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Case study: Impact of *Hypoderma lineatum* upon live growth, carcass attributes, and hide grade of fed beef cattle.

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ABSTRACT

A case study evaluated the influence of cattle grubs on growth during the finishing phase, carcass attributes, and hide grade. At arrival processing (d 0), some crossbred bulls within a load of cattle were noted to be infested with the common cattle grub {*Hypoderma lineatum* (Villers)} and were treated with an anthelmintic. Cattle were palpated (d 12) to quantify rate of grub infestation; grubs were manually extracted from the left side of animals whereas right-side grubs remained. Two grub-infested cattle were euthanized (d18) to quantify hide and carcass damage. Cattle were periodically weighed (d 12, 40, 70, 96, 124, 152, 180, 208, 234, 236, 264) to assess growth between grub-free and grub-infested animals. Finished cattle were commercially slaughtered (n=9 on d 234; n=19 on d 264); individual quality and yield grade parameters were assessed. Hides were individually identified and tracked through de-fleshing, de-hairing, and blue-chroming processes; blue-chrome hides were graded as #1, #2, or #3 hides. No difference in initial weight (*P*=0.89), finished weight (*P*=0.35), average daily gain (*P*=0.59), hot carcass weight (*P*=0.38), longissimus muscle area (*P*=0.91), 12th rib subcutaneous fat depth (*P*=0.64), KPH fat (*P*=0.38), or yield grade (*P*=0.84) was detected between grub-free and grub-infested cattle. Grub-infested cattle tended (*P*=0.07; Small^{20} vs Slight^{60}) to have more marbling than did grub-free cattle. No difference in hide damage or value occurred between left sides (manually extracted) and right sides (grubs allowed to remain). Hide damage resolved during the finishing period and all grub-damaged hides met #1 criteria.

KEYWORDS: cattle, grubs, hide

INTRODUCTION

Cattle grubs, also called wolves or warbles, are the larval or maggot stage of insects known as heel flies, warble flies, or gadflies (Bishopp et al. 1926). Larval stages of the flies have historically been parasites of concern to cattle producers in North America because they cause damage that can decrease the value of the host (Drummond 1987). Heel flies are known to reduce cattle comfort and daily growth, whereas grubs are known to damage the hide and lessen its value (Bishopp et al. 1926). Two species of cattle grubs are common in the U.S.; the

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most widespread is the common cattle grub, *Hypoderma lineatum* (Villers), present in every state; the other is the northern cattle grub, *Hypoderma bovis* (Linnaeus), dominant in the northern U.S. Heel flies develop from grubs that have burrowed to and dropped from the backs of cattle. Heel flies appear during the first warm days of spring and their activity increases as the season advances (Scholl 1993). Heel flies usually attach themselves low on the legs, particularly above the hoof, and deposit as many as 300 eggs on the hair of the animal. This is why the name "heel fly" has been used throughout time.

Economic losses are primarily attributable to the larvae that migrate through the host tissues and penetrate the skin, resulting in diminished hide value (Andrews 1978). Meat of slaughtered cattle infested with grubs may also require extensive trimming, thus decreasing carcass weight and value (Hendrickx et al. 1993). Control of cattle grubs or heel flies has historically been an important insect challenge confronting the U.S. cattle industry (Bishopp et al. 1926). Before chemicals were available, grubs were manually extracted from the host; extraction was common via finger pressure to squeeze the larvae out of back of the host (Bishopp et al. 1926). Early chemical treatment included use of arsenic or coal-tar creosote solutions used in dipping vats to eliminate eggs of the heel fly (Bishopp et al. 1926). Later developments brought insecticides including rotenone (McKay 1952) and organophosphates (Rogoff et al. 1960; Rich and Ireland 1961; Fink and Riley 1976; Stendel 1977) to the marketplace. The landmark discovery of avermectins (Burg 1979) led to development and widespread use of ivermectin (Campbell et al. 1983; Leaning 1984), doramectin (Hendrickx et al. 1993; Vercruysse et al. 1993), and eprinomectin (Shoop et al. 1996; Rehbein et al. 2012) to rid cattle of endo and ectoparasites.

