Research note

Two new eye colors, cherry and carmine, in *Aedes togoi*

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Studies on genetic linkage of mutants have been carried out in the mosquito *Aedes (Finlaya) togoi* (Theobald), a vector of filariae of various species or types, in order to produce genetical materials for this mosquito. Expected three linkage groups have been tentatively classified in the species, whose chromosome number (n) is three; the linkage group 1 involves M (sex-determining locus), reddish eye (rd), and straw-colored larva (s), and the linkage group 2 ruby eye (ru) and pigmented pupa (p), while plum eye (pm), yellow larva (y), and curved wing (c) belong to the linkage group 3 (Tadano, 1976, 1977 a, b, c).

During the course of experiments with this mosquito two more eye colors—cherry (ch) and carmine—were detected; both characters can be recognized in larval and pupal stages but gradually change from light to thick colors after emergence. Crosses were made to reveal modes of inheritance of these two eye colors especially with relation to those of other mutants of eye colors, rd , ru , and pm . This presents the results of the crosses.

Materials and Methods: Carmine-eyed pupae were initially found among the offspring from a cross containing ru and rd , and they bred true in all the generations after isolation of the sexes. Cherry-eyed pupae of both sexes were detected in a cross involving pm and the MUR strain (collected

at Miura City, Kanagawa Prefecture), but selection of several generations was needed for pure " ch " before this strain could be employed for crosses, since this freshly isolated strain showed evidence of mixed colors varying from darkish red to cherry.

The rd was originally isolated from the Taipei (Taiwan) strain, the y from the Nagasaki strain, while the other strains used in this study (ru , c and pm) were derived from the MUR strain. The Taipei and MUR strains were utilized as wild type strains to make the heterozygotes when they were needed. The methods of rearing and crossing in this study were same as those previously mentioned (Tadano, 1976, 1977 a). All the eye color mutants studied here can be best identified in the pupal stage.

Results and Discussion: Allelism tests had been first performed between the eye color strains concerned before cross experiments with them were made; in these tests mass crosses were made, and the F_1 pupae of an arbitrary number ranging between about 150 and 350 were examined for eye colors in each of the eight crosses described in Table 1.

Tests 1, 4, and 5 show that the carmine strain must be homozygous for rd and ru because all the F_1 offspring examined were phenotypically identical with either the rd or ru parental strain. In addition to these allelism tests an intercross of ($++$ females $\times$ carmine males) F_1 was made, which produced four phenotypes of wild type, ru , rd , and carmine eyes. Therefore, it can be claimed that the carmine-eyed individuals have the rd , ru/rd , ru genotype, and there is interestingly a non-epistatic interaction between the rd and ru alleles.

Tests 2, 3, and 6 gave self-explanatory results, since the rd , ru , and pm alleles are non-allelic to each other as cited above, whereas tests 7 and 8 indicate that pm and ch are allelic, pm being dominant over ch . It was found beforehand that pm was linked to curved wing (c) and yellow larva (y), they being arranged in the following sequence: c —(17–18%)— y —(40–41%)— pm (Tadano, 1977 c). In an attempt to testify this sequence the five crosses given in Table 2 were made, which involved c , y , and ch .

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Each family obtained from the $F_1 \times F_1$ (cross 1) and testcrosses (crosses 2-5) were tested by χ^2 for the expected ratio (1:3 or 1:1) of each phenotype including sex. All the families that did not differ significantly ($P < 0.05$) from the expected ratios were pooled

Table 1 Allelism tests between *rd*, *ru*, *pm*, *ch*, and carmine

Test	Parental cross Female $\times$ Male		F ₁ phenotype	F ₁ No.*
1	<i>rd</i>	carmine	<i>rd</i>	250
2	<i>rd</i>	<i>ru</i>	wild type	150
3	<i>ru</i>	<i>rd</i>	wild type	200
4	carmine	<i>rd</i>	<i>rd</i>	350
5	carmine	<i>ru</i>	<i>ru</i>	250
6	<i>pm</i>	<i>ru</i>	wild type	150
7	<i>pm</i>	<i>ch</i>	<i>pm</i>	250
8	<i>ch</i>	<i>pm</i>	<i>pm</i>	270

* Approximate numbers of the F₁ female and male pupae examined

for calculations of χ^2 values for linkage and of recombinations, and the other families differing from the expected ratios were excluded from these calculations.

