



Prevalence and intensity of helminth parasites and coccidia in specific age groups of dairy cattle in southwestern Montana  
by Marian Therese Teitsch

A thesis submitted in partial fulfillment of the requirements for the degree of \ Master of Science in Veterinary Science  
Montana State University  
© Copyright by Marian Therese Teitsch (1987)

**Abstract:**

A survey was conducted to determine the identity, prevalence and intensity of helminth parasites and coccidia in southwestern Montana dairy cattle and to evaluate host age and specific management procedures in their possible relationship to endoparasitic infections. Fecal samples were collected at five intervals during 1986 from ten dairy farms in Gallatin County. Four specific groups of cattle, the "A," "B," "C" and "D" groups represented separate age categories within each of the ten herds. The "A" group was composed of pre-weaned calves less than three months old, that were housed in indoor or outdoor hutches. Open heifers, three to approximately twelve months of age were denoted as the "B" group. The "C" group ranged in age from 13 to 24 months while the "D" group was comprised of cattle which had calved at least once and were included in the active milking herd.

Data concerning the prevalence and intensity of various helminth parasites and coccidia were gathered and compiled. The results showed that 28.6% of all cattle examined during the survey were positive for gastrointestinal nematode eggs. Five and two-tenths percent, 34.0%, 38.8% and 22.0% of the A, B, C and D age groups, respectively, were similarly infected. The most prevalent type of infection (21.5%) was the *Cooperia-Trichostrongylus-Ostertagia* group, followed by the *Haemonchus-Oesophagostomum* group (11.6%), *Nematodirus* spp. (5.6%), *Trichuris* sp. (1.0%) and *Strongyloides papillosus* (0.2%). All D age group adult cattle were negative for *Nematodirus* spp. The B and C age groups had the highest prevalence of infection with gastrointestinal helminths.

The B age group passed the highest number of helminth eggs per gram of feces. The actual distribution of worm burdens followed a negative binomial distribution, with the majority of cattle sampled having light infections.

*Dictyocaulus viviparus* larvae were recovered only from groups B and C. Five of ten herds were positive for lungworms in group C, whereas group B at two of the ten farms harbored *D. viviparus*. Mean larval counts for both B and C groups infected with *D. viviparus* were 40.0 larvae per gram of feces. Lungworm prevalence in pastured replacement heifers was greater than in drylot managed heifers.

Of 2,000 fecal samples, 33.4% contained one or more of seven *Eimeria* species identified during the survey. *Eimeria canadensis* was the most prevalent oocyst observed.

This study indicates that although subclinical parasitism is widespread among the dairy cattle surveyed, groups B and C were the most heavily parasitized with various helminth species and were the only age groups positive for lungworm. Therefore, it is felt that these age groups should be monitored closely and treated for helminth parasites if deemed necessary.

PREVALENCE AND INTENSITY OF HELMINTH PARASITES AND  
COCCIDIA IN SPECIFIC AGE GROUPS OF DAIRY  
CATTLE IN SOUTHWESTERN MONTANA

by

Marian Therese Teitsch

A thesis submitted in partial fulfillment  
of the requirements for the degree

of

Master of Science

in

Veterinary Science

MONTANA STATE UNIVERSITY  
Bozeman, Montana

June 1987

N378  
T2355  
Cop. 2

APPROVAL

of a thesis submitted by

Marian Therese Teitsch

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

13 May 1987  
Date

David E. Worley  
Chairperson, Graduate Committee

Approved for the Major Department

May 13, 1987  
Date

C. Asper  
Head, Major Department

Approved for the College of Graduate Studies

May 18, 1987  
Date

Henry L. Parsons  
Graduate Dean

## STATEMENT OF PERMISSION TO USE

In presenting this thesis in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the Library shall make it available to borrowers under rules of the Library. Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgment of source is made.

Permission for extensive quotation from or reproduction of this thesis may be granted by my major professor, or in his/her absence, by the Director of Libraries when, in the opinion of either, the proposed use of the material is for scholarly purposes. Any copying or use of the material in this thesis for financial gain shall not be allowed without my written permission.

Signature

Marian T. Fetscher

Date

May 13, 1987

## ACKNOWLEDGEMENTS

I would like to take this opportunity to express my thanks to all those people who offered encouragement and guidance during this study in Montana. I feel especially thankful for the understanding, patience and assistance of Dr. David E. Worley without whom this project would not have been possible. I thank Dr. Jack Catlin, Dr. William Quinn, and Dr. Donald Burgess for their contributions, time and enthusiasm.

I am grateful to Skip Sterner and my sister Sue, who helped me in the field and to Roli Espinosa for encouragement and help with all aspects of the thesis. Appreciation is expressed to Dr. Richard Lund for assistance with statistical analyses, Mrs. Josephine Jensen for typing the manuscript, and to my family for their continual support throughout the study.

Finally, I would like to thank Dr. Emery Field for his interest and assistance and extend special thanks to the ten dairy cooperators who allowed access to cattle for this study.

## TABLE OF CONTENTS

	PAGE
ACKNOWLEDGEMENTS.....	iv
LIST OF TABLES.....	vi
LIST OF FIGURES.....	vii
ABSTRACT.....	viii
INTRODUCTION.....	1
MATERIALS AND METHODS.....	9
RESULTS.....	16
DISCUSSION.....	45
SUMMARY.....	64
REFERENCES CITED.....	66
APPENDIX.....	75

## LIST OF TABLES

TABLE	PAGE
1. Sampling dates for dairy cattle parasite survey.....	11
2. Percent of 'B' group heifers infected with helminth parasites at five seasonal intervals.....	19
3. Percent of 'C' group heifers infected with helminth parasites at five seasonal intervals.....	19
4. Prevalence of gastrointestinal helminth parasites in 'A' group calves on ten dairy farms.....	21
5. Prevalence of gastrointestinal helminth parasites in 'B' group heifers on ten dairy farms.....	22
6. Prevalence of gastrointestinal helminth parasites in 'C' group heifers on ten dairy farms.....	23
7. Prevalence of gastrointestinal helminth parasites in 'D' group cattle on ten dairy farms.....	24
8. Mean gastrointestinal worm egg counts for all cattle sampled during the survey.....	28
9. Prevalence (%) of <u>Eimeria</u> spp. in cattle on ten dairy farms.....	41
10. Composite prevalence (%) of <u>Eimeria</u> spp. on ten dairy farms.....	42

## LIST OF FIGURES

FIGURE	PAGE
1.	Location of ten dairy farms surveyed for helminth parasites in southwestern Montana.....10
2.	Prevalence of gastrointestinal nematodes in dairy cattle in Gallatin County, Montana.....17
3.	Frequency distribution of gastrointestinal nematode egg counts in 'B' group heifers.....30
4.	Frequency distribution of gastrointestinal nematode egg counts in 'C' group heifers.....31
5.	Frequency distribution of gastrointestinal nematode egg counts in 'D' group cattle.....32
6.	Mean worm egg counts for cattle infected with gastrointestinal nematodes on ten Montana dairy farms.....34
7.	Mean worm egg counts for 'B', 'C' and 'D' groups of cattle infected with the <u>Cooperia-Trichostrongylus-Ostertagia</u> group of nematodes.....35
8.	Mean worm egg counts for 'B', 'C' and 'D' groups of cattle infected with the <u>Haemonchus-Oesophagostomum</u> group of nematodes.....37
9.	Mean worm egg counts for 'B' and 'C' groups of heifers infected with <u>Nematodirus</u> spp.....38
10.	Mean larval counts for 'B' and 'C' groups of heifers infected with <u>Dictyocaulus viviparus</u> ...40

## ABSTRACT

A survey was conducted to determine the identity, prevalence and intensity of helminth parasites and coccidia in southwestern Montana dairy cattle and to evaluate host age and specific management procedures in their possible relationship to endoparasitic infections. Fecal samples were collected at five intervals during 1986 from ten dairy farms in Gallatin County. Four specific groups of cattle, the "A," "B," "C" and "D" groups represented separate age categories within each of the ten herds. The "A" group was composed of pre-weaned calves less than three months old, that were housed in indoor or outdoor hutches. Open heifers, three to approximately twelve months of age were denoted as the "B" group. The "C" group ranged in age from 13 to 24 months while the "D" group was comprised of cattle which had calved at least once and were included in the active milking herd.

Data concerning the prevalence and intensity of various helminth parasites and coccidia were gathered and compiled. The results showed that 28.6% of all cattle examined during the survey were positive for gastrointestinal nematode eggs. Five and two-tenths percent, 34.0%, 38.8% and 22.0% of the A, B, C and D age groups, respectively, were similarly infected. The most prevalent type of infection (21.5%) was the Cooperia-Trichostrongylus-Ostertagia group, followed by the Haemonchus-Oesophagostomum group (11.6%), Nematodirus spp. (5.6%), Trichuris sp. (1.0%) and Strongyloides papillosus (0.2%). All D age group adult cattle were negative for Nematodirus spp. The B and C age groups had the highest prevalence of infection with gastrointestinal helminths.

The B age group passed the highest number of helminth eggs per gram of feces. The actual distribution of worm burdens followed a negative binomial distribution, with the majority of cattle sampled having light infections.

Dictyocaulus viviparus larvae were recovered only from groups B and C. Five of ten herds were positive for lungworms in group C, whereas group B at two of the ten farms harbored D. viviparus. Mean larval counts for both B and C groups infected with D. viviparus were 40.0 larvae per gram of feces. Lungworm prevalence in pastured replacement heifers was greater than in drylot managed heifers.

Of 2,000 fecal samples, 33.4% contained one or more of seven Eimeria species identified during the survey. Eimeria canadensis was the most prevalent oocyst observed.

This study indicates that although subclinical parasitism is widespread among the dairy cattle surveyed,

groups B and C were the most heavily parasitized with various helminth species and were the only age groups positive for lungworm. Therefore, it is felt that these age groups should be monitored closely and treated for helminth parasites if deemed necessary.

## INTRODUCTION

An initial step in determining the economic importance of internal parasitism in Montana dairy cattle is to define the extent of the condition. Data on prevalence, intensity and distribution of these parasites are a prerequisite to effective parasite control and yet, no comprehensive surveys on parasitism of Montana dairy cattle have appeared in the literature. Internal parasitism of cattle may be one of the most significant diseases affecting the cattle industry today (Swisher and McGilliard, 1978). Because internal parasitism of dairy cattle is primarily subclinical, it is detectable only by laboratory methods (Yazwinski and Tilley, 1980). Therefore, the presence and damaging effects of internal parasites are often difficult to detect and rarely suspected by dairymen. Internal parasitism is an especially important disease in young dairy heifers. These animals, if housed in a contaminated environment, quickly acquire worm burdens (Anderson and Waller, 1983) which can place constraints on the rate of development, feed intake and utilization, weight gain, and possibly lifetime productivity of affected cattle (Yazwinski and Tilley, 1980; Gibbs, 1982). It has been speculated as well that nematodiasis of young cattle may have a harmful effect on milk production during first lactation (Gibbs, 1982).

The prevalence and severity of helminth disease is due to many factors, some of which include climate, weather, management practices, host age, heredity and physiological state (Anderson and Waller, 1983). Although it appears that helminth populations undergo seasonal variation, helminths are constantly present in dairy animals and larvae are constantly available to infect new hosts and reinfect previously infected hosts (Gutierrez et al., 1979).