Laake et al. (1942) reported records from the Institute of American Meat Packers which indicated that 42% of hides contained visible grub damage. As an illustration of the availability and use of avermectins throughout our industry to control cattle grubs, subsequent reports document a notable decline in grub damage. The 1991 National Beef Quality Audit reported that 1.3% of the carcasses observed had visible grubs (Lorenzen et al. 1993), which declined to 0.03% in the 1995 audit (Boleman et al. 1998). In the 2000, 2005, 2011, and 2016 National Beef Quality Audits (Boleman et al. 1998; Garcia et al. 2008; McKeith et al. 2012; Eastwood et al. 2017), no instances of visible grubs were reported. Similarly, the Canadian Beef Quality Audit reported only 0.1% of carcasses with evidence of grubs in 1996 (Van Donkersgoed et al. 1997) with a further decline to 0.008% in the subsequent audit in 1998 (Van Donkersgoed et al. 2001).

The objective of this case study was to determine if differences in live growth, carcass attributes, and hide value existed between cattle that arrived infested with grubs and those free from grubs.

MATERIALS AND METHODS

Initial discovery, cattle processing, and feeding. While processing crossbred bulls (n=32; origin San Angelo, TX) upon arrival, some animals in the load of cattle were discovered to be infested with grubs whereas others were not affected. All 32 cattle were de-wormed with *fenbendazole* (SafeGuard®; Merck Animal Health; Summit, NJ) and *doramectin* (Dectomax®; Zoetis, Florham Park, NJ) upon arrival (d 0) to treat internal and external parasites. Dectomax® is labeled for the treatment and control of cattle grubs. In addition, metaphylaxis was administered (*tulathromycin*; Draxxin®; Zoetis; Florham Park, NJ), cattle were vaccinated for BVD/PI-3/BRSV (*Vista® 5 SQ*; Merck Animal Health; Summit, NJ), and individually identified with a visual ear tag. Cattle were placed on a starter ration (d 0) and later transitioned to a finishing ration (d 45).

Manual removal, castration, and further processing. Twelve days after arrival, all cattle were re-weighed and manually palpated to quantify grub infestation; a hide map (Figure 1) was used to record location of the individual grubs. Of the 32 animals, 25 were infested with grubs whereas seven were grub-free. Grubs were manually extracted from the left side of infested animals to assess potential need for or benefit from physical removal; grubs on the right side remained in animals. Also on d 12, animals were administered a growth-promoting implant (*200 mg trenbolone acetate and 40 mg estradiol*; Revalor® XS; Merck Animal Health) and castrated using restrictive surgical tube bands (The Callicrate Bander®; St. Francis, KS). Extracted grub samples were sent to Texas A&M Veterinary Medical Diagnostic Lab (TVMDL), College Station, TX for species confirmation.

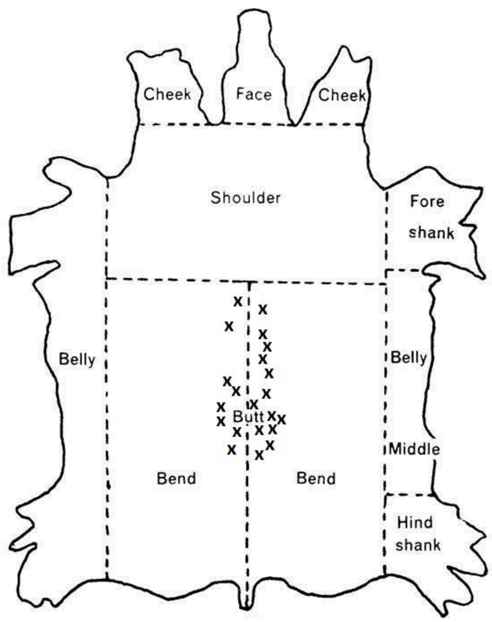

Figure 1. Hide map used to document grub presence and location in feeder cattle finished at the WTAMU Research Feedlot (d 18).