Since *c* and *y* are known to be not sex-linked, phenotypical scores in both sexes are combined for tabulation in Table 2. χ^2 values for linkage and recombination values (%) were calculated according to Bailey (1961) for each of three combinations of *c*, *y*, and *ch* (Table 3). All the χ^2 values except two values for *c-ch* from crosses 1 and 3 were significant ($P < 0.01$), indicating the linkage among the three alleles. Percent recombinations ($\pm$ standard errors) range from 13.01 ± 0.28 to 15.53 ± 0.95 for *c-y*, from 43.01 ± 1.34 to 48.79 ± 1.34 for *c-ch*, from 34.66 ± 1.30 to 42.38 ± 1.30 for *y-ch*. Approximate percent recombinations were calculated in the case of the $F_1 \times F_1$ (cross 1) (Serra, 1965). From data of these percent recombinations the gene sequence has been again revealed

Table 2 Results of crosses showing the relationship among *c*, *y*, and *ch*

Cross	Female $\times$ Mal	Progeny phenotype (Females+Males)								Families pooled
		+	<i>c</i>	+	<i>c</i>	+	<i>c</i>	+	<i>c</i>	
		+	+	<i>ch</i>	<i>ch</i>	+	+	<i>ch</i>	<i>ch</i>	
1	$\frac{ch\ y\ +}{+ + c} \times \frac{ch\ y\ +}{+ + c}$	275	140	78	38	125	2	70	3	6
2	$\frac{ch\ y\ c}{ch\ y\ c} \times \frac{+ + +}{ch\ y\ c}$	367	68	219	12	19	211	74	360	11
3	$\frac{+ + +}{ch\ y\ c} \times \frac{ch\ y\ c}{ch\ y\ c}$	345	76	257	33	31	274	78	310	8
4	$\frac{ch\ y}{ch\ y} \times \frac{ch\ y}{+ +}$	161	—	95	—	108	—	189	—	7
5	$\frac{ch\ y}{+ +} \times \frac{ch\ y}{ch\ y}$	92	—	62	—	54	—	86	—	3

Table 3 Chi-square analysis (C. S. = chi-square value) of crosses involving *c*, *y*, and *ch*, and percent recombination (% R.) among these alleles

Cross	<i>c-y</i>		<i>c-ch</i>		<i>y-ch</i>	
	C. S.	% R.	C. S.	% R.	C. S.	% R.
1	79.02	15	1.55*	46	17.88	40
2	728.01	13.01 ± 0.28	26.01	43.01 ± 1.34	125.16	34.66 ± 1.30
3	667.40	15.53 ± 0.95	0.82*	48.79 ± 1.34	32.62	42.38 ± 1.30
4	—	—	—	—	39.08	36.71 ± 2.05
5	—	—	—	—	13.08	39.46 ± 2.85

* Not significant ($p > 0.20$)

to be *c-y-ch*, and there is a nearly free recombination between *c* and *ch*, which was shown in the previous studies on *c* and *pm*. Thus, the results of these crosses and the allelism tests gave evidence that *pm* and *ch* are multiple alleles (*pm* > *ch*) in the linkage group 3.

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摘 要

トウゴウヤブカの2種の新しい眼色

トウゴウヤブカから新しい眼色2種 cherry と carmine が分離されたので遺伝様式を調べてみた。Cherry (*ch*) と plum eye (*pm*) は複対立因子であり、第3連鎖群に存在する。優劣関係は *pm* > *ch* であり、yellow larva (*y*) から 35~42% の組換え率のところに位置する。一方、carmine 眼色は *rd* (reddish eye: 第1連鎖群) と *ru* (ruby eye: 第2連鎖群) との同型接合体 (*rd, ru/rd, ru*) に表われる眼色であり、non-epistatic な相互作用が *rd* と *ru* 因子との間にあることがわかった。