A BAIT/CARBON DIOXIDE TRAP FOR THE COLLECTION OF THE WESTERN TREE HOLE MOSQUITO *AEDES SIERRENSIS*

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The tree hole mosquito *Aedes sierrensis* (Ludlow) is widespread in California, occurring in 52 of the 58 counties (Loomis et al. 1956). It has long been considered an important pest species, particularly in wooded residential areas during the spring and summer. This problem has become more pronounced as a result of the continuous development of rural woodlands for human residences. Several studies have implicated *Ae. sierrensis* as a vector of filarial worms, which adds another dimension to the importance of this species. Weinmann et al. (1973) demonstrated its role as a vector in the transmission of *Setaria yehi* Desset to deer, and Weinmann and Garcia (1974, 1980) implicated it as a possible vector of canine heartworm, *Dirofilaria immitis* Leidy among dogs and coyotes in California.

Determining the relative abundance of adult *Ae. sierrensis* has been hampered by the lack of a suitable trapping system. Adult *Ae. sierrensis* rarely enter light traps, or carbon dioxide (CO_2) baited light traps. Therefore, quantification of adult populations has largely depended upon oviposition traps (Mortensen et al. 1978), or upon landing and biting rates on humans or other mammals, occasionally supplemented with CO_2 (Bennett 1980).

This paper describes a trap for collecting live adult *Ae. sierrensis*, and presents representative results from three geographically distinct habitats in northern California.

The trap was a modification of a small Magoon trap used by Rudnick (1986) for the collection of mosquitoes in Malaysia. The use of CO_2 and animal bait as a combined attractant was based on principles employed by Reeves (1951, 1953). Rabbits were selected as a bait because of their relatively small size, ease of handling, and our observations of *Ae. sierrensis* feeding on caged rabbits.

Figure 1 depicts the trap with the roof and base sections separated for purposes of illustration. The roof, door, and the upper and lower screen panels were separately constructed from a frame of mitered aluminum screen molding. Lumite™[1] plastic screen (12.5 mesh/cm; natural color) was fitted into the frames to enclose the panels and door. The aluminum molding provided strong support while keeping the overall weight fairly light (ca. 6 kg).

The roof was constructed from four triangular Lumite screen panels stitched together and fitted into a frame. It measured 60 x 60 x 50 cm high. A suspension hook anchored the four support lines from each corner of the roof. The peak of the roof was suspended from a line to the hook (Fig. 1a).

A single nylon line from the hook suspended the rabbit cage in the center of the trap. The cage was stabilized by three lines from the cage to the inside of the trap. During collection of mosquitoes, the lines could be disconnected so that the cage could be moved aside for easier access to the mosquitoes.

The base section measured 60 × 60 × 56 cm. Four vertical corner supports of 2 × 2 × 60 cm angle iron molding served to attach the sides of the trap. Foam insulation was used to form a tight seal when the door was closed with hook and eye latches.

The Lumite screen and the clear Plexiglas™ base of the trap reduced midday light by about 33%. Visibility into the trap was partially obscured by the screen, but not by the Plexiglas.

Locally purchased Dutch rabbits[2] from 3 to 8 months in age and from 2 to 4 kg in weight were used as the animal bait. One rabbit was housed in a 25 × 25 × 40 cm welded wire mesh mounted on an aluminum pan for collection of wastes. During confinement in the trap, rabbits were provided with water, carrots and alfalfa pellets.

Three kg of dry ice were placed into a 15 × 20 × 30 cm styrofoam box and insulated with newspapers and the lid. This box was then placed on the roof and held in position by slipping corners of the box under the trap support lines. A 2 cm hole on the lower side of the box allowed the CO_2 to flow through the trap.

Mosquitoes entered the trap via entrance

[1] Chicopee Manufacturing Co. Cornelia, GA 30531.

[2] In conducting this research the authors adhered to the "Guide for the Care and Use of Laboratory Animals", prepared by the Committee on Care and Use of Laboratory Animals of the Institute of Animal Resources, National Research Council (DHEW Publication No. [NIH] 80-23, revised 1978, reprinted 1980).