Meat laboratory harvest. Two cattle (258, 343 kg) infested with grubs were randomly selected and slaughtered (d 18) at the West Texas A&M University Meat Laboratory to quantify carcass and hide losses in feeder calves. Cattle were immobilized using a captive bolt pistol, exsanguinated, and the hide was removed using a pneumatic de-hider. Esophageal surroundings were inspected for evidence of grubs or grub tracts. De-hided carcasses were evaluated for number of grubs observed in/on the subcutaneous fat (Figure 2). Carcasses were trimmed near

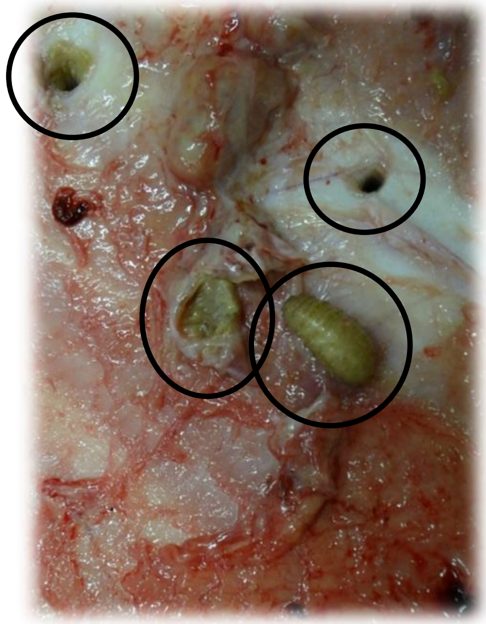

Figure 2. Cattle grubs and hide damage in a feeder calf harvested at the WTAMU Meat Laboratory (d 18).

where grubs were located. Carcasses were eviscerated and split into halves, then the *longissimus dorsi* muscles were dissected and examined for grubs. After thorough examination, both dismantled carcasses were disposed in a local landfill because those animals had not met withdrawal times for *Vista® 5 SQ* (21 d) or Dectomax® (35 d). Both hides were manually fleshed and converted into rawhide to document hide damage in the feeder calves (Figure 3).

Live animal growth. Two animals (grub-free) died from bovine respiratory disease during the study (d 15, d 50). The remaining cattle were periodically reweighed (d 40, d 70, d 96, d 124, d 152, d 180, d 208, d 234, d 236, d 264) to assess potential differences in growth rate.

Commercial slaughter and hide processing. Cattle were individually weighed before shipment for slaughter. Cattle were slaughtered in two groups (n=9 on d 234; n=19 on d 264) at Tyson Fresh Meats, Amarillo, TX. Data collected during the slaughter and grading processes were individual animal identification, liver score (Brown & Lawrence 2010), hot carcass weight, longissimus muscle area, 12th rib subcutaneous fat depth, kidney-pelvic-heart fat, yield grade, marbling score, and quality grade (USDA 1997). Hides were individually identified and tracked through the hide-preservation process. Hides were green de-fleshed (initial mechanical removal of fat and muscle), lime de-fleshed (soaking hide in alkaline solution), and placed into containers where they underwent a de-hairing process for 24 h. Hides were placed into a different container for 24 h where they underwent the chroming process to create wet blue chrome leather. After blue-chroming, hides were individually graded as #1, #2, or #3 according to industry standards (United States Hide, Skin & Leather Association 2014).

Figure 3. Cattle grub damage in rawhide from a feeder calf harvested at the WTAMU Meat Laboratory (d 18).

Statistical analysis. The primary outcome variable of interest was the subjective ordinal hide-grade score. Secondary outcome variables were interval scale live animal growth and both interval and ordinal carcass grading outcomes. Because the case study was unbalanced (grub-infested=23; grub-free=5) and because the assumptions of ANOVA (independence, normal distribution, and homogeneity of variances) were not met, the data were analyzed using non-parametric methods. The Mann-Whitney U test was chosen to analyze the data because they were represented as two independent samples. Median and quartile deviation for each variable were determined via the UNIVARIATE procedure of SAS (version 9.4; SAS Institute, Cary, NC).

RESULTS

Meat laboratory harvest. Grubs observed in the back of the two feeder cattle during the meat laboratory harvest (d18 – 03December2014) corresponded with timing of the grub cycle on the southern High Plains. The grubs were identified by TVMDL as *Hypoderma lineatum*. Holes from the grubs manually extracted from the left side on d 12 did not heal in 6 d. No evidence of grubs or grub tracts was observed in the esophageal surroundings. Grub tracts inclusive of holes and subcutaneous fat tears were documented throughout the backs of the hosts. No evidence of grubs or grub tracts was observed in the longissimus muscle. Hides fleshed and converted into rawhide demonstrated the hide damage over the dorsal aspect of the host.