Subclinical parasitism in dairy cattle has been reported for a number of years and in many countries (Fréchette and LaMothe, 1981). Some of the studies involved necropsy data, while others based their results on fecal egg counts. In Germany, Barth et al. (1981) reported that 100% of mature dairy cattle examined were harboring moderate nematode burdens, yet only 13.0% were passing detectable numbers of eggs. In Ireland, 23 helminth species were identified, with Ostertagia spp. being the most common (Taylor and Cawthorne, 1972). Rose (1968) recorded similar data in southeast England, while Fox and Jacobs (1981) determined that 85.2% of 460 adult cows in Great Britain harbored patent nematode infections. In Great Britain, Ostertagia ostertagi was identified as the most prevalent species (Hong et al., 1981), as was the case in the Netherlands (Borgsteede and van der Burg, 1982). In Switzerland, Eckert and coworkers (1981) noted that high percentages of calves on alpine pastures were excreting

coccidian oocysts during the grazing season. In contrast, statistics for coccidiosis are nonexistent in France. Parasitic gastroenteritis in France is mainly due to infections with Ostertagia ostertagi and Cooperia oncophora (Raynaud et al., 1981a). Dictyocaulus viviparus, the cattle lungworm, was commonly found in wet grazing areas in northwestern and central France (Raynaud et al., 1981a). Dictyocaulus viviparus was also noted in Pakistani cattle in a survey which found that 304 of 726 cattle examined (41.87%) were found to be infected with various helminthic species (Afzal et al., 1981). In a survey conducted in the Libyan Arabic Republic, Goda (1974) found that 52.7% of the cattle sampled were infected with Dictyocaulus viviparus and in Korea, D. viviparus was found in the lungs of necropsied cattle (Lee et al., 1973). Sauvage and coworkers (1974) reported high prevalence of Haemonchus spp. (65.1%), Bunostomum phlebotomum (13.3%), and Oesophagostomum radiatum (12.7%) in Ugandan calves less than a year of age. Based on their study, 16.0% of these cattle had 500 or more eggs per gram of feces, while 50.0% had 200 eggs per gram of feces. Overend (1984) reported that small numbers of abomasal trichostrongyles were found in 93.0% of Australian cattle surveyed. In this study and in surveys conducted in New Zealand (Brunsdon, 1964; Brunsdon, 1969; McKenna, 1983), Ostertagia spp., Trichostrongylus spp., and Cooperia spp. appeared to be the most prevalent. In the tropical climate

of Puerto Rico, Dikmans (1952) determined that Haemonchus contortus and Oesophagostomum radiatum were the most prevalent species. Dictyocaulus viviparus has been shown to be widespread in the province of Quebec (Gupta and Gibbs, 1975). Ostertagia spp. and Cooperia spp. are the gastrointestinal helminths of primary importance in Quebec (Fr chet te and Gibbs, 1971), while in British Columbia, Bruce (1921) reported that coccidia were prevalent in range cattle of all ages. Subclinical parasitism in dairy cattle therefore has been reported in many surveys from many areas of the world.

Reports from across the United States indicate that parasitism is widespread and not restricted to any one geographic area (Malczewski et al., 1975). Surveys indicate further that dairy cows generally have low worm burdens (< 3000) and low fecal egg counts (< 10 eggs per gram of feces), although there is a high prevalence of infection (> 80%)(Herd, 1983b).

In a Maine dairy cattle survey, the overall prevalence of gastrointestinal parasites was 95.7, 98.7 and 96.7% for adult cattle, heifers, and calves, respectively (Gibbs et al., 1975; Yazwinski and Gibbs, 1975). Ostertagia spp. and Cooperia spp. comprised the highest percentage of the total worm burden in a survey conducted by Randall and Gibbs (1977). In this survey, Nematodirus spp. and Oesophagostomum spp. were less prominent species, and Moniezia sp., the

cattle tapeworm, was found in 25.1% of the cattle surveyed. Dictyocaulus viviparus was rarely noted in these surveys. Stoddard (1971) found that 74.0% of calves, 87.0% of heifers and 40.0% of the adult cattle in New Hampshire were infected with gastrointestinal parasites. Coccidial infections were reported to be common but comparable to infection rates in Wisconsin, Montana and Illinois. Ostertagia spp., Trichostrongylus spp. and Cooperia spp. were the most common genera of parasites in New York calves (Baker, 1949), while in Ohio, cows and heifers were passing eggs of the aforementioned species in addition to eggs of Haemonchus spp. (Herd et al., 1980). In Pennsylvania, Rothenbacher and coworkers (1980) found an overall infection rate of 44.0 percent with an average egg per gram count of 13.0 in cattle from three to 24 months of age. In adult cattle, the average egg per gram count decreased to 3.6. Studies in North Carolina indicated that Haemonchus spp. were the most prevalent gastrointestinal helminth while Eimeria bovis was the most common coccidian oocyst observed (Bell, 1957; Grisi and Todd, 1978). In Florida, Cooperia spp., Haemonchus spp. and Ostertagia spp. were found in 100%, 85.0%, and 75.0%, respectively, of calves from four to twelve months of age (Becklund, 1961). Ostertagia spp. were the most prevalent gastrointestinal helminth in Georgia cattle (Andrews et al., 1953; Becklund, 1962).

Ciordia (1975), in a survey of gastrointestinal parasitism in Georgia, found that 98.0% of calves, 80.0% of heifers and 58.0% of adult cattle were infected with internal parasites. Coccidia were present in 71.0% of these cattle, with the highest prevalence noted in calves, while Moniezia sp. was present in both calves and heifers. Nine eimerian species were found in the feces of calves in Alabama (Christensen, 1941; Davis and Bowman, 1951), while in Mississippi, five species were reported (Ward, 1946). A survey done in Arkansas (Yazwinski and Tilley, 1980) revealed that Cooperia spp. were the most prevalent nematodes on twenty farms surveyed. Two studies carried out on Wisconsin dairy farms determined that Haemonchus sp. was a major parasite as were Ostertagia spp. (Grisi and Todd, 1978; Gutierrez et al., 1979).

Ten species of coccidia were found in another Wisconsin study (Hasche and Todd, 1959). In Kentucky, lungworm larvae were found in 86.0% of calves surveyed on pasture (Lyons et al., 1981). Sharma and Case (1962) found that Haemonchus sp. was most prevalent in a study completed in Missouri. Data from Iowa (Zimmermann and Hubbard, 1961) showed that coccidia were present in 34.8% of cattle surveyed. These cattle had a 47.4% prevalence of trichostrongyles, while Leland and coworkers (1973) found a 67.3% prevalence rate for gastrointestinal nematodes in a Kansas survey. In Oklahoma, 95.0% of all nematodes were Ostertagia spp.

(Cooperider et al., 1948). In Texas (Smith, 1967; Bell, 1977) as in New Mexico and Arizona (Becklund and Allen, 1958), Haemonchus spp. and Ostertagia spp. were most prevalent in dairy cattle. Dictyocaulus viviparus was often seen and was a primary cause of death in Texas calves (Smith, 1967). A survey for gastrointestinal parasites of cattle in Wyoming showed that Cooperia spp. and Ostertagia spp. were most common (Hones and Bergstrom, 1963). Eight eimerian species were identified in 72.0% of Oregon cattle (Nyberg et al., 1967) while in Washington, Malczewski and coworkers (1975) found that 77.0% of fecal samples examined contained Eimeria oocysts. Ostertagia spp. were reported as the most prevalent nematode in cattle, while Dictyocaulus larvae were seen in only 1.0% of cattle there (Malczewski et al., 1975).

Data concerning internal parasites of dairy cattle are available from many areas of the United States but are lacking in the state of Montana. Relatively little information was available on bovine endoparasitism in the northern Great Plains and Rocky Mountain region of the United States prior to the studies of Jacobson and Worley (1969), who conducted a survey which defined the incidence, distribution and intensity of helminth parasites and coccidia in Montana beef cattle. In their survey, 85.6% of 486 calves and 59.1% of 479 cows were infected with gastrointestinal nematodes. The prevalence of the Cooperia-Trichostrongylus-Ostertagia

complex was greatest with a 69.7% infection rate. The average egg per gram of feces (EPG) count for all cattle in the survey was 16.8 while the mean egg count for calves was 26.7 EPG and 6.7 EPG for adult cattle. Moniezia sp. was found in 10.1% of calves and 4.2% of adult cattle, while 64.9% of all cattle were infected with coccidia. The distribution of Dictyocaulus viviparus, previously unrecognized in Montana, was studied by Jacobson and Worley (1969) as well. Dictyocaulus viviparus larvae were detected in fecal samples of 7.1% of 422 calves. All adult cattle were negative for this parasite. In a later study, Winters and Worley (1975) detected lungworm in 27 of 35 herds surveyed. This survey revealed that 7.8% of all cattle were positive for lungworm with a prevalence of 6.6%, 11.5% and 3.3% prevalence in calves, yearlings and cows, respectively.

Since similar information on endoparasitism in Montana dairy cattle is non-existent, a survey was designed to determine the identity, prevalence and intensity of helminth parasites and coccidia in southwestern Montana dairy cattle, and to evaluate host age and specific management procedures in their possible relationship to endoparasitic infections in these cattle.

## MATERIALS AND METHODS

Ten dairy farms in Gallatin County were identified as stations for the study of internal parasites of dairy cattle in southwestern Montana. Two of the farms were located in the Bozeman area, one near Manhattan, six in the vicinity of Amsterdam, and one outside of Belgrade (Figure 1). The ten dairy farms were chosen on the basis of two criteria: 1) importance as a center of dairy production, and 2) the dairy manager's willingness to participate in the study. The farms were located in a relatively concentrated area with the two most distant farms lying approximately 32 miles apart. Although the farms were located within relatively close proximity of one another, the topography varied from valley lowland to mountainous terrain, at elevations ranging from approximately 1,311 to 1,527 m above sea level. Management practices and degree of mechanization varied from farm to farm as well, creating unique environments at each site.

A total of 2000 fecal samples was collected at five intervals from milk fed calves housed in hutches, heifers from three to approximately twelve months of age, older heifers thirteen to twenty-four months of age, and adult milking cattle. These samples were collected during the period of 31 January 1986 to 11 November 1986. Five seasonal

## GALLATIN COUNTY, MONTANA

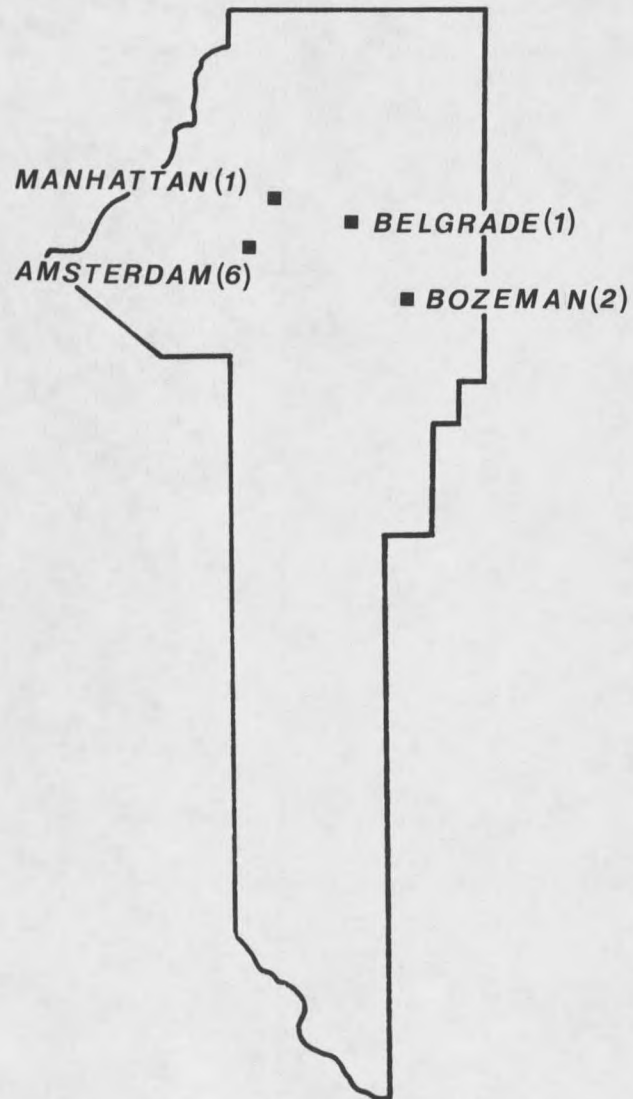


Figure 1. Location of ten dairy farms surveyed for helminth parasites in southwestern Montana.

sampling periods were chosen for all ten farms (Table 1). Samples were obtained from cattle which were grouped and coded according to age and stage of development. Since the majority of the dairymen participating in this study grouped their cattle according to either age or level of development, the following groups were relatively uniform from farm to farm. All fecal samples were obtained from calves by the direct rectal method. All other cattle fecal samples were obtained within a few minutes after deposition by random lot or pasture sampling methods. On each farm, five random

Table 1. Sampling dates for dairy cattle parasite survey.

