TRAPPING TABANIDS WITH MODIFIED MALAISE TRAPS BAITED WITH CO_2 [1]

R. R. BLUME,[2] J. A. MILLER,[3, 4] J. L. ESCHLE,[2] J. J. MATTER [2] AND M. O. PICKENS [3, 5]

Agricultural Research Service, USDA, Kerrville, Texas 78028

ABSTRACT. When a modified Malaise trap was constructed and tested, CO_2 emitted from a bottle at a rate of 3 liters per minute significantly increased the numbers of tabanids captured. A total of 8 species of tabanids were captured in the traps in addition to other arthropods of medical and veterinary importance.

The Malaise trap described by Malaise (1937) and Townes (1962) and modified by Gressitt and Gressitt (1962) is recognized as a useful tool in collecting flying insects. For example, Easton *et al.* (1968) employed this type of trap in west Texas to collect biting flies. Also, the apparent attractiveness of CO_2 to tabanids as well as to other biting flies was reported by Wilson *et al.* (1966), Olkowski and Anderson (1967), Everett and Lancaster (1968), Knudsen and Rees (1968), and Roberts (1970).

Therefore, during July, August, and September 1969, we made a series of studies to compare the numbers of tabanids taken in modified Malaise traps baited with CO_2 with the numbers caught in identical traps that were not baited. Since Moe and Tyrrell (unpublished data) [6] found that a lactating cow produces approximately 5000 liters of CO_2 in a 24-hour period or 3.47 liters per minute, we selected an emission rate of 3 liters per minute as the bait for these traps.

[1] Mention of a proprietary product in this paper does not constitute an endorsement of this product by the USDA.

[2] Entomology Research Division.

[3] Agricultural Engineering Research Division.

[4] Present address: P.O. Drawer GE, College Station, Texas 77840.

[5] The authors gratefully acknowledge the assistance of W. J. Gladney of the Entomology Research Division who identified the Culicidae. R. H. Roberts of the Entomology Research Division who verified the identification of the tabanids, and the staff of the U. S. National Museum who identified the simuliids and hippoboscids.

[6] P. W. Moe and H. F. Tyrrell, Animal Health Division, USDA, Beltsville, Md. 20705.

METHODS AND MATERIALS

TRAP CONSTRUCTION. The trap as constructed is pictured in Fig. 1. The three legs of aluminum tubing (1 cm ID) that formed the tripod frame were vertical to 1.2 m above ground at which point they were bent (ca. 45° off the vertical). Thus, when adjacent legs were connected (and braced) with aluminum tubing at the angle, the upper portion of the legs formed a pyramid the base of which was an equilateral triangle (Fig. 2A). The apex of this pyramidal section (ca. 1.9 m above ground) was finished and braced by welding three steel rods (equally spaced and angled) to a 10-cm-diameter steel ring. These rods could then be fitted into the hollow tripod frame.

Suspended within and congruent to the pyramid section of the frame was a canopy constructed of clear, nylon-reinforced, plastic film that was attached to the frame with nylon cord threaded through grommets installed along all edges. A baffle of black, nylon-reinforced, plastic film was made by joining (heat fusion) together three pieces of material (ca. 1.2 x 1.1 m) along one edge of each piece. The upper corner of each wing of the baffle was attached to the frame of the pyramidal upper section (beneath the canopy and 2 cm above its lower edge), and the lower corners of the baffle were attached to each leg of the tripod at a point about 15 cm above the ground.

The collection cage (Fig. 2B) was a 1.4-liter clear plastic container (14 cm diameter) with a screen top and an entrance made of a screen-wire funnel. The original screw-on lid of this container and the lid and upper 3 cm of a similar smaller container (9 cm diameter) were arranged to form a transition from the canopy to the collection cage as follows: A 9-cm-diameter hole was cut in the large lid, and the 3-cm section of the smaller container was fitted in the hole and glued. A 7-cm hole was cut in the center of the screw-on lid of the smaller container, and the apex of the plastic canopy was cut and fitted around the small lid and secured with a metal band. The transition therefore rested on and extended through the metal ring at the apex of the frame, and the apex of canopy was screwed on to the transition. Tabanids thus traveled from within the canopy, through the transition, through the screen funnel, and into the collection cage.

