of Animal Breeding, Tohoku University.

A procedure of albumen exchange was referred to Mizuma (3) and Mizuma and Hashima (4). The period of operation was determined so that it might result in the highest hatchability: That is, at 73 to 78 hours after the onset of incubation.

Differing from the method of the authors above mentioned, albumen quantity in this experiment was represented not by a milliliter but a gram, in order to know accurately and to record the albumen quantity exchanged. Prior to incubation hatching, eggs were weighed to the nearest one-twentieth of a gram, classified into three classes of five gram interval: 47.50 to 52.45g, 52.5 to 57.45 g and 57.50 to 62.45g, respectively. Albumen volume were then estimated from the regression equation (5) for the medians of each class, that is, 50, 55 and 60g. Hatching eggs were set up after one-half of whole albumen estimated was determined to be exchanged. It came in consequence to 14.3, 16.0 and 17.7 g respectively for each class above described.

Just prior to the operation, developing eggs were weighed again and then recipient albumen were removed until the egg weight amounted decreasingly to weight deducted exchanging quantity. The albumen from donor eggs were drawn out with a syringe from the petri dish in which the eggs were opened, and injected into a chick egg until egg weight restored again to that before operation. In the process of operation, however, some eggs failed to be injected with the same quantity of albumen as removed, while others were supplied excess quantity over the level removed. Consequently, a range of egg weight difference before and after operation was -3.3 to $+0.7$ g, i.e., on average, -1.1 g. This indicated that in most cases donor albumen failed to fill up the same quantity of albumen as recipient removed. This deviations of difference were unavoidable to minimize the physical shock to hatching eggs in the operation.

Quail eggs as a donor were layed 5 days including the day of operation, then all incubated until utilised. Pooled donor albumen from four quail eggs combined variously on the date of laying and laying bird, were injected into one hatching egg. Injection of donor egg albumen into a recipient egg did not involve an antibiotic. After operation, the holes at both ends of the recipient eggs were sealed with gyps and then the eggs were returned to an incubator.

All hatching eggs were candled at the operation and the 18th day of incubation to eliminate unfertilized eggs and dead embryos. A conventional method was referred to for other procedures accompanied by incubation.

The procedures to measure body weight, organ weights and the bone length were referred to those described in detail in the previous papers (2) (6). Sex of chick was ignored. Statistical analysis of data was also practised in the same way as in the previous paper (2).

Results and Discussion

Hatchability: data in Table 1 give us suggestive information on the effects of both quantitative and qualitative sides of albumen: perhaps due to a physical shock at operation, per cent hatchability of living embryos at time of operation was lower in the experimental than in the control, but the difference was not ensured statistically ($\chi^2=2.2850$).

TABLE 1. Hatchability of Albumen-Exchanged Eggs

	Exchanged ^{a)}	Control	
No. set	24	23	
No. infertilized	2	4	
No. fertilized	22	19	
No. living embryo at operation	19	18	
No. hatched	13	16	
Hatched/set (%)	54.2	69.6	
Hatched/fertilized (%)	59.1	84.2	$\chi^2=3.1075$
Hatched/living embryo (%)	68.4	88.9	$\chi^2=2.2850$

a) One half of whole albumen estimated was exchanged with that of quail.

TABLE 2. Mean Organ Weight of Newly Hatched Chicks from Eggs Exchanged with a Large Quantity of Quail Albumen at Early Period of Incubation

	Mean		Difference
	Exchanged ^{a)}	Control	
Egg weight (g)	55.63 $\pm 0.94^b$	56.92 ± 0.91	1.29
Body weight (g)	35.87 ± 0.98	39.00 ± 0.72	3.13*
Heart (mg)	227.3 ± 9.0	239.8 ± 6.8	12.5
Gizzard (mg)	1909.3 ± 118.6	1785.1 ± 45.7	124.2
Pancreas (mg)	49.3 ± 4.2	49.4 ± 3.0	0.1
Liver (mg)	842.4 ± 28.5	847.6 ± 26.2	5.2
Unassimilated yolk (g)	3.7726 ± 0.3603	5.7688 ± 0.2831	1.9962***

a) One half of whole albumen estimated was exchanged with that of quail.

b) Standard error of the mean.

* Significant at 5% level.