Dairy farm	<u>Season</u>				
	Winter 1986	Spring 1986	Summer 1986	Fall 1986	Late Fall 1986
1	21 Feb	03 June	04 Aug	15 Sept	06 Nov
2	20 Feb	13 May	21 July	12 Sept	30 Oct
3	31 Jan	17 Apr	20 June	10 Sept	28 Oct
4	31 Jan	04 Apr	16 June	11 Sept	11 Nov
5	06 Feb	06 May	14 July	12 Sept	04 Nov
6	20 Feb	20 May	28 July	09 Sept	23 Oct
7	27 Feb	09 June	11 Aug	15 Sept	06 Nov
8	07 Feb	29 Apr	07 July	16 Sept	04 Nov
9	27 Feb	27 May	04 Aug	12 Sept	30 Oct
10	07 Feb	22 Apr	30 June	09 Sept	23 Oct

samples were obtained from calves in hutches, fifteen samples from open heifers, and ten samples were collected from both bred heifers and milking cattle. The calves were generally housed in indoor or outdoor hutches up until two to three months of age, at which time they were weaned. These animals, which were coded as the "A" group, were then placed in outdoor pens or on pasture depending on the management practice which characterized each individual farm. The "B" group was composed of open heifers ranging from three to four months of age to approximately fifteen months of age. The bred heifers, or "C" group, were generally sixteen to twenty-four months of age. Animals classified as milking cattle, the "D" group, were those cattle which had calved at least once and were currently part of the active milking herd.

Fecal samples were transported to the laboratory where a 60-gram portion of each was immediately processed for lungworm (Dictyocaulus viviparus) larvae with the standard Baermann technique (Baermann, 1917). Some of the samples were refrigerated at 4 ° C for approximately twelve hours before they were processed. A ten-gram portion of each fecal sample was then assayed for gastrointestinal parasites with the Lane centrifugal flotation method (Lane, 1928). When assaying for lungworm larvae, 250 ml funnels were used. A 60-mesh screen, six centimeters in diameter, was placed in the funnel, approximately four cm. from the top. The feces

was weighed and placed in an 18 cm<sup>2</sup> piece of cheesecloth and then placed in the funnel which had been previously clamped and filled with water.

The Lane quantitative flotation method (Lane, 1928), as modified by Dewhirst and Hansen (1961), was used to determine the total number of nematode eggs per gram of feces (EPG), the presence or absence of tapeworm eggs and the presence and frequency of coccidian oocysts. A saturated NaCl solution (Specific gravity = 1.2) was used as the flotation medium. Differential worm egg counts were made according to the egg classification criteria of Levine (1978).

Coccidian oocysts were differentiated on the basis of morphologic features. Oocysts were not counted but were ranked according to relative frequency. When one to several oocysts were present under a 22 mm. coverslip, the infection was designated as a +1. If one to three oocysts were observed per low power field (75X), the infection was classified as a +2. Four to seven or more oocysts per field were ranked as a +3. Individual species of Eimeria were not ranked according to frequency but were noted if present, to determine the relative species fluctuations between dairy farms and at the same dairy farm.

With the assistance of committee members and a local veterinarian, a questionnaire was written to determine management practices at each of the ten dairy farms.

Questions were written with reference to four major management categories: 1) feeding, 2) housing, 3) use of medications and 4) health problems (Appendix). To determine basic similarities and differences between the dairy farms and in an attempt to categorize the farms on the basis of management, similar questions under the four management categories were formulated for the four cattle age groups on each farm. With the cooperation of each dairy manager, the questionnaires were completed.

Seasonal helminth parasite prevalence data for B and C group heifers were analyzed. For each of the five sampling periods, the number of B and C group heifers infected with the Cooperia-Trichostrongylus-Ostertagia complex (classified as group I nematodes), the Oesophagostomum-Haemonchus complex (classified as group II nematodes), Nematodirus spp. and Dictyocaulus viviparus (the cattle lungworm) were compared. General seasonal trends in the number of infected B and C group heifers infected with the above helminths were noted. Since the survey was conducted over a one year period, it was concluded that observations over a more extensive period would be necessary to correlate seasonal trends with bovine endoparasitism at the participating farms.

Data were analyzed using the completed questionnaires. Summary statistics and comparison of means tests (Lund, 1985) were used for data analysis as well. Chi-square tests

were used to determine if significant differences existed between prevalence data for cattle on the ten dairy farms. Chi-square tests were also used to determine if significant differences existed among management practices on the ten farms. The Spearman rank test (Lund, 1985) was used to determine whether parasite populations could be correlated with an overall management index derived from analysis of each question form. The Fischer test (Lund, 1985) was used to determine if significant differences existed in the prevalence of D. viviparus for heifers maintained under drylot versus pasture conditions. P values < 0.05 were considered statistically significant.

## RESULTS

Of 2000 bovine fecal samples from all animals examined during the survey, 28.6% were positive for gastrointestinal nematode eggs. Analysis of prevalence data by dairy farm indicated that gastrointestinal nematode infections ranged from 4.0% at farm 1 to 44.5% at farm 7 (Figure 2). Forty-three percent, 39.5%, 38.5%, 35.0% and 31.5% of the cattle from farms 3, 10, 5, 6 and 2, respectively, were infected with gastrointestinal nematodes, indicating an 11.5% difference in prevalence of infection between farm 3 and farm 2. Stomach and intestinal nematode eggs were found in 23.0%, 17.5% and 9.5% of bovine fecal samples from farms 9, 8, and 4, respectively.

Prevalence data analyzed by age group revealed that 5.2% of 250 calves 3 months and younger were infected with gastrointestinal nematodes, while 34.0% of 750 open heifers (B group) harbored similar infections. In the C group (bred heifers), there was a 38.8% prevalence of gastrointestinal nematode infection, while the mature dairy cattle (D group) maintained a 22.0% infection rate. Prevalence data revealed that the B and C groups were generally the most heavily parasitized groups at all ten farms. The A group had the lowest rate of infection with gastrointestinal nematodes. The prevalence of gastrointestinal parasite

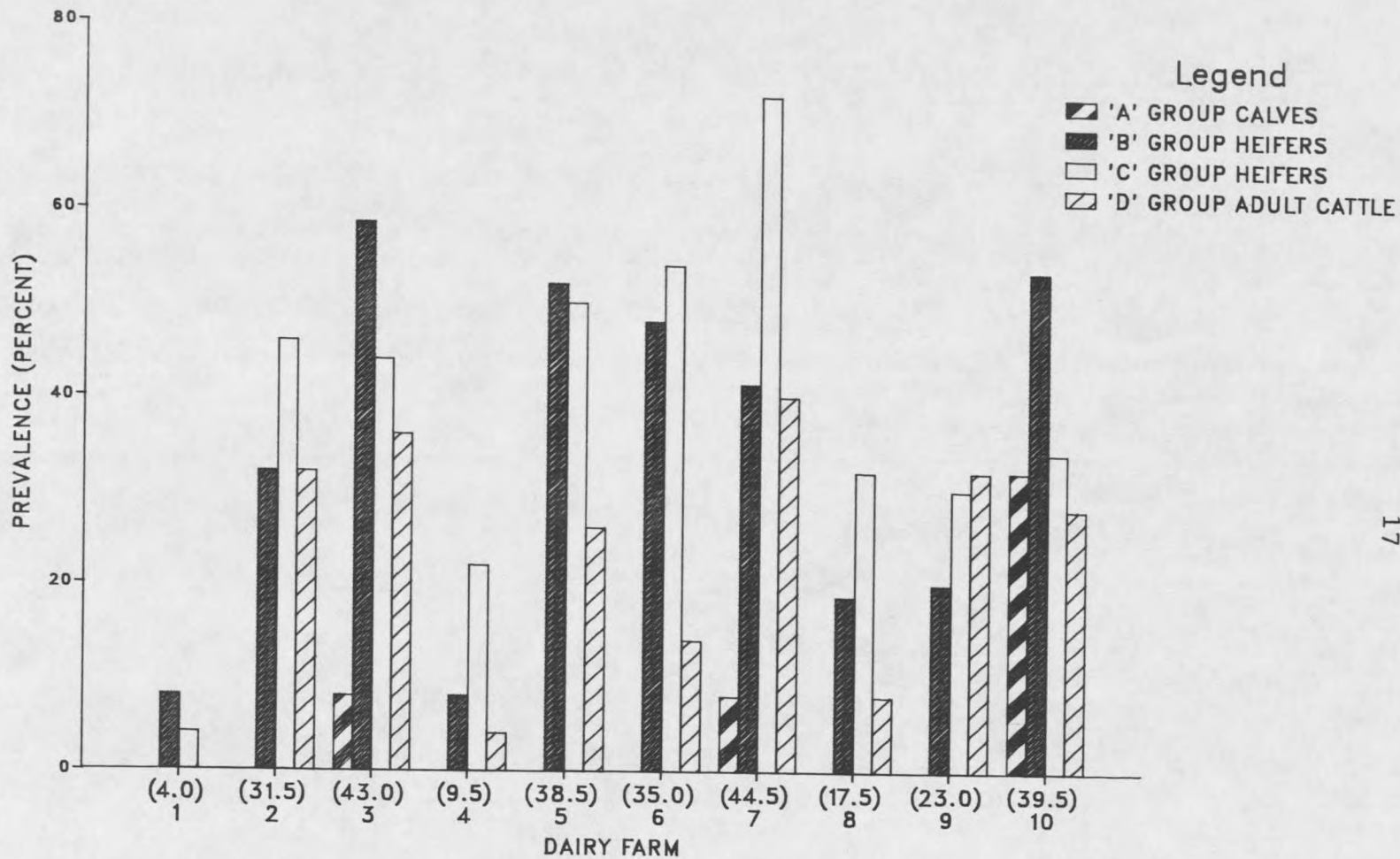


Figure 2. Prevalence of gastrointestinal nematodes in dairy cattle in Gallatin County, Montana. ( ) = overall % infected animals per farm.

infection in the D group was generally greater than the rate of infection in the A group, yet less than the infection rates of both groups B and C. The chi-square test was used to compare the total number of infected animals in each separate age group. No significant difference was noted in the number of infected animals between the B and C groups. However, these two groups had significantly greater numbers of infected animals than either the A or D groups ( $p < .001$ ).

Because heifers in the B and C groups were the most heavily parasitized, parasite prevalence data for these two groups were analyzed to determine if seasonal variations in the number of infected animals in these groups occurred during the course of the study (Tables 2 and 3). Overall percent prevalence of group I, group II, Nematodirus spp. and Dictyocaulus viviparus were calculated for B and C group heifers for each of the five seasonal sampling periods.

Prevalence data revealed that the number of B group heifers infected with group I nematodes was lowest in the winter sampling period (12.0%), rose in the spring, remained relatively high through the summer period and reached a peak in the fall (31.0%). The number of B group heifers infected with group II nematodes followed a similar trend. A fall peak in the number of B group heifers infected with Nematodirus spp. was noted as well. However, the number of heifers infected with this parasite remained high through

Table 2. Percent of 'B' group heifers infected\* with helminth parasites at five seasonal intervals.

Parasite	Sample Period				
	Winter 1986	Spring 1986	Summer 1986	Fall 1986	Late Fall 1986
Group I <sup>a</sup>	12.0	27.0	25.0	31.0	25.0
Group II <sup>b</sup>		4.0	14.0	29.0	27.0
<u>Nematodirus</u> spp.	10.0	9.0	9.0	14.0	11.0
<u>Dictyocaulus</u> <u>viviparus</u>			3.0	3.0	

\* Blank space denotes zero value.

a Cooperia-Trichostrongylus-Ostertagia

b Haemonchus-Oesophagostomum

Table 3. Percent of 'C' group heifers infected\* with helminth parasites at five seasonal intervals\*.