To prevent the trap from being toppled by wind, we inserted the legs of the trap into tubes placed in the center of coffee cans that were three-quarters filled with concrete. Also, stays were hooked over the edges of the cans and driven into the ground. The cans were then filled up with oil to protect against ants.

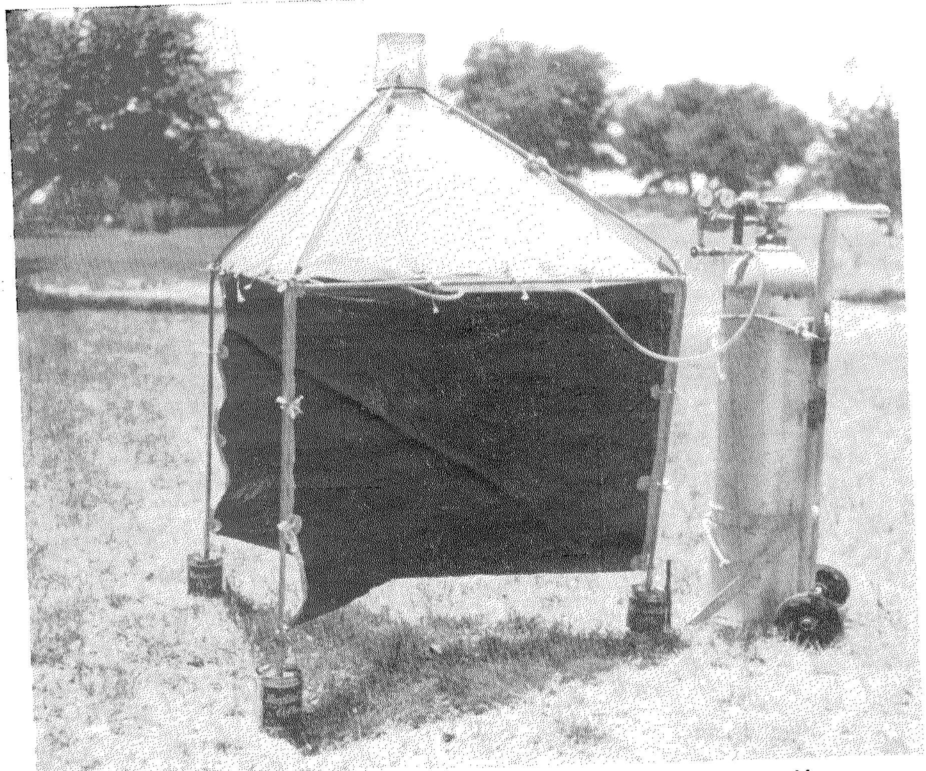

Fig. 1.—Modified Malaise trap of the type used for collection of tabanids.

When CO_2 was used in the traps, it was metered into the traps from high-pressure cylinders through Tygon® tubing and released at about the center of the canopy, about 20 cm below the apex.

Thorsteinson (1958), working with the Manitoba fly trap, concluded that heat might be a factor in attracting horse flies. Later work by Bracken and Thorsteinson (1965) showed that temperature exerted little influence on the attractiveness of glossy black objects for tabanids. Bracken *et al.* (1962), Bracken and Thorsteinson (1965), and Thorsteinson *et al.* (1966) emphasized the role of color and number of reflecting surfaces in the number of adult tabanids attracted to an object. Therefore, black plastic was used for the baffle because of the tendency of that color to absorb heat and also because visual highlights were produced by the sun on wrinkles on the plastic. Clear plastic was used for the canopy because of the positive phototropic tendency of the insects. Thus, insects flying into the baffle, whether because of attraction or random flight, moved upward into the canopy and finally into the collection cage.

