

tive than distilled water. The results of these tests are shown in Table 4.

The materials that were found to prevent or reduce oviposition in this study might not be practical under field tests because of their cost and short period of effectiveness. However, the results obtained suggest that effective chemicals might be found. The possibility of finding effective repellents for other mosquito species because of their more limited range of breeding conditions in nature seems even more favorable.

SUMMARY. One hundred and fifty-one chemicals were tested in water samples against gravid *Culex pipiens quinquefasciatus* Say to determine if they were attractive or repellent. Thirty-three of these materials prevented oviposition at 50 p.p.m. or less in distilled water in single-beaker cage tests. Thirteen were effective

at 10 p.p.m. or less but only Triton X-155 (a surfactant) was effective at 2 p.p.m. Beechwood creosote and *N*-butyl-*N*-ethyl-*o*-veratrylamine were the only compounds that increased the attractiveness of distilled water.

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SOME OBSERVATIONS ON BITING FLIES ATTACKING SHEEP

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With the initiation of studies by the U. S. Department of Agriculture on the transmission of bluetongue disease of sheep with the fly *Culicoides variipennis* (Coquillett), one of the important steps in incriminating this species as the vector was establishing that it attacked sheep in the field. An examination of the literature showed no published records of *variipennis* biting sheep. In the fall of 1960 a number of field collections were made with a portable animal-bait trap, using a sheep. This paper presents some of the records obtained; these were made near Grand Junction, Colo.,² on the western slope of the Continental Divide.

¹The Simuliidae were determined by Alan Stone of this Division, who also corrected the author's determinations of the Culicidae. The author is indebted to his assistant, J. E. Wright, for his help in both the design and construction of the animal-bait trap.

²At the Leo James farm.

The animal-bait trap consisted of an 8-foot-square piece of olive-drab canvas stretched on a pipe frame, and a pyramidal white cloth tent whose base was attached to an 8-foot-square pipe frame of lighter construction. These two frames were hinged together along one side, and in the open position they lay on the ground side by side. The frames were connected by heavy springs, and the tent side was held down with a weight. A sheep was staked out in the center of the canvas, and the trap was sprung from a distance to avoid contamination by human odor. As soon as the trap was closed the flies were collected, with special attention being given to those that remained engorging on the sheep.

This study was preliminary, since methodology was being developed at the same time for serological work, and for epidemiological studies in which many of

TABLE 1.—Freshly engorged biting flies collected from animal-bait-trap on Sept. 8-10 and Oct. 5-9

Species	Flies observed feeding	
	Number collected	Body region
<i>Culicoides variipennis</i> (Coquillett)	5	sheared belly area
" <i>stonei</i> James	..	..
<i>Leptoconops kerteszi</i> Keiffer	common	inside ear
<i>Simulium vittatum</i> Zetterstedt	10	inside ear
" <i>piperi</i> Dyar & Shannon	2	sheared belly area
<i>Aedes dorsalis</i> (Meigen)	..	..
" <i>vexans</i> (Meigen)	1	leg
" <i>nigromaculis</i> (Ludlow)	..	..
<i>Culiseta inornata</i> (Williston)	..	..

the flies collected were held for three days to allow time for the complete digestion of any recent blood meal. Thus, collection of mosquitoes was frequently neglected, though they were commonly observed biting the sheep. The use of light was minimized after sunset to avoid attracting insects by phototropism.

For all the collections here listed, the trap was located in approximately the same spot, a corral area where the ground was bare and brown. In September the days were clear and sunny with little or no wind. In October, the 5th, 6th, and 7th were mostly clear with moderate wind in occasional gusts, and the 8th and 9th were quite cloudy with fairly strong gusts of wind and occasional light rain.

In Table 1 are listed the freshly engorged biting flies collected from the animal-bait trap on September 8-10 and October 5-9. The body region used for feeding is noted if the specimens were seen engorging.

In addition to the above, the following species were represented by specimens that were not freshly engorged: *Culicoides hiroglyphicus* Malloch, *haematopodus* Malloch, and *stellifer* (Coquillett); *Simulium griseum* Coquillett and *arcticum* Malloch; *Aedes melanimon* Dyar; *Anopheles pseudopunctipennis franciscanus* McCracken; *Stomoxys calcitrans* (L.); and *Siphona irritans* (L.).