Parasite	Sample Period				
	Winter 1986	Spring 1986	Summer 1986	Fall 1986	Late Fall 1986
Group I <sup>a</sup>	22.0	39.0	45.0	33.0	26.0
Group II <sup>b</sup>	1.0	9.0	10.0	30.0	24.0
<u>Nematodirus</u> spp.	4.0	1.0	1.0	1.0	12.0
<u>Dictyocaulus</u> <u>viviparus</u>		6.0	16.0	7.0	

\* Blank space denotes zero value.

a Cooperia-Trichostrongylus-Ostertagia

b Haemonchus-Oesophagostomum

the late fall and winter sample periods and tapered with the onset of spring. Dictyocaulus viviparus larvae were noted in B group heifers only during the summer and fall sampling periods. The number of infected animals was comparable in both periods.

The number of C group heifers infected with group I nematodes was lowest in the winter sample period. The number<sup>o</sup> of group I infected animals rose in spring, peaked in the summer and gradually tapered through the fall and late fall sampling periods. Numbers of C group heifers infected with group II nematodes increased from 1.0% in the winter period to a peak of 30.0% in the fall sample period. The number of Nematodirus spp. infected C group heifers was highest in late fall and remained relatively high through the winter period. Very few C group heifers were positive for Nematodirus spp. during the spring, summer and fall periods. Dictyocaulus viviparus larvae were noted in feces of C group heifers in the spring, summer and fall sampling periods. The number of C group heifers that were passing lungworm larvae reached a peak in the summer sampling period. No lungworm larvae were found in the feces of either B or C group heifers in either the fall or late fall sampling periods.

Tables 4, 5, 6 and 7 list the prevalence of gastrointestinal helminth parasites in each of the four cattle groups on the ten dairy farms.

Table 4. Prevalence of gastrointestinal helminth parasites in 'A' group calves on ten dairy farms. \*,a

Farm No.	1	2	3	4	5	6	7	8	9	10	$\bar{x}^b$
No. of animals examined	25	25	25	25	25	25	25	25	25	25	
Gastrointestinal nematodes combined			8.0				8.0	4.0		32.0	5.2
<u>Cooperia-</u> <u>Trichostrongylus-</u> <u>Ostertagia</u>										20.0	2.0
<u>Haemonchus</u> spp. <u>Oesophagostomum</u> spp.										8.0	0.8
<u>Nematodirus</u> spp.							8.0	4.0		16.0	2.8
<u>Trichuris</u> sp.			8.0							4.0	1.2
<u>Strongyloides papillosus</u>											
<u>Moniezia</u> sp.											

\* Values represent % positive for the given parasite.

a Blank space denotes zero value.

b Mean prevalence for all farms.

Table 5. Prevalence of gastrointestinal helminth parasites in 'B' group heifers on ten dairy farms. \*,a

Farm No.	1	2	3	4	5	6	7	8	9	10	$\bar{x}^b$
No. of animals examined	75	75	75	75	75	75	75	75	75	75	
Gastrointestinal nematodes combined	8.0	34.7	58.7	9.3	52.0	48.0	33.3	14.7	21.3	56.0	33.6
<u>Cooperia-Trichostrongylus-Ostertagia</u>	2.7	25.3	52.0	5.3	44.0	42.7	13.3	2.7	13.3	41.3	24.3
<u>Haemonchus sp.</u> <u>Oesophagostomum spp.</u>		1.3	30.7	2.7	28.0	30.7	4.0		9.3	25.3	14.9
<u>Nematodirus spp.</u>	5.3	5.3	22.7	6.7	6.7	13.3	27.0	12.0	6.7	16.0	12.1
<u>Trichuris sp.</u>	1.3		8.0		4.0				1.3	2.7	1.7
<u>Strongyloides papillosus</u>		1.3	1.3							1.3	0.4
<u>Moniezia sp.</u>				4.0		10.7				8.0	2.3

\* Values represent % positive for the given parasite.

a Blank space denotes zero value.

b Mean prevalence for all farms.

Table 6. Prevalence of gastrointestinal helminth parasites in 'C' group heifers on ten dairy farms. \*,a

Farm No.	1	2	3	4	5	6	7	8	9	10	$\bar{x}^b$
No. of animals examined	50	50	50	50	50	50	50	50	50	50	
Gastrointestinal nematodes combined	6.0	46.0	46.0	22.0	50.0	54.0	52.0	32.0	32.0	38.0	40.0
<u>Cooperia-</u> <u>Trichostrongylus-</u> <u>Ostertagia</u>	2.0	40.0	42.0	12.0	42.0	52.0	60.0	26.0	24.0	32.0	33.2
<u>Haemonchus</u> spp. <u>Oesophagostomum</u> spp.	2.0	12.0	12.0	2.0	20.0	20.0	30.0	18.0	18.0	12.0	14.6
<u>Nematodirus</u> spp.	2.0			8.0	2.0	2.0	6.0	4.0	4.0		2.8
<u>Trichuris</u> sp.			2.0			2.0			2.0	2.0	0.8
<u>Strongyloides papillosus</u>											
<u>Moniezia</u> sp.		2.0	4.0			12.0	8.0			2.0	2.8

\* Values represent % positive for the given parasite.

a Blank space denotes zero value.

b Mean prevalence for all farms.

Table 7. Prevalence of gastrointestinal helminth parasites in 'D' group cattle on ten dairy farms. \*,a

Farm No.	1	2	3	4	5	6	7	8	9	10	$\bar{x}^b$
No. of animals examined	50	50	50	50	50	50	50	50	50	50	
Gastrointestinal nematodes combined		32.0	38.0	6.0	26.0	14.0	40.0	8.0	32.0	28.0	22.4
<u>Cooperia-</u> <u>Trichostrongylus-</u> <u>Ostertagia</u>		26.0	26.0	6.0	12.0	8.0	32.0	6.0	24.0	24.0	16.4
<u>Haemonchus</u> spp. <u>Oesophagostomum</u> spp.		14.0	10.0	4.0	16.0	8.0	10.0	4.0	20.0	4.0	9.0
<u>Nematodirus</u> spp.											
<u>Trichuris</u> sp.											
<u>Strongyloides</u> <u>papillosus</u>								2.0			0.2
<u>Moniezia</u> sp.	2.0	6.0	2.0	2.0		2.0	8.0		10.0	4.0	3.6

\* Values represent % positive for the given parasite.

a Blank space denotes zero value.

b Mean prevalence for all farms.

Eggs of group I nematodes were found in feces from 21.6% of the cattle examined. Only five calves (2.0%) were infected with group I parasites while 182 (24.3%), 166 (33.2%), and 82 (16.4%) of the B, C and D groups, respectively, were similarly infected. A higher percentage of cattle in each group from each of the ten dairy farms was passing group I eggs than any other helminth egg or larva observed during the study.

In all but the A group, the next most prevalent gastrointestinal helminth eggs observed were those of the group II complex. Nematodirus spp. were most prevalent in the A group and were found in 2.8% of calves while only 0.8% of all calves were infected with the group II nematodes (Table 4). Group II eggs were found in 11.6% of all fecal samples examined. The B and C groups had comparable infections of group II nematodes with a 14.9% and 14.6% prevalence, respectively, while 9.0% of adult cattle were positive for this group of parasites. Calves from all farms (except farm 10) were negative for group II parasites. Cattle in the B group from all farms harbored group II nematodes with the exception of the heifers from farms 1 and 8. All cattle in the C group were infected with this group of parasites while only farm 1 had adult cattle that were free of this group of nematodes. The highest prevalence for group II parasites was recorded from heifers in the B group at farms 3 and 6 (30.7% positive).

Eggs of Nematodirus spp. were found in 5.6% of all cattle examined. Twelve and one-tenth percent and 2.8% of groups B and C, respectively, were infected with Nematodirus spp. while all adult cattle were negative for this parasite. The B group of heifers at farm 7 showed the highest incidence for Nematodirus spp. (27.0%).

Other gastrointestinal helminth eggs observed and the percentage of positive cattle were: Trichuris sp., 1.0% and Strongyloides papillosus, 0.2%. Trichuris sp. eggs were found in 8.0% of calves at farm 3 and 4.0% of calves at farm 10. All other calves were negative for whipworm. Five of the ten farms harbored Trichuris sp. in the B group with an overall prevalence of 1.7% in this group. Farms 3, 6, 9 and 10 all had 2.0% prevalence of Trichuris sp. eggs in the C group heifers while adult cattle on the ten farms were negative for this parasite. Strongyloides papillosus was not present in either the A or C groups of cattle and was seen only in 0.4% of the B heifers and 0.2% of the D group of cattle.

Two and five-tenths percent of 2000 cattle were passing Moniezia sp. eggs in their feces. These eggs were not found in any of the A group calves but were found in 2.3%, 2.8% and 3.6% of B group heifers, C group heifers and D group cattle, respectively. In the B group, only cattle at farms 4, 6 and 10 were infected with Moniezia sp. Cattle in the C group at farms 2, 3, 6, 7 and 10 were positive for

Moniezia sp. while only on farms 5 and 8 were adult cattle in the D group free of this cestode. Twelve percent of the C group heifers and 10.7% of the B group heifers at farm 6 were infected with tapeworms. Less than 10% of the B group heifers, C group heifers and D group cattle from all other farms harbored Moniezia sp.

Dictyocaulus viviparus larvae were recovered only from B group and C group heifers. All 250 calves and 500 adult cattle were found to be negative for this parasite. Five of the ten farms were positive for lungworms in the C group heifers whereas B group heifers at two of the ten farms harbored D. viviparus. The highest prevalence of lungworm occurred in C group heifers from farm 2 where 16.0% of 50 animals were positive. Of the C group heifers at farms 6 and 7, 12.0% were positive, while 10.0% and 8.0% of these heifers at farms 3 and 5, respectively, were similarly infected. One-tenth percent (1 animal in 75) and 1.3% (9 animals in 75) of B group heifers from farms 3 and 6, respectively, were infected with D. viviparus.

The average number of nematode eggs per gram of feces for all cattle sampled was 3.1 (range 0-222). The intensity of parasite egg production in cattle was compared between dairy farms (Table 8). Heifers in the B group at farm 3 were passing more eggs per gram of feces (avg. 36.5) than animals from any other farm (Table 8). Calves from farm 10 had a mean count of 26.3 EPG while 2.0, 3.0 and 4.0 EPG were

Table 8. Mean gastrointestinal worm egg counts for all cattle sampled during the survey.

Farm	Group				Overall Prevalence <sup>a</sup>
	A	B	C	D	
1		5.3	4.0		4.9
2		10.6	5.0	9.5	8.3
3	3.0	36.5	8.5	1.7	21.3
4		17.0	3.6	14.7	9.3
5		10.2	5.6	3.5	7.6
6		17.8	6.7	3.1	12.2
7	2.0	4.5	9.1	4.2	6.3
8	4.0	2.5	9.1	2.5	5.9
9		6.5	18.2	6.9	10.0
10	26.3	15.6	6.8	4.7	12.8

<sup>a</sup> Measured as eggs per gram of feces (EPG).

\* Blank space denotes zero value.

the average figures for calves on farms 7, 3, and 8 respectively. All other A group calves at the remaining farms were negative. Heifers in the B group at farms 6, 4, 10, 2 and 5 had mean counts of 17.8, 17.0, 15.6, 10.6, and 10.2 EPG, respectively. Less than 10.0 EPG were recorded for B groups at the remaining 4 farms. Heifers in the C group at farm 9 had an average of 18.2 EPG. Heifers in the C group at the other nine farms had counts of less than 10.0 EPG. None of the adult cattle at farm 1 passed eggs. Milking cows at farm 4 had an average EPG count of 14.7

while 9.5 and 6.7 EPG were the averages for cattle located at farms 2 and 9, respectively. All other farms showed averages of less than 5.0 EPG for the D group cattle.

