THE DIFFERENCES BETWEEN HORN FLY[1] DENSITIES ON CATTLE PASTURED IN WYOMING AND NEBRASKA AS POSSIBLY INFLUENCED BY ELEVATION

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ABSTRACT

Adult horn fly densities were determined at three elevations (800, 1800 and 2400 m) over two years using fly counts on cattle. In 1995, cattle at the 800 m elevation had the highest density of flies. In 1996, the greatest density of flies occurred on cattle at the 1800 m elevation. In both 1995 and 1996, the fewest flies were recorded on cattle at the 2400 m elevation, with densities below 90 flies per side. Based on published economic injury levels, control of horn flies at elevations above 2400 m may not be economically justifiable in Wyoming. Cattle grazed at elevations at or below 1800 m may not have horn fly populations large enough to merit control and therefore should be examined for fly densities before control measures are taken.

INTRODUCTION

The horn fly, *Haematobia irritans* (L.) (Diptera: Muscidae), is one of the most important pests of beef cattle in the United States (Bruce 1964). Its blood feeding habits and its occurrence in large populations cause decreased weight gains, feed efficiency and milk production (Byford et al. 1992).

Many researchers have attempted to determine the factors that influence levels of horn fly populations on cattle, including hair color (Ernst and Krafsur 1984, Schreiber and Campbell 1986), time of day (Schreiber and Campbell 1986), breed (Steelman et al. 1991, 1994) and age of cattle (Haufe 1986, Steelman et al 1993). These efforts have met with varying results. Studies investigating the relationship between elevation and horn fly density have not been reported in the literature.

Cattle production in the mountainous state of Wyoming occurs at a variety of elevations. If densities of horn flies are considerably lower at higher elevations, producers may be less likely to utilize prophylactic insecticide treatments, thereby reducing production costs and maintaining an insecticide susceptible population of horn flies. The objective of the study was to determine if differences existed in horn fly densities on cattle grazed at different elevations.

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MATERIALS AND METHODS

A study of adult horn fly densities on cattle was conducted during the summers of 1995 and 1996 at three locations at each of three elevations. The first elevation, 800 m (2,700 ft), was near North Platte, Nebraska. The second elevation, 1800 m (6,000 ft), was located near Cheyenne, Wyoming. The third elevation, 2400 m (8,000 ft), was near Albany, Wyoming in the Medicine Bow Mountains. Three locations which pastured heifers in 1995 were replaced in 1996 by locations with cow/calf herds.

Selection of cattle herds in this study was not based on animal breed or color. Ernst and Krafsur (1984) found no differences in horn fly densities due to host breed or color. In their study only 3.3% of the total variance in horn fly counts was attributable to the host animals, and 83% of the variance was attributed to the date of sampling. In this study, adult horn fly population densities on cattle were determined on three dates, in both years. Binoculars (7 x 50 mm) were used to count all visible horn flies on one side of up to 30 heifers or cows in each herd.

In each year, the first sampling was conducted at each location 10 to 14 days after adult horn flies were first observed on cattle. This resulted in staggered sampling dates during the summer. In 1995, adult horn flies were first sampled at the 800 m locations in mid June, at the 1800 m locations in early July and at the 2400 m locations in mid-late July. In 1996, adult horn flies were first sampled at the 800 and the 1800 m locations in the first week of July and at the 2400 m locations in the second week of July. In both years, the second and third sampling dates followed approximately one month after the previous sampling date.

The locations chosen for this study were considered to be fixed effects in all the analyses of variance because certain qualifications needed to be satisfied. These included: no insecticide use on the cattle, the cattle must be maintained at the same elevation for the duration of the study, and the animals must be grazed on unimproved native range pastures. The elevations used in this study were also considered to be fixed effects in the analyses of variance, as they were selected to represent specific zones at which cattle were pastured in Wyoming and Nebraska. A nested analysis of variance and a Tukey's multiple mean separation test between the three elevations at each sampling date were conducted on the horn fly data (GLM Procedure, SAS Institute Inc. 1992). In this analysis the variable, location, was nested within the elevation.

