Sublethal Effects and Mortality of Tabanids (Diptera: Tabanidae) Induced by Fenvalerate Treatment of Cattle[1]

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ABSTRACT The effect of fenvalerate spray treatments of cattle upon the feeding success and survival of tabanids was examined. There was a reduction in feeding time for tabanids feeding on treated cows ranging from 27.4 to 38.8%. There was also a 31% reduction in engorgement weight of *Tabanus fuscicostatus* Hine. The time that flies were allowed to feed upon fenvalerate-treated steers had no significant effect upon mortality rates or knockdown percentages.

KEY WORDS Insecta, Tabanidae, pyrethroid, bloodmeal.

Horse flies and deer flies are among the major insect pests of humans and animals worldwide. Losses to U.S. beef cattle production due to tabanid attacks recently have been estimated to be $54 million in U.S. stocker cattle alone (Drummond 1987). Such losses are generally attributed to increased energy requirements caused by irritation and blood loss. In a recent study (Perich et al. 1986), reduction in weight gain of 0.1 kg per beef cow per day has been associated with a daily horse fly attack rate of as few as 66 flies. Animal production losses have been demonstrated by chemical (Roberts and Pund 1974) and physical protection (Perich et al. 1986). In addition to weight loss, tabanids have been indicted as mechanical vectors of more than 25 pathogenic agents of domestic animals (Krinsky 1976, Foil 1989), including *Anaplasma marginale* (Wilson and Meyer 1966) and bovine leukemia virus (Foil et al. 1988). Control strategies for tabanids are limited, although residual insecticides on animals have been shown to be toxic to these flies (Bay et al. 1976, Harris and Oehler 1976, Presley and Wright 1986).

The effect of survival of flies that have completed a bloodmeal on the subsequent tabanid burden of livestock is unknown. Recent studies on the parity rate of tabanids (Foil et al. 1989) indicated the presence of "localized" populations returning to the site of a previous bloodmeal. Observations on feeding time, bloodmeal size and survival of tabanids that fed on fenvalerate-treated and control cattle were made during the above study and are the subject of this report.

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Materials and Methods

Study site. The study was conducted in the Thistlethwaite Wildlife Management Area (WMA) located in central Louisiana (St. Landry Parish, 30°39′N, 92°00′W). No domestic livestock are allowed on the refuge and deer populations are maintained at moderate levels by controlled hunting. Roads along main gas pipe lines allow easy access to most of the refuge. A field laboratory with controlled temperature (23.5 ± 1°C) is located on the periphery of the refuge.

Feeding times. Holstein cows (350 - 400 kg) were placed daily between 1030 and 2030 h (CST) in portable pens in each of two areas on the WMA from 23 to 30 August 1986. Three control cows were placed in one area, and three additional cows, sprayed daily with 4 - 6 liters of 0.5% fenvalerate water dispersible liquid (Fermenta Animal Health, Kansas City, MO) at 100 to 200 psi and rinsed with water at the end of each day (Foil et al. 1989), were placed in the other area. The closest distance between the two areas was 1.7 km. In 1987, Holstein steers (200 - 250 kg) treated as above were placed in pairs daily between 0830 and 2030 h (CST) in portable pens at two sites in each of the two areas in the WMA from 24 to 28 June. During both years, workers moved slowly among the sites and estimated tabanid burden. The feeding time of any tabanid observed to land, probe and take an uninterrupted blood meal also was recorded.

Engorgement weights. On 22 June 1988, two Jersey bullocks were sprayed with 0.05% fenvalerate and stanchioned in the WMA; two control bullocks were stanchioned nearby. Arriving flies, *Tabanus fuscicostatus* Hine, were allowed to feed to engorgement (cessation of feeding without subsequent probing) and were then immediately trapped in plastic cups and frozen on dry ice to stop metabolic activities. Unfed and engorged flies were subsequently weighed using a model B-6 Mettler balance. On 19 July 1988, *T. fuscicostatus* females collected in the WMA from canopy traps (Catts 1970) baited with dry ice were transported to the St. Gabriel Experiment Station (St. Gabriel, LA) and fed individually on Jersey bullocks (control and sprayed with 0.05% fenvalerate) and processed as above. Wing length was measured from the base of the costa to the tip of the wing (Leprince and Bigras-Poulin 1988) for each engorged fly collected in 1988 and for unfed flies collected in 1987 at the WMA. Unfed weights were derived from a linear regression of weight (WT) in mg versus wing length (WL) in mm, based on 297 specimens collected on 1 June (n = 150) and 24 July (n = 147) 1987.