Calves were passing an average of 0.9 EPG (range 0-146), while B group heifers had a mean count of 5.2 EPG (range 0 to 222). The C group heifers had a mean count of 3.0 EPG (range 0-64) and the adult cattle were passing an average of 1.2 EPG (range 0-24). Analysis of EPG distribution data revealed that 98.2% of the calves, 92.8% of the B group heifers, 97.4% of the C group heifers and 99.2% of the D group cattle had counts ranging from 0 to 20 EPG. None of the calves were passing 21-50 EPG while 5.2%, 2.4% and 0.6% of B, C and D group cattle, respectively, were passing a similar number of eggs. Eight tenths percent of calves, 2.0% of B group heifers, 0.2% of C group heifers and adult cattle were passing 51 or more EPG. Figures 3, 4 and 5 depict the actual EPG distribution in the B, C and D groups, respectively. Because the actual EPG distribution is not normally distributed and follows a negative binominal distribution, most members of a host population have low EPG, and fewer individuals have high EPG counts.

The percentage of cattle showing no eggs in their feces ranged from 94.8% of the calves to 62.2% of the C group heifers, while 66.9% of the B group heifers and 78.0% of adult cattle were negative for worm eggs in their feces.

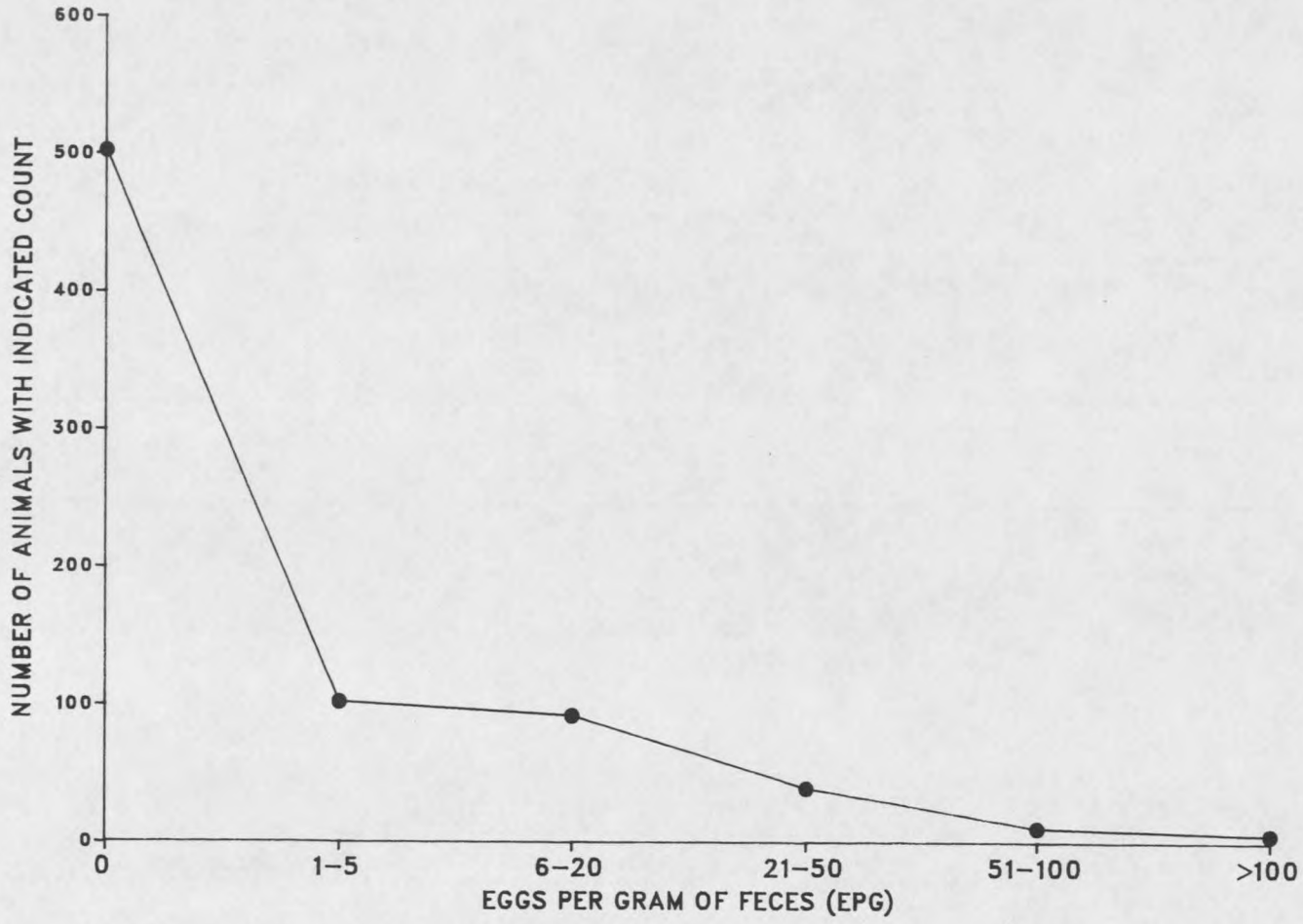


Figure 3. Frequency distribution of gastrointestinal nematode egg counts in 'B' group heifers.

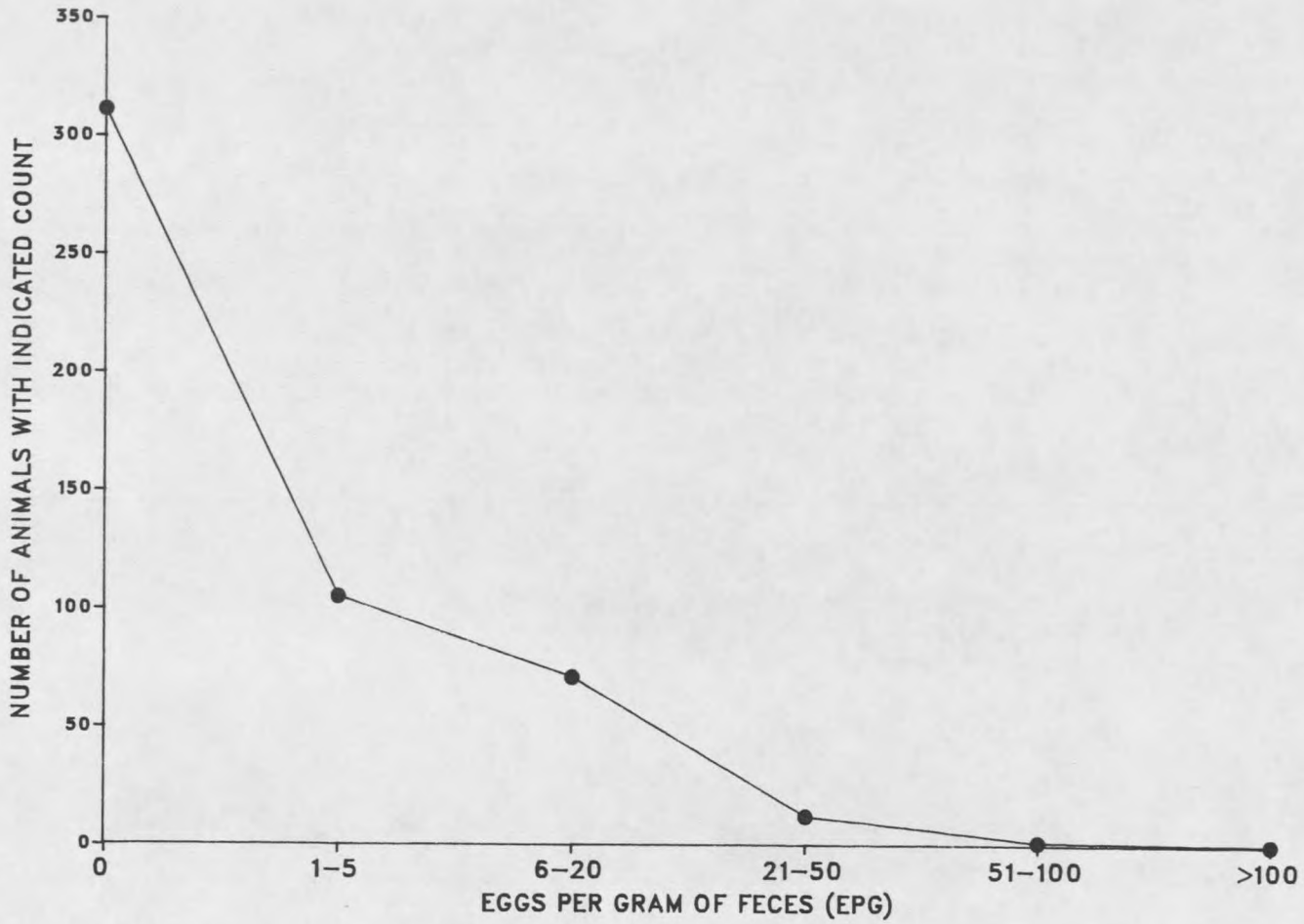


Figure 4. Frequency distribution of gastrointestinal nematode egg counts in 'C' group heifers.

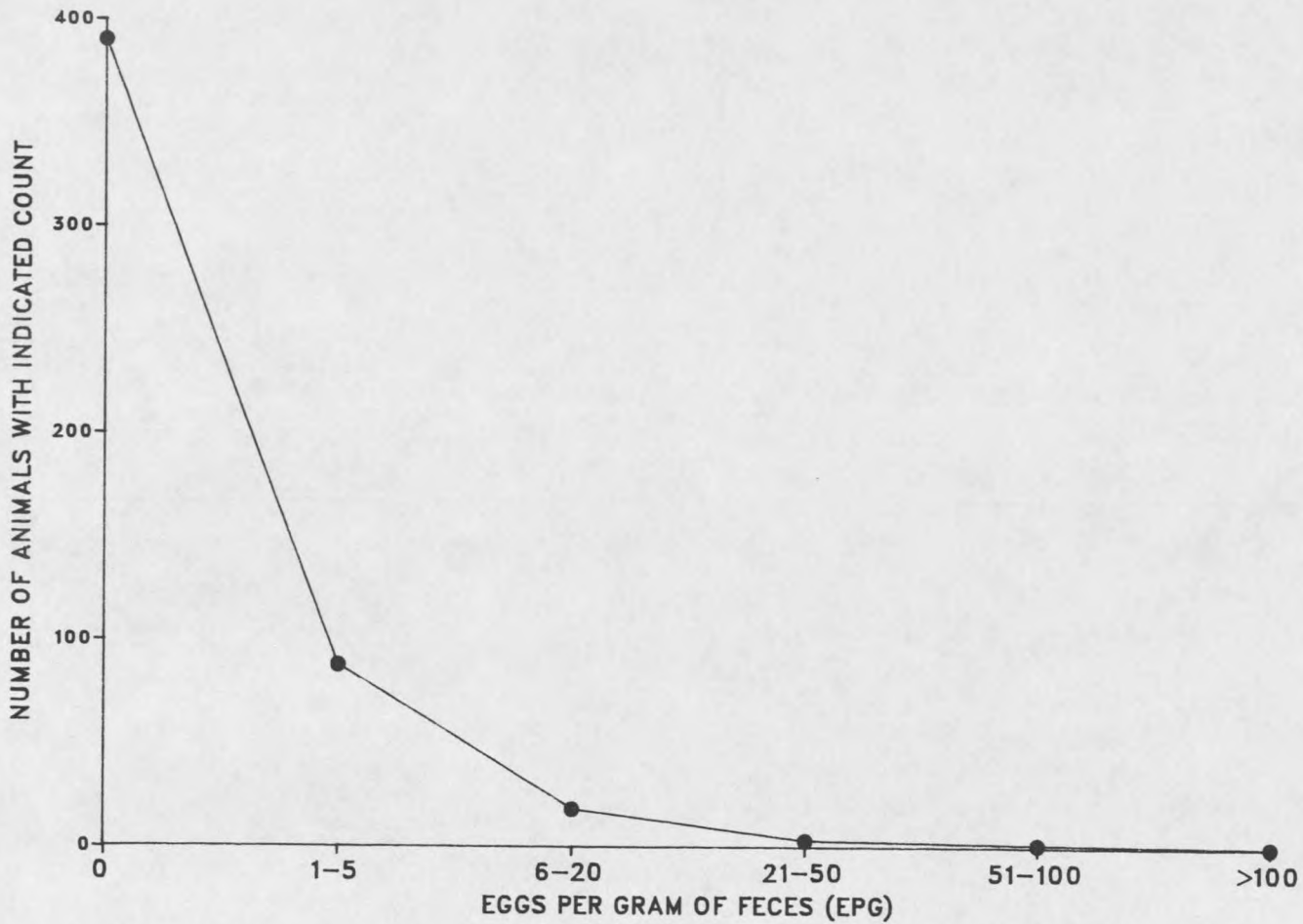


Figure 5. Frequency distribution of gastrointestinal nematode egg counts in 'D' group cattle.

