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RELATIVE ATTRACTIVENESS OF CO_2 AND A STEER TO TABANIDAE, CULICIDAE, AND *STOMOXYS CALCITRANS* (L.)[1,2]

R. H. ROBERTS
Entomology Research Division, Agr. Res. Serv., USDA, Stoneville, Mississippi 38776

ABSTRACT. Malaise traps baited with CO_2 released at the rate of 3.5 liter/minute, or with a steer, collected 4 times more Tabanidae than unbaited traps. Twelve species of tabanids showed no preference between the two baits; two species showed preference for CO_2. Collections of *Psorophora confinnis* (Lynch Arribálzaga) were increased by a factor of 13 when the traps were baited with CO_2 and by 23 when they were baited with the steer compared with unbaited traps. The numbers of *Stomoxys calcitrans* (L.) collected in traps baited with CO_2, with the steer, or unbaited were 221, 254, and 151, respectively.

The attractancy of CO_2 for Tabanidae is well known (DeFoliart and Morris 1967, Wilson *et al.* 1966). However, CO_2 may not be the only attractant given off by the host; other materials may have attractancy when they are present in conjunction with CO_2. For example, Acree *et al.* (1968) recently showed that L-lactic acid was such an attractant for Culicidae. The present investigation was made at the Livestock Insects Investigations Laboratory at Stoneville, Mississippi, to compare the attractancy of CO_2 and a steer for horse flies and to determine whether an adjunct attractive substance might be present. Data for Culicidae and stable flies, *Stomoxys calcitrans* (L.), are included since these insects were also collected.

MATERIALS AND METHODS. An 8-ft-square wire strand pen was constructed in a small grove of trees adjacent to a grazing pasture on the Delta Branch Experiment Station, Stoneville, Mississippi. Frames (4x8 ft.) covered with ¼-in.-mesh hardware cloth were placed on end around the perimeter of the pen to form an 8-ft.-high barrier. One Malaise trap (Townes 1962) constructed from natural saran screen was placed on each side of the pen (Fig. 1). The bait steer was a 6-year-old Hereford weighing about 1200 pounds.

The CO_2 used as bait was released in the center of the pen at a rate of 3.5 liters/minute from a 50-lb. tank by means of a single-stage regulator, a needle valve, and a compact flowmeter. This rate of

[1] In cooperation with the Delta Branch of the Mississippi State University Agricultural and Forestry Experiment Station, State College, Mississippi 39762.

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

FIG. 1.—Bait pen, barrier fence, and 2 of the 4 Malaise traps. (Traps on far side of pen are not visible.)

CO_2 was selected on the basis of unpublished data supplied by P. W. Moe and H. F. Tyrrell of the Animal Science Division, Agr. Res. Serv., USDA. They found that fasted dairy cows produced an average of 1617 liters of CO_2 and that lactating dairy cows produced 5005 liters of CO_2 in 24 hours. Also, beef heifers growing slowly produced an average of 1727 liters of CO_2 and heifers on full feed produced 2639 liters of CO_2 in 24 hours. The highest value, 5005 liters/day or 3.5 liters/minute, was selected arbitrarily for the present test.

Collections of trapped insects were made after a 24-hour period starting at 9 am (Central Daylight Time) one day and ending at 9 am the following day. One series of collections consisted of a 3-day period during which the traps were baited randomly with the steer, with CO_2, or unbaited. During the period July 15–August 29, 1970, 12 such series were conducted.

RESULTS AND DISCUSSION. The total numbers of each species of Tabanidae and Culicidae collected are shown in Tables 1 and 2, respectively. A total of 221, 254, and 151 *Stomoxys calcitrans* (L.) were taken in traps baited with CO_2, with the steer, and unbaited, respectively.

The CO_2 and the steer both increased the total numbers of Tabanidae collected compared with the unbaited traps by a factor of 4. There was no difference between the two types of bait in the total number of tabanids collected. All the species, except for two, were collected in approximately equivalent numbers with each type of bait. The CO_2 significantly increased the numbers of *T. fuscicostatus* collected by a factor of 2 and the numbers of *T. sulcifrons* collected by a factor of 1.5 compared with the steer. Although twice as many *C. flavidus* were taken in the traps baited with CO_2, the numbers were too few for adequate statistical analysis.