Feeding time versus survival. On 23 July 1987, *T. fuscicostatus* females were caught in canopy traps in the WMA and transported to the field laboratory. Flies were fed individually on either stanchioned Holstein steers sprayed with 0.01% fenvalerate or control steers. The flies were allowed to feed for either 30, 60, 90 120 s or to engorgement (> 120 s). Flies that completed engorgement before 120 s were discarded and flies that fed for 5 min were interrupted. After feeding, the flies were placed in holding containers (Zyzak et al. 1989) and knockdown (unable to translocate but alive) and mortality were recorded at 1, 24 and 48 h post-exposure.

Results

Feeding times for five of the observed species, *T. fuscicostatus, T. lineola F., T. pallidescens* Philip, *T. wilsoni* Pechuman, and *T. proximus* Walker were recorded

on treated and control cattle (Table 1). The feeding time was significantly reduced for all species (T-test, $P < 0.05$) but *T. wilsoni,* for which there was a smaller sample size. The reduction in feeding time ranged from 27.4% in *T. wilsoni* to 38.8% in *T. lineola.* Average feeding time among *T. fuscicostatus, T. lineola, T. pallidescens* and *T. wilsoni* did not differ within control or within fenvalerate (0.05%) treated cows (ANOVA, $P > 0.05$). Feeding time of *T. proximus* was significantly higher than other tabanid species feeding on control or fenvalerate-treated cows (ANOVA, $P < 0.05$). Average feeding time was reduced, and longer feeding times were not recorded for flies fed on fenvalerate treated cows (Fig. 1).

The engorged weight of *T. fuscicostatus* fed on sprayed cows was significantly reduced on both dates examined (Table 2). Average wing length evaluated from engorged flies for each sampling day (9.02 mm on 22 June, 8.50 mm on 19 July, 1988) was used in the linear regression model to estimate average unfed body weight (WT = 0.011*WL - 0.055). The bloodmeal size was reduced by 38% on the first date (flies naturally arriving and feeding on cattle) and by 23% on the second date (flies trapped and subsequently fed on cattle).

Knockdown of flies fed on the steers treated with 0.01% fenvalerate was nearly 100% (all but 1 of 300 flies) at 1 h post exposure (Table 3). Mortality in all control flies was 1% at 24 h and 2% at 48 h. Feeding time for flies (> 120 s) on controls was 204 ± 63 s (± SD) (7 flies in this group had times over 5 min and the value used to calculate the mean was 300 s), and the feeding time for flies on treated steers was 166 ± 25 s (no flies fed over 5 min). Although all flies from treated steers were knocked down, approximately 30% of all flies were unaffected at 48 h post-exposure. At 24 h post-exposure, there was a trend toward percentage affected (knockdown plus mortality) increasing with exposure time (62% at 30 s, 85% at >120 s); however, at 48 h, time of exposure was unrelated to percentage affected (Table 3).

Discussion

The reduction in feeding time of flies observed naturally feeding on treated cattle (fenvalerate 0.05%, Table 1) or flies trapped and fed on treated cattle (0.01% fenvalerate, >120 s, Table 3) was consistent. Furthermore, longer feeding times were absent for flies naturally feeding or trapped and fed upon treated cattle (Fig. 1 and > 120 s Table 3). Presently, there is no information that would allow speculation on the effect that reduced feeding time of flies would have an economic impact of tabanid feeding on cattle. We view the contemporary contribution of these data as a caution for researchers comparing tabanid incidence on control and treated livestock in field studies. If an insecticide causes a 30% reduction in feeding time, then at any time the number of feeding flies on a treated cow should be 30% less than those on a control cow, although the total number of flies feeding on both would be equivalent. Therefore, if comparisons of tabanid incidence are made between controls and animals treated with an insecticide for which the effects on tabanid feeding time have not been established, the number of flies that arrive and feed over a standard period should be recorded.