Since calves are generally housed in a protected environment, parasite acquisition does not take place until these calves are placed in group pens or on pasture with other animals. Because young heifers have not yet developed immunity against helminth parasites, they are highly susceptible to infection with these parasites. Functional immunity is generally developed during the second grazing season, if pastured, or otherwise at about two years of age. Adult dairy cattle, like calves, will generally have low EPG counts since these mature animals have acquired immunity to helminth parasites, and are once again housed under more protected and sanitary conditions than most replacement heifers.

In the present study, group I nematodes, group II nematodes, Nematodirus spp. and lungworm comprised the majority of helminth eggs / larvae seen in the feces of infected cattle. The average EPG (composed of group I eggs, group II eggs and Nematodirus spp.) was negligible in the A group. Therefore, only data relating to infected cattle in the B, C and D groups were compared in respect to EPG data. The mean EPG of group I eggs in B group heifers (Avg. EPG 12.6) was nearly two times as great as that of the C group heifers (Avg. EPG 6.7) ( $p < .001$ ) and was more than two times that of the adult cattle (Avg. EPG 5.1) ( $p < .001$ ) (Figure 6). Mean worm egg counts for B, C and D cattle on each farm that were infected with group I nematodes are

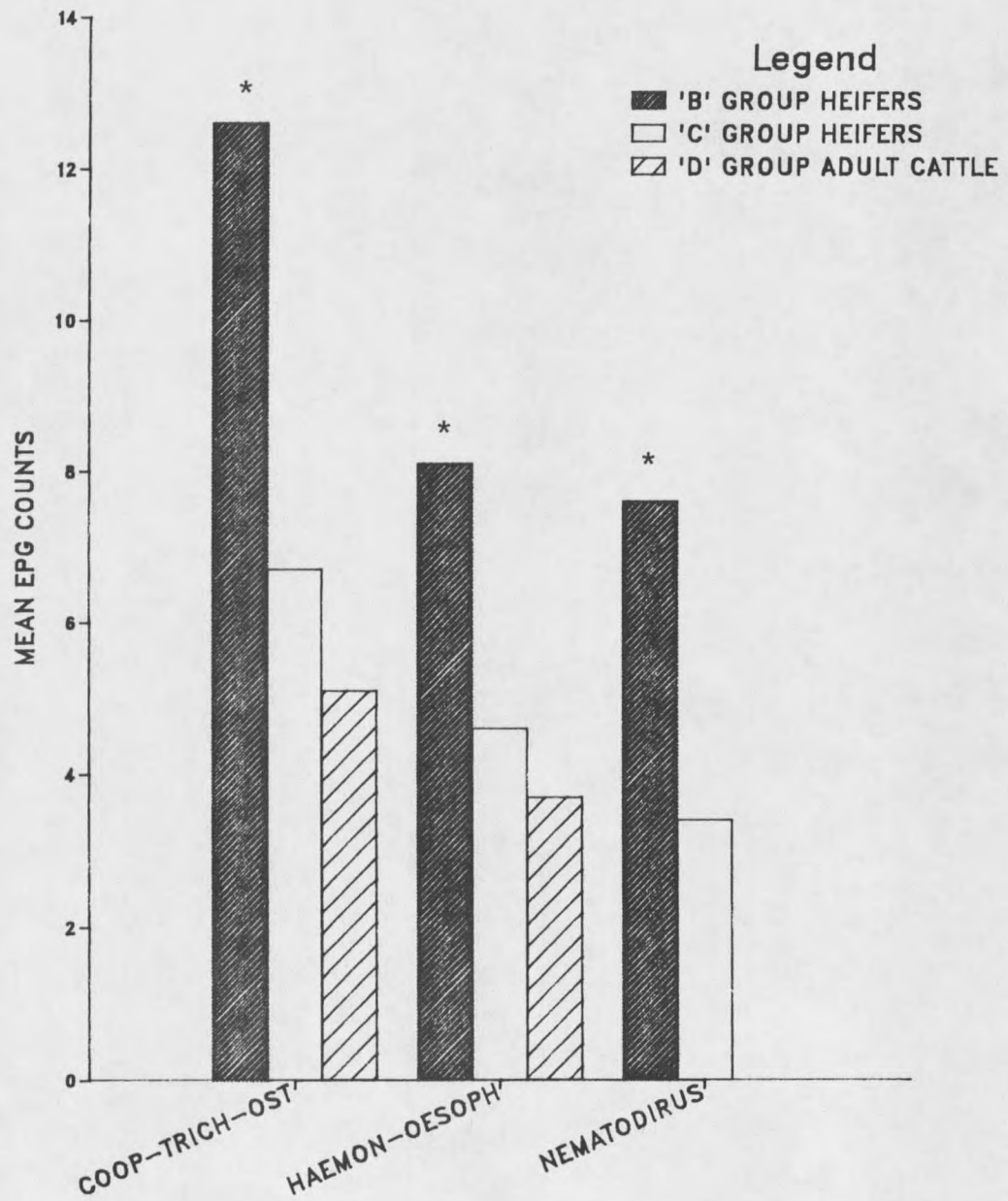


Figure 6. Mean worm egg counts for cattle infected with gastrointestinal nematodes on ten Montana dairy farms (\* =  $p < .001$ ).

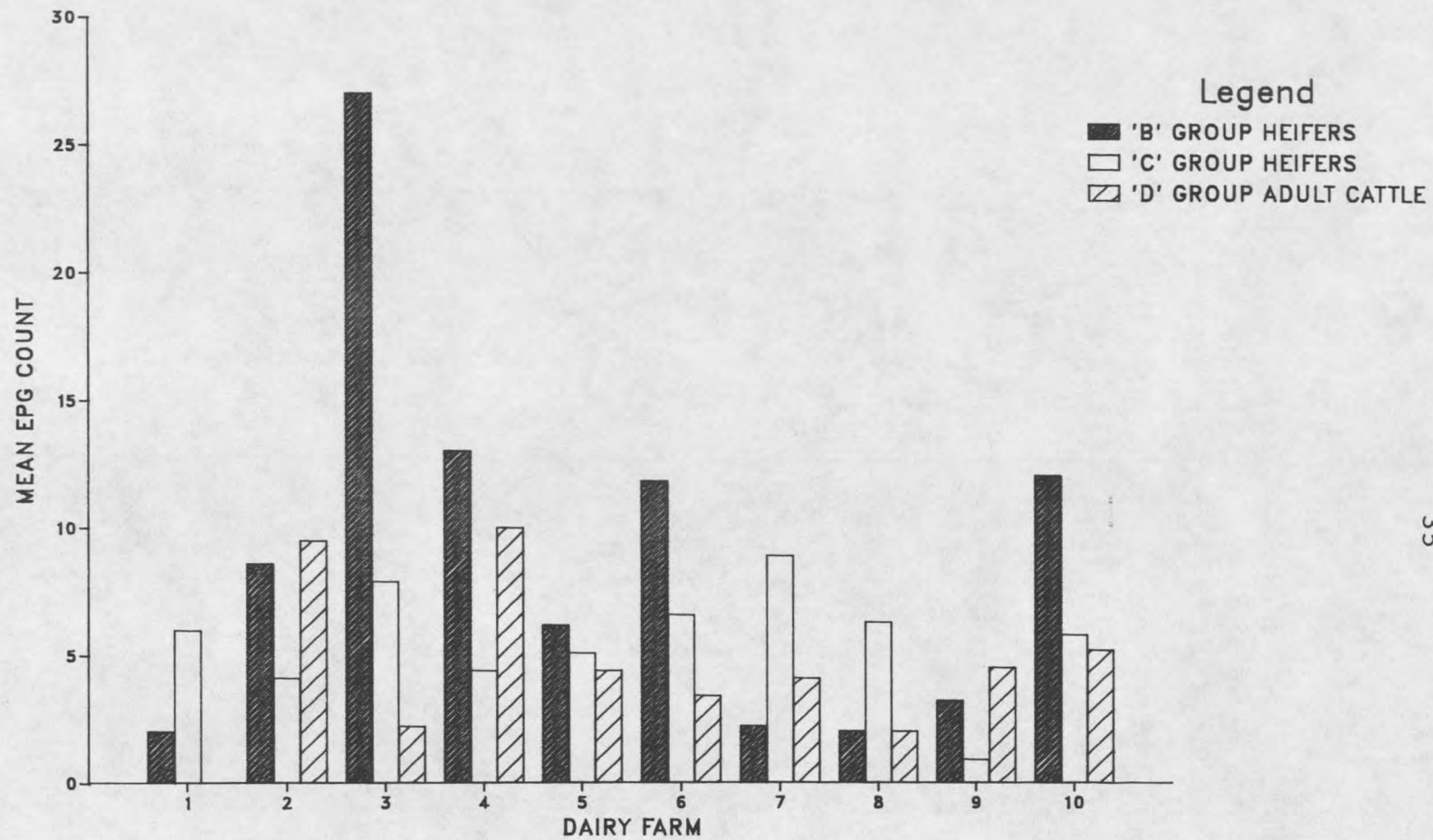


Figure 7. Mean worm egg counts for 'B', 'C' and 'D' groups of cattle infected with the Cooperia-Trichostrongylus-Ostertagia group of nematodes.

depicted in Figure 7. Group II eggs (Haemonchus-Oesophagostomum) occurred with an average EPG rate of 8.1, 4.6 and 3.7 in B, C and D groups, respectively (Figure 6). The mean EPG of group II eggs in B group heifers was significantly higher than both C group heifers ( $p < .001$ ) and D group cattle ( $p < .001$ ). Mean worm egg counts for cattle infected with group II nematodes on each farm are depicted in Figure 8. Group B heifers infected with Nematodirus spp. showed an average of 7.6 EPG which was significantly greater than group C heifers (Avg. EPG 3.4) ( $p < .001$ ) (Figure 6). Mean worm egg counts for cattle infected with Nematodirus spp. on each farm are depicted in Figure 9. Adult cattle and calves did not harbor Nematodirus spp. (Figure 9). Comparisons were drawn between pastured and drylot managed B and C group heifers on the ten farms. The percentage of fecal samples with parasite eggs was significantly larger from heifers placed on pasture than from those kept under drylot conditions ( $p < .001$ ). This was true for heifers in both the B and C groups where the chi-square test was used to determine level of significance. Similar findings have been reported in Washington (Malczewski et al., 1975), Kansas (Leland et al., 1973) as well as North Carolina, Wisconsin and Pennsylvania (Grisi and Todd, 1975).