TRAPPING LOCATIONS. Most of the study with the modified traps was conducted in Kerr Co., Texas. However, on two occasions, traps were placed in south and east

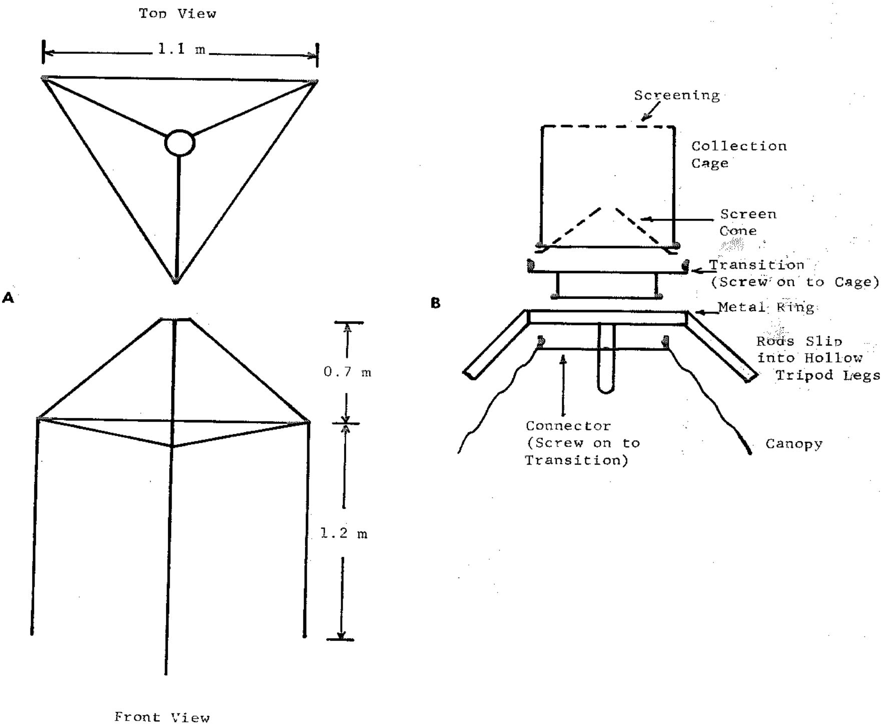

FIG. 2.—Schematic drawing of (A) the modified trap and (B) the collection cage showing details of construction. (Not drawn to scale.)

Texas—Wharton Co., near Boling on August 7 and 8, and Brazos Co., near College Station on August 28 and 29.

The studies in Kerr Co. were conducted in a 212-hectare pasture about 3.2 km southwest of Kerrville in an area where the terrain and vegetation were typical of that found throughout the Edwards Plateau region of Texas. The elevation varies there from about 515 to 608 m above sea level, the nearly level plateau is cut with rather deep, narrow valleys, and the pastures support a heavy growth of oak (several species), Mexican juniper, and native grasses. During the first trapping period, July 15–18, the pasture contained 68 cattle. No livestock were present during the three other trapping periods, August 13–14, August 18–19, and September 9–10.

The study in July was made with two traps (similar to the modified traps described except that they had four legs instead of three and were 30.5–45.7 cm taller), one placed on an open hillside overlooking a deep valley and the other on a hillside clearing surrounded by a heavy growth of juniper. The two sites were about 400 m apart on a north-south line. The studies in August and September were made with two traps (about 60 m apart) on the open hillside used in July and two more traps (60 m apart) in the bottom of the valley below the hillside location. The two areas were about 800 m apart. In all three tests, CO_2 (3 liters per minute) was released at one of the two traps at each location throughout the study. Traps were checked and flies were removed in the morning and again in the afternoon, at which time the CO_2 source was moved.

The study site in Wharton Co. was on the northeast edge of a deciduous, hardwood forest that contained a group of Brahma cattle. Traps 1 and 2, 60 m apart, were located on a north-south line in a cleared lane 3–4.5 m wide at the east edge of the forest; thus, these locations were bordered on the east by a cultivated field containing a herd of Holstein heifers. Traps 3 and 4, 60 m apart, were located on an east-west line in a similar cleared lane along the north side of the forest. Trap 3 was about 40 m from trap 2. CO_2 was released at the rate of 3 liters per minute in traps 1 and 3 throughout the study.

In Brazos Co., four traps were placed at the south edge of an abandoned field near College Station, Texas in an area where the terrain was rolling; a small stream bisected the field. The traps were located on a southeast-northwest line about 15 m from the stream and were spaced about 60 m apart. CO_2 was released (3 liters per minute) in traps 1 and 3 throughout the test period. No cattle were present in the field.

