Inheritance of Two Alkaline Phosphatase Variants in Fowl Plasma

Abstract. *Starch-gel electrophoresis of plasma reveals two mutually exclusive forms of alkaline phosphatase. Analysis of the plasma of 931 birds from 96 sib families of two inbred lines through two generations shows that the faster-moving isozyme is determined by an autosomal gene* Ap^2 *which is completely dominant to its allele* Ap^4 *determining the slower form.*

Electrophoresis of alkaline phosphatase isozymes, from many sources, on starch gels indicates they are under genetic control. Specific reports on *Drosophila melanogaster* (*1*), sheep (*2*), cattle (*3*), and humans (*4*) have been made in this regard. Quantitative studies have shown (*5*) that the amount of alkaline phosphatase in the serum of the domestic fowl is under genetic control, but to our knowledge there are no prior reports of this enzyme being shown by electrophoresis to have more than one form.

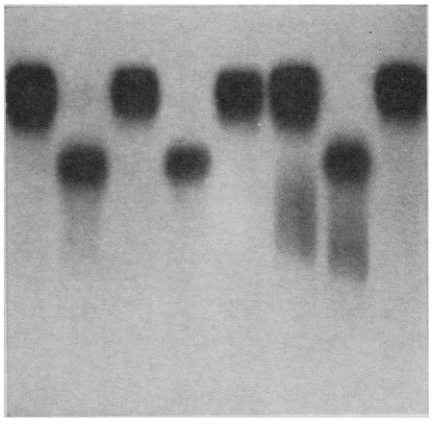

Fig. 1. Starch gel electrophoresis of chicken plasma showing two zones of alkaline phosphatase activity. (0.04*M* tris buffer adjusted to *p*H 8.6 with boric acid, 5 volt cm^{-1} for 16 hrs, stained with fast blue RR as a dye coupler and α-naphthyl phosphate as substrate. Origin at bottom, direction of migration upwards.)

Table 1. Frequency of progeny phenotypes from various matings in two inbred lines. (Under Matings, 22 = Ap^2/Ap^2; 24 = Ap^2/Ap^4; 44 = Ap^4/Ap^4. Parent genotypes were determined by a combination of phenotype and progeny test or parentage, except ? = unknown.)

Matings (♂♂ × ♀♀)	Progeny phenotypes	
	Ap^2 (fast)	Ap^4 (slow)
Inbred line 45		
22 × 24	67	0
24 × 22	17	0
24 × 24	81	19
24 × 44	15	15
44 × 24	25	24
44 × 44	0	84
Inbred line 79		
22 × 2?	71	0
22 × 24	114	0
22 × 44	61	0
24 × 2?	9	0
24 × 24	54	15
24 × 44	19	26
44 × 22	66	0
44 × 44	0	149

Heparinized blood samples were obtained from birds 3 to 4 weeks of age, at which time the amount of alkaline phosphatase is relatively large. Electrophoresis was conducted in horizontal gel trays (*6*). The staining was a dye-coupling procedure (*7*). Gels were preserved in a mixture of methanol, water, and acetic acid (50:50:10) until photographed by reflected light on high-contrast copy film. This procedure provided zymograms which were clearly differentiated and easily interpreted. As yet we have seen only two forms of the enzyme, one of which moves decidedly faster than the other (Fig. 1).

We have examined plasma samples from more than 900 birds of two individually pedigreed lines and surveyed an additional 2000 samples from eleven other lines. We have never found more than one isozyme in any one plasma. Analysis of the pedigreed families showed that the fast-moving form is determined by a simple autosomal dominant gene which is allelic to a recessive gene responsible for the slower isozyme. We have assigned the symbols Ap^2 and Ap^4 to the genes for fast and slow components, respectively. In a heterozygous individual Ap^2 excludes the appearance of the product of the Ap^4 allele. Thus, birds having the slow form are homozygous recessive (Ap^4Ap^4). Birds possessing the fast form may be homozygous dominant (Ap^2Ap^2) or heterozygous (Ap^2Ap^4).

The evidence for the theory of genetic control by two alleles with complete dominance is based on data collected on two generations in two inbred lines. We studied a total of 16 sires, 96 dams, and 931 offspring. The data are summarized in Table 1. Since the classes of progeny fit the 1:0, 1:1, 3:1, or 0:1 ratios expected with simple dominance ($\chi^2 = 0.13$) and there are no differences between reciprocal matings, an autosomal locus controls the two phenotypes. Why the Ap^2 gene in the heterozygous chicken should exclude the product of its Ap^4 allele from appearing in, or being detected in, the plasma is unknown.

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References and Notes

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Mirror-Image Reversal in Pigeons

Both Levine (*1*) and Mello *et al.* (*2*) have noted that light passes readily from one eye of the pigeon to the other through the paper-thin interorbital septum. In the latter case this trans-septal transmission of light occurred even though the pigeons were wearing goggles which somewhat restrict the peripheral field of view. One of us (Siegel) has observed that if one of the pigeon's eyes is enucleated and a bright stimulus presented to the remaining eye, the focused image of the stimulus appears on the septum at the rear of the evacuated orbital cavity. Since the retina normally abuts the septum at this point in the intact pigeon, this observation implies that, under some circumstances, a stimulus presented to one eye of the pigeon could stimulate the contralateral eye through this rear projection system. An image propagated trans-septally would not only be greatly attenuated in intensity, but would be the mirror image of what it would have been had it traveled the more usual route to the retina.

Interpretation of Mello's report (*3*), of maximal generalization with the "untrained eye" to the mirror image of an oblique line used in training the other eye, is complicated by this possibility, particularly since the sensitivity