



Distribution and seasonal prevalence of the bovine lungworm (*Dictyocaulus viviparus*) in selected areas in western Montana  
by John Brandon Winters

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Zoology  
Montana State University  
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Abstract:

A survey was conducted to determine the distribution and seasonal prevalence of bovine lungworm infections in beef herds of three western Montana counties. The purebred beef herd at the Montana Agricultural Experiment Station served as a pilot herd to indicate the seasonal dynamics of lungworm infections in herds in the area studied.

Infected cattle were detected on 27 of 35 ranches (77.1%) in Gallatin, Park and Ravalli counties. Of 16 ranches sampled in Gallatin Co., 12 (75%) yielded infected animals, whereas lungworm infections occurred on four of seven (57.1%) ranches in Park Co. and 11 of 12 (91.7%) ranches in Ravalli Co.

Based on 2,125 Baermann examinations of fecal samples collected from October, 1967 to August, 1969, 7.8% of all cattle were infected with *D. viviparus*. Incidences of 7.5%, 4.3% and 7.9% were obtained from all age groups in Gallatin, Park and Ravalli counties, respectively. Infection rates according to age showed that 6.6% of calves (less than 12 months old), 11.5% of yearlings (1 to 2 years) and 3.3% of cows (more than 2 years) harbored lungworms.

The mean number of larvae per gram of feces (l.p.g.) for all infected cattle was 0.37. Mean counts according to age for all infected animals were 0.39 l.p.g. in calves, 0.36 l.p.g. in yearlings and 0.42 l.p.g. in cows.

A seasonal occurrence of lungworm infections in calves was demonstrated in the three counties and in the pilot herd. With the exception of Ravalli Co. where inadequate late summer and early autumn sampling data were obtained, a "lungworm season" in calves extending from August to November was established. In yearlings in Ravalli Co., peaks of infection generally occurred in early summer, whereas in Gallatin and Park counties, many yearlings harbored lungworms into midautumn.

Recovery of *D. viviparus* larvae from pasture which was grazed by infected calves the previous fall apparently constituted the first documented record of overwinter survival of lungworm larvae in North America.

The significance of yearlings as carrier animals of bovine lungworms was demonstrated. The highest prevalence (11.5%) was found in this age group.

DISTRIBUTION AND SEASONAL PREVALENCE OF THE BOVINE LUNGWORM  
(DICTYOCAULUS VIVIPARUS) IN SELECTED AREAS IN WESTERN MONTANA

by

JOHN BRANDON WINTERS

A thesis submitted to the Graduate Faculty in partial  
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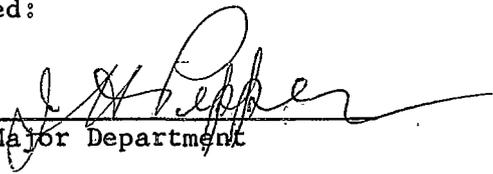
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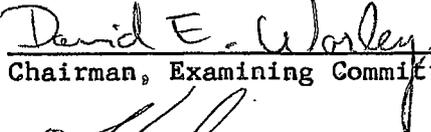
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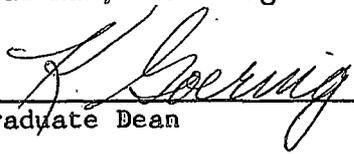
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Bozeman, Montana

December, 1969

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## ABSTRACT

A survey was conducted to determine the distribution and seasonal prevalence of bovine lungworm infections in beef herds of three western Montana counties. The purebred beef herd at the Montana Agricultural Experiment Station served as a pilot herd to indicate the seasonal dynamics of lungworm infections in herds in the area studied.

Infected cattle were detected on 27 of 35 ranches (77.1%) in Gallatin, Park and Ravalli counties. Of 16 ranches sampled in Gallatin Co., 12 (75%) yielded infected animals, whereas lungworm infections occurred on four of seven (57.1%) ranches in Park Co. and 11 of 12 (91.7%) ranches in Ravalli Co.

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Recovery of D. viviparus larvae from pasture which was grazed by infected calves the previous fall apparently constituted the first documented record of overwinter survival of lungworm larvae in North America.