RESULTS AND DISCUSSION

The results of the studies are summarized in Table 1. Rainfall in all areas was considerably below normal before and during the study so the numbers of tabanids were lower than in years of normal

TABLE 1.—Total numbers of tabanids captured at three locations with modified Malaise traps baited or unbaited with CO_2 (3 liters per minute). 1969.

Observation date		Location	Total tabanids captured during 24-hour period: With CO_2	Without CO_2
July	15	Kerrville,	18	0
	16	Kerr Co.	37	0
	17		15	3
	18		13	0
August	7	Boling, Wharton Co.	34	8
			11	2
	13	Kerrville,	123	35
	14	Kerr Co.	114	24
	18		52[a]	19
	19		45	19
	28	College Station,	19	5
	29	Brazos Co.	26	3
Sept.	9	Kerrville,	50	14
	10	Kerr Co.	61	9
		Total	618	141

[a] Only one trap baited with CO_2.

rainfall. Also, weather conditions (intermittent rain accompanied by gusty winds) were unfavorable for trapping during the test in Brazos Co. All tabanids captured in Kerr Co. were *Tabanus abactor* Philip and were, with one exception, females, but several additional species of tabanids do occur in Kerr Co. (Blume, unpublished data). Species captured in Wharton Co. and Brazos Co. were as follows:

Tabanus subsimilis Belardi	Brazos and Wharton Cos.
T. mularis Stone	Brazos Co.
T. sulcifrons Macquart	Wharton Co.
T. proximus Walker	Wharton Co.
Chrysops flavidus Wiedemann	Wharton Co.
C. pikei Whitney	Brazos Co.
C. callida Osten Sacken	Brazos Co.

Tabanus subsimilis and *Chrysops pikei* were the species taken in largest numbers in Brazos Co.; the predominant species in Wharton Co. (from the numbers captured) were *T. subsimilis* and *C. flavidus*. All specimens, except for one male *T. subsimilis* taken in Wharton Co., were female.

We did not analyze statistically the attractiveness of CO_2 for individual species because of variability in trap catches caused by climatic conditions and seasonal fluctuations of species.

As Table 1 shows, more tabanids were captured when CO_2 was released than when it was not. When the data on total tabanids captured each trapping day were analyzed by the simple "t" test (Snedecor and Cochran, 1967), there was a highly significant t ($t=4.89^{**}$) indicating that the traps baited with CO_2 trapped significantly more tabanids than the unbaited traps. Also, the total collected in baited traps was 4.4 times that collected in unbaited traps.

Additional insects of possible medical and veterinary importance captured in the traps included:

Aedes triseriatus (Say)	Kerr Co.
Anopheles crucians Wiedemann	Wharton Co.
Culex erraticus (Dyar and Knab)	Kerr and Brazos Cos.
Psorophora confinnis (Lynch Arribálzaga)	Brazos and Wharton Cos.
Simulium vittatum Zett.	Kerr Co.
S. mediovittatum Knab	Kerr Co.
Lipoptena mazamae Rondani	Kerr Co.

References Cited

Bracken, G. K., Hanec, W. and Thorsteinson, A. J. 1962. The orientation of horse flies and deer flies (Tabanidae: Diptera). II. The role of some visual factors in the attractiveness of decoy silhouettes. Can. J. Zool. 40:685–695.

Bracken, G. K. and Thorsteinson, A. J. 1965. The orientation behavior of horse flies and deer flies (Tabanidae: Diptera). IV. The influence of some physical modifications of visual decoys on orientation of horse flies. Entomol. Exp. Appl. 8:314–318.

Easton, E. R., Price, M. A. and Graham, O. H. 1968. The collection of biting flies in West Texas with Malaise and animal-baited traps. Mosq. News 28(3):467–469.

Everett, R. and Lancaster, J. L., Jr. 1968. A comparison of animal and dry-ice-baited traps for the collection of tabanids. J. Econ. Entomol. 61:863–864.

Gressitt, J. L. and Gressitt, M. K. 1962. An improved Malaise trap. Pacific Insects 4(1): 87–90.

Knudsen, A. B. and Rees, D. M. 1968. Methods used in Utah for sampling tabanid populations. Mosq. News 28(3):356–361.

Malaise, R. 1937. A new insect trap. Entomologisk Tidskr. 58:148–160.

