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Density and distribution of cattle lice (Phthiraptera: Haematopinidae, Linognathidae, Trichodectidae) on six steers

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Abstract

The density and distribution of four species of cattle louse, *Bovicola bovis* (L.), *Haematopinus eurysternus* (Nitzsch), *Linognathus vituli* (L.), and *Solenopotes capillatus* (Enderlein), were elucidated from the hides of six slaughtered steers. Adult and nymphal lice were first removed from one hide by hand and the location of each specimen mapped. The remaining lice were removed by a detergent wash, and KOH dissolution of hide and hair. Lice from the remaining five hides were removed using KOH dissolution of cattle hair and subsequent filtration of the effluent. *Bovicola bovis* was most abundant, followed by *H. eurysternus*, *L. vituli* and *S. capillatus*. Significant variation was observed in *B. bovis*, *H. eurysternus* and *L. vituli* population densities. *Solenopotes capillatus* population densities did not differ significantly. All species were contagiously distributed, i.e. 'clumped', suggesting species dependant predilection sites. Predilection sites were ranked according to louse density to facilitate the development of field sampling strategies. Additional biological data were gathered on sex and life stage ratios for each species.

Keywords: Mallophaga; Cattle biting louse; *Bovicola bovis*; Anoplura; Shortnosed cattle louse; *Haematopinus eurysternus*; Longnosed cattle louse; *Linognathus vituli*; Little blue cattle louse; *Solenopotes capillatus*

1. Introduction

Cattle may become infested by four species of louse: the cattle biting louse, *Bovicola bovis* (L.); the shortnosed cattle louse, *Haematopinus eurysternus* (Nitzsch); the longnosed cattle louse, *Linognathus vituli* (L.); and the little blue cattle louse, *Solenopotes*

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was examined in detail (Hanlin, 1994). When processed, large sections of each hide were thawed and subdivided into 18 corresponding body regions (Fig. 1) as identified by Youtz and Carlson (1970). The shape and area of each body region were determined with the aid of a transparent grid that was scored into 9 cm^2 squares (3×3 cm). The grid was placed over each region of the hide, then the outline (map) was drawn on a grid patterned data sheet. From these maps we were able to recreate the entire hide of the steer.

To gather detailed information on louse density and distribution, the hide of one steer (Steer 1) was further divided into 15×15 cm squares (total area 225 cm^2) and mapped. Some pieces from the edges of the body regions were smaller than 225 cm^2. A visual search for lice was performed on the entire hide of Steer 1 by careful examination of each hide sample under a 100 watt, incandescent lamp. The hair was parted by sliding a teasing needle through the hair at the skin surface at 3 mm intervals and pressing the hair back, exposing about 4 cm of underlying skin. Each louse collected was identified to species, sex, and life stage, and the location of the specimen recorded on a map of each hide piece. Hair length was measured at the approximate center of 200 samples. Pieces of hide that were extremely dirty were noted.

Following the visual search, each sample was washed to remove any missed specimens. Each sample was placed in a 946 ml widemouth jar with 600 ml of water and 8 drops of Triton X-100 wetting agent (Henry and McKeever, 1971). The jar was then placed in a padded bucket and agitated in a Red Devil™ paint conditioner for 8 min.

About 25 ml of ethanol was added to the shaken samples to eliminate suds. The hide was submerged in tap water in an enamel pan and re-examined. Few specimens found, were removed, identified, and included in the wash filtrate data set. The detergent wash

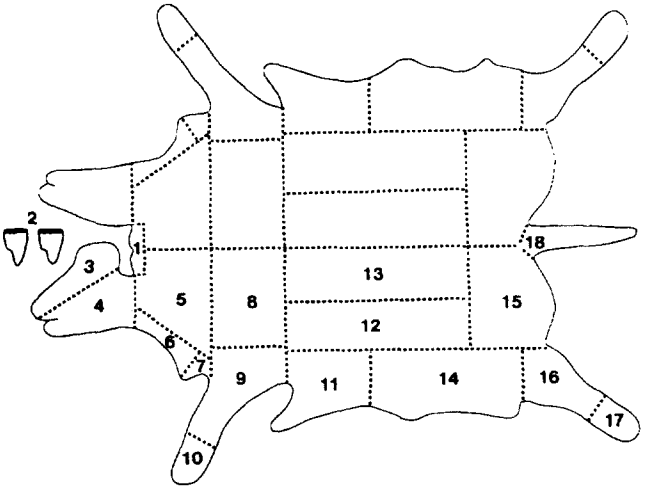

Fig. 1. Steer hide subdivided into body regions: 1 poll; 2 ears; 3 face and forehead; 4 jaw and muzzle; 5 neck and crest; 6 dewlap; 7 brisket; 8 shoulder; 9 foreleg; 10 foreshank; 11 foreflank; 12 rib. 13 back, 14 belly, 15 rump, 16 hindleg, 17 hindshank, 18 tail. Adapted from Youtz and Carlson (1970).

