THE EFFECTIVENESS OF SEVERAL TYPES OF MALAISE TRAPS FOR THE COLLECTION OF TABANIDAE AND CULICIDAE[1]

R. H. ROBERTS

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

Abstract. A total of 12 species of Tabanidae and 18 species of Culicidae were collected in 8 types of Malaise traps, but the species representation varied greatly between types. Factors that apparently influenced the collections were: contrast in the color of the trap and the background, the size and shape of the trap opening, the presence or lack of baffles, the design of the collecting and killing apparatus, and the overall size of the trap.

Several types of traps used in studies of Tabanidae (DeFoliart and Morris 1967, Hanec and Bracken 1964, Thompson 1969, Thorsteinson *et al.*, 1965; Wilson *et al.*, 1966) have all had bait (CO_2 or a decoy) to entice the flies into the trap. However, in recent studies (Roberts 1970), I found that the color of unbaited traps had an important effect on numbers collected and that other aspects of trap design might influence collections. The present paper reports data obtained in 1970 with Malaise traps of several designs.

Materials and Methods. The traps used in the study are shown in Figures 1–3 and were as follows:

1. Kerrville Malaise trap with gray plastic screen (Easton *et al.*, 1968) (Figures 1 and 3).
2. Kerrville Malaise trap with natural saran screen (Fig. 2).
3. A commercial Malaise trap with olive-green screen (Fig. 1).
4. Triangular Malaise trap with black plastic baffles and a clear plastic canopy (Blume *et al.*, 1972) (Fig. 2).
5. Manitoba fly trap (Thorsteinson *et al.*, 1965) except that a doughnut-shaped decoy constructed from four 6-in.-diameter stovepipe elbows painted with a black acrylic paint was substituted for the spherical decoy (Fig. 3).
6. TVA Malaise trap with both green and natural saran screen (Breeland and Pickard 1965) (Fig. 2).
7. Stoneville Malaise trap with natural saran screen (Roberts, 1970) (Fig. 3).
8. Stoneville Malaise trap with natural saran screen plus a 9-in.-diameter plastic decoy painted with black acrylic paint (Fig. 3). These traps varied in size and can be grouped according to size as follows: Traps 6, 7, and 8, the largest; Traps 1 and 2, medium size; Traps 3, 4, and 5, the smallest.

The study was made May 6–16, 1970 in the Experimental Forest of the Delta Branch Experiment Station, Stoneville, Mississippi. The 8 trap sites were from 0.25 to 0.75 mile apart and were located on the shoulders of the roads that circumscribed a 10-block area within the forest. A Latin square design was used to test each trap at each site. The analysis of variance for trap, site, and day significance was made on the square root of (original data plus 0.5) and Duncan's test for variables was made on the means of the transformed data.

Collections were started each day between 1:00 and 1:30 p.m. (Central Daylight Time) and terminated the following morning between 10:00 and 10:30 a.m. The numbers of each species (♀♀ only) of Tabanidae and Culicidae collected from each trap were recorded.

Results and Discussion. Collection of Tabanidae. Table 1 shows the total number of each of the 12 species of Tabanidae collected in each type of trap. Four

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FIG. 1.—Kerrville Malaise trap with gray screen (left) and commercial trap (right).

FIG. 2.—Triangular trap (left), Kerrville Malaise trap with natural saran screen (center), and TVA Malaise trap (right).

Fig. 3.—Manitoba fly trap (left), Kerrville Malaise trap with gray screen (center), and Stoneville Malaise trap (right).

species were present in sufficient numbers for statistical analysis.

Trap 8 collected significantly more tabanids than any of the other traps used, and Trap 1 caught the least. However, Trap 2, which differed from Trap 1 only in having natural saran screen instead of gray plastic screen, collected 4 times as many as Trap 1, which supports my 1969 conclusions (Roberts, 1970) concerning the influence of natural saran screen on numbers of tabanids trapped.