Mean larval counts for cattle infected with Dictyocaulus viviparus were 40.0 larvae per gram (LPG) of

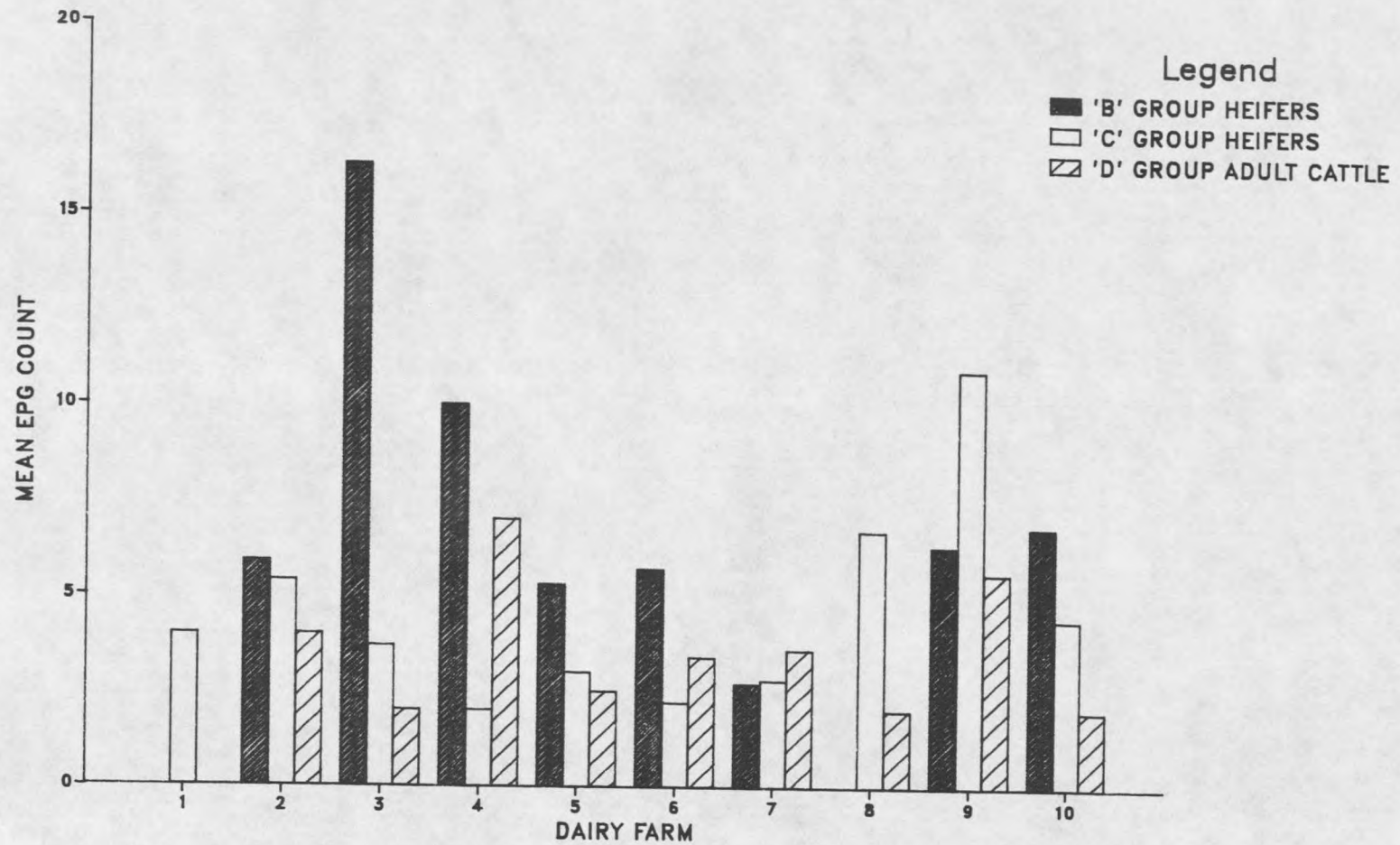


Figure 8. Mean worm egg counts for 'B', 'C' and 'D' groups of cattle infected with the Haemonchus-Oesophagostomum group of nematodes.

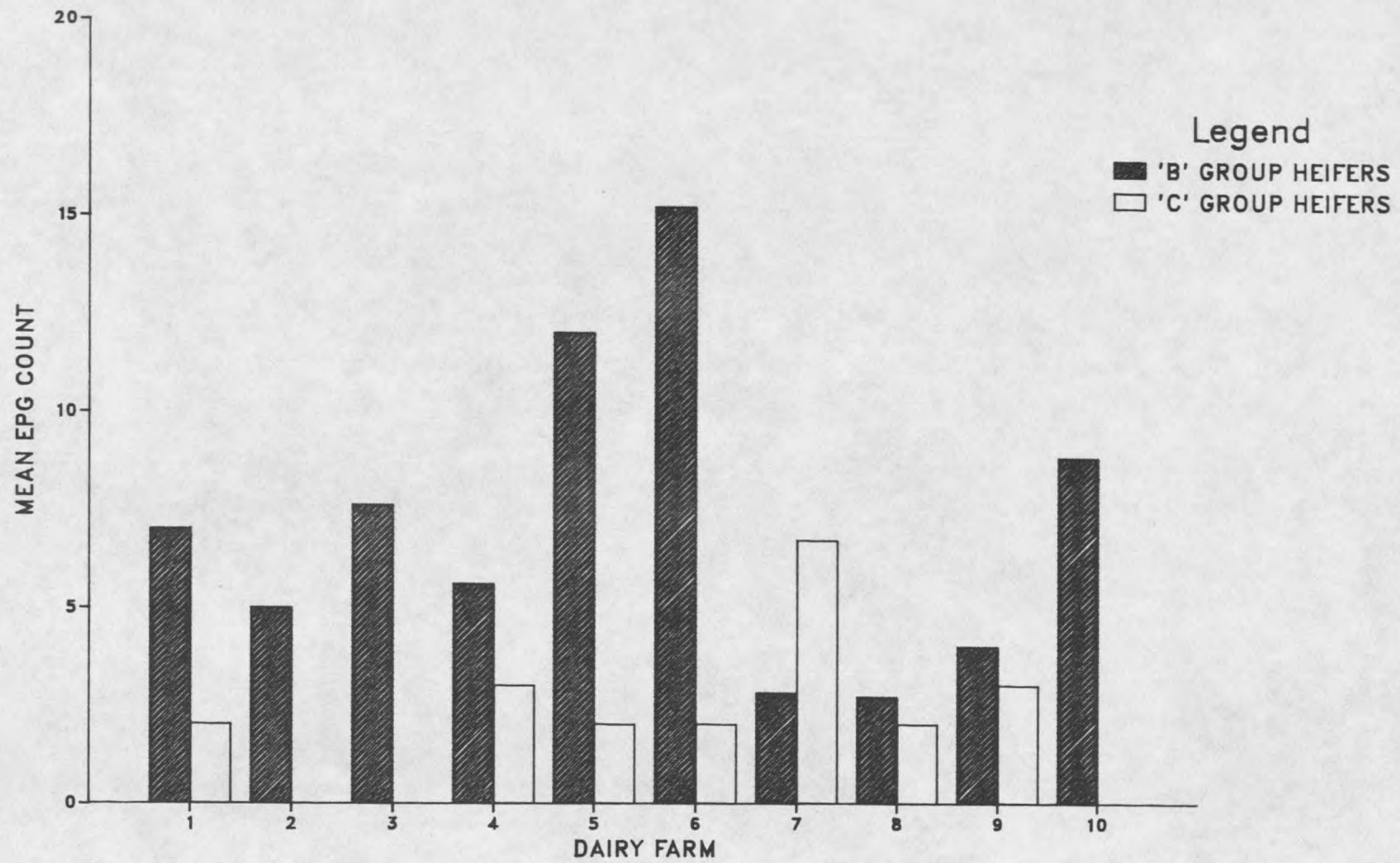


Figure 9. Mean worm egg counts for 'B', and 'C' groups of heifers infected with Nematodirus spp..

feces for both the B and C groups. Ten B group heifers at two farms were positive for lungworm. At farm 6, lungworm larval counts for nine B group heifers averaged 44.2 LPG. Eight C group heifers at farm 2 harbored 736 larvae (avg. LPG 92.0) while average LPG counts of 27.2, 20.2, 17.8 and 10.0 were found in C group heifers at farms 6, 7, 5 and 3, respectively (Figure 10). All adult cattle and calves were negative for lungworm. The Fischer test was used to compare lungworm prevalence in pastured or drylot-managed C group heifers. This test showed that farms that pastured these heifers had a significantly higher prevalence of lungworm than farms where these heifers remained on drylot ( $p = .024$ ). Of the five lungworm infested pastures, four were poorly drained.

Of 2000 fecal samples examined, 33.4% were positive for coccidian oocysts. An analysis of infection rates indicated Eimeria canadensis was the most common oocyst observed (21.9%) followed by E. bovis which was present in 16.0% of the cattle examined (Table 9). More than twice as many of the B group heifers (53.1% positive) harbored Eimeria spp. than did calves (26.4% positive). Over 5 times as many C group heifers (34.8%) were positive for Eimeria spp. oocysts than adult cattle (6%).

A comparison of coccidian occurrence in A group calves on ten dairy farms (Table 10) revealed a range from 0.0 (farm 2) to 68.0% (farm 3). Farm 10 showed a 64.0%

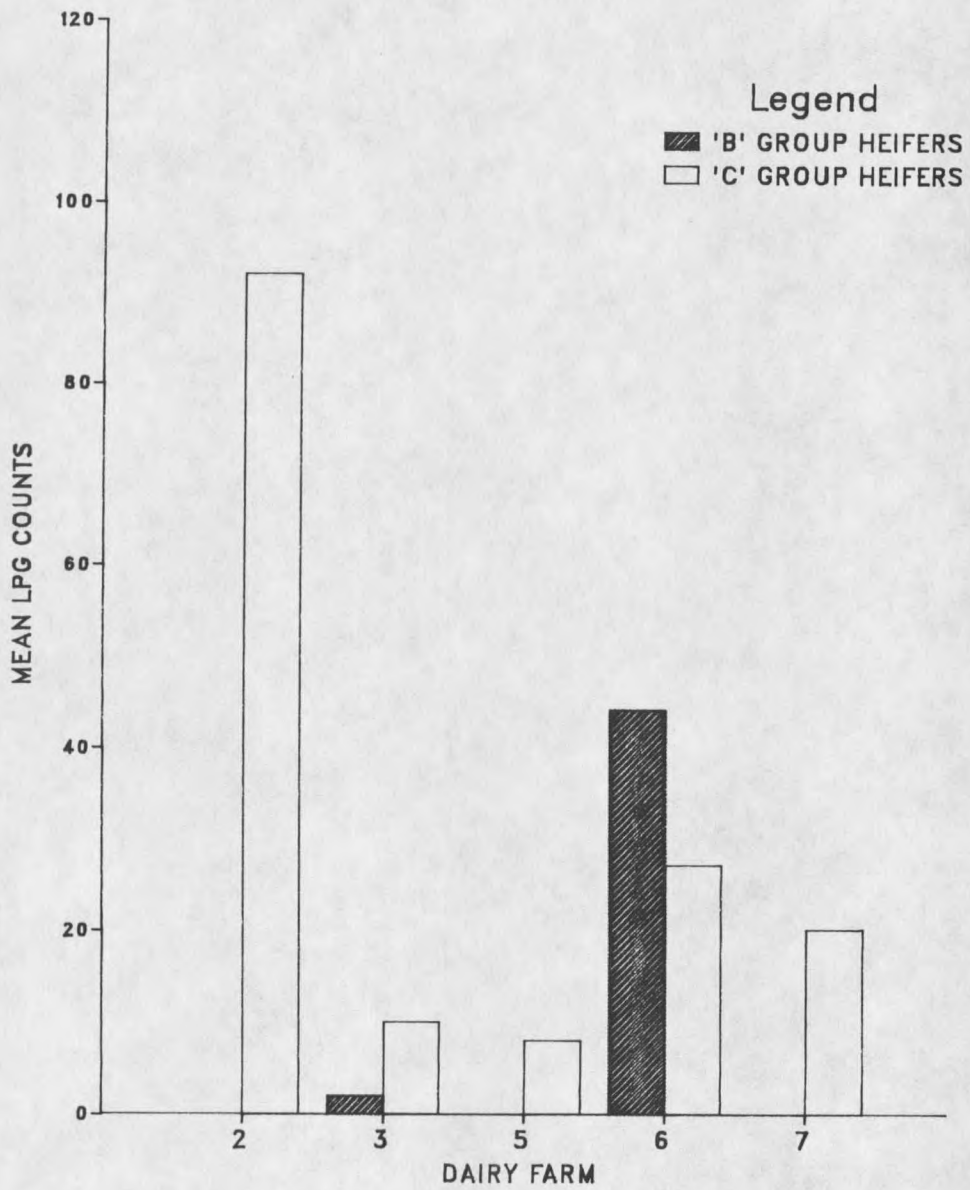


Figure 10. Mean larval counts for 'B' and 'C' groups of heifers infected with Dictyocaulus viviparus.