Table 1
Number of cattle lice collected from the hide of Steer 1 using three consecutive extraction techniques

Species	Method	Adult		Nymph	Total
		Male	Female		
B. bovis	Visual	3	1111	281	1395
	Wash	3	1467	827	2297
	KOH [a]	0	47	33	80
	Total	6	2625	1141	3772
H. eurysternus	Visual	212	398	2054	2664
	Wash	70	77	341	488
	KOH [a]	0	0	13	13
	Total	282	475	2408	3165
L. vituli	Visual	33	132	173	338
	Wash	14	16	57	87
	KOH [a]	0	0	8	8
	Total	47	148	238	433
S. capillatus	Visual	13	38	82	133
	Wash	15	33	47	95
	KOH [a]	0	0	1	1
	Total	28	71	130	229
Total lice		363	3319	3917	7599

[a] Actual hide area subjected to KOH dissolution as 21.1% of entire area.

subjected to KOH dissolution was 11 406 cm^2 and represented 21.1% of the total surface.

Bovicola bovis was the most abundant species (3772 specimens), followed by *H. eurysternus* (3165), *L. vituli* (433) and *S. capillatus* (229). Sex ratios of adult lice varied with species. The female to male sex ratio for *B. bovis* was 437:1, while for *L. vituli, S. capillatus* and *H. eurysternus*, sex ratios were, 3.1:1, 2.5:1 and 1.7:1, respectively.

Nymphs of all three species of sucking louse were more abundant than were adults. Adult *B. bovis*, however, were more abundant than nymphs. Ratios of nymphs to adults were 3.1:1 for *H. eurysternus*, 2.4:1 for *S. capillatus*, 1.3:1 for *L. vituli* and 0.4:1 for *B. bovis*.

3.1. Louse recovery methodology

Henry and McKeever (1971) recovered 90.9 ± 2.1% of the lice present on cotton rats by washing the cadavers in detergent solution. In the present study this technique recovered 95% of all cattle lice that remained on the host following visual search and removal. *Bovicola bovis* was the only species that remained on the hide in substantial numbers following washing. Presumably washing is less effective for removing biting lice than sucking lice on vertebrate hosts because biting lice grip hair firmly with the mandibles (Lipovsky, 1951).