Olkowski, W. and Anderson, J. R. 1967. Relationships between host attack rates and CO_2-baited Malaise trap catches of certain tabanid species. Proc. 35th Annu. Meet. Amer. Mosq. Cont. Assoc., p. 77.

Roberts, R. H. 1970. Tabanidae collected in a Malaise trap baited with CO_2. Mosq. News 30(1):52–53.

Snedecor, G. W. and Cochran, W. G. 1967. Statistical Methods. The Iowa State Univ. Press, Ames, Iowa. p. 59–61.

Thorsteinson, A. J. 1958. The orientation of horse flies and deer flies (Tabanidae: Diptera). I. The attractance of heat to tabanids. Entomol. Exp. Appl. 1:191–196.

Thorsteinson, A. J., Bracken, B. G. and Hanec, W. 1965. The orientation behavior of horse flies and deer flies (Tabanidae: Diptera). III. The use of traps in the study of orientation of tabanids in the field. Entomol. Exp. Appl. 8: 189–192.

Thorsteinson, A. J., Bracken, B. G. and Tostowaryk, W. 1966. The orientation behavior of horse flies and deer flies (Tabanidae: Diptera). V. The influence of the number and inclination of reflecting surfaces on attractiveness to tabanids of glossy black polyhedra. Can. J. Zool. 44:275–279.

Townes, H. 1962. Design for a Malaise trap. Proc. Entomol. Soc. Wash. 64(4):253–262.

Wilson, B. H., Tugwell, N. P. and Burns, E. C. 1966. Attraction of tabanids to traps baited with dry ice under field conditions in Louisiana. J. Med. Entomol. 3(2):148–149.

COMPETITIVENESS OF MALE *CULEX PIPIENS QUINQUEFASCIATUS* STERILIZED BY TEPA OR APHOLATE IN FIELD CAGES [1]

R. S. PATTERSON,[2] M. D. BOSTON AND C. S. LOFGREN

Entomology Research Division, Agr. Res. Serv., USDA, Gainesville, Fla. 32601

ABSTRACT. *Culex pipiens quinquefasciatus* Say males were chemosterilized by exposure to residues of tepa on polystyrene strands or by external dusting with technical apholate and released into large outdoor cages containing untreated cycling populations of the species. Males sterilized with tepa appeared competitive with normal males after releases had been made for 4 generations, and males sterilized with apholate competed very well in one test but did not compete in a second test. Handling and rearing techniques were important factors influencing male vigor.

Sterility can be induced in *Culex pipiens quinquefasciatus* (*fatigans*) Say by irradiation or chemosterilization (Patterson and Lofgren, 1968). However, irradiated males were not as competitive as normal males in laboratory mating studies, and chemosterilized males were (Weidhaas and Schmidt, 1963; Smittle *et al.*, 1968). The first outdoor field cage studies were made by Patterson *et al.* (1968) with males sterilized with apholate by applying a technical dust to the adults (Das, 1967). The released mosquitoes did not compete as well with the normal males as expected, but over 50 percent of the egg rafts assayed were infertile, which indicated that at least some treated males were performing. We then made further field cage tests with chemosterilized males but used other methods of handling the insects.

[1] This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation by the USDA.

[2] Present address: World Health Organization, Research Unit on Genetic Control of Mosquitoes, 2–3 Ring Road, Kilokri, New Delhi—14, India.

METHOD. From May to August we sterilized the males by forcing them to crawl through a 3-inch layer of polystyrene strands which had been dipped in a 2 percent solution of tepa in a mixture of acetonitrile and water (3:1). This was accomplished by placing the male pupae in 2 inches of water in a 1 gallon waxed-paper container and packing the treated strands loosely over the water. Thus, the young adults had to crawl over the treated strands if they were to emerge into the cage and disperse. The procedure had no obvious deterimental effect on the emerging adults, and we planned to use this treatment throughout the study. However, in August, we received a new lot of tepa which for some unexplained reason, was toxic to the mosquitoes. Metepa was used for 2 weeks, but it was not as effective a sterilant as tepa when it was applied in this way. As a result, treatments with apholate dust were used during September and October. The apholate was applied as in the study by Patterson *et al.* (1968): the adults were dusted when they were 24