RED-EYE, A SEX-LINKED MUTANT IN THE MOSQUITO ERETMAPODITES QUINQUEVITATATUS THEOBALD¹

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ABSTRACT. A recessive, sex-linked mutant is described in Eretmapodites quinquevittatus. The mutant, red-eye (re), exhibits complete penetrance and can be determined in the larvae, pupae, and adults of both males and females.

INTRODUCTION

The genus Eretmapodites of the family Culicidae is confined to the Ethiopian region and Madagascar (Gillett 1975). The genus is divided into at least 34 species and 4 subspecies (Stone et al. 1959, Stone 1961, 1963, 1967, 1970). Only two species, E. chrysogaster (Gillett 1958) and E. quinquevittatus (Hartberg and Gerberg 1971) have been successfully colonized in the laboratory. Most diagnostic characteristics of this genus are the same as those of the Aedes and the form of the genitalia suggests some affinity with the subgenera Stegomyia and Aeimorphus (Edwards 1941).

Eretmapodites species have been reported to be good laboratory vectors of yellow fever (Bauer 1928) and Chikungunya (Gilotra and Shah 1967). Viruses isolated from wild caught Eretmapodites include Rift Valley Fever virus (Smithburn, Hadlow and Gillett 1948), Semliki Forest virus (Macnamera 1953), Spondweni virus (McIntosh et al. 1961, Worth et al. 1961), Nyando virus (Ardoin and Simpson 1965, Serie et al. 1968), Nkolbisson virus (Salaun et al. 1969), an unidentified viral agent MTMP131 (Henderson et al. 1969), and others.

Since mosquitoes of this genus are known and/or potential vectors of many arboviruses and are very similar to the genus Aedes which has many members of great medical and economic importance, it is imperative that a better knowledge of their genetics be developed. The development of a formal genetics of this genus will provide the basic tools needed for comparative genetic studies between this genus and other mosquito genera, such as the Aedes, in which more genetic information is available. Comparative genetic studies should lead to a greater understanding of speciation within the Culicidae. To the best of the authors' knowledge, only one formal genetic investigation of this genus has been made to date. A report of this study has been submitted to the Journal of Medical Entomology. We describe here the mutant red-eye (re) in E. quinquevittatus and assign it to a linkage group.

MATERIALS AND METHODS

The mutant red-eye (re) was first isolated in 1976 by the senior author. Several red-eyed male and female pupae were isolated from the EQ-GL stock of E. quinquevittatus. The resulting adults were crossed and their progeny inbred to establish a pure-breeding red-eye stock which was designated EQ-RE/GL. Another strain of E. quinquevittatus (EQ-PURE) with normal eye phenotype was also used in this investigation. All of the strains used were selected from the colonies maintained at the Mosquito Genetics Labora-

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Rearing methods used were generally similar to those described by Hartberg and Gerberg (1971) for rearing *E. quinquevittatus* and those described by Craig and VandeHey (1962) for genetic research with *Ae. aegypti*. Rearing was in an insectary room with a temperature of 27±2°C and ambient RH. Larvae were fed on a suspension of liver powder and adults were provided with dry sugar cubes and an opportunity for the females to take a blood meal from an anesthetized mouse.

Preliminary observations of mitotic chromosomes from fourth-instar larval brain cells of *E. quinquevittatus* indicate that no heteromorphic chromosomes are present (Hartberg, unpublished). From this fact and the results obtained from the testcrosses in the present study, sex in *E. quinquevittatus* is considered to be determined by a single gene (or a small block of chromosome) designated as *m* on linkage group 1. Females are homogametic (*m/m*) and males heterogametic (*M/m*). This mode of sex determination has been demonstrated in several mosquito species (Gilchrist and Haldane 1947, McClelland 1962, Barr and Myers 1966, Bat-Miriam and Craig 1966, Baker 1968, Hartberg and Craig 1974, Tadano 1976, Tadano and Kanda 1976). The sex locus *m* can be used as a genetic marker for linkage studies.

In the present study, the linkage relationship of red-eye (*re*) with sex (*m*) was determined from the results of testcrosses. F₁ males from reciprocal crosses between males and females from the EQ-RE/GL and EQ-PURE stocks were backcrossed to females from the EQ-RE/GL stock. This allowed for the testing of linkage between *re* and *m* in both the coupling and repulsion phase.