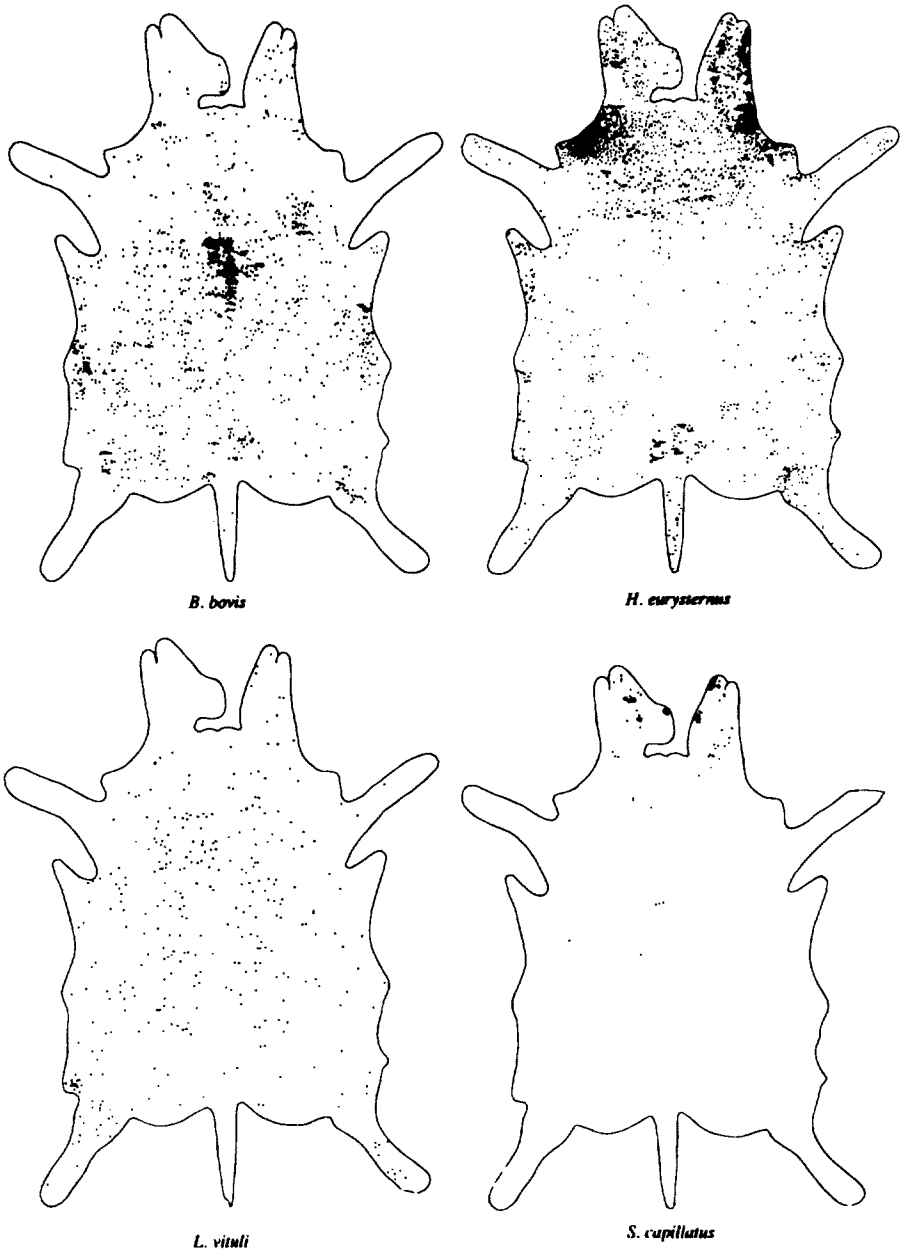

Fig. 2. Distribution of lice on the hide of Steer 1 as determined by visual search. Each dot represents one louse.

3.2. The spacial distribution of cattle lice on an individual steer

Maps prepared from the visual search of individual pieces of hide were combined to provide a distribution pattern for each lice species (Fig. 2). Each dot in the figure

withers, head, and dewlap regions, respectively. Although rejected in the subsequent analysis, the visual examination of the *L. vituli* distribution suggested a random distribution.

All louse distributions fit the negative binomial model for contagious distribution, i.e. 'clumped' (Andrewartha and Birch, 1954), (Table 4). The Chi-square goodness-of-fit test was used to determine relative fitness to a random distribution model. Chi-square values exceeding the table value were rejected. Rejection of the null hypothesis for the Poisson model was sufficient to assume the distribution was contagious (Elliott, 1977), however the use of the negative binomial confirmed that the distribution were contagious (Andrewartha and Birch, 1954).

Greatest concentrations of *B. bovis* were in the poll, back, rump, and shoulder regions (Table 5). In general, these findings are in agreement with winter-time observations of Craufurd-Benson (1941); Matthysse (1946); Chalmers and Charleston (1980), and DeVaney et al. (1988). Interestingly the poll harbored adult *B. bovis* exclusively, while nymphal densities were greatest in the back region. Ova of this species were found on the back, shoulder, and neck.

Most *H. eurysternus* per unit area were found on the dewlap than on the neck and crest and jaw and muzzle regions. There appeared to be a disproportionately high concentration of adults, especially females, in the region of the dewlap. Eggs of this species were found in several regions: jaw and muzzle, neck and crest, dewlap, shoulder, fore flank, brisket, belly, foreleg, hindshank, thigh and rump. Scharff (1962) included the shoulder, and Craufurd-Benson (1941) the rump and perineum, as winter sites of high *H. eurysternus* density, however, these areas were relatively unimportant sites in our study. DeVaney et al. (1988) observed high densities of *H. eurysternus* in the poll and neck region.

Solenopotes capillatus adults, nymphs and eggs were located primarily on the face/forehead and jaw/muzzle fewer than 12% of this species were located in all other body regions combined. Matthysse (1946) reported that this species is usually found on the neck and head of infested animals. Geden et al. (1990) concluded that omission of the head and dewlap regions of the host in lice sampling may underestimate sucking lice populations.

Linognathus vituli adults and nymphs were most abundant on the shoulder then the back. Adults appeared to be particularly abundant in the shoulder region. DeVaney et al. (1988) and Chalmers and Charleston (1980) reported high numbers of *L. vituli* on the

Table 4
Chi-square values for the poisson and negative binomial tests of cattle lice distributions on a steer

Species	Mean	Poisson		Negative binomial	
		χ^2	$df^{(n-2)}$	χ^2	$df^{(n-3)}$
B. bovis	10.91	5325.3 [a]	13	16.65	13
H. eurysternus	9.39	7694.8 [a]	12	30.50	21
L. vituli	1.19	115.3 [a]	4	7.18	5
S. capillatus	0.62	179.0 [a]	4	13.11	7

[a] Rejection of the null hypothesis, Ho: distributions are random, ($P \leq < 0.05$).