Because sufficient cow herds were not available in 1995, three herds of yearling heifers were used in that year's study. The variables, location and elevation, were considered to be fixed effects. A nested analyses of variance and a Tukey's multiple mean comparison using orthogonal contrasts was conducted to determine if a significant difference existed between adult horn fly densities on heifers and on cows sampled at an elevation and within a date (GLM Procedure, SAS Institute Inc. 1992). In this analysis the variable, location, was nested within the elevation.

RESULTS AND DISCUSSION

Monthly high temperatures and rainfall totals for 1995 and 1996 are presented for each elevation (Table 1). In both years, the highest average monthly maximum temperatures were recorded at 800 m followed by temperatures at 1800 m, with temperatures at 2400 m far lower. Season-long daily high and low temperatures for the summers of 1995 and 1996 at the three elevations are reported in Kaufman (1997).

The cow herds carried significantly more horn flies than did the heifer herds at every sampling date (Table 2). Based on these results, adult horn fly counts on heifers were eliminated from further analysis.

TABLE 1. Average High Temperatures and Total Rainfall for Three Elevations Sampled Over Two Years.

		Average High Temperature (°C)			Rainfall (cm)		
Year	Month	800 m[a]	1800 m[b]	2400 m[c]	800 m[a]	1800 m[b]	2400 m[c]
1995	Jun	25.8	24.0	18.8	8.86	10.11	5.16
	Jul	30.7	29.0	22.6	4.50	7.27	1.85
	Aug	33.4	31.0	22.8	1.40	2.45	1.09
	Sep[d]	---	27.0	21.4	---	7.97	5.18
1996	Jun	27.0	25.2	21.6	8.92	4.59	1.74
	Jul	28.1	27.5	24.4	15.77	7.95	3.44
	Aug	27.4	27.0	23.4	8.66	4.59	3.38
	Sep[d]	---	21.5	17.8	---	5.94	4.72

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[c]Centennial 1 N Station (National Climatic Data Center, Asheville, NC 28801). The Albany (2400 m) locations are approximately 8 miles from the Centennial weather station at the same elevation.
[d]September 1 - 15 reported.
--- no data collected.

In 1995, significantly more flies were found on cattle grazed at the 800 m elevation than on cattle at either the 1800 m or 2400 m elevations at the first sampling date (Table 3). No difference was found in horn fly densities on cattle between the 1800 m or the 2400 m elevations. No significant differences in horn fly densities were found at the 800 m and the 1800 m elevations at the second sampling date, but each had significantly greater horn fly densities than cattle at the 2400 m elevation. On the third sampling date, cattle at the 800 m elevation had significantly greater horn fly densities than cattle at the 1800 m elevation, which had significantly greater horn fly densities than cattle the 2400 m elevation.

Cattle at the 1800 m elevation were found to have significantly greater horn fly densities than cattle at either the 800 m or the 2400 m elevations at the first sampling date in 1996 (Table 3). However, no difference was found in horn fly densities on cattle between the 800 m or the 2400 m elevations. On the second sampling date, cattle grazed at the 800 m elevation had significantly greater horn fly densities than cattle at the 1800 m elevation, which had significantly greater horn fly densities than cattle grazed at the 2400 m elevation. No significant differences in horn fly densities were found between cattle grazed at the 800 m and the 1800 m elevations on the third sampling date, but each had a significantly greater fly densities than cattle at the 2400 m elevation.

In this study, factors other than the altitude at which cattle were grazed, undoubtedly influenced horn fly densities. Evaluation not only encompasses the height above the sea level, but also influences the biotic and abiotic factors that exist in such an ecosystem. These other factors include; latitude, longitude, climatological factors, vegetative influences, insect fauna of the dung pats, human alterations and others. The 800 m and 1800 m elevation locations are characterized by rolling plains and tablelands of moderate relief, and vegetation class is termed a shortgrass prairie (Bailey 1995). The 2400 m elevation locations are characterized by rugged glaciated mountains, with local relief of 900 to 2100 m, and striking vegetational zonation, controlled by a combination of altitude, latitude, direction of

TABLE 2. Comparison of 1995 Horn Fly Densities Between Yearling Heifers and Cows at the Same Elevation and Sampling Date.

