

SERUM ALBUMIN POLYMORPHISM IN QUAIL AND CHICKEN-QUAIL HYBRIDS

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SERUM albumin polymorphism has been reported in such animals as pigs (KRISTJANSSON 1963), horses (STORMONT and SUZUKI 1963), cattle (ASHTON 1964; ASHTON and LAMPKIN 1965), chickens (McINDOE 1962) and turkeys (QUINTEROS, STEVENS, STORMONT and ASMUNDSON 1964). BECKMAN, CONTERIO and MAINARDI (1963) examined the serum protein patterns of avian species hybrids and found that in eight out of 11 interspecific crosses there was a difference between the parental species with respect to the major fast moving protein. In the hybrids, both parental protein components were present.

At this laboratory, similar differences of serum protein fractions have been observed in Japanese quail and in chicken-quail hybrids. SMITHIES (1955) has shown that the major protein component of human serum in starch gel electrophoresis is albumin. The corresponding major component in chickens was reported to be albumin by its solubility characteristics (McINDOE 1962). By analogy the major protein component in other species has been designated as albumin (KRISTJANSSON 1963; STORMONT and SUZUKI 1963; QUINTEROS *et al.*, 1964). Thus, from migration rate and quantitative considerations the corresponding major protein fractions in quail serum have also been designated as albumin.

This report describes the phenotypic differences observed in Japanese quail and in chicken-quail hybrids and attributes the differences to a genetically variable locus determining albumin fractions in quail.

MATERIALS AND METHODS

Females from three lines of Japanese quail (*Coturnix coturnix japonica*) are artificially inseminated with semen from chicken (*Gallus domesticus*) and those females showing the highest fertility are selected each generation to reproduce the quail lines. These three selected lines (909, 910 and 916) show higher fertility and produce more hybrids when mated with chickens than do the unselected control lines of quail (905, 903 and 916 respectively) from which they originated.

Separate blood samples drawn from the chickens, the quail and their hybrids were mixed with citrated saline (2% sodium citrate + 0.5 percent NaCl) in the ratio of 1 ml citrate to 2 ml of blood.

Horizontal starch gel electrophoresis was carried out using the method described by FEENEY, ABPLANALP, CLARY, EDWARDS and CLARK (1963). The gel buffer (pH 8.6) contained 0.076 M Tris, 0.005 M citric acid, and 2.0 M urea; the electrode buffer (pH 8.6), 0.3 M boric acid and 0.06 M NaOH. However, the procedure in the present study differed in that electrophoresis was

carried out at room temperature at 150 volts, 15 ma for the first half hour, at which time the sample filter papers were removed and the voltage set at 350. The runs were stopped when the borate boundary had migrated 10.5 cm from the point of insertion. Gels were stained in a solution of one percent Buffalo Black in water, methanol and acetic acid at a ratio of 50:50:10.

RESULTS AND DISCUSSION

Three albumin phenotypes Q_1Q_1 , Q_1Q_2 and Q_2Q_2 were observed in quail of both sexes as shown in Figure 1. Each of the phenotypes Q_1Q_1 and Q_2Q_2 is characterized by a single dark staining zone with Q_1Q_1 migrating at a faster rate than Q_2Q_2 . The phenotype Q_1Q_2 has two zones, the slower of which corresponds to Q_2Q_2 and the faster to Q_1Q_1 . These observations suggest that the three phenotypes are controlled by a pair of codominant autosomal alleles, herein designated as Alb^o_1 and Alb^o_2 .

Data on parents and offspring from pair matings of quail are presented in Table 1. Since this study was carried out in retrospect, no $Q_2Q_2 \times Q_2Q_2$ matings

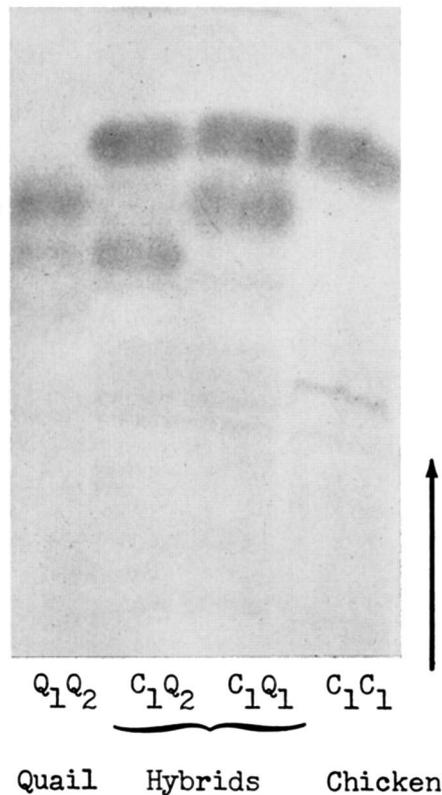
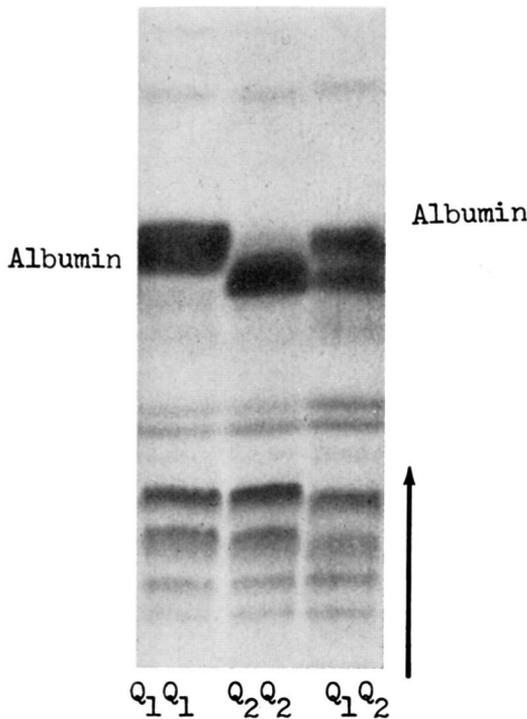