Table 9. Prevalence (%) of Eimeria spp. in cattle on ten dairy farms.

<u>Eimeria</u> <u>Species</u>	<u>Group</u>				Overall Prevalence
	A	B	C	D	
<u>Eimeria</u> <u>bukidnonensis</u>		5.0	3.2	0.2	2.7
<u>Eimeria</u> <u>auburnensis</u>	6.4	10.2	3.2	1.6	5.6
<u>Eimeria</u> <u>canadensis</u>	12.0	35.2	25.6	3.0	21.9
<u>Eimeria</u> <u>bovis</u>	18.4	26.5	14.0	1.0	16.0
<u>Eimeria</u> <u>ellipsoidalis</u>	1.2	1.0	0.2		0.6
<u>Eimeria</u> <u>zuernii</u>	8.8	10.5	3.0	0.4	5.9
<u>Eimeria</u> <u>cylindrica</u>	7.2	4.4	0.2	0.2	2.7

\* Blank space denotes zero value

prevalence, while 52.0%, 36.0%, 20.0%, 8.0%, 8.0%, 5.9% and 4.0% were positive at farms 4, 7, 1, 5, 8, 9 and 6, respectively. The B group heifers showed prevalence rates ranging from 72.0% (farm 3) to 34.7% (farm 1) while the range for C group heifers was 22.0% (farm 3) to 48.0% (farm 4). Farms 1 and 6 had no adult cattle positive for Eimeria spp. Prevalence figures for calves from the eight remaining farms ranged from 14.0% at farm 8 to 2.0% at farm 9.

Table 10. Composite prevalence (%) of Eimeria spp. on ten dairy farms.\*

Dairy farm	Group				Composite Prevalence by Farm <sup>a</sup>
	A	B	C	D	
1	20.0	34.7	28.0		22.5
2		58.7	40.0	6.0	33.5
3	68.0	72.0	22.0	6.0	42.5
4	52.0	53.3	48.0	12.0	41.5
5	8.0	61.3	34.0	8.0	34.5
6	4.0	52.0	34.0		28.5
7	36.0	42.7	32.0	4.0	29.5
8	8.0	45.3	42.0	14.0	32.0
9	5.9	54.7	40.0	2.0	31.5
10	64.0	56.0	28.0	8.0	38.0
Composite Prevalence by Group <sup>b</sup>	26.4	53.1	34.8	6.0	33.4

\* Blank space denotes zero value

a Based on 200 animals/farm.

b Based on the following groups: "A" group (250 animals), "B" group (750), "C" group (500), and "D" group (500).

Questionnaires completed by each dairy cooperator were used in more detailed data analysis. Answers to questions in regard to four categories (feeding, housing, use of medications and health problems) (Appendix) were used as an aid in determining the type of management at each farm.

In general, calves on each of the ten farms were similarly managed. Management of adult milking cattle on the ten farms was similar as well. Answers to questions regarding the A and D groups were relatively uniform. Calves at all ten farms were housed in indoor or outdoor hutches and were fed milk or milk replacer up to approximately two months of age, at which time they were weaned. Similar feeding and treatment practices were also reported. Minor feeding variations were noted in the milking cattle at various farms, but housing, treatments and health problems were generally similar.

Information relating to the use of medications was helpful as an indicator of the emphasis placed on health care, but was not used further to analyze the data on endoparasitism. Answers regarding health problems were most often subjective and thus were not useful in comparing health management practices among the ten farms.

Answers to questions concerning feeding and housing of the B and C groups (high parasite prevalence groups) were very useful in analysis of parasite prevalence data in relation to specific management criteria. Cattle in the B and C groups were placed into one of two groups which included summer pastured animals and drylot managed animals. The questionnaires were useful in determining if manure was spread on pastures, and if pastures were irrigated or poorly drained.

Seventy percent of the farms housed B group heifers on drylot while the remaining 30.0% pastured this group. One hundred percent of the B group heifers housed on drylot were negative for lungworm. Sixty six and six tenths percent of pastured B group heifers were maintaining lungworm infections. Pastured heifers in the B group had the highest gastrointestinal nematode egg counts as well.

Similar feeding and housing management criteria were analyzed in relation to the C group heifers. Six of ten farms pastured the bred heifers during the summer months while the remaining four farms used drylot management. Those farms using drylot management had the lowest prevalences of gastrointestinal parasitism among the C group heifers and 100% of drylot-managed C group heifers were negative for lungworm. Eighty three and three tenths percent of pastured C group heifers were maintaining lungworm infections. Furthermore, 80.0% of pastures grazed by infected C group heifers were poorly drained.

## DISCUSSION

Parasites are, by definition, organisms which obtain their livelihood at the expense of other animals. Common internal parasites of cattle include gastrointestinal worms and lungworms of the class Nematoda, coccidia of the class Sporozoa, and the cattle cestode, or tapeworm, Moniezia sp. (Swisher and McGilliard, 1978). In young cattle, helminthosis is, after malnutrition, the most important cause of unthriftiness in many areas of the world (Brunsdon, 1964). The growth rate in calves may be retarded if they graze pastures with more than 100 infective larvae per kilogram of dry matter (Herd, 1983a). In replacement heifers, infections with gastrointestinal parasites may delay maturity (Kennedy, 1983) while in the milking herd, subclinical gastrointestinal parasitic infections may depress milk production by approximately two kilograms per day for a period of nine weeks if the infection is continuous (Gibbs, 1982). Directly and indirectly, internal parasites of cattle are involved in weight loss, lowered fertility, decreased viability, down-grading of carcasses, delayed conception, and reduced disease resistance as well (Snijders, 1980). More specifically, the brown stomach worm, Ostertagia ostertagi is the cause of loss of acid secretory capacity and subsequent rise in the pH within the

abomasum of the infected animal (Anderson and Waller, 1983). Acid secretion in the abomasum is not affected until the fourth stage larvae of O. ostertagi molt and become immature adult worms (L<sub>5</sub>). In so doing, these immature forms emerge from the gastric glands and release secretions which inhibit acid secretion by the gastric cells in the abomasal mucosa. Parasites that live in the small intestine also interfere with the absorption of nutrients and trace elements e.g. selenium and phosphate. These parasites may produce clinical symptoms related to deficiencies rather than direct parasitism (Snijders, 1980).

Microscopic examination of the feces for worm eggs will determine if egg-laying worms are present (Snijders, 1980). Infective larvae produced from these eggs exist in most areas of the animal's environment (Grisi and Todd, 1978; Raynaud et al., 1981b). While numerous studies have indicated that most dairy cows pass low numbers of worm eggs in their feces and that younger cattle pass considerably greater numbers of eggs than the cows (Baker, 1949; Anderson and Waller, 1983), there is some difficulty in interpreting what an EPG count means with respect to the probable number of adult worms in an animal (Dewhirst and Hansen, 1961). It has been suggested that the value of 300 eggs per gram of feces for mixed strongyle eggs indicates borderline subclinical infections in cattle (Leland et al., 1973; Ciordia, 1975). None of the dairy cattle in the

present study passed 300 eggs per gram of feces. Some researchers feel that there is little correlation between an egg count and the severity of an infection since infection is dependent upon the host-parasite relationship, dilution in watery droppings, uneven distribution of eggs in the feces, and the varying developmental stages of roundworms in the host (Swisher and McGilliard, 1978; Gutierrez et al., 1979). Post-mortem examinations may be necessary to accurately evaluate the type and severity of parasitism present. The most practical method to assess worm burden in live animals is by counting eggs per gram of feces (Gutierrez et al., 1979). It has been calculated that one egg per gram of manure can mean 18,000 - 23,000 eggs per cow per day which are added to the environment. Thus, significant transmission of endoparasitic disease may occur even at low EPG (Kennedy, 1983).

Cattle parasite survey data from states other than Montana have been accumulated in Iowa (Zimmermann and Hubbard, 1961), Arizona and New Mexico (Becklund and Allen, 1958), Missouri (Sharma and Case, 1962), Kansas (Leland et al., 1973), Wisconsin (Grisi and Todd, 1978; Gutierrez et al., 1979), Georgia (Ciordia, 1975), Maine (Yazwinski and Gibbs, 1975; Randall and Gibbs, 1977), Ohio (Herd et al., 1980), Pennsylvania and North Carolina (Grisi and Todd, 1978). In these studies, the overall percent prevalence for gastrointestinal parasites ranged from 47.4% in Iowa cattle

(Zimmermann and Hubbard, 1961) to a high of 93.7% in Maine cattle (Randall and Gibbs, 1977). In Montana, Jacobson and Worley (1969) reported that 70.7% of all beef cattle surveyed were positive for gastrointestinal parasites whereas the overall percentage of infected cattle in the present study was found to be 28.6%. The differences in percent of infected animals in the above two studies may best be attributed to differing management practices. Pastured dairy replacement heifers and beef cattle and calves are similarly managed. However, pre-weaned dairy calves are generally housed in protected hutches while mature dairy cattle are kept in freestall housing. Animals housed under these conditions are generally exposed to fewer helminth parasites and are not subjected to contamination from helminth eggs and larvae which survive on pastures.

An understanding of the typical nematode life cycle (lung or gastrointestinal worm) is important in interpreting prevalence data for these nematode species. With most nematodes, the adult parasite lays eggs within the definitive host. These eggs pass out in the feces in the case of the stomach and intestinal worms. In lungworms, the eggs and first-stage larvae are coughed up from the lungs, swallowed and passed in the manure. Feces containing these eggs or larvae contaminate the environment. The eggs hatch in the manure and the larvae molt twice and develop into

infective forms. After the second molt, the third stage larva (L<sub>3</sub>) is typically the stage which enters the host. From this L<sub>3</sub> larva, adulthood is reached within the definitive host (Bond, 1978; Newby, 1985). In nematodes, these infective larvae are active grass climbers, under favorable weather conditions, and generally do so in early morning or evening when moisture is present on foliage (Bond, 1978; Craig, 1979). Climate affects the variety of parasites in a geographic locality, and weather factors including moisture and temperature contribute to determination of the time of transmission (Goldberg, 1968; Carmel and Todd, 1979; Craig, 1979; Snijders, 1980; Anderson and Waller, 1983). Rates of egg hatching and development of larvae increase linearly with increases in temperatures between 5 to 35 °C (Anderson and Waller, 1983).

The life cycle of certain nematode species may be altered depending upon the seasonal variations in different geographic localities. Worms such as Ostertagia spp. attain optimal egg production when the environment is most favorable (Kennedy, 1983). Seasonal trends in worm loads of dairy cattle have been reported in Wisconsin (Grisi and Todd, 1978; Gutierrez et al., 1979; Newby, 1985), Maine (Yazwinski and Gibbs, 1975; Randall and Gibbs, 1977; Gibbs, 1979), Washington (Malczewski et al., 1975), Quebec (Frechette and Gibbs, 1971) and England (Burrows et al., 1980). In these studies as in the present study, increases

in egg counts were noted in the spring. In surveys that studied hypobiosis the rise in EPG counts in some animals was attributed to development of arrested larvae which in turn, led to increased egg output.

Nematodiasis persists on enzootic farms in one or both of two major ways: 1) the larvae may overwinter on pasture in soil, on foliage or within dung pats, or 2) they may undergo arrested development (