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, 1977a, 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, 1977a). 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 × 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,* and *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, 1977c). In an attempt to testify this sequence the five crosses given in Table 2 were made, which involved *c, y,* and *ch.*
Each family obtained from the F₁×F₁ (cross 1) and testcrosses (crosses 2-5) were tested by chi² 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 for calculations of chi² 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. Chi² 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 chi² 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 (± 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 F₁×F₁ (cross 1) (Serra, 1965).

From data of these percent recombinations the gene sequence has been again revealed

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

<table>
<thead>
<tr>
<th>Test</th>
<th>Parental cross</th>
<th>F₁ phenotype</th>
<th>F₁ No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 rd</td>
<td>carmine</td>
<td>rd</td>
<td>250</td>
</tr>
<tr>
<td>2 rd</td>
<td>ru</td>
<td>wild type</td>
<td>150</td>
</tr>
<tr>
<td>3 ru</td>
<td>rd</td>
<td>wild type</td>
<td>200</td>
</tr>
<tr>
<td>4 carmine</td>
<td>rd</td>
<td>rd</td>
<td>350</td>
</tr>
<tr>
<td>5 carmine</td>
<td>ru</td>
<td>ru</td>
<td>250</td>
</tr>
<tr>
<td>6 pm</td>
<td>ru</td>
<td>wild type</td>
<td>150</td>
</tr>
<tr>
<td>7 pm</td>
<td>ch</td>
<td>pm</td>
<td>250</td>
</tr>
<tr>
<td>8 ch</td>
<td>pm</td>
<td>pm</td>
<td>270</td>
</tr>
</tbody>
</table>

* Approximate numbers of the F₁ female and male pupae examined

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

<table>
<thead>
<tr>
<th>Cross</th>
<th>Female×Male</th>
<th>Progeny phenotype (Females+Males)</th>
<th>Families pooled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>+ c + c + c + c + c</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ + ch ch + + ch y y</td>
<td></td>
</tr>
<tr>
<td>1 ch y +</td>
<td>ch y +</td>
<td>275 140 78 38 125 2 70 3 6</td>
<td></td>
</tr>
<tr>
<td>2 ch y c</td>
<td>+ + c</td>
<td>367 68 219 12 19 211 74 360 11</td>
<td></td>
</tr>
<tr>
<td>3 + + c</td>
<td>ch y c</td>
<td>345 76 257 33 31 274 78 310 8</td>
<td></td>
</tr>
<tr>
<td>4 ch y</td>
<td>ch y c</td>
<td>161 — 95 — 108 — 189 — 7</td>
<td></td>
</tr>
<tr>
<td>5 ch y</td>
<td>ch y</td>
<td>92 — 62 — 54 — 86 — 3</td>
<td></td>
</tr>
</tbody>
</table>

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

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

* 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.

REFERENCES


Abstract

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 因子との間にあつることがわたった。