FIGURE 1.—Photograph of starch gel of plasma from three Japanese quail, illustrating the three serum albumin phenotypes.

FIGURE 2.—Photograph of a starch gel of plasma from a homozygous chicken male (C_1C_1), a heterozygous quail female (Q_1Q_2), and their hybrid offspring C_1Q_1 and C_1Q_2 .

TABLE 1

Results of various crosses involving serum albumin alleles Alb^Q₁ and Alb^Q₂ in Japanese quail

Mating type	No. of mated pairs	Offspring genotype			P of χ^2
		<i>Alb</i> ^Q ₁ <i>Alb</i> ^Q ₁	<i>Alb</i> ^Q ₁ <i>Alb</i> ^Q ₂	<i>Alb</i> ^Q ₂ <i>Alb</i> ^Q ₂	
Q ₁ Q ₁ × Q ₁ Q ₁	14	49	0	0
Q ₁ Q ₁ × Q ₁ Q ₂	6	21	24	0	>0.5
Q ₁ Q ₁ × Q ₂ Q ₂	6	0	26	0
Q ₁ Q ₂ × Q ₁ Q ₂	3	8	15	4	>0.25
Q ₁ Q ₂ × Q ₂ Q ₂	4	0	14	14

TABLE 2

Gene frequency of Alb^Q₁ and Alb^Q₂ in three Japanese quail populations

Line	Line of origin	Genotype frequency			Gene frequency	
		<i>Alb</i> ^Q ₁ <i>Alb</i> ^Q ₁	<i>Alb</i> ^Q ₁ <i>Alb</i> ^Q ₂	<i>Alb</i> ^Q ₂ <i>Alb</i> ^Q ₂	<i>Alb</i> ^Q ₁	<i>Alb</i> ^Q ₂
909	905	17	57	18	.49	.51
910	903	21	22	..	.74	.26
916	908	40	1.00	.00

were available among those made to reproduce the lines, but observed matings are consistent with the hypothesis of two codominant alleles at one autosomal locus.

The above results were obtained from pooled data of the three lines 909, 910 and 916. Genotype frequencies of separate lines are given in Table 2. The Q₂ allele is predominant in line 909 which originated from control line 905. The presence of the Q₂ allele in line 910 has been traced in retrospect to two 909 birds introduced into line 910. One such mating occurred in generation 4 and one in generation 7. Up to this time no Q₁Q₂ × Q₁Q₂ matings have been made in line 910 which explains the lack of Q₂Q₂ individuals. Line 916 apparently lacks the Q₂ gene.

The phenotypes observed in chicken-quail hybrids are shown in Figure 2. To attain greater separation of zones for illustrative purposes the borate buffer front in this gel was allowed to migrate 12.5 cm rather than the standard 10.5 cm for all other gels. The chicken male parent possesses a serum albumin fraction (C₁C₁) which migrates faster than either of the two quail serum albumins described. Figure 2 shows the results of a cross of a chicken (C₁C₁) with a heterozygous female quail Q₁Q₂. One hybrid has the genotype *Alb*^C₁*Alb*^Q₁ while the other has *Alb*^C₁*Alb*^Q₂. This result agrees with the genetic hypothesis concerning the *Alb* locus in that the hybrid receives one allele (C₁) from the chicken and either allele Q₁ or Q₂ from the quail.

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SUMMARY

By means of starch gel electrophoresis three serum albumin phenotypes designated Q_1Q_1 , Q_1Q_2 and Q_2Q_2 have been demonstrated in quail. From family data it is concluded that these are controlled by two codominant autosomal alleles Alb^{Q_1} and Alb^{Q_2} . Allele Q_1 was present in all quail populations studied while allele Q_2 originated from one control line. All chickens studied showed only one serum albumin phenotype (C_1C_1) which migrated at a faster rate than did either quail phenotype. Hybrids derived from crossing chicken and quail always show two serum albumin zones, one acquired from the chicken and one from the quail. Thus, hybrids were found to be of either genotype $Alb^{C_1}Alb^{Q_1}$, or $Alb^{C_1}Alb^{Q_2}$.

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