

reared to an adult male. The larva was found in a small, deep, flooded depression at the base of roots in a boggy area where the forest had been cleared to install a power line. The larva was associated with those of *Culiseta morsitans* (Theob.). Although the habitat was characteristic of *melanura*, a repeat visit to the area failed to turn up more larvae.

Collection of this species in Newfoundland is a considerable northern extension of its range and was unexpected. The only previous Canadian records were from southern Ontario and Quebec (Chant et al. 1973, Ellis and Wood 1974). *Culiseta melanura*, the principal sylvan vector of eastern encephalitis virus (EE) in birds, is the only medically important culicid species now known to occur in Newfoundland. The presence of EE virus in birds on the Island, however, has not been established.

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A SEX-LINKED MUTANT, MAROON-EYE, IN *AEDES ALBOPICTUS*

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Fifteen years have passed since Bat-Miriam and Craig (1966) described the first 8 mutants

in the dengue vector *Aedes (Stegomyia) albopictus* (Skuse). Only 13 mutants have been thus far described for this species, and genetic linkage studies have been performed for only 5 of them. A homeotic mutant, *proboscipedia* (*prb*), is situated at a map distance of about 20 units from the sex locus (*M, m*) (Bat-Miriam and Craig 1966, Quinn and Craig 1971); 2 dominant alleles, *White-body* (*Wb*) and *Frosty-body* (*F*), are linked to *pigmented pupa* (*p*) with 3.5 recombination units. Both *Wb* (or *F*) and *p* are inherited independently of the sex allele (*m*). Furthermore, inheritance of *brown-eye* (*b*) shows an independent assortment with either *sex*, *Wb*, or *p* (Tadano et al. 1980, Tadano 1981).

Recently, Yong et al. (1981) have reported 2 enzyme variants, glucose phosphate isomerase (*Gpi*) and phosphoglucotomutase (*Pgm*), in this mosquito and that these loci were segregated independently. The genetic relationships between these enzymes and the morphological mutants (including *sex*) are unknown.

This paper describes a new recessive sex-linked mutant, *maroon-eye* (*mar*) in *Ae. albopictus*, and also provides a tentative assignment of linkage groups for this species.

MATERIALS AND METHODS

The following 3 strains were used for this study: (1) the Nagasaki strain, (2) the *White-body* (*Wb*) mutant which was originally derived from the Nagasaki strain, and (3) the *maroon-eye* (*mar*) mutant isolated from the Okinawa strain. The rearing methods employed have been previously described (Tadano et al. 1980). Mass crosses were used for these experiments, but blood-fed females in the experimental cages were isolated into individual plastic cups for single ovipositions. Each egg batch was hatched separately and reared as a family. Phenotypes of the offspring were also scored in single families. A few families which did not produce the offspring phenotypes at theoretical ratios due to a very low hatchability or high larval mortality were neglected from the subsequent considerations, but all other families were pooled in each cross experiment for further statistical treatments.

RESULTS AND DISCUSSION

The *mar* mutant has dull brick red eyes at the pupal stage, but it has almost the same eye color as its wild type at the larval and adult stages. The *mar* phenotype is quite similar to that of *brown-eye* (*b*). When the *mar* pupae were initially detected in an inbred line of the

Table 1. Crosses to elucidate genetic relationships among *mar*, *Wb*, and *sex(m)*.

Cross	Genotype*		Phenotype of offspring						Families examined		
	Female	Male	++	+Wb	mar+	marWb	++	+Wb		mar+	marWb
A	$\frac{mar\ m}{mar\ m}$	$\times \frac{mar\ m}{+M}$	5		36		56		3		2
B	$\frac{mar\ m}{+m}$	$\times \frac{mar\ m}{mar\ M}$	176		167		170		143		6
C	$\frac{+m}{mar\ m}$	$\times \frac{mar\ m}{mar\ M}$	278		248		285		273		11
D	$\frac{mar\ m}{mar\ m}$	$\times \frac{+m\ Wb}{mar\ M}$	207	229	11	7	16	19	218	200	12
E	$\frac{mar\ m}{mar\ m}$	$\times \frac{mar\ m}{+M\ Wb}$	3	4	117	101	113	125	1	5	5
F	$\frac{+m\ Wb}{mar\ m}$	$\times \frac{mar\ m}{mar\ M}$	156	142	119	116	130	140	131	154	12
G	$\frac{mar\ m}{+m\ Wb}$	$\times \frac{mar\ m}{mar\ M}$	84	65	50	52	51	70	72	71	5

* Alleles above the lines in genotypes were derived from the mothers and the alleles below the lines from the fathers.

Okinawa strain, these pupae were mistaken for the *b* pupae although subsequent reciprocal allelism tests between the 2 eye color mutants revealed that they are not allelic. The *mar* gene exhibits full penetrance, but with a little variation in the expression ranging from maroon to reddish brown.

A preliminary cross, $(+m/mar\ m) \times (+m/mar\ M)$, produced the progeny of 25 families at the following phenotypic ratio—♀ +: ♀ *mar*: ♂ +: ♂ *mar* = 892: 17: 586: 462. The hypothesis of an independent assortment between the sex allele (*m*) and *mar* was rejected, based on a chi-square value of 467.5 (d.f.=3), and this value indicated close linkage between the 2 alleles.

Seven backcrosses, 4 of which involved *Wb*, were made as given in Table 1. First of all, the 1:1 segregation of each allele was examined by a chi-square in each of these backcrosses; all alleles, except *mar* involved in cross A, segregated at a 1:1 ratio ($P > 0.05$). In cross A fewer *mar* individuals were yielded than its wild-type ones ($0.05 > p > 0.02$). The chi-square tests for linkage between alleles indicated that the *sex* and *mar* loci are closely linked since the chi-square values for between *sex* and *mar* ranged from 70.56 (cross A) to 707.39 (cross D); whereas, all chi-square values for *sex-Wb* and for *mar-Wb* were 0.00 up to 2.44, which confirmed the previous finding (Tadano et al. 1980, Tadano 1981) that *Wb* is an autosomal gene.

The recombination distance between the *sex* and *mar* loci ranged from 2.8 ± 0.8 (cross E) to 8.0 ± 2.7 (cross A) map units; its weighted mean calculated from the results of crosses A, D, and E was 5.0 ± 0.6 map units.

Finally, the mutants of *Ae. albopictus* studied to date were assigned to 3 linkage groups: *proboscipedia* (*prb*) (Bat-Miriam and Craig 1966, Quinn and Craig 1971), *mar*, and *sex* to linkage group 1; *Wb* (and its allele *F*) and *p* to linkage group 2; and *b* to linkage group 3.

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FIELD EVALUATION OF *BACILLUS THURINGIENSIS ISRAELENENSIS* AGAINST *AEDES VIGILAX* AND *CULEX SITIENS* IN FIJI¹

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A new strain of *Bacillus thuringiensis* demonstrating rapid larvicidal activity against mosquitoes was isolated in 1977 by Goldberg and Margalit (1977) and was later named *Bacillus thuringiensis* var. *israelensis* (*Bti*) (de Barjac 1978). Preliminary field trials with *Bti* in the United States have demonstrated its efficacy for use against many species of mosquitoes breeding in irrigated pastures, storm drains, ponds, dairy lagoons, salt marshes (Garcia et al. 1980) and rice plots (Hembree et al. 1980).

This paper reports on the field application of *Bti* against *Aedes vigilax* (Skuse) and *Culex*

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