The significance of yearlings as carrier animals of bovine lungworms was demonstrated. The highest prevalence (11.5%) was found in this age group.

## INTRODUCTION

The bovine lungworm, Dictyocaulus viviparus (Bloch, 1782) (Nematoda; Trichostrongyloidea), is responsible for the disease known as verminous or parasitic bronchitis in cattle. It has a cosmopolitan distribution in cattle, and also has been reported in elk, moose, white-tailed and Columbian black-tailed deer (Enigk and Hildebrandt, 1964).

D. viviparus is considered to be one of the most injurious helminth parasites of cattle (Schwartz, 1942). Parasitic bronchitis is of great economic significance in many parts of the world. Failure to gain weight normally is a frequent sequela of this disease. Another important consequence is a decline in milk production in infected animals (Petrelius, 1951; Campbell and Wetherill, 1957). Mortality, especially in foreign countries, has been attributed to lungworm infections. The majority of severe outbreaks of dictyocaulosis have been confined to the British Isles where climatic and pasture conditions favor development and transmission of lungworm larvae. Jarrett et al. (1954) confirmed the disease-producing capabilities of D. viviparus and stated that during certain months parasitic bronchitis is the most important killing disease of British cattle. Epizootics of parasitic bronchitis have been reported in North America by Witter and Rountree (1953), Rountree et al. (1954) and Campbell and Wetherill (1957). Smith (1967) stated that D. viviparus was a significant factor in the death of 300 to 400-pound calves in Texas. In Russia, Penkov (1945)

encountered 50% mortality in cattle on farms in his district, whereas Dmitriev (1964) reported 213 deaths from another section. Lungworms were responsible for heavy mortality in Indian cattle (Malaki, 1961). An epizootic in Brazil resulted in 14% mortality in a herd of 1,200 animals (Rocha et al., 1967). Wertejuk (1965) noted that in 1963 in Poland 1,171 cattle died from severe D. viviparus infections.

Since this species of Dictyocaulus occurs throughout the world, numerous references on distribution exist in the literature. The bovine lungworm, which is enzootic to most areas of the United Kingdom, has also been observed in parts of South America, Scandinavia, Turkey, Japan, Fiji, New Zealand, the majority of European countries and many other regions of the world.

There have been no specific surveys on the distribution and incidence of D. viviparus in North America. In fact, the bovine lungworm has been virtually ignored in several statewide or regional surveys for helminths of cattle. Becklund (1961) examined viscera from 20 Florida calves for gastrointestinal parasites but apparently did not check the lungs. Surveys conducted by Bell (1957) in North Carolina and by Porter (1942a) in southeastern United States included only gastrointestinal nematodes. In studies of bovine parasitism conducted in Wisconsin (Cox and Todd, 1962) and in Illinois (Szanto et al., 1964), fecal samples collected from selected farms were not examined for lungworms.

According to Swanson et al. (1959) and Becklund (1964), D. viviparus is found in most regions of North America and in Hawaii. Choquette (1954) stated that parasitic bronchitis is widely distributed in Canada. Severe lungworm infections were reported by Campbell and Wetherill (1957) in cattle in Ontario. Graesser (1957) reported that D. viviparus in Alberta cattle has increased markedly in the past 5 years. Lafortune (1954) observed a mild outbreak of verminous bronchitis in a dairy herd in Quebec. At necropsy, one of 60 calves was found infected with lungworms in Hawaii (Alicata, 1960). On the mainland of the United States, numerous records of lungworm infections in cattle exist in the literature. Bailey (1955) stated that bovine lungworms are quite prevalent in southeastern United States where the climate is conducive to larval development on pasture (Rubin, 1956). Schwartz (1942) noted that lungworms were deleterious to southern cattle.

In Florida, D. viviparus has been commonly observed (Porter et al., 1941; Swanson et al., 1956). Swanson et al. (1959) concluded that parasitic bronchitis was an acute problem in Florida. Bovine lungworms have been frequently encountered in Georgia (Cooperrider, 1952; Andrews et al., 1953; Becklund, 1962). Studies by Porter (1942b), Ward (1946) and Smith (1967) revealed the presence of D. viviparus in cattle in Alabama, Mississippi and Texas, respectively. Reports from Maine have listed lungworm infections in cattle (Witter and Rountree, 1953; Rountree et al., 1954).