Sampling Date[a]	Elevation (m)	Comparison[b]	N[c]	Mean No. Horn Flies	Mean Separation
1	800	Cow	20	74.35	a
		Heifer	59	41.11	b
		EMS = 765.60; F-value = 21.82			
	2400	Cow	55	38.80	a
		Heifer	30	13.53	b
		EMS = 765.60; F-value = 18.88			
2	800	Cow	30	162.67	a
		Heifer	60	71.61	b
		EMS = 3475.10; F-value = 47.71			
	2400	Cow	55	87.82	a
		Heifer	30	55.37	b
		EMS = 3475.10; F-value = 6.36			
3	800	Cow	30	139.00	a
		Heifer	60	64.57	b
		EMS = 1519.74; F-value = 72.91			
	2400	Cow	55	34.18	a
		Heifer	30	12.87	b
		EMS = 765.60; F-value = 6.50			

[a]800 m sampling date 1 = June 19, sampling date 2 = Aug. 1-4, sampling date 3 = Aug. 28-29; 2400 m sampling date 1 = July 20-25, sampling date 2 = Aug. 23, sampling date 3 = Sept. 13.
[b]Degrees of freedom = 1. Alpha = 0.05. 800 m cow herd size = 150 animals, heifer herd sizes = 72 and 48 animals; 2400 m cow herd sizes = 100 and 50 animals, heifer herd size = 200 animals.
[c]N = number of animals sampled.

TABLE 3. Adult Horn Fly Counts on Cattle Among Elevations and by Date for 1995 and 1996.

		1995		1996	
Sampling Date [a]	Elevation (m)[b]	N[c]	Mean No. Horn Flies[d]	N[c]	Mean No. Horn Flies[d]
1	800	20	74.35 a	90	51.61 b
	1800	88	32.71 b	60	85.68 a
	2400	55	38.80 b	79	47.18 b
1995: HSD = 13.72, DF = 157, n = 54, EMS = 908.16, F-value = 15.62, r = 3.346					
1996: HSD = 9.54, DF = 221, n = 76, EMS = 621.42, F-value = 47.21, r = 3.337					
2	800	30	162.67 a	90	108.80 b
	1800	90	154.74 a	90	126.19 a
	2400	55	87.81 b	79	72.53 c
1995: HSD = 30.68, DF = 169, n = 58, EMS = 4882.35, F-value = 18.4, r = 3.344					
1996: HSD = 14.55, DF = 250, n = 86, EMS = 1638.54, F-value = 42.85, r = 3.334					
3	800	30	139.00 a	60	135.60 a
	1800	90	87.84 b	90	155.17 a
	2400	55	34.18 c	88	36.78 b
1995: HSD = 20.15, DF = 169, n = 58, EMS = 2106.64, F-value = 53.50, r = 3.344					
1996: HSD = 19.66, DF = 230, n = 79, EMS = 2743.95, F-value = 126.17, r = 3.336					

[a] 1995, 800 m cow herd size = 150 animals, heifer herd sizes = 72 and 48 animals; 1800 m cow herd sizes = 92, 100, and 800 animals, 2400 m cow herd sizes = 100 and 50 animals, heifer herd size = 200 animals; 1996, 800 m cow herd sizes = 150, 84, and 138 animals, 1800 m cow herd sizes = 92, 100, and 800 animals, 2400 m cow herd sizes = 50, 100 and 600 animals.

