Rat Eye Color:

The Genes Involved and Their Interaction[1]

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INTRODUCTION

The purpose of this paper is to discuss the genes involved in determining eye color and coat color in rats and the relationship of these genes to each other.

Rats have the following coat and eye color combinations: dark eyes and agouti coat, dark eyes and black coat, ruby eyes and yellow coat, pink eyes and yellow coat, ruby eyes and dark cream coat, pink eyes and cream coat, and pink eyes and albino coat.

Three genes have been described by Dunn as affecting eye color. The first of these is the albino locus with its four alleles: a causing pink eyes and albino coat, a^p causing pink eyes and yellow coat, a^r causing ruby eyes and yellow coat, and a^e allowing full color (Dunn, 1962). The two other genes described by Dunn (Sinnott, Dunn, Dobzhansky, 1958) showed simple dominance. The genes *P* and *R* permitted full color; homozygous *pp* resulted in pink-eyed yellow animals, and homozygous *rr* in ruby-eyed yellow animals. Animals of the genotype *pprr* were expected to appear pink-eyed and yellow.

METHODS AND MATERIALS

Animals of the coat and eye color combinations described above were investigated. Hooded rats of all except the dark cream with ruby eyes and the albino occurred, and these were considered as completely pigmented in counting offspring but were not used in further breeding.

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Methods used in breeding were standard; specific crosses have been considered in the following section.

Results and Discussion

In pink-eyed yellow animals investigated, the presence of the homozygous $a^p a^p$ condition was determined by crossing an albino, *aa*, with a pink-eyed yellow. Agouti offspring occurred instead of the pink-eyed yellows which would have been obtained from crossing an $a^p a^p$ animal. Evidence supporting this was the light belly coloration characteristic of full-colored agouti animals and similar to that described by Dunn (1921).

This investigation indicated a gene in addition to the three previously reported, and the alleles of this gene were studied. Creams crossed with black animals produced all black offspring; the F_1 animals crossed with the parent cream produced dark-eyed black and pink-eyed cream animals in a 1:1 ratio. Using other animals, agouti bred with pink-eyed cream produced only dark-eyed black and dark-eyed agouti animals. The allele for pink eyes and cream coat, b^c, was recessive to the one for dark eyes and black coat, b^b, and dark eyes and agouti coat, b^a; and b^b was recessive to b^a.

One or more dilution genes caused an observable lightening in the color of all animal coats. One animal occurred which had ruby eyes and a dark cream coat. In three crosses with a cream animal, which had previously bred in the expected manner, only black offspring were obtained. Backcrosses and $F_1 \times F_1$ crosses produced offspring in ratios of pink-eyed cream and dark-eyed black animals as expected from the loci discussed above. It has been hypothesized that the genotype of the ruby-eyed cream animal was that of a homozygous black animal with a homozygous recessive dilution factor or factors.

Of greatest interest was the interaction of these genes. For typical crosses, see Figure 1.

Animals which were ruby and pink-eyed yellow because of the *p* and *r* alleles were also studied. A family of rats was obtained which when inbred yielded several generations of pink-eyed yellow rats only. A similar family was obtained which when inbred for five generations produced pink and ruby-eyed yellow animals only. When pink-eyed yellows from the first family were crossed with pink-eyed yellows from the second family, only pink-eyed yellow animals were obtained. However, when six pink-eyed yellows from the first family were crossed with six ruby-eyed yellows from the second family, four crosses yielded pink and ruby yellows and unanticipated dark-eyed agoutis; two produced only pink and ruby-yellow animals. The genotype of the unanticipated agouti animal was $a^p a^p PpRrb^c b^a$. The genotype of family one was $a^p a^p ppRrb^c b^a$. In family two, the pink eyed yellow animals were $a^p a^p pprrb^c b^a$, and the ruby-eyed yellows were $a^p a^p Pprrb^c b^a$.

The interaction between these genes indicated a possible order of function. The alleles at the albino locus governed the formation of the original substrate, and no animal developed more pigment than dictated here. The *P* locus acted next, as *pp* prevented the formation of further pigmentation. If the above genes caused sufficient substrate, homozygous *rr* permitted only partial utilization of this substrate, resulting in ruby eyes and yellow coat. The last locus to function was the *b* locus, with b^c inhibiting almost all pigment, and b^b inhibiting yellow pigment (Dunn, 1921). The time or times of function of the dilution factors have not been hypothesized because of insufficient information.

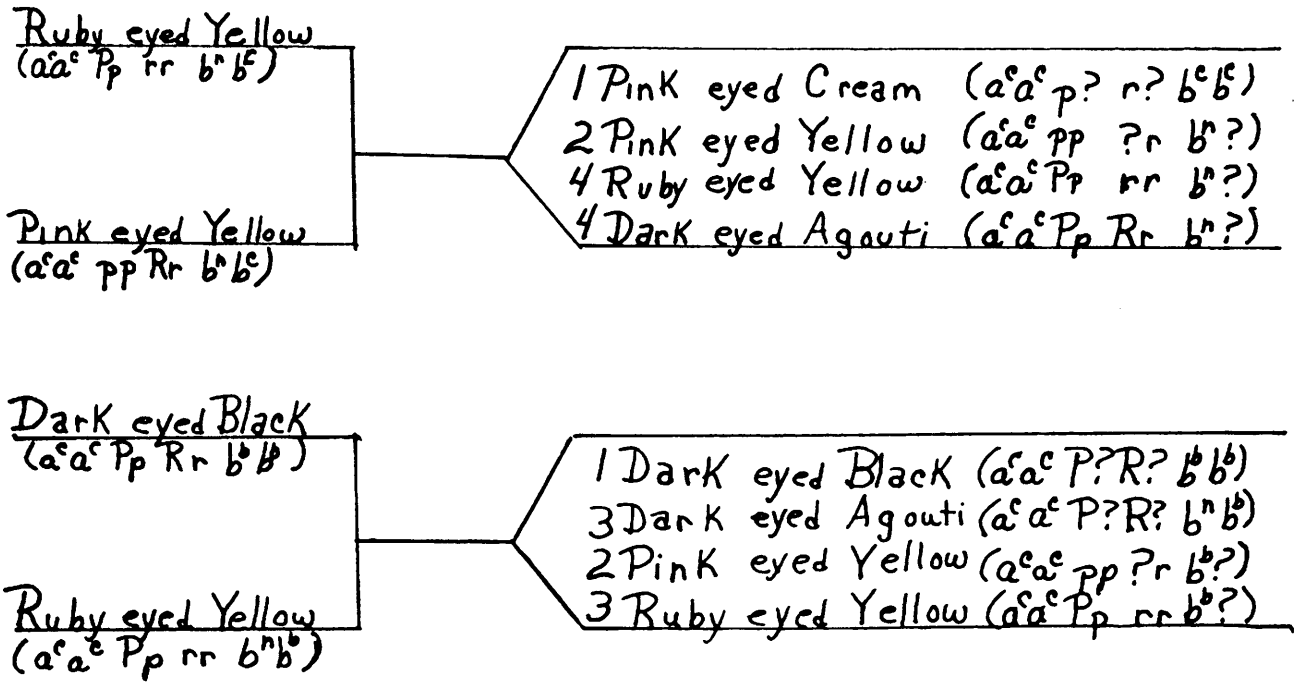

Figure 1. Typical crosses showing gene interaction.

SUMMARY

A series of three alleles controlled formation of dark eyes and black coat, pink eyes and cream coat, and dark eyes and agouti coat. This gene functioned with three other genes and an unknown number of dilution factors in determining the final phenotype of the rat's eyes and coat.

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