** Significant at 1% level.

*** Significant at 0.5% level.

Mean Chick Weight and Unassimilated Yolk Weight: as shown in Table 2, body weight of the experimental chicks at hatching was significantly less (3.1 g) than in the control. This result may be due mainly to the operative errors, rather than negative effect by foreign albumen. That is, it may be due to possible accumulative effects in the experimental eggs of the removal of 1.1 g of albumen as described in the previous section. In addition, the group difference in the initial egg weight from which thirteen chicks for each group were hatched amounted to 1.3 g (Table 2), which was disadvantageous against experimental birds.

The explanation would appear to be correct, in the light of discussion by Mizuma and Hashima (4) that the birth weight of a chicken decreased about as much as the weight of albumen removed, and referring to many investigators' and our consideration (6) that hatching weight was highly correlated with egg size.

In contrast with the control birds, the experimentals had significantly less unassimilated yolk in the abdomen. Though more extensive surveys are necessary, this suggests to us that the experimentals consumed more yolk materials to compensate for the reduced quantity of albumen. In other words, even if there exists a certain ratio of albumen to yolk for highest hatchability, quantitative relations between the two major components of the egg which lead to successful hatching can be considerably extended; they seem to substitute for each other to some extent where deficiency exists of one component or the other.

Nevertheless, putting the above facts together, the foreign albumen has some unknown effect on embryogenesis and hatching though it seems to have been utilized by chick embryo.

Mean Organ Weight and Metatarsal Bone Length at Hatching: no significant differences between two groups were found in any of the organ weights investigated and differences were near zero in the pancreas. Experimental and control birds were not significantly different anywhere in per cent organ weights of body weight

TABLE 3. *Mean Organ Weight as a Percentage of Hatching Weight in Newly Hatched Chicks from Eggs Exchanged with a large Quantity of Quail Albumen at Early Period of Incubation*

	Mean		Difference
	Exchanged ^{a)}	Control	
Heart	0.64 ±0.02 ^{b)}	0.62 ±0.02	0.02
Gizzard	5.35 ±0.35	4.60 ±0.15	0.75
Pancreas	0.14 ±0.01	0.13 ±0.01	0.01
Liver	2.37 ±0.10	2.18 ±0.07	0.19

a) One half of whole albumen estimated was exchanged with that of quail.

b) Standard error of the mean.

TABLE 4. Actual and Per Cent Lengths of Metatarsal Bone at Hatching.

	Mean		Difference
	Exchanged ^{a)}	Control	
Bone length (cm)	2.204 ±0.022 ^{b)}	2.240 ±0.016	0.36
Per cent length ^{c)}	67.1 ±0.8	66.1 ±0.4	1.0

a) One half of whole albumen estimated was exchanged with that of quail.

b) Standard error of the mean.

c) Per cent metatarsal bone length to cube root of body wt.

(Table 3), nor were the actual and per cent bone lengths (Table 4). Ryle (7) in comprehensive experiments on albumen or yolk exchange suggested that any significant effect on weight does not become apparent until more than three months after hatching, about the period of the onset of sexual maturity; it is, moreover, an effect not extending to the general body dimensions.

In this experiment, Leghorn embryos subjected to the foreign albumen during embryonic life hatched and grew as normal chicks without any proportional changes. Accordingly, it would appear in conclusion that quail egg albumen has no specialized effects on chick organ differentiation but supplied sufficient nutrients to chick embryos, in spite of the differences in the immunological quality of albumen in two genera as described by Ookura and Furuya (1).

References

- 1) Ookura, E., and Furuya, M., *Abstr. of the Spring Meetg. of the Japan Poultry Science Association, Japan Branch of W.P.S.A.*, p. 12 (1966) (in Japanese)
- 2) Arai, K., Mizuma, Y., and Nishida, S., *Tohoku J. Agr. Res.*, in press
- 3) Mizuma, Y., *Tohoku J. Agr. Res.*, **10**, 43 (1959)
- 4) Mizuma, Y., and Hashima, H., *Tohoku J. Agr. Res.*, **12**, 221 (1961)
- 5) Arai, K., Mizuma, Y., and Nishida, S., *Proc. Commemorating 15th Yr. of Foundation of Lab. of Anim. Breed, Tokyo Univ. of Agr.*, p. 55 (1965) (in Japanese, with English summary)
- 6) Arai, K., Mizuma, Y., and Nishida, S., *Tohoku J. Agr. Res.*, **23**, 33 (1972)
- 7) Ryle, M., *J. Exp. Biol.*, **34**, 529 (1957)