Verminous bronchitis is indigenous to several areas in Wyoming (Honest and Tucker, 1962). According to Lytle (1931), dictyocaulosis was quite common in calves in Oregon and the Pacific Northwest; he also indicated that the disease was increasing in these areas. Rubin (1956) considered the Pacific Coast states and the southeast to be the two prominent sites where lungworm disease occurs in the United States.

The southwest is believed to be relatively free of lungworm infections. Becklund and Allen (1958) examined 80 bovine fecal samples and 10 sets of lungs from New Mexico and Arizona cattle, but detected no lungworm larvae. Dewhirst et al. (1958) found no D. viviparus in cattle in Arizona.

The earliest documented infection of D. viviparus in Montana cattle occurred in 1931 and was listed in the 1930-1932 annual report of the Montana State Veterinary Surgeon. This case involved two calves from the northwestern part of the state. Included in Livestock Sanitary Board records from 1942-1964 were two case reports of dictyocaulosis in cattle in western Montana in 1949 and 1953 and several reports of cattle lungworm infections in southeastern Montana in 1962. Since 1962, Veterinary Research Laboratory (VRL) records contain numerous reports of occurrences of lungworms in southwestern Montana. These data were obtained from Baermann examinations of fecal samples and from necropsies of animals submitted to the VRL. A survey of endoparasitism in Montana cattle by Jacobson and Worley (1969) revealed the presence of D. viviparus in all areas of the state except the north central section.

The cyclical occurrence of dictyocaulosis in cattle is well established. Patent infections, particularly in calves, occur during certain months or seasons. The seasonal incidence in a herd varies geographically, i.e., it is contingent upon climatic and environmental conditions. Many British researchers have investigated this phenomenon thoroughly. Among them were Jarrett et al. (1954) who described epizootics in August and September resulting from light initial infections contracted by calves in the spring. Workers in Russia (Krastin, 1944; Orlov, 1946; Boev and Ivershina, 1954; Gadzhiev, 1954), Germany (Frick, 1964), Poland (Świetlikowski, 1959; 1965; Wertejuk, 1963), Czechoslovakia (Hovorka and Podhájecký, 1965), Sweden (Petrelius, 1951), Denmark (Henriksen, 1967) and Canada (Choquette, 1954) have also studied the seasonal dynamics of parasitic bronchitis in bovine herds. The only North American investigation on the cyclical incidence of verminous bronchitis in cattle was Choquette's 1954 study in Quebec.

Overwinter survival of D. viviparus larvae on pasture has been the source of considerable controversy for many years. Conflicting accounts from many parts of the world have been published on this aspect of lungworm bionomics. Even in Great Britain, where climatic extremes do not approach those found in western North America, varying views have been expressed concerning the longevity of bovine lungworm larvae on pasture.

As early as 1920, Daubney stated that the preparasitic stages of D. viviparus could easily withstand the winters in the British Isles. Many British researchers have published data in concurrence with

Daubney's statement (Taylor, 1951; Jarrett et al., 1954; 1955; 1957; Bell, 1955; Cunningham et al., 1956; Rose, 1956; Allan and Baxter, 1957). Conversely, in other studies carried out in the United Kingdom, Soliman (1952), Stableforth (1953), Michel and Rose (1954), and Michel and Shand (1955) disputed Daubney's assertion.

Świetlikowski (1956; 1959; 1965) confirmed that lungworm larvae were able to survive Polish winters. Elsewhere in Europe, Enigk and Düwel (1962) and Gräfner et al. (1965) observed that D. viviparus larvae were capable of tolerating winters in northcentral Germany, whereas Wetzel (1948; 1952) found no evidence of larval survival throughout the winters in eastern Germany. Similarly in the Soviet Union, two workers (Orlov, 1946; Morozov, 1958) claimed that larval persistence over the winter was not possible, while Danilin (1959) attributed lungworm infections in the spring to larvae which had remained alive during the previous winter. In Belgium, Vercruyse (1952) stated that infective larvae of D. viviparus were unable to overwinter on pasture. Although no conclusive information is available on the overwintering of lungworm larvae in Canada, Choquette (1954) maintained that if larvae were unable to withstand winter conditions in western Europe, they could hardly survive the more stringent Canadian winters.