TABLE 1.—Species and number of Tabanidae collected in Malaise traps July 15–August 29 (12 collections 24 hours each).

Speices	No. collected by indicated bait		
	CO_2	Steer	None
Chlorotabanus			
crepuscularis (Bequaert)	4	6	0
Chrysops			
flavidus Wiedemann	35	17	1
Leucotabanus			
annulatus (Say)	5	2	0
Tabanus			
abdominalis F.	264	257	30
americanus Forster	1	3	0
atratus F.	8	10	1
calens L.	4	2	0
fuscicostatus Hine	324	167	43
lineola F.	19	25	4
mularis Stone	2	1	0
proximus Walker	16	15	0
subsimilis Bellardi	1299	1458	410
sulcifrons Macquart	554	359	134
venustus Osten-Sacken	1	2	0
Total (Avg. no./repl.)	2533 (211.0)	2327 (193.9)	623 (51.9)

Seven species of Tabanidae were collected only in baited traps, but the populations of these species were low at the time of the study so their absence from the unbaited traps is not considered significant. However, the attractive properties of the two baits for these species indicate the value an attractant would have in surveys.

Of the six species of Culicidae collected (Table 2), only *P. confinnis* was collected in large numbers. The number was increased by a factor of 13 when CO_2 was the bait and by a factor of 23 when the steer was the bait compared with the unbaited traps. The numbers of *Aedes vexans* and *Anopheles quadrimaculatus* collected were also increased by the baits, but the difference in the attractivenes between the baits was not significant.

The data obtained with a rate of CO_2 of 3.5 liters/minute indicate that only CO_2 is attracting horse flies to the host. If other attractants, e.g., L-lactic acid, were involved, greater numbers would have been collected with the steer bait as occurred with *P. confinnis*. However, two factors need to be considered in

TABLE 2.—Species and number of Culicidae collected in Malaise traps July 15–August 29 (12 collections 24 hours each).

Speices	No. collected by indicated bait		
	CO_2	Steer	None
Aedes			
vexans (Meigen)	48	38	11
Anopheles			
quadrimaculatus Say	190	141	20
Culex			
erraticus (Dyar and Knab)	3	8	1
salinarius Coquillett	7	1	0
Psorophora			
confinnis (Lynch Arribálzaga)	1221	2186	94
ferox (Humboldt)	1	0	0
Total (Avg. no./repl.)	1470 (122.5)	2374 (197.8)	126 (10.5)

viewing the results. From the data obtained from the Animal Science Division, the steer used in this study did not produce CO_2 at the same rate as that released from the tanks, and this difference could have biased the collections in favor of the CO_2. However, studies of lower levels of CO_2 indicated that the optimum level for attractancy is about 1 liter/minute (Roberts 1971), and rates above this level did not significantly increase the numbers of the tabanids collected in Malaise traps. The second factor for consideration is that of vision. Since horse flies are attracted by visual objects (Bracken 1962), the size, shape, and color of the host should be a factor in locating the host. The construction of the pen and the placement of the traps hid the steer from view, especially from a distance. Also, the traps have visual attractancy for horse flies (Roberts 1970), but the degree of difference in attraction between the traps and the steer is not known. If the visual attractiveness of the trap is less than that of the steer, then again, here was a bias in favor of the CO_2.

One other point deserves comment. After the construction of the pen and placement of the traps, preliminary collections were made without the barrier. When the steer was placed in the pen, many horse flies were seen to approach, avoid the traps, feed on the steer, and leave, again avoiding the traps. Few engorged flies were collected in the traps. After the panels were installed, horse flies were occasionally seen within the enclosure feeding on the steer. The majority of these flies had accompanied the steer when it was placed in the pen. In addition, the panels did not fit together with precision so a few flies managed to reach the steer via the small gaps between some of the panels. After engorgement, these flies flew over the top of the barrier and escaped. Unfed flies did not fly over the 8-ft. barrier to reach the steer; these flies flew around the barrier in attempting to reach the steer and were collected in the traps.

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