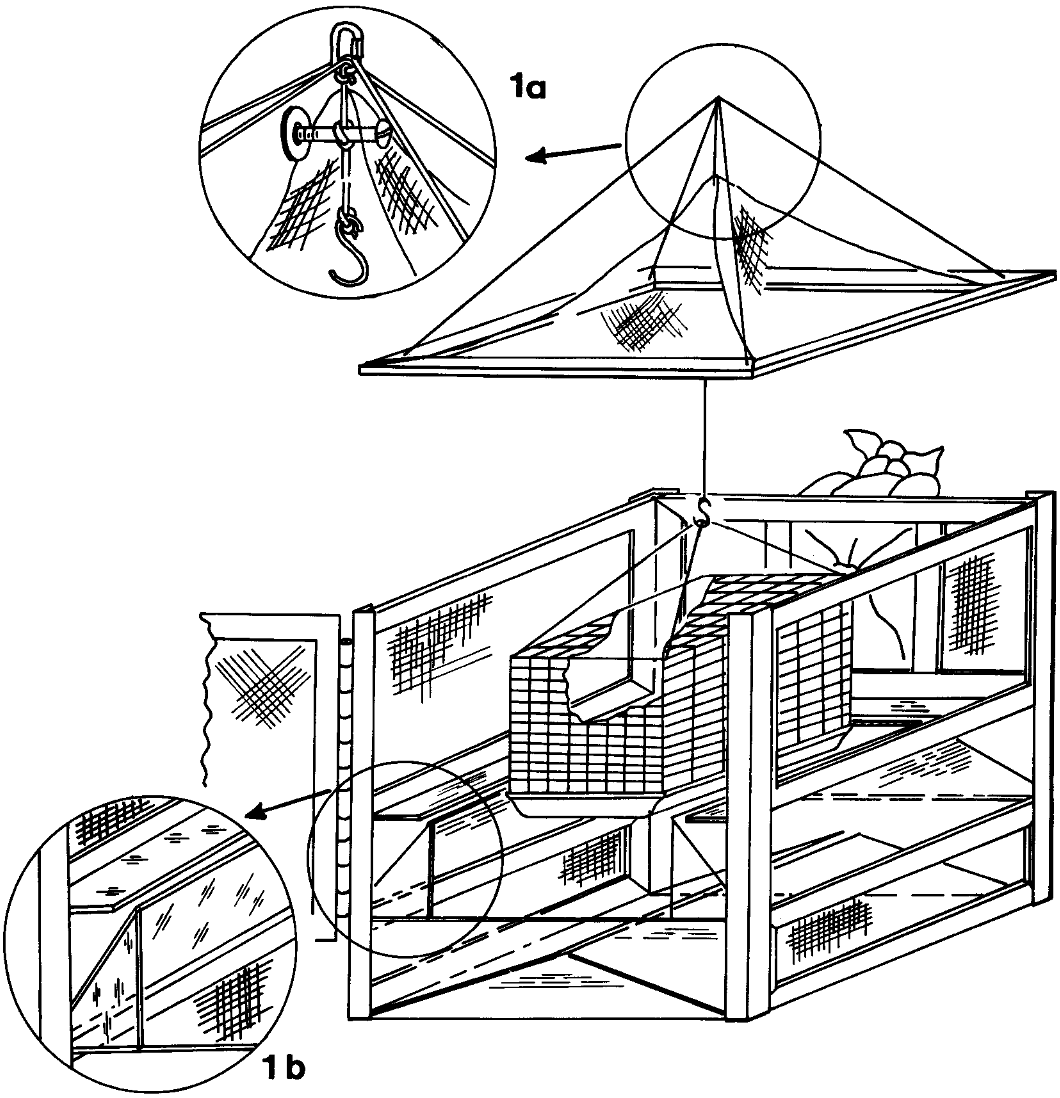

Fig. 1. Schematic diagram of a rabbit/CO_2 trap. The door is shown in the open position, and the roof has been lifted to allow better visibility of the inside. Figure 1a details the roof and rabbit cage suspension system, and Fig. 1b shows detail of the capture slots.

slots in the base section constructed of clear 3 mm Plexiglas. The upper slot was 1 cm wide, and ran along the entire length and width of the trap just below the side and rear panels (Fig. 1b). The basal entrance slot was formed between the two clear plastic panels set at a 20° angle from the horizontal. Once inside the trap, most mosquitoes would fly up into the upper section and would be unable to find their way out. A 20 × 30 cm opening in the rear panel was fitted with a cloth sleeve to facilitate removal of the mosquitoes.