The collecting apparatus of Traps 1 and 2 may also affect the numbers collected. Insects that enter these traps move to the top of the trap and exit through a 4-in.-diameter plastic tube (tipped at a 30° angle to the vertical about 12 in. above the trap) into a large square funnel (8 in./side at the top and 14 in. high). Since the killing jar is located at the bottom of this funnel, a large volume must be filled with fumes from the killing agent (in this study, potassium cyanide) if the flies are to be incapacitated; flies that are only slightly affected can easily leave the funnel via the plastic tube because it does not have baffles that would prevent their exit. In subsequent limited studies with these traps, I found that when a wire funnel was inserted into the plastic tube just below the 30° bend, the volumes of insects trapped between the funnel and the walls of the tube were almost as great as the volume collected in the killing jar.

Trap 3 was relatively ineffective in trapping tabanids. Several factors appear to be involved in the low trapping yields. The olive-green color of the screen is such that the trap blends into the background and may not be readily detected by the tabanids. Also, the collecting and killing apparatus is so located at the top of the trap that flies which enter the clear plastic cap at the peak of the trap and are incapacitated by the fumes from the kill-

Table 1.—Number of each species of Tabanidae collected in 8 types of Malaise traps (total of 8 collections).

Species	Number of specimens collected in[a]								
	1	2	3	4	5	6	7	8	All traps
Chrysops									
callidus Osten Sacken	0	2	0	0	1	3	1	0	7
flavidus Wiedemann	43 ab[b]	254 c	103 b	48 ab	9 a	89 b	654 d	903 d	2103
Hybomitra									
lasiophthalma (Macquart)	12 a	99 a	61 a	81 a	127 a	22 a	241 a	1727 b	2370
Tabanus									
atratus F.	0	0	0	1	0	0	1	16	18
equalis Hine	0	0	0	0	0	0	3	0	3
fuscicostatus Hine	0	12	0	0	0	2	6	7	27
lineola F.	5 ab	16 bc	0 a	2 a	3 ab	5 ab	20 c	115 d	166
mularis Stone	0	0	0	0	0	0	1	1	2
subsimilis Bellardi	71 ab	97 b	13 a	28 ab	112 b	123 b	441 c	1455 d	2340
trimaculatus Palisot de Beauvois	0	0	0	0	0	0	0	1	1
venustus Osten Sacken	0	2	0	0	0	2	0	1	5
wilsoni Pechuman	0	2	0	0	0	0	1	1	4
Total	131 a	484 a	177 a	160 a	252 a	246 a	1369 b	4227 c	7046

[a] Trap type:
1—Kerrville with gray plastic screen
2—Kerrville with natural saran screen
3—Commercial trap
4—Triangular trap
5—Manitoba fly trap
6—TVA trap
7—Stoneville with natural saran screen
8—Stoneville with black decoy

[b] Numbers followed by same letter horizontally not significant at 5% level of confidence by Duncan's test for variable on the means of the square root of (original data+0.5).

ing jar (attached to a funnel suspended within and near the top of the plastic cap), may not fall into the funnel and then into the killing jar. If they are not incapacitated directly over the funnel, they drop back into the lower part of the trap. A design that would insure retention of all specimens might increase the numbers collected. Finally, the low profile and trianguar shape of the trap opening may contribute to the small collections. Although this opening is nearly 8 ft. across at ground level, it tapers rapidly and terminates about 3 ft. above the ground. Thus, the trap opening at 2–3 ft. above the ground is relatively small. Since field observations of tabanids indicate that they tend to fly 2–6 ft. above ground, the available opening would restrict the number of flies which could enter the trap.

The low number collected from Trap 4 was unexpected because I had assumed that the black plastic baffles would attract tabanids. Perhaps an increase in collections with this trap might be achieved by placing wings on the legs so the flies cannot leave. The 120° angle between baffles apparently affords an easy exit and does not confine flies within the trap until they work their way up into the collection cap.

Traps 5 and 6 collected similar total numbers of tabanids but differed in numbers of some species collected, particularly *H. lasiophthalma* and *C. flavidus*. Trap 5 was the only trap in the study that did not possess baffles to prevent flies from passing through. This trap without the decoy, over a 3-day period, collected only 6 specimens of *T. subsimilis*. Since the Malaise trap operates on the principal that the insects collected are those that tend to rise when an obstacle is encountered, this trap might benefit from the incorporation of a barrier into its design.

The total collections in Trap 7 were 5 times greater than in Trap 6. The collections in Trap 8 were 3 times greater than those in Trap 7. Thus, the data obtained in the present study and in my previous study (Roberts, 1970) of trap

TABLE 2.—Number of each species of Culicidae collected in 8 types of Malaise traps (total of 8 collections).

