

THE GENETICS OF COLORLESS EYE IN *CULEX TRITAENIORHYNCHUS*

C. J. DUBASH, R. K. SAKAI AND R. H. BAKER

Pakistan Medical Research Center, 6, Birdwood Road, Lahore, Pakistan

AND

The International Health Program, University of Maryland School of Medicine,
10 South Pine Street, Baltimore, MD 21201

ABSTRACT. The genetic analysis of a new white eye mutant, colorless eye (ma^c), is presented. The data indicate that it is not allelic to

the previously described sex-linked white eye (w) but is an allele of the linkage group 2 mutant, maroon eye (ma).

Culex tritaeniorhynchus Giles, an important vector of Japanese encephalitis, has been under intensive genetic investigation, and a large number of mutations have been described (Baker and Sakai 1974b). Several eye color mutations including the sex-linked white eye (Baker 1969) and its temperature-sensitive red eye allele, rose eye (Baker and Sakai 1973, 1974a), as well as a recently discovered autosomal maroon eye (Dubash et al. 1980) have been subjected to genetic analyses. This is a report of the genetic and linkage analyses of a new white eye mutation, colorless eye (ma^c).

The colorless eye mutant was observed during routine handling of the Curly wing strain, a chromosome 1 mutant (Baker and Sakai 1977). The colorless eye individuals were isolated and in the next generation, a true breeding strain was established.

MATERIALS AND METHODS

The following strains of *Cx. tritaeniorhynchus* were used to elucidate the genetics of colorless eye:

1) White eye (w)—this strain is homozygous for the recessive sex-linked (chromosome 1) white eye (Baker 1969).

2) Rose eye (w^{re})—this strain is homozygous for the recessive, temperature-sensitive rose eye (Baker and Sakai 1974a). Rose eye is allelic and semi-dominant to white eye (Baker and Sakai 1973).

3) Maroon eye (ma)—this strain is homozygous for the recessive, temperature-sensitive, autosomal (chromosome 2) maroon-eye (Dubash et al. 1980).

4) Colorless eye (ma^c)—this strain is homozygous for colorless eye.

5) Ebony body; colorless eye ($e; ma^c$)—this strain is homozygous for ebony body (Sakai et al. 1972) and colorless eye.

6) Balloki—this is a wild type strain (Baker and Sakai 1974b).

Mass matings were made for all crosses, but single egg rafts were reared as individual families, and the data for each family were recorded separately. Upon emergence each adult was scored for sex, eye and body phenotypes.

RESULTS AND DISCUSSION

Table 1 summarizes the results of crosses (1-4) to determine possible allelism between colorless eye and the chromosome 1 mutants, *w* and *w^{re}*. All these crosses gave rise to wild type progeny indicating non-allelism between colorless eye and the 2 allelic chromosome 1 mutants. Crosses 5-8 are reciprocal crosses between the chromosome 2 mutant, maroon eye, and the chromosome 1 white and rose eye mutants, respectively. The resulting progeny were all wild type indicating that maroon eye also is not allelic to either *w* or *w^{re}*.

In Table 2 are the results of crosses investigating possible allelism between colorless and maroon eyes. All of the progeny of the reciprocal crosses between the maroon and colorless strains (crosses 9 and 10) showed a new, non-wild type phenotype, pink eyes. These observations suggest that maroon and colorless are allelic, and since the progeny showed an

intermediate phenotype, the alleles are codominant. When these heterozygous pink eyed females were backcrossed to maroon males (crosses 11 and 13) and the reciprocal (crosses 15 and 17), the progeny of all 4 crosses consisted of pink and maroon eyed females and males in approximately 1:1:1:1 ratios. When heterozygous pink eyed females were backcrossed to colorless males (crosses 12 and 14) and the reciprocal (crosses 16 and 18), the progeny consisted of pink and colorless females and males in 1:1:1:1 ratios. Intercrosses of heterozygous females and males (cross 19 and 20) produced offspring of 3 phenotypes (colorless, pink, or maroon individuals) in 1:2:1 ratios. These results support the preliminary hypothesis that maroon and colorless are codominant alleles at a single locus.