Growth performance. No difference in initial weight (P = 0.89), finished weight (P = 0.35), or interim or overall average daily gain ($P \geq 0.21$) were detected between grub-free and grub-infested cattle (Table 1).

Table 1. Median ± quartile deviation of initial weight, number of grubs, periodic average daily gain, finished-weight, and total ADG of grub-free cattle and grub-infested cattle.

	Grub-Free	Grub-Infested	*P-value*
Initial Weight, kg	304.0	301.9	0.89
Grubs palpated d 12, n	0	16	
ADG d 0-d 12, kg	1.28 ± 1.25	0.76 ± 0.34	0.22
ADG d 12-d 40, kg	0.84 ± 1.96	1.64 ± 0.48	0.21
ADG d 40-d 70, kg	1.57 ± 0.66	1.41 ± 0.25	0.68
ADG d 70-d 96, kg	1.66 ± 0.045	1.55 ± 0.24	0.52
ADG d 96-d 124, kg	1.38 ± 0.14	1.30 ± 0.22	0.41
ADG d 124-d 152, kg	1.91 ± 0.21	1.90 ± 0.23	0.50
ADG d 152-d 180, kg	1.68 ± 0.14	1.65 ± 0.16	1.00
ADG d 180-d 208, kg	1.30 ± 0.02	1.30 ± 0.26	0.67
ADG d 208-d 236, kg	1.68 ± 0.23	1.47 ± 0.22	0.66
ADG d 236-d 264, kg	1.07 ± 0.05	1.00 ± 0.16	0.62
Finished weight, kg	678.03	658.00	0.35
Overall ADG, kg	1.47 ± 0.06	1.49 ± 0.16	0.59
12th rib subcutaneous fat, cm	1.25	1.37	0.64
Hot carcass weight, kg	435.58	417.76	0.38
Longissimus muscle area, cm^2	92.84	91.10	0.91
Kidney-pelvic-heart fat, %	1.73	1.92	0.38
Yield grade[a]	3.26	3.35	0.84
Marbling score[b]	36	42	0.07
Liver Abscess, %	0.00%	3.57%	0.06

[a] USDA YG = 2.5 + (2.5 × 12th-rib subcutaneous fat thickness, in.) + (0.0038 × HCW, lb) + (0.2 × percentage KPH) − (0.32 × LM area, in^2).
[b] Marbling Scores: 30 = Slight; 40 = Small; 50 = Modest.

Carcass attributes. Carcass attributes including hot carcass weight (P = 0.38), longissimus muscle area (P = 0.91), 12th rib subcutaneous fat depth (P = 0.64), KPH fat (P = 0.38), or yield grade (P = 0.84) did not differ between carcasses from grub-free and grub-infested animals. Grub-infested cattle tended to have more liver abscesses (P = 0.06), and more marbling (P = 0.07; Small^{20} vs Slight^{60}) than did grub-free cattle. These results were unexpected and might be indicative of a type-I error related to the small sample size rather than a repeatable result.

Hide damage. No difference in hide damage or value occurred between left sides (manually extracted) and right sides (grubs allowed to remain) of the cattle. Hide damage observed in feeder calves resolved during the finishing period and all grub-damaged hides met #1 criteria (Figure 4).

Figure 4. Individually identified blue-chrome hide.

CONCLUSION AND DISCUSSION

Our results agreed with Scholl et al. (1988) who reported that infestation by cattle grubs did not affect carcass grade, back-fat thickness, marbling score, or rib-eye area when steers were slaughtered. Furthermore, our results suggested that grub-infested feeder cattle treated with avermectin can be expected to demonstrate growth performance, carcass characteristics, and hide grades equivalent to cattle free of grubs. In conclusion, modern anthelmintic technology has made it possible to eliminate grubs/heel flies from cattle populations. Timely application of avermectin can prevent grubs from reducing beef-system value.

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