Table 2 gives some records of *C. variipennis* collected. Until the sheep in the trap was sheared, specimens of this species were

not seen engorging, though they were commonly noted flying up at the belly and alighting there. After shearing, a total of 8 specimens was actually seen engorging (3 of these were collected from a staked sheep, and therefore do not appear in the trap-collection records). One of the specimens fed by crawling up into the short hair covering the belly, and the remaining seven fed at a tiny bare area where the sheep's belly had been nicked during shearing. A careful examination was always made, but no flies were observed feeding on the various short-haired parts of the head, though this type of feeding might have been expected from laboratory data recorded at Kerrville with released wild flies.

As evident in Table 2, *variipennis* will feed from noon to late evening; but no specimens were taken at temperatures above 90° F., and large numbers occurred only from late afternoon through dusk. Engorgement was more common when the sheep was sheared.

Specimens of *Leptoconops* were observed feeding from late morning to dusk (specimens seen engorging occurred in Collections 17-19, 27-30, and 43). In Collections 19 and 30, they were present in moderate numbers along with the first *variipennis* to appear that day. The occurrence of *Leptoconops* and three species of *Simulium* is indicated in Table 2. *Simulium arcticum* was represented only by one female specimen, which was recovered in a trap-collection on October 9.

TABLE 2.—*Culicoides variipennis* (Coquillett) and some other biting flies recovered from an animal-bait trap operated near Grand Junction, Colorado, September 8–10 and October 5–8, 1960

Collection no.	Date	Time trap closed	Minutes sheep exposed	Temperature (° F.)		Number of flies collected				
				Shade	Sun	<i>variipennis</i>				
						Females			Males	Females of other species ^a
						Freshly engorged	Not freshly engorged			
Sheep unshpared										
16	Sept. 8	1:20 p.m.	10	..	..	0	0	0		K G
17		1:50	20	88	101	0	0	0		K
18		2:30	20	88	98	0	0	0		K G
19		5:05	20	88	90	0	2	0		K G
20		6:10	30	83	85	0	61	16		V
21		6:40	15	72	(sunset-6:20)	2	28	4		K
22		7:05	10	71		1	29	1		G
23		7:35	15	70		0	10	2		
24		10:35	10	58		2	8	0		
25	Sept. 9	5:25 a.m.	395	55		0	0	0		
26		11:00	20	79	80	0	0	0		K G
27		11:30	15	..	..	0	0	0		K
28		2:15 p.m.	15	87	92	0	0	0		K
29		5:00	15	88	90	0	0	0		K
30		5:45	30	..	..	1	15	1		K V
31		6:20	10	77	77	0	1	3		G V
32		6:45	15	72	(sunset-6:20)	0	13	1		
33		7:10	10	71		0	1	0		
34		10:20	15	59		0	1	0		
35	Sept. 10	1:45 a.m.	15	50		0	0	0		
36	Oct. 5	3:45 p.m.	15	82	85	0	2	0		V
39		5:35	10	72	75	1	10	0		V
40		6:15	10	64	(sunset-5:40)	0	69	11		V
41	Oct. 6	12:35 p.m.	15	79	80	0	1	0		
42		12:55	10	79	80	0	0	0		
43		4:10	15	79	82	1	4	1		K G
44		4:35	15	78	82	1	11	2		K G V P
45		5:00	15	75	79	0	37	7		K G V P
46		5:20	10	69	73	0	32	5		V P
47		5:40	5	67	68	0	38	2		V P
48		6:00	10	66	(sunset-5:38)	0	42	5		V
Sheep with ventral area sheared										
50	Oct. 7	5:16 p.m.	10	73	73	7	58	11		V P
51		5:45	10	69	(sunset-5:25)	4	25	12		V P
52	Oct. 8	5:45 p.m.	10	65	cloudy	5	10	0		G V P
53		6:10	10	63	cloudy	5	30	1		G V P

^a K = *Leptoconops kerteszi* Keiffer.

G = *Simulium griseum* Coquillett.

V = " *vittatum* Zetterstedt.

P = " *piperi* Dyar & Shannon.

^b The catches from Collections 32 and 33 were combined through error.