[b] 1995, 800 m sampling date 1 = June 19, sampling date 2 = Aug. 1-4, sampling date 3 = Aug. 28-29; 1800 m sampling date 1 = July 5-6, sampling date 2 = Aug. 7, sampling date 3 = Sept. 8; 2400 m sampling date 1 = July 20-25, sampling date 2 = Aug. 23, sampling date 3 = Sept. 13; 1996, 800 m sampling date 1 = July 2-3, sampling date 2 = July 30-31, sampling date 3 = Aug. 13, 30; 1800 m sampling date 1 = July 5, sampling date 2 = Aug. 2, sampling date 3 = Aug. 28; 2400 m sampling date 1 = July 12, sampling date 2 = Aug. 9, sampling date 3 = Sept. 4.

[c] N = number of animals sampled.

[d] r = studentized 5% level for multiple range test, Alpha = 0.05.

prevailing winds and slope exposure. A more complete ecological description of the three areas sampled can be found in Bailey (1995).

Air temperatures in 1995 and 1996 at the 2400 m elevation did not surpass the maximum developmental threshold and activity temperature of 32.2 °C for horn flies reported by Bruce (1964). Temperatures at the 1800 m elevation exceeded the threshold 24 times in 1995 and 4 times in 1996, while temperatures at the 800 m elevation exceeded the threshold 40 times in 1995 and 7 times in 1996. These high temperatures at the 800 m elevation may be associated with the bimodal curve in Western Nebraska adult horn fly populations reported by Campbell (1976), which was similar to those observed in Texas (Bruce 1964, Palmer and Bay 1984). Greenham (1972) and Palmer et al. (1981) found maximum temperatures in dung pats to be at least 10 °C higher than the maximum air temperature, while minimum temperatures in the pat were similar to minimum air temperatures. Horn fly larvae do not survive if subjected to more than 2 h daily of temperatures above 44 °C , a maximum of 34 °C air temperature (Palmer and Bay 1984) or 6 h at 42 °C (Palmer et al. 1981). Pupae do not survive if exposed to temperatures of 44 °C for 6 h (Palmer et al. 1981).

Adult horn fly populations at the 1800 m elevation were significantly greater than at the 800 m elevation on the second sampling date in 1995. The high temperatures observed in 1995 may have killed the horn fly larvae in Nebraska, thus slowing the growth rate of the adult population, resulting in a biomodal curve as reported by Campbell (1976). Temperature levels were not as high in 1996 as they were in 1995, which may account for the significantly larger horn fly levels observed at 800 m at the second sampling date in 1996.

At the second and third sampling date in both 1995 and 1996, significantly fewer horn flies were counted on cattle pastured at the 2400 m elevation compared to cattle grazing at the 800 m and the 1800 m elevations. These differences may reflect fewer season-long accumulated developmental degree days. Cool temperatures and other diapause-inducing signals also may have contributed to the reduced horn fly densities at the 2400 m elevation on the third sampling date. These observations suggest that temperature, as influenced by elevation, plays an important role in the size of horn fly populations. Bruce (1964) reported that the optimum conditions for adult horn fly activity are between the relatively narrow temperature limits of 26.7 and 32.2 °C. He also reported that at temperatures below 20 °C, the adult horn fly becomes sluggish and is inactive below 4.4 °C. Lysyk (1992) reported that nearly 100% of horn flies reared at less than 16 °C entered diapause, regardless of the photoperiod to which the parents were exposed.

Horn fly densities at the 2400 m elevation reached a maximum of 87 flies per side in 1995 and 73 flies per side in 1996. Densities at the 1800 m elevation reached a maximum of 155 flies per side in both 1995 and 1996, while densities at the 800 m elevation were 163 flies per side in 1995 and 136 flies per side in 1996. Haufe (1979), working in western Canada, suggested an economic injury level of ca. 250 horn flies per animal. Schreiber et al. (1987) concluded that an economic injury level for horn flies is at a density greater than 200 flies per animal. The horn fly counts in this study were conducted on only one side of the animal. If the numbers generated in this study are doubled, no control of horn flies would be needed for cattle maintained at elevations of 2400 m and above. Control of horn flies at the 1800 m and 2400 m elevations may be justified during the middle and/or end of the summer, if horn fly densities build to levels greater than 125 flies per side.

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