Species	Number of specimens collected in[a]								
	1	2	3	4	5	6	7	8	All traps
Aedes									
atlanticus Dyar & Knab	1	0	0	0	0	6	4	8	19
canadensis (Theobald)	179 cd[b]	96 bc	17 ab	1 a	2 a	842 f	305 de	424 e	1866
cinereus Meigen	0	0	0	0	0	2	0	0	2
flavescens pallens Ross	0	0	0	0	0	0	0	2	2
grossbecki Dyar & Knab	8 bc	0 a	0 a	0 a	0 a	24 d	15 cd	2 ab	49
infirmatus Dyar & Knab	1	1	0	0	0	12	1	4	19
sticticus (Meigen)	18 ba	2 a	0 a	0 a	0 a	64 bc	15 a	66 c	165
triseriatus (Say)	4	0	0	0	0	6	0	2	12
vexans (Meigen)	82 ab	33 a	2 a	7 a	4 a	238 bc	167 b	553 c	1086
Anopheles									
crucians Wiedemann	2	0	0	0	0	22	12	4	40
quadrimaculatus Say	0	1	0	0	0	0	1	0	2
Culex									
erraticus (Dyar & Knab)	0	0	0	1	0	0	6	2	9
restuans Theobald	3	0	0	0	0	20	10	10	43
salinarius Coquillett	0	0	0	0	0	4	3	4	11
territans Walker	4	1	0	0	0	16	4	8	33
Psorophora									
ciliata (F.)	0	0	0	0	0	0	1	0	1
confinnis (Lynch Arribálzaga)	0	0	0	0	1	0	0	0	1
ferox (Humboldt)	232 b	18 a	27 a	13 a	0 a	606 c	120 b	169 b	1185
horrida (Dyar & Knab)	0	0	0	0	0	2	0	0	2
varipes (Coquillett)	14	2	3	0	0	24	8	6	57
Total	548 b	154 a	49 a	22 a	7 a	1888 d	672 bc	1264 c	4604

[a] See footnote, Table 1.
[b] See footnote, Table 1.

color indicated two independent attractive factors affected the collections in Trap 8, the screen color, and the presence of a decoy.

Collections of Culicidae. A total of 18 species of Culicidae was collected (Table 2). The largest collections (in decreasing order) were taken in Traps 6, 8, 7, and 1. More mosquitoes were collected in dark-colored Malaise traps than in similar light-colored traps (6 vs. 7, and 1 vs. 2). Also, the decoy on Trap 8 was evidently attractive since this trap collected twice as many Culicidae as the similar Trap 7 which had no decoy. However, the gray-screened Trap 1 collected 3 times more than Trap 2 which had natural saran screen but less than Trap 7 which also had natural saran screen, so, trap size may be a factor. The other three traps collected few mosquitoes.

The data obtained from the present study indicate that in addition to color contrast with the background, other factors that affect collections are: the size and shape of the trap opening, the design of the collecting and killing apparatus, the presence of baffles to prevent flies from passing through the trap, and the overall size of the trap.

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References Cited

Blume, R. R., Miller, J. A., Eschle, J. L., Matter, J. J. and Pickens, M. O. 1972. Trapping tabanids with modified Malaise traps baited with CO_2. Mosq. News 32(1):90–95.

Breeland, S. G. and Pickard, E. 1965. The Malaise trap—an efficient and unbiased mosquito collecting device. Ibid. 25(1):19–21.

DeFoliart, G. R. and Morris, C. D. 1967. A dry-ice baited trap for the collection and field storage of hematophagous Diptera. J. Med. Entomol. 4(3):360–2.

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):465–9.

Hanec, W. and Bracken, G. K. 1964. Seasonal and geographical distribution of Tabanidae (Diptera) in Manitoba, based on females captured in traps. Can. Entomol. 96(10):1362–9.

Roberts, R. H. 1970. Color of Malaise trap and the collection of Tabanidae. Mosq. News 30(4):567–71.

Thompson, P. H. 1969. Collecting methods for Tabanidae (Diptera). Ann. Entomol. Soc. Amer. 62(1):50–57.

Thorsteinson, A. J., Bracken, G. K. 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. 8:189–92.

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. 3:148–9.