Overwinter survival of bovine lungworm larvae has not been verified in the United States. Porter (1942b) found that larvae were capable of remaining infective for 1 week, but not for 6 to 7 weeks, in Alabama. In Florida, larvae were shown to retain their infectivity less than 5

months (Porter et al., 1941). Honess and Tucker (1962) reported that D. viviparus could not tolerate the winter season in Wyoming. The latter claim was not based on an infectivity study, i.e., grazing susceptible calves in the spring on pastures vacated of parasitized animals since the previous fall.

Another facet of parasitic bronchitis which has been accorded worldwide attention is the significance of carrier animals in the propagation of the disease. A carrier is generally defined as an animal which harbors lungworms throughout the winter and ultimately serves as a source of infection to vulnerable calves the following spring. Adult lungworms, which persist in the lungs of cattle over the winter period, or inhibited fifth-stage larvae, which mature only when the resistance mechanism of the host is depressed, may perpetuate the disease from year to year. Taylor and Michel (1952) elucidated the phenomenon of retarded development in D. viviparus by observing fifth-stage worms in the lungs of adult cattle which had not been exposed to a source of infection for several weeks. The role of carriers in the epizootiology of lungworm infections has been investigated in the British Isles (Stableforth, 1953; Taylor and Michel, 1953; Jarrett et al., 1954; 1955; 1957; Michel, 1955; Michel and Shand, 1955; Rose, 1956). Other studies on the significance of carrier animals have been conducted in Russia (Krastin, 1944), Germany (Wetzel, 1948; Enigk and Düwel, 1962), Poland (Świetlikowski, 1965), Belgium (Pouplard, 1968) and Scotland

(Cunningham et al., 1956). Choquette (1954) suggested that carriers may be responsible for contaminating the pastures with infective larvae in Canada.

Owing to a paucity of data on lungworm infections in Montana cattle, the present study was initiated to determine the distribution and incidence of D. viviparus in cattle from three counties in western Montana. A second objective involved determining a seasonal lungworm cycle in bovine herds using the herd at the Montana Agricultural Experiment Station as an indicator. Another objective was to assess the importance of overwinter larval survival on pasture in propagating the infection.

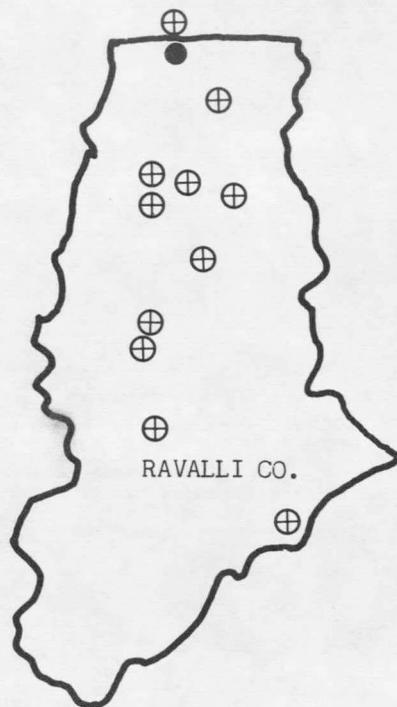
## MATERIALS AND METHODS

This survey was designed to determine the distribution and seasonal prevalence of D. viviparus in three western Montana counties where large numbers of cattle are produced. A map showing the geographic location of these counties is presented in Figure 1.

From October, 1967 to August, 1969, 2,125 fecal samples were collected from 35 ranches in Gallatin, Park and Ravalli counties and from the herd at the Montana Agricultural Experiment Station. The majority of samples were procured from cattle on pasture by picking up the freshly deposited feces from calves (less than 12 months of age), yearlings (1 to 2 years old) or adults (more than 2 years). In a few instances rectal sampling was employed. In cases where all animals were of a particular age or when calf and cow samples were distinguishable, fecal pats dropped within the last 24 hours were collected.