The 31% reduction in bloodmeal size of *T. fuscicostatus* fed on fenvalerate sprayed cows may be related to the average reduction in feeding time. Observations on daily blood loss have yielded estimates of over 200 cc/animal in Oklahoma (Hollander and Wright 1980); a conservation of 62 ml of blood per animal per day

Table 1. Feeding time (s) of females of *Tabanus* species on control and fenvalerate sprayed (0.05%) cows in Louisiana.

SPECIES	UNTREATED COWS			TREATED COWS		
	n	X ± SD	RANGE	*n*	X ± SD	RANGE
T. fuscicostatus	53	151.85 ± 88.38*	45 - 420	76	102.05 ± 40.11†	37 - 275
T. lineola	55	140.36 ± 71.55*	30 - 360	31	85.87 ± 29.71†	44 - 175
T. pallidescens	23	127.70 ± 68.70*	49 - 373	34	95.03 ± 30.96†	53 - 174
T. wilsoni	7	145.86 ± 73.19*	54 - 248	8	105.88 ± 37.74*	39 - 165
T. proximus	18	256.22 ± 87.76*	92 - 460	20	171.15 ± 71.62†	55 - 399

* Means in rows within species followed by the same symbol are not significant ($P > 0.05$) using the ANOVA.

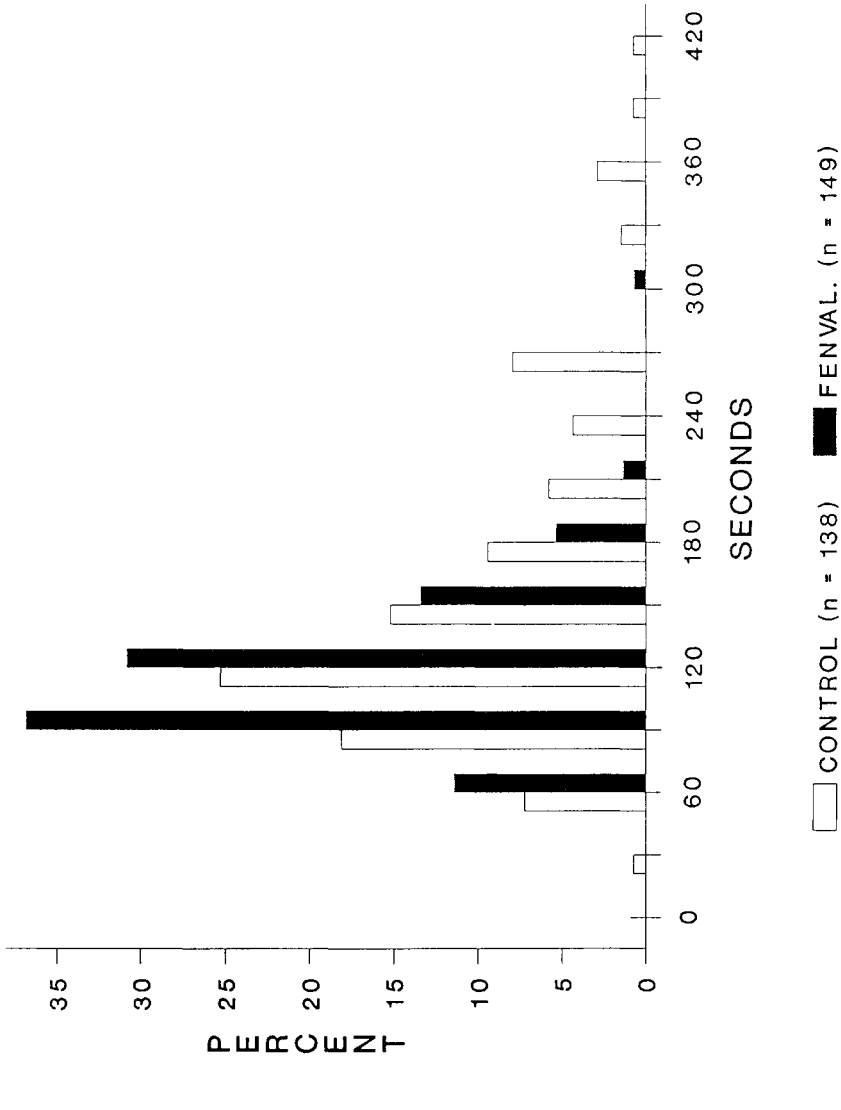

Fig. 1. Distribution in relative percentage of feeding time of tabanids (*T. fuscicostatus, T. lineola, T. pallidescens* and *T. wilsoni*) that fed on control and fenvalerate (0.05%) treated Holstein cows.

Table 2. Engorged weight (mg), bloodmeal size (mg) and reduction in bloodmeal size of *T. fuscicostatus* feeding on control and fenvalerate sprayed (0.05%) cows.

DATE	STATUS	CONTROL				FENVALERATE (0.5%)				% REDUCTION
		n	X	±	SD	*n*	X	±	SD	
22-VI-1988	Engorged	53	95.5	±	15.6†	33	76.8	±	21.0‡	
	Unfed*		46.7				46.7			
	Bloodmeal size		48.8				30.1			38%
19-VII-1988	Engorged	51	81.7	±	17.4†	48	72.3	±	14.2‡	
	Unfed*		40.9				40.9			
	Bloodmeal size		40.8				31.4			23%
Pooled bloodmeal size			44.9				30.9			31%

Means in row followed by different symbols were significant ($P < 0.05$) using the ANOVA.

* Unfed weight was derived from a linear regression of weight versus wing length (mm) based on 297 specimens collected in 1987.

Table 3. Mortality rates (%M) and knockdown percentages (%KD) of *T. fuscicostatus* females feeding for given time on control and fenvalerate sprayed (0.01%) steers on 23 July 1987.

FEEDING TIME	CONTROL STEERS			FENVALERATE (0.01%) TREATED STEERS							
