EFFECT OF *DIROFILARIA IMMITIS* ON THE FECUNDITY OF *AEDES TRIVITTATUS*

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ABSTRACT. Laboratory studies on the effect of *Dirofilaria immitis* on the egg production of the mosquito *Aedes trivittatus* revealed that *D. immitis*-infected mosquitoes produced significantly fewer eggs than uninfected mosquitoes. Egg production decreased as parasite burdens increased, but only mosquitoes harboring more than 15 *D. immitis* were severely affected. The ability of *Ae. trivittatus* to retain microfilariae within the blood clot seems beneficial to it by reducing parasite burdens, thereby increasing the mosquito's reproductive potential.

INTRODUCTION

Aedes trivittatus functions as a natural vector of *Dirofilaria immitis* in central Iowa (Christensen 1977, Christensen and Andrews 1976), but as with other mosquito-filarial worm systems, the infection can be lethal to the vector when parasite burdens are high (Christensen 1978). A more subtle effect of developing filariae on their mosquito hosts is their utilization of nutrients that in normal circumstances would be used for reproductive purposes in egg formation.

Javadian and Macdonald (1974) used 2 strains of laboratory-reared *Ae. aegypti* to test the effect of infection with *Brugia pahangi* and *Dirofilaria repens* on egg production in these mosquitoes. Infection with either parasite significantly decreased egg production, although not until the 2nd oviposition in *Brugia*-infected mosquitoes.

The present study was conducted to determine the effect of a different filarial worm, *D. immitis*, on the egg production of *Ae. trivittatus* to see if results similar to those reported by Javadian and Mac-

donald (1974) would be obtained using 1st generation mosquitoes from a field-collected population of a known natural vector.

MATERIALS AND METHODS

Ae. trivittatus used in this study were hatched from eggs obtained from field-collected mosquitoes in central Iowa. Methods used for rearing and exposing mosquitoes to infection were the same as previously described (Christensen 1977, Christensen and Rowley 1978).

Five-day-old female *Ae. trivittatus* were manually copulated (Christensen and Rowley 1978), taken off their sucrose diet, and then exposed to *D. immitis*-infected or uninfected dogs the next day. The 2 *D. immitis*-infected dogs had microfilaremias of 60 and 337 microfilariae/20 μl blood. Microfilaremias were determined by drawing two 20 μl blood samples from each dog immediately before feeding mosquitoes. Both infected dogs were obtained from John W. McCall (School of Veterinary Medicine, University of Georgia) through a program supported by the U.S.-Japan Cooperative Medical Sciences Program—NIAID.

Mosquitoes fully engorged with blood were separated after feeding and placed individually into ovipositional cages (Christensen and Rowley 1978). Cages were placed on an ovipositional substrate consisting of 6 to 8 layers of cheesecloth wrapped around a layer of cotton. Substrate was contained in white enamel trays (25 × 42 × 7 cm) and well moistened with water. Ten to 12 cages were placed in each tray. Mosquitoes were provided with 0.3M sucrose, and the trays were covered with glass plates. All trays with mosquitoes were maintained at 26.5 ± 1°C and 80 ± 5% RH under a 16-hr photoperiod with a 90-min crepuscular period at the beginning and end of each light period.

Mosquitoes were examined daily and the time that each mosquito began ovipositing was recorded. All mosquitoes that oviposited were offered a 2nd blood meal on a rabbit. The number of eggs laid by each mosquito after each blood meal was recorded separately. Mosquitoes refusing to take a 2nd blood meal, those not ovipositing after 12 days following either the 1st or 2nd blood meal, and those that oviposited after the 2nd blood meal were dissected to check for additional eggs remaining in the ovaries, and to count the number of *D. immitis* in mosquitoes given an infective blood meal.

Mean numbers of eggs oviposited and produced by infected and uninfected mosquitoes following each blood meal were compared using a Student's t-test. Mean numbers of eggs produced in relation to parasite burden were compared using a Newman-Keul's test.

RESULTS AND DISCUSSION

Numbers of mosquitoes feeding on each host, numbers ovipositing, and mean numbers of eggs produced are presented in Table 1.

Approximately 70% of the mosquitoes that fed on an infected or uninfected dog oviposited, and of these, only 30 fed a

Table 1. Egg production in *Dirofilaria immitis*-infected and uninfected *Aedes trivittatus*.

Host(s)	Blood Meal	No. Fed	No. Ovipositing (%)	Mean No. Eggs Oviposited ± S.D.	Mean No. Eggs Produced ± S.D.
Infected Dog	1st	137	99 (72.3)	48.9 ± 24.5	59.3 ± 19.8*
Infected Dog/Rabbit	2nd	16	11 (68.7)	26.9 ± 21.7	32.9 ± 25.9
Uninfected Dog	1st	148	106 (71.6)	52.4 ± 22.8	66.9 ± 22.4*
Uninfected Dog/Rabbit	2nd	14	9 (64.3)	38.6 ± 14.1	46.4 ± 23.0

* Significantly different ($P < 0.01$).

second time on a rabbit (Table 1). This percentage of *Ae. trivittatus* ovipositing is about normal for this mosquito when subjected to manual copulation in the laboratory (Christensen and Rowley 1978).

No significant differences were noted between mean numbers of eggs deposited by infected and uninfected mosquitoes in either the 1st or 2nd egg laying. There were, however, significantly fewer eggs produced by infected mosquitoes (59.3) as compared with controls (66.9) (Table 1).

