DOG-TO-DOG TRANSMISSION OF HEARTWORM BY *AEDES CANADENSIS*[1]

W. E. Bickley[2], R. S. Lawrence[2],
G. M. Ward[3] and R. B. Shillinger[4]

College Park, Maryland 20742

Ludlam et. al. (1970) emphasized the "paucity of finite data on the actual transmission in nature" of dog heartworm by mosquitoes. Bickley (1976) pointed out that apparently there have been only 2 published reports of observations on actual transmission of *Dirofilaria immitis* (Leidy) from dog-to-dog by mosquitoes since Bancroft's uncontrolled study in 1901. Kume and Itagaki (1955) used *Aedes togoi* (Theobald) as the experimental vector in Japan, and Bemrick and Moorhouse (1968) used *Ae. vigilax* (Skuse) in Australia. Research by Seeley and Bickley (1974) and Bickley (1976) provided evidence that *Culex salinarius* Coquillett is not an efficient vector.

Jankowski and Bickley (1976) reported that 75% of the females of *Ae. canadensis* (Theobald) which fed on a heavily infected dog supported the development of the parasite to the infective stage in the head and mouthparts and that the average number of infective larvae per mosquito was 4.7. The investigations reported here were designed to carry out additional procedures which might furnish direct evidence of dog-to-dog transmission by *Ae. canadensis*.

Methods followed were very similar to those described by Seeley and Bickley (1974), Jankowski and Bickley (1976) and Bickley (1976). Mosquito larvae and a few pupae were collected in the field at College Park, Maryland in late March and early April, 1976. Larvae were cared for in the laboratory and allowed to pupate. The total number of pupae used was 12,290. Unsexed pupae were placed in cylindrical plastic or cardboard feeding containers, at an average rate of 307 per container in ca. 200 ml. water. The top of each container was modified to provide an opening covered with plastic or aluminum screening or cloth mesh. After emergence of adults, water was drained from the containers, and distilled water and 10% sucrose-water were provided in cotton wads. Surviving females were maintained at ca 20°C. and ca 80% RH. After ca. 4 days they were given opportunities to feed on the side of the unanesthetized, shaved, donor dogs (CPR) mentioned by Jankowski and Bickley (1976) and Bickley (1976). The primary feeding trials usually ca. 20 min each, occurred during the period April 2–15. On April 15 the microfilaremia level in the donor dog averaged 86 per 20 mm^3 (3 samples, 1 collection). This was lower than was anticipated, but the dog had been exposed to low outside temperatures, occasionally below freezing, which may have resulted in fewer circulating microfilariae. Some groups of females were given more than 1 primary feeding trial.

After a blood meal females were aspirated into holding containers, like the feeding containers, and furnished water and sugar-water on cotton wads. Secondary feeding trials were conducted on post-prandial days 17–25, during the period April 26–May 8. The recipient dog (CAN) was a mongrel female born in January 1976 and kept in a screened enclosure or otherwise protected from wild insects. The control dog (CHE) was a female littermate of the recipient dog and was kept under the same conditions. Several groups of surviving female mosquitoes were given more than 1 opportunity to take a 2nd blood meal. Blood from both dogs was examined for microfilariae 30 weeks after the last feeding. A week later, on December 9, 1976, a lethal dose of pentabarbital sodium was injected via the cephalic vein into each dog, and a necropsy examination was performed immediately after death. Dissections of mosquitoes followed commonly accepted techniques.

A total of 753 female mosquitoes sucked blood from the donor dog. Of these, 62 fed on the recipient dog. The microfilaremia level of the recipient dog 30 weeks after the last experimental mosquito feeding was 0.66 per 20 mm^3 (2 microfilariae in 3 samples, 1 collection). The blood of the control dog was negative (6 samples, 1 collection).

On post-mortem examination no heartworms were found in the control dog. In contrast, 16 mature heartworms (6♂, 10 ♀) were found in the heart and pulmonary artery of the recipient dog.