Maroon eye had previously been assigned to linkage group II (Dubash et al. 1980); therefore, a series of crosses were performed to confirm linkage of colorless

Table 1. Results of crosses to investigate the possible allelism among several eye mutants, *Culex tritaeniorhynchus*.

Cross No.	Parental Genotypes*				f#	Progeny Phenotypes		X ² testing for 1:1 segregation ♀:♂	
	♀	♂	♀	♂		♀	♂		
1.	$\frac{w}{w}$	♀	X	$\frac{ma^c}{ma^c}$	♂	5	214	216	0
2.	$\frac{ma^c}{ma^c}$	♀	X	$\frac{w}{w}$	♂	5	275	294	0.63
3.	$\frac{w^{re}}{w^{re}}$	♀	X	$\frac{ma^c}{ma^c}$	♂	5	205	204	0
4.	$\frac{ma^c}{ma^c}$	♀	X	$\frac{w^{re}}{w^{re}}$	♂	5	143	145	0.01
5.	$\frac{w}{w}$	♀	X	$\frac{ma}{ma}$	♂	7	360	346	0.27
6.	$\frac{ma}{ma}$	♀	X	$\frac{w}{w}$	♂	7	267	250	0.56
7.	$\frac{w^{re}}{w^{re}}$	♀	X	$\frac{ma}{ma}$	♂	5	229	234	0.05
8.	$\frac{ma}{ma}$	♀	X	$\frac{w^{re}}{w^{re}}$	♂	5	241	249	0.13

* *w* = sex-linked white eye; *ma^c* = the colorless eye mutant.

w^{re} = rose eye, an allele of white eye; *ma* = maroon eye.

= number of families tested.

Table 2. Results of crosses confirming allelism between maroon eye and colorless eye, *Culex tritaeniorhynchus*.

Cross No.	Parental Genotype*	f#	Progeny Phenotypes						X ² testing for 1:1 segregation			1:2:1 segregation ma ^c :p:ma
			♀			♂			♀:♂	p:ma ^c	p:ma	
			ma ^c	p	ma	ma ^c	p	ma				
9.	$\frac{ma^c}{ma^c} \text{♀} \times \frac{ma}{ma} \text{♂}$	7	0	265	0	0	255	0	0.19	—	—	—
10.	$\frac{ma}{ma} \text{♀} \times \frac{ma^c}{ma^c} \text{♂}$	7	0	270	0	0	260	0	0.18	—	—	—
11.	$\frac{ma^c}{ma} \text{♀} \times \frac{ma}{ma} \text{♂}$	5	0	118	114	0	118	112	0	—	0.21	—
12.	$\frac{ma^c}{ma} \text{♀} \times \frac{ma^c}{ma^c} \text{♂}$	5	180	212	0	177	196	0	0.47	3.40	—	—
13.	$\frac{ma}{ma^c} \text{♀} \times \frac{ma}{ma} \text{♂}$	5	0	86	69	0	80	78	0.02	—	1.15	—
14.	$\frac{ma}{ma^c} \text{♀} \times \frac{ma^c}{ma^c} \text{♂}$	5	126	149	0	140	145	0	0.17	1.40	—	—
15.	$\frac{ma}{ma} \text{♀} \times \frac{ma^c}{ma} \text{♂}$	10	0	119	123	0	117	119	0.07	—	0.07	—
16.	$\frac{ma^c}{ma} \text{♀} \times \frac{ma^c}{ma} \text{♂}$	10	119	116	0	107	120	0	0.13	0.21	—	—
17.	$\frac{ma}{ma} \text{♀} \times \frac{ma}{ma^c} \text{♂}$	10	0	168	166	0	174	165	0.03	—	0.17	—
18.	$\frac{ma^c}{ma^c} \text{♀} \times \frac{ma}{ma^c} \text{♂}$	10	136	146	0	152	136	0	0.06	0.06	—	—
19.	$\frac{ma^c}{ma} \text{♀} \times \frac{ma^c}{ma} \text{♂}$	5	79	163	76	79	166	77	0.02	—	—	0.57
20.	$\frac{ma}{ma^c} \text{♀} \times \frac{ma}{ma^c} \text{♂}$	5	65	132	66	67	133	67	0.03	—	—	0

* ma^c = colorless eye; ma = maroon eye; p = pink eyes; in heterozygous individuals the genes of maternal origin are printed above the line and those contributed by the father below the line.