As expected cattle louse population densities varied among the six steer hides examined (Table 6). Significant variation was observed in *B. bovis*, *H. eurysternus*, and *L. vituli* population densities ($F = 4.96$, df = 5, $P \leq 0.0005$; $F = 20.54$, df = 5, $P \leq 0.0001$; and $F = 14.02$, df = 5, $P \leq 0.0001$, respectively). *Bovicola bovis* densities were greatest on Steers 5 and 6. *Haematopinus eurysternus* population densities were significantly higher on Steer 6 than the other animals. Similarly, *L. vituli* densities were greatest on Steer 6. No significant variation was observed in the *S. capillatus* population densities ($F = 2.03$, df = 5, $P \leq 0.0824$). Estimations of cattle louse populations prior to slaughter reflected, in part, the final population counts from all the steers (Table 6).

Sex ratios of adult lice varied with species and host (Table 7). The average female:male sex ratio for *B. bovis* was 322:1, while for *H. eurysternus*, *L. vituli* and *S. capillatus*, sex ratios were, 2.3:1; 2.0:1; and 1.3:1, respectively. *Bovicola bovis* is a parthenogenic species with populations weighted in favor of females. Mock (1974), in an in vitro study, observed that males were produced in alternate generations at a ratio of 2.4 females per male. A much greater proportion of *B. bovis* females was found in our study than in studies by Craufurd-Benson (1941) and Matthysse (1946) who examined the skin surface and hair of living animals and found female to male sex ratios of 24:1 and 30:1, respectively. Matthysse (1946) however, stated that in 'old established' infestations, males could not be found. Seasonal variation in cattle lice populations may cause extreme female to male ratios similar to that observed in our study. Cattle lice are winter active pests and spring time populations may, in fact, be 'old' and 'established'.

Matthysse (1946) reported a sex ratio for *H. eurysternus* of 4:1 females to males. Craufurd-Benson (1941) reported ratios from 7:1 to 15:1 in 'breeding colonies,' which were clusters of females and third instar nymphs located primarily on the top of the neck. The brisket, tail, and base of the horns, according to Craufurd-Benson, were 'secondary breeding areas' of *H. eurysternus*. Based on sex ratio, we could not classify any body region as a breeding colony nor breeding area in our study.

Nymphal cohorts were more abundant than were adults. Adult *B. bovis*, however, were more abundant than nymphs on three steers (Table 7). Average ratios of nymphs to adults were 1.5:1 for *B. bovis*, 2.0:1 for *H. eurysternus*, 1.1:1 for *L. vituli* and 1.4:1 for *S. capillatus*.

Table 6
Mean density of four species of cattle louse collected from the hides of six slaughtered steers

Steer	Ranking *	Mean cattle lice density			
		B. bovis	*H. eurysternus*	*L. vituli*	*S. capillatus*
1	Light	0.289a **	0.692a	0.149a	0.054a
2	Heavy	0.349ab	0.656a	0.161a	0.062a
3	Light	0.331ab	0.661a	0.152a	0.070a
4	Moderate	0.428abc	0.652a	0.148a	0.052a
5	Moderate	0.475bc	0.667a	0.149a	0.103a
6	Heavy	0.540c	0.818b	0.344b	0.047a

* Ranking of infestation prior to slaughter. ** Tukey's Studentized Range (HSD) test was performed on the mean lice density (lice/cm^2), $P \leq 0.005$. Means in columns followed by the same letter are not significantly different.

df = 17, $P \leq 0.1555$, respectively). However, it was apparent from the Tukey's test of the means, that significant cattle lice populations were concentrated on specific body regions (Table 8).

Predilection sites for each louse species were determined by ranking each body region with respect to lice density and pooling these data to represent a reasonable louse distribution for the six steers studied. Relatively heavy *B. bovis* populations were found on the poll, shoulder, back, rump and tail of the hosts. *Haematopinus eurysternus* were most dense on the dewlap, brisket, poll, neck and crest, and shoulder. *Linognathus vituli* were found at highest densities on the rump, back, shoulder, ribs, and belly. *Solenopotes capillatus* occurred most abundantly on the face and forehead, jaw and muzzle, neck and crest, dewlap and ears of the hosts. The ranking varied slightly between steers and, although not exact, lice distributions were similar between Steer 1 (Table 7, Fig. 2) and the pooled data from all steers (Table 8).

4. Conclusion

The use of the KOH dissolution technique was the most efficient use of time and effort for the collection of lice from a large animal. The visual determination of louse population densities was least efficient for *B. bovis* particularly when the hair coat was dirty. Hair length was not highly correlated to louse density or to the efficient visual search for three of the four species encountered. Cattle lice, on naturally infested hosts, tend to populate specific body regions. Contagious distributions were more obvious for *B. bovis, H. eurysternus*, and *S. capillatus* than *L. vituli. Bovicola bovis* was the most abundant species encountered followed by *H. eurysternus, L. vituli* and *S. capillatus*. Although breed or cross breed differences were not taken into account, assimilation of these data into cattle louse sampling strategies may be important to the accurate assessment of louse populations on bovine hosts.

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