Traps were set in two (one rural and one suburban) coastal hardwood forest habitats in Marin County, and a Sierra Nevada mixed conifer forest at Blodgett Experimental Forest (elevation 1200 m), El Dorado County. The results reported here represent data collected from spring through early fall of 1978.

Traps were set from about 1400 until 1000 hr the following day. Each trap station was operated weekly from first emergence of adults in the spring to their last appearance in the fall. Trap stations at the same location were separated by a minimum of 50 m.

Additional experiments tested the effects of different bait combinations of rabbits and/or CO_2 upon the resulting sex ratio of *Ae. sierren-*

sis. Six bait stations were baited accordingly: two with a caged rabbit; two with 1 kg of dry ice, and two with a caged rabbit and 1 kg of dry ice. The stations were set up under the forest shade, at least 50 m apart, and the baits placed on the ground. A D-Vac™[3] vacuum sampler was used to collect mosquitoes for a 5 minute period as they hovered about the six bait stations. Bait stations were compared with four rabbit/CO_2 traps set in the same general area. These traps were set 50 m from each other and from the D-Vac sample stations. Bait stations were run between 1700 and 2000 hr in July, 1978, which corresponded to the peak activity period for this species.

Table 1 compares trapping results for the three sites. Activity periods detected by these traps were from early April to mid-August in the coastal sites compared to mid-May to late October in the montane site. Up to 1,500 *Ae. sierrensis* were recovered in a single trap period at the rural coastal woodland, although numbers averaged much lower (200–400). Differences between peak activity periods in the coastal and montane sites probably reflects differences in local environmental conditions.

[3] D-Vac Co. P. O. Box 2905 Riverside, CA 92516.

Males were frequently observed hovering or landing on the outside of the baited traps, but were seldom recovered in high numbers inside. While male:female ratios of *Ae. sierrensis* caught inside the rabbit/CO_2 traps ranged from 1:21 to 1:95, this ratio was 1:2.5 for mosquitoes collected at the bait stations by the D-Vac (Table 2), indicating a much higher proportion of males in the population at large than was recovered inside the rabbit/CO_2 traps.

The proportion of females in the D-Vac samples was higher with rabbit-only and rabbit/CO_2 baits than was recovered in the CO_2-only samples (Table 2). This suggests that the rabbit plays an additional role in the attraction and persistence of females to a specific site. Twice as many females were recovered with the rabbit/CO_2 combination than with the rabbit-only baits, suggesting that CO_2 augments the attraction of the rabbit.

Although several researchers have used either CO_2 or a live animal bait (e.g., Gillies and Wilkes 1969) to capture a variety of mosquito species, few have used the two baits in combination. Landry and DeFoliart (1986) found that although *Ae. triseriatus* was attracted to CO_2, the success of their CDC trap was not improved with by the addition of a live mouse in combination with CO_2.

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Table 1. Female *Aedes sierrensis* recovered from rabbit/CO_2 baited traps set in Fairfax and Novato, Marin County, and at Blodgett Forest, El Dorado County, 1978.

Location	No. trap stations	Mean number/trap-period (No. of trap periods)								
		Apr	May	Jun	Jul	Aug	Sep	Oct	Range	Mean
Coastal										
Suburban	6	38	68	46	18	3	—*	—	0–252	39.1
Woodland		(10)	(13)	(16)	(19)	(2)				
Coastal										
Rural	5	193	536	432	371	75	34	—	0–1, 512	355.4
Woodland		(22)	(24)	(13)	(10)	(2)	(4)			
Montane										
Conifer	8	—	—	30	224	62	45	4	0–901	79.9
Forest				(17)	(32)	(36)	(33)	(26)		

* No traps set during this month.

Table 2. Ratios of male to female *Aedes sierrensis* from rabbit/CO_2 traps and D-Vac samples near differing bait types.*

Trap type	No. of samples**	Males	Females	Approx. ratio male:female
Rabbit/CO_2 trap	12	19	2419	1:127
CO_2 only (D-Vac)	6	63	56	1:1
Rabbit only (D-Vac)	6	10	99	1:10
Rabbit/CO_2 (D-Vac)	6	74	200	1:3

* All samples collected over the same three day period in late July, 1978 at Blodgett Experimental Forest.
** Total number of trapping periods for each collecting method.

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