(sec)	*n*	24h	48h	*n*	1h	24h			48h		
		%M	%M		%KD	%KD	%M	%(KD + M)	%KD	%M	%(KD + M)
30	40	3	3	60	98	20	42	62	0	70	70
60	40	0	5	60	100	23	47	70	7	68	75
90	40	0	0	60	100	18	53	72	0	67	67
120	40	0	5	60	100	13	60	73	0	68	68
>120	60	0	0	60	100	25	60	85	2	78	80
Total	220	1	2	300	100	20	52	72	2	70	72

(31%) of the reported loss might be of significant economic benefit. Qualitative observations have previously excluded any beneficial effects of pyrethroids for tabanid burdens of cattle. However, these results indicate that quantitative studies on the effect of different insecticides on tabanid feeding success should be conducted.

The fact that mortality of the flies fed on treated cows did not increase significantly with exposure time is consistent with available information. Zyzak et al. (1989) showed that the LD_{50} for topically applied fenvalerate was less for unfed flies than for engorged flies; the extra weight of the bloodmeal appeared to afford some slight protection. We assume that, as a group, the flies allowed to feed for longer periods would have ingested a larger amount of blood, which might have counteracted any increased exposure. The fact that significant differences in mortality were not observed among exposure times should facilitate evaluation of products against field populations of tabanids. As Presley and Wright (1986) pointed out, many tabanid species prefer to feed on the legs and it is extremely difficult to collect totally engorged flies from the legs. Our results indicate that using flies allowed to feed for a period of 30 s or greater at the natural feeding site should be adequate in field tests of the efficacy of the insecticide formulations.

Without the advent of a systemic repellent for livestock, absolute tabanid control with insecticides appears unlikely; but partial tabanid population control in defined circumstance appears feasible (Foil et al. 1989). Furthermore, the results of this study indicate that there are sublethal effects of a pyrethroid (fenvalerate) on feeding tabanids; these sublethal effects could provide economic benefit and need further investigation.

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