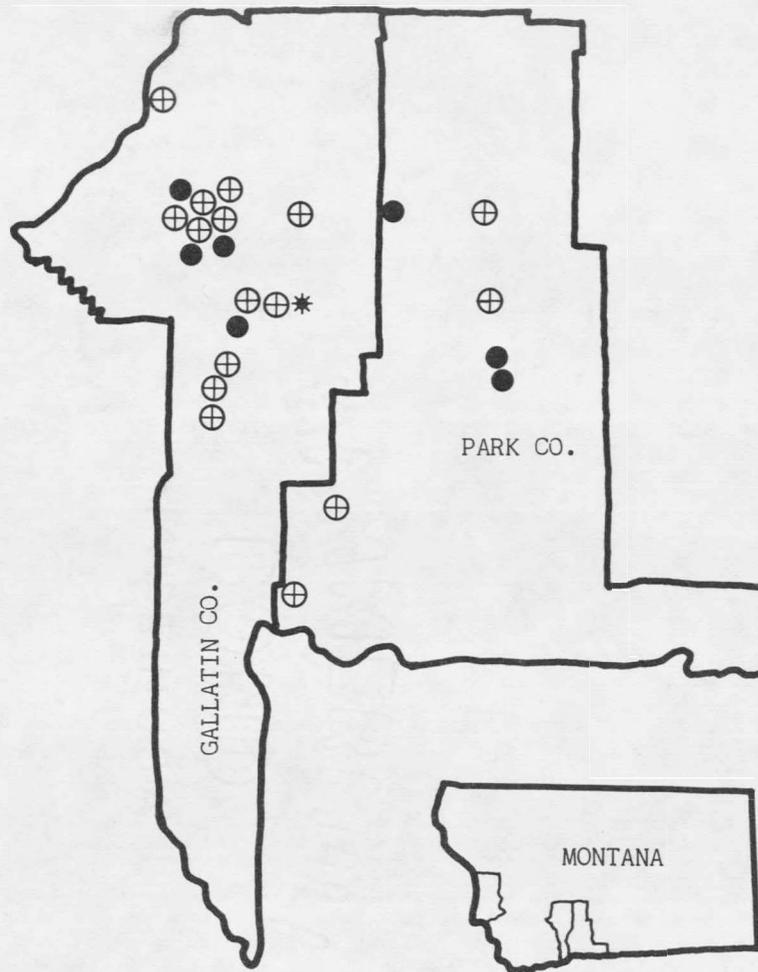
Initially, sampling was conducted during randomly selected months, but after the "lungworm season" was established, intensive collecting was confined to a 2 to 3-month period in the autumn. Sporadic sampling during other seasons was employed to confirm the seasonal incidence in calves and yearlings and to detect lungworm infections in adults.

Fecal samples from eight to 12 calves, yearlings and adult cattle normally were obtained from ranches in Gallatin and Park counties at each collection period. In Ravalli Co., the prevalence and seasonal



RAVALLI CO.

- ⊕ Designates ranch with infected cattle.
- Designates ranch with no infected cattle.
- \* Designates herd at the Montana Agricultural Experiment Station.



GALLATIN CO.

PARK CO.

MONTANA

Figure 1. Location of beef herds sampled in western Montana.

occurrence of bovine lungworms were studied on 12 ranches located throughout the county. Fecal samples were collected from approximately 15 animals on each ranch at 3-month intervals from weaning until the animals were about 18 months of age. They were obtained by personnel of the Western Montana Branch Station, packed in insulated shipping cartons and shipped via bus to the Veterinary Research Laboratory. All samples were assayed for D. viviparus larvae within 48 hours after collection.

Some ranchers in the three counties operated closed herds, whereas others purchased cattle periodically. The majority of the animals sampled were commercial grade Hereford or Angus cattle. Dairy cattle were not included in the survey.

The herd at the Montana Agricultural Experiment Station served as a pilot group of cattle in this investigation, i.e., results of periodic collections provided a general indication of the incidence and cyclical occurrence of lungworms in herds elsewhere in western Montana. This group of cattle was chosen because it was a native closed herd, and management and herd history were well established. Prior to the inception of the present study, lungworm incidence data collected in the autumn of 1966 were available for calves and cows. Subsequent samplings of calves and cows were conducted during the fall of 1967 and 1968. Calves were checked frequently during the summer months to determine when they initially acquired lungworm infections. To ascertain

the significance of adult cattle as carriers, sampling of cows was carried out from July, 1968 to August, 1969.