= the number of families tested.

eye with *e* in that linkage group (Table 3). Reciprocal crosses between *e*; ma^c and the Balloki wild type strain (cross 21 and 22) produced all F₁ wild type progeny, which indicated that ma^c is recessive to wild type and confirmed previous observations that *e* is also recessive (Sakai et al. 1972). In backcrosses of heterozygous females to *e*; ma^c males (cross 23 and 24), linkage was absolute between *e* and ma^c, in agreement with previous observations that little or no crossing over is observed among linked loci in females of *Cx. tritaeniorhynchus* (Baker and Sakai 1974b). In backcrosses of *e*; ma^c females to heterozygous males (cross 25 and 26), the non-significant chi squares testing for linkage between sex and *e* and sex and ma^c supported the hy-

pothesis that neither locus is sex linked. The highly significant chi squares for independent segregation between *e* and ma^c confirmed the observations of the heterozygous female crosses. The observed frequencies of recombination between *e* and ma^c are recorded in the last column of Table 3. As no significant heterogeneity was observed between the data from crosses 25 and 26, the data were pooled and the overall frequency of recombination was $1.310 \pm 0.003\%$.

ACKNOWLEDGMENTS

This study was supported by Grant No. AI-10049 from the National Institute of

Table 3. Results of crosses to elucidate the genetic and linkage relationships among *e*, *ma*± and sex, *Culex tritaeniorhynchus*.

Cross No.	Parental Genotype*	f#	Progeny Phenotypes				X ²	testing for:				% recombination <i>e-ma</i> ^c					
			♀		♂			1:1 segregation		Linkage							
			+ e	<i>ma</i> ^c	+ e	<i>ma</i> ^c		♀:♂	+: <i>ma</i> ^c	sex-e	sex- <i>ma</i> ^c						
21.	<i>e ma</i> ^c ♀ X + + δ <i>e ma</i> ^c ♀ X + + δ	7	330	0	0	357	0	0	1.06	—	—	—	—				
22.	+ + ♀ X <i>e ma</i> ^c δ + + ♀ X <i>e ma</i> ^c δ	6	320	0	0	292	0	0	1.28	—	—	—	—				
23.	<i>e ma</i> ^c ♀ X <i>e ma</i> ^c δ + + ♀ X <i>e ma</i> ^c δ	7	246	0	0	247	0	0	0.01	0.19	0.19	—	990**	0			
24.	+ + ♀ X <i>e ma</i> ^c δ <i>e ma</i> ^c ♀ X <i>e ma</i> ^c δ	7	181	0	0	191	0	0	0.05	0.02	0.02	—	738**	0			
25.	<i>e ma</i> ^c ♀ X <i>e ma</i> ^c δ <i>e ma</i> ^c ♀ X <i>e ma</i> ^c δ	12	277	3	4	300	289	1	7	268	0.31	0.02	0.07	2.08	1.32	1089**	1.305 ± 0.003
26.	<i>e ma</i> ^c ♀ X + + δ <i>e ma</i> ^c ♀ X + + δ	12	256	3	3	277	263	4	4	254	0.19	0.10	0.10	1.06	1.06	1095**	1.315 ± 0.003

* e = ebony body, *ma*^c = colorless eye, + = wild type; in heterozygous individuals the maternal contribution is printed above the line and those of paternal origin below the line.

= number of families tested.

** = P < 0.01.

Allergy and Infectious Diseases, NIH. We appreciate the technical help of Messrs. M. Saghir, N. Hussain, T. Mahmood, L. Chaudhry, Z. Ahmad, M. Ali, R. Yamin and M. R. Sindhoo and the assistance of the U. S. Agency for International Development in Pakistan.

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