EFFECTS OF LARVAL NUTRITION ON THE HOST-SEEKING BEHAVIOR OF ADULT *AEDES AEGYPTI* MOSQUITOES

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ABSTRACT. Adult female *Aedes aegypti* that were reared on a suboptimal diet as larvae were less likely to engage in host-seeking behavior than were adults derived from larvae reared on an optimal diet. A postemergence carbohydrate diet of either 1 or 10% sucrose solution did not affect this response. When the progeny of field-collected *Aedes vexans* were reared in the laboratory, the adults were significantly larger than their parents. This indicated that the larvae of the field population were not as adequately nourished as their laboratory-reared progeny.

INTRODUCTION

The conditions under which larval mosquitoes are maintained can profoundly affect the physiology of the resulting adults. Inadequate nutrition and overcrowding as larvae can reduce the size (Wada 1965, Mogi 1984), potential fecundity (Nayar 1969), energy reserves (Nayar and Sauerman 1970), longevity (Hawley 1985), expression of autogeny (O'Meara 1979, Lounibos et al. 1982) and blood-feeding success (Terzian and Stahler 1949, Haramis 1983; Nasci 1986a, 1986b) of adult females. In addition, the smaller females that develop from undernourished larvae sometimes require two consecutive blood meals in order to mature a single batch of eggs (Feinsod and Spielman 1980). Field studies by Nasci (1986a, 1986b) have indicated that smaller mosquitoes are not well represented in the populations of females that have blood-fed, suggesting that larger individuals are more successful in obtaining a blood meal and reproducing than are smaller ones. In this study, we examined the effect of suboptimal larval diet, resulting in smaller adults, on the host-seeking behavior of laboratory populations of *Aedes aegypti* (Linn). We also present some preliminary data based on field-collected *Ae. vexans* that suggest that field populations of mosquitoes do not always attain their maximum potential size.

MATERIALS AND METHODS

Larval *Aedes aegypti* were reared at 27°C, under a 14:10 (L:D) photoperiod, with either a standard diet or low diet (Klowden and Lea 1978). Adults were continuously maintained on 1 or 10% sucrose solutions available from cotton wicks. Host-seeking behavior was measured with a laboratory olfactometer (Klowden and Lea 1978). Mosquitoes were considered to have responded to a host in this device when they flew upwind through a 1-m long compartment into a trap in response to stimuli from a human host during a 10-min test. A minimum of 3 replicates of each experiment were performed. Adult females were 4–6 days old at the time of the olfactometer test. In some experiments, females were allowed to feed to repletion on an anesthetized laboratory rat.

Field populations of female *Aedes vexans* Meigen were collected near the town of Clark Fork in northern Idaho as they blood-fed on human volunteers. The mosquitoes were transported to the laboratory and those that matured eggs from the blood were allowed to oviposit. Their progeny were then reared on the standard larval diet, and following adult emergence, the lengths of wings of the females (axillary incision to apical margin) were compared to those of the parents. Data were statistically examined by a one-way analysis of variance or an arcsine test for the equality of 2 percentages (Sokal and Rohlf 1969).

RESULTS AND DISCUSSION

Suboptimal larval nutrition, resulting in smaller adult mosquitoes, can significantly affect the ability of females to find a host for a blood meal. This effect of poor larval nutrition could not be reversed when adults were given adequate carbohydrate. Regardless of the concentration of sucrose present following emergence, females reared on the low larval diet were significantly less likely to engage in host-seeking than those reared on the standard diet (Table 1). Consequently, a postemergence meal of nectar may not be able to substitute for a suboptimal larval diet in a field population.

When an adult mosquito population is maintained on sucrose, an inhibition of host-seeking behavior usually accompanies oogenesis following a blood meal (Klowden and Lea 1979). However, when maintained in the absence of sucrose, a large proportion of the gravid population continues to seek a host (Klowden 1986). To examine whether deficient larval nutrition can also affect the host-seeking inhibition that is expressed during egg maturation, we tested the host-seeking behavior of the blood-fed gravid adults reared as larvae on the low diet,

Table 1. Host-seeking behavior of laboratory-reared *Aedes aegypti* before and 48 hr after a blood meal.

Adult diet	Larval diet	Percent responding to host* (n)
1% sucrose	Low	59 (160)[a]
	Standard	87 (307)[b]
10% sucrose	Low	61 (170)[a]
	Standard	83 (302)[b]
Blood	Low	0 (31)
	Standard	0 (76)

* The percentages followed by the same letter are not significantly different, $P > 0.05$.

and otherwise maintained on 10% sucrose, at 48 hr after they ingested blood. The inhibition of host-seeking when mature eggs were present occurred to the same extent as in females reared on a standard larval diet (Table 1, Klowden and Lea 1979), and was not affected by larval rearing conditions.

The laboratory-reared progeny of the field-collected *Ae. vexans* were larger than their parents, as evidenced by their significantly longer wing lengths (Table 2). This presumably was a result of the more favorable larval diet on which the progeny were reared. Therefore, the potential adult size was not realized when larvae developed under field conditions. Our field collections were not meant to yield definitive data on the sizes of *Ae. vexans*, but merely to demonstrate that under these conditions, mosquitoes do not always attain their maximum size. Rearing the laboratory strain of *Ae. aegypti* on a low larval diet also resulted in smaller adults (Table 2).

Our data demonstrate that small adult *Ae. aegypti* mosquitoes derived from suboptimal larval rearing conditions are less successful in finding a host for a blood meal. This same phenomenon may contribute to the reduced success of other mosquito species that has been reported from the field (Haramis 1983; Nasci 1986a, 1986b). Therefore, it may be misleading to apply behavioral data derived from laboratory populations which are reared on optimal diets to field populations that may develop under less than ideal conditions. Agudelo-Silva and Spielman (1984) suggested that mosquito control strategies to reduce larval populations may actually increase disease transmission rates by reducing the competition for limited larval resources. Our data also indicate that competition for these resources may significantly affect the ability of the resulting adults to obtain a reproductive diet.

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Table 2. Wing lengths of field-reared and laboratory-reared mosquitoes.

Species	Treatment	n	Wing length (mm)
Aedes vexans	Field-reared	17	3.60[a]
	Lab-reared	169	3.97[a]
Aedes aegypti	Low larval diet	37	2.55[b]
	High larval diet	20	3.27[b]

[a] $F = 27.15$; $P < 0.01$.
[b] $F = 130.99$; $P < 0.001$.

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