**RESULTS AND DISCUSSION**

**DESCRIPTION.** The normal eye color of *E. quinquevittatus* is brownish-black. In

<table>
<thead>
<tr>
<th>Trial no.</th>
<th>Cross</th>
<th>Female Progeny</th>
<th>Male Progeny</th>
<th>% recombination and S.E.¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>re m × re m</td>
<td>+ M</td>
<td>re</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>re m × re m</td>
<td>+ M</td>
<td>re</td>
<td>m</td>
</tr>
<tr>
<td>3</td>
<td>re m × re m</td>
<td>+ M</td>
<td>re</td>
<td>m</td>
</tr>
<tr>
<td>4</td>
<td>re m × re m</td>
<td>re M</td>
<td>re</td>
<td>m</td>
</tr>
<tr>
<td>5</td>
<td>re m × re m</td>
<td>re M</td>
<td>re</td>
<td>m</td>
</tr>
<tr>
<td>6</td>
<td>re m × re m</td>
<td>re M</td>
<td>re</td>
<td>m</td>
</tr>
</tbody>
</table>

**Average % recombination** 16.8 ± 0.8

¹ Standard error calculated using following formula (Serra, 1965):

\[
S.E. = \sqrt{\frac{P(1-P)}{n}} \quad \text{where } P = \text{crossover value (as fraction of 1)},
\]

\[n = \text{no. of individuals.}\]
the mutant red-eye (re) the eye color is red and the color darkens with age. Both the ocelli and compound eye are affected, and the character can be determined in the larvae and pupae, as well as in the adults. Both males and females are affected. In the adult the red-eye appears to bulge, probably due to enlarged eye facets. Penetration is complete. F1 progeny from reciprocal crosses between EQ-PURE and EQ-RE/GL (red-eye) females. The genotypes of the individuals in each cross are given in the table. The data indicate that re is sex-linked, with an average recombination value of 16.8 ± 0.8 (range 12.9 ± 1.8 to 20.2 ± 2.3).

It is interesting to compare re in Er. quinquevittatus to similar sex-linked recessive eye color mutants reported from species in the closely related genus Aedes (McClelland 1962, Hartberg and Craig 1974, Tadano 1976). With the discovery of other mutants in Er. quinquevittatus, and establishment of linkage maps, it will become possible to make comparisons to other species where more genetic information is available. Such comparisons should prove instructive in determining evolutionary relationships.

References Cited


ANOPHELES NUNEZTOVARI AND MALARIA TRANSMISSION IN SURINAM

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ABSTRACT. During recent entomological surveys a tremendous increase in numbers of Anopheles nuneztovari Gabaldon has been observed in the interior of Surinam. The construction of the Aobaka dam, which gave rise to the Brokopondo storage lake, was the main factor responsible for this increase. The scarcity of An. darlingi, the principal vector of Plasmodium falciparum in Surinam, and the failure to capture this species during recent epidemics of malignant malaria in certain areas where An. nuneztovari abound, indicate that the latter might be involved in active transmission of the parasite. Breeding experiments with An. nuneztovari showed a duration of 1 day for the egg stage, 7 days for the larval stages and 1 day for the pupal stage. The gonotrophic cycles may last 4 days each, except the 1st which takes 5 days. The daily biting activity pattern of this species shows a unimodal pattern with a sharp peak at 6:00–7:00 pm. The maximum and minimum parous rates which may be reached over a longer period of time are 0.69 and 0.14 respectively, the mean being 0.34. This rather high parous rate indicates that this species may well act as a good vector of pathogens, because it feeds readily on man and occurs in large numbers during certain periods of the year. It appears that the population of An. nuneztovari at Brownsweg is fully susceptible to DDT, dieldrin and malathion.

INTRODUCTION

Anopheles nuneztovari Gabaldon was initially reported from Surinam in 1949 (Vander Kuyf 1949). Until now this species was considered to be relatively unimportant because of its limited geographical distribution and abundance. Its role as a potential vector of Plasmodium falciparum was totally neglected. This paper presents the results of recent entomological surveys which show that this species now occupies vast areas in the interior of Surinam, where it occurs in great numbers. It appears that in a large part of the interior An. nuneztovari is at present the dominant anthropophilic mosquito, outnumbering other species by far, and there are indications that it might have been involved in recent malaria outbreaks. It became clear...