Infected *Ae. trivittatus* that took a 2nd blood meal showed a reduction in mean numbers of eggs produced from 59.3 eggs/mosquito in the 1st oviposition to 32.9 eggs/mosquito in the 2nd egg laying, or a reduction of 44.5%. Uninfected

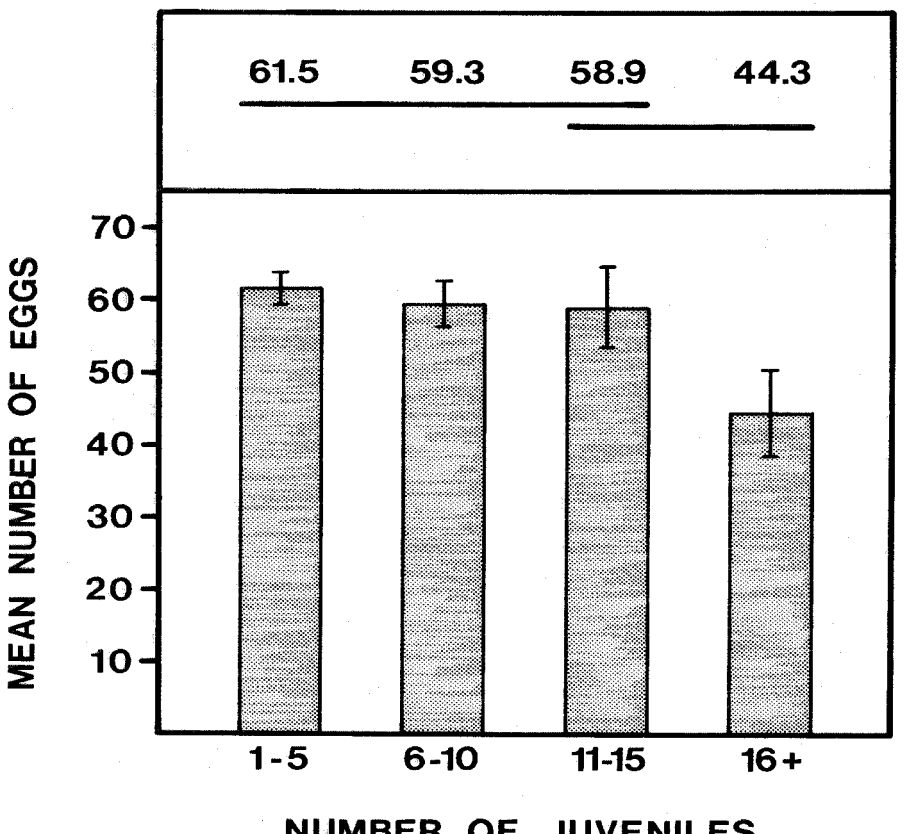

Figure 1. Mean numbers of eggs produced ± standard error by *Aedes trivittatus* infected with different numbers of *Dirofilaria immitis*. Newman-Keul's comparison of means, where any means not underlined by the same line are significantly different ($P < 0.05$).

mosquitoes in this same category showed a reduction from 66.9 to 46.4 eggs/mosquito for a 30.6 reduction.

The fewer number of eggs produced by infected as compared with uninfected mosquitoes was significant, but was still 88.4% of the mean number produced by uninfected mosquitoes. Javadian and Macdonald (1974) found no significant difference in egg production between *B. pahangi*-infected and uninfected *Ae. aegypti* following the 1st blood meal, but *D. repens*-infected *Ae. aegypti* produced significantly fewer eggs than controls after 1 blood meal. *D. repens*-infected mosquitoes produced only 80.4% (77 versus 96 eggs/mosquito) of the number of eggs laid by uninfected *Ae. aegypti*. In both mosquito-parasite systems studied by Javadian and Macdonald (1974), a significant difference was noted in mean numbers of eggs produced following a 2nd blood meal. The small number of *Ae. trivittatus* that took blood a 2nd time in the present study probably accounts for the lack of any significant differences in egg production during the 2nd oviposition.

As the intensity of infection increased, the mean number of eggs produced by *Ae. trivittatus* decreased, although this was not significant until parasite burdens exceeded 15 juveniles/mosquito (Fig. 1). Javadian and Macdonald (1974) also recorded decreased egg production as parasite burdens increased in both *D. repens* and *B. pahangi*-infected *Ae. aegypti*.

The survival of *D. immitis*-infected *Ae. trivittatus* is not seriously threatened until parasite burdens exceed 15 juvenile/mosquito (Christensen 1978). Data from the present study indicate that the reproductive potential of this mosquito also is not severely limited until this same level of infection intensity is reached. The ability of this mosquito to retain approximately the same number of *D. immitis* microfilariae within the blood clot of an ingested meal as those migrating to the Malpighian tubules (Christensen 1977) benefits this vector-parasite system by helping to insure the survival of the mosquito for the extrinsic developmental period of the parasite (Christensen 1978). This same phenomenon likely benefits the reproductive capability of *Ae. trivittatus* in a similar manner.

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"Taxonomists' Glossary of Mosquito Anatomy" by Ralph E. Harbach and Kenneth O. Knight was recently published by the Plexus Publishing Co., Box 550, Marlton, NJ 08053. Additional information about this book can be obtained from the publisher.