These data furnish direct evidence that *Ae. canadensis* transmits *D. immitis*. The experiment simulated natural conditions insofar as possible. In a sense the mosquitoes were force fed; nevertheless the mosquitoes fed on the dogs, morning, afternoon, and evening. Mortality in feeding and holding containers was high, and an appreciable number of females refused a 2nd blood meal, yet over 8% *did* refeed.

Dissections of 82 blood-fed mosquitoes were made, 35 after 1 blood meal and 47 after the 2nd blood meal. These dissections revealed the presence of developing and 3rd stage infective parasites in various parts of the body of 50% of the mosquitoes regardless of the number of feedings. The total number of parasites per positive speci-

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[2] Department of Entomology, University of Maryland.

[3] Department of Veterinary Science, University of Maryland.

[4] Maryland Department of Agriculture.

men averaged 3.6. This compares with the average of 6.2 of Jankowski and Bickley (1976), but in the present study, half of the positive specimens had re-fed and had released an unknown number of parasites. More consideration should be given to the 3rd-stage infective parasites found in the head and/or mouthparts because these are the only forms capable of development in the dog. These "mature" forms were found in 20, or 50%, of the dissected specimens; the average number per mosquito was 2.6. Five of these 20 specimens had re-fed, and this suggests that if these females had taken a 3rd blood meal they would have been capable of transmitting the heartworm.

In Maryland *Ae. canadensis* is widely distributed, and females are often abundant and pestiferous from mid-April to mid-June depending upon local weather conditions. At some locations, such as the Pocomoke Swamp in Worcester County, adult females may be encountered throughout the summer and early fall. Results of this investigation clearly indicate that transmission of heartworm by *Ae. canadensis* occurs 3 weeks after the 1st blood meal. From a practical standpoint this means that control of, or protection from *Ae. canadensis*, and administration of preventive medication should begin in mid-May in Maryland. *Ae. canadensis* is not a domestic mosquito, but it invades yards and parks in suburban areas.

With the direct proof that *Ae. canadensis* is a vector, the incrimination of other species such as *Ae. vexans,* based on good circumstantial evidence, is more credible.

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THE LIFE CYCLE OF A PROGRAM

ARLOWE HULETT
Agricultural Extension Service,
Rm. 203, Courthouse
Laramie, Wyoming 82071

A seed, or sometimes an idea, must germinate for a time before it emerges into a plant or a program. So it was that the mosquito control program in the Little Laramie Valley came into being.

As far back as 1955 the late Rulon Lewis of the USDA Agricultural Research Service said, "I can see the time when you'll be able to control mosquitoes in the valley."

Preparation of the seedbed took years. But six years to germinate?

A Ft. Klamath, Oregon rancher, Francis Bacchi, visited relatives who live in the area in 1970. He said the mosquitoes were as much a problem here as they were in his area. Through a spraying program they were getting excellent control.

This message was relayed to the Albany County Extension Office. We immediately asked for more details and started gathering information. In 1970 we mailed a copy of an article from a magazine telling how "Oregon Cattlemen Slug it Out with Mosquitoes" to several ranchers in the valley.

In the summer of 1971 Extension Entomologist, Everett Spackman, and University of Wyoming Entomologist, Jack Lloyd, and I initiated some attempts at adult mosquito control on beef cattle at the Talbott Ranch on Pahlow Lane. That summer several ranchers estimated their loss at nearly $25.00 per animal. Writing of mosquito control, Orval Garson said in 1971, "The blessings that could accrue to humans and animals alike with eradication of these pests would be incalculable." Previous to this Spackman, Lloyd, and I had met several times with officials of the City of Laramie and personnel of the Communicable Disease Center in Fort Collins to help develop a practical and efficient control program for urban residents.

In the interval from 1971 I would occasionally "water" that germinating thought with some questions of local ranchers and inquiries of chemical companies.

During the summer of 1975 the germinating thought began to emerge. Edgar Loban, a Little