The standard Baermann apparatus (Baermann, 1917) was employed for detection of lungworm larvae in the feces. Approximately 75 g of feces were wrapped in a double layer of gauze and suspended in a 250-ml plastic funnel containing tepid water. An 80-mesh screen 6 cm in diameter was placed in the funnel 4 cm from the top to support the feces and to prevent large pieces of debris from filtering down. An 8-cm section of rubber tubing with a pinch clamp was attached at the base of the funnel. The samples remained set up for 18 to 24 hours to ensure that all larvae had migrated through the feces and settled to the bottom of the funnel. Approximately 20 ml of fluid were collected and examined with a dissecting microscope for first-stage D. viviparus larvae.

A larva per gram (l.p.g.) count was computed for each animal by dividing the total number of larvae observed by the weight of the feces. To facilitate interpretation of larval concentrations in feces, one of four degrees of fecal consistency (compact, moist, wet and very wet) was assigned to each sample.

Pasture sampling was employed to determine whether lungworm larvae were capable of overwintering. Collections were made in April and May, 1969 from a pasture that had been grazed by parasitized calves from the pilot herd the previous summer. Two to 12 oz of grass, litter, feces and soil were collected from 10 sites, eight of

which were confined to a small area adjacent to a water source. The other two samples were taken from the center of the pasture.

Three techniques were used for the detection of D. viviparus larvae on pasture: the methods of Baermann (1917), Michel and Parfitt (1955) and Donald (1967). The Baermann technique was employed most frequently since an accurate quantitative estimation of the level of pasture infestation was not considered essential. Samples were immersed in water in 2000-ml glass funnels equipped with a 40 or 60-mesh screen for 1 to 3 days. During this period repeated 20-ml portions were removed and examined for D. viviparus larvae. Larval identifications were confirmed using a compound microscope.

## RESULTS

Results of 2,125 Baermann examinations from October, 1967 to August, 1969 revealed that 7.8% of all cattle sampled during the study were infected with D. viviparus. Infection rates by age group showed 6.6%, 11.5% and 3.3% of calves, yearlings and cows, respectively, to be positive for lungworms (Table I). Of 35 ranches sampled in three western Montana counties, 77.1% contained infected cattle.

In Gallatin Co., lungworm larvae were detected in 7.5% of 560 fecal samples from all age groups (Fig. 2). Of 285 calves checked, 9.5% showed the presence of larvae. Incidence data from yearlings revealed that 13.2% of 91 were infected, whereas 1.6% of 184 cows were passing larvae. Data from a yearling operation 2 miles west of Bozeman (Gallatin Co.), where 32.7% of 264 animals sampled were infected, were excluded from Figure 2 because the yearlings had been purchased from various sites in Montana. The rate of infection in this group of yearlings also constituted the highest prevalence of lungworms encountered in a single herd in the present study; results of two midsummer samplings in 1968 showed that 70% and 64.3% of 10 and 28 animals were passing larvae. In August, 1969, 31.4% (60/191) of the entire yearling herd was found infected. Seventy-five percent (12/16) of the ranches sampled harbored infected cattle.

Lungworm larvae were found in the feces of 4.3% of 161 animals sampled in Park Co. Six and eight-tenths percent of 73 calves were positive. Of 50 yearling and 38 cow samples, 2% and 2.6% yielded

TABLE I. Percentage Incidence of Dictyocaulus viviparus in Three Age Groups of Cattle from Three Western Montana Counties.

Age Group	County				
	Gallatin	Park	Ravalli	Pilot Herd	All Animals
Calves	9.5 (27/285)	6.8 (5/73)	2.0 (10/494)	14.0 (26/186)	6.6 (68/1038)
Yearlings	13.2 (12/91)	2.0 (1/50)	13.0 (73/562)	1.9 (1/52)	11.5 (87/755)
Cows	1.6 (3/184)	2.6 (1/38)	*	6.4 (7/110)	3.3 (11/332)
All Animals	7.5 (42/560)	4.3 (7/161)	7.9 (83/1056)	9.8 (34/348)	7.8 (166/2125)

\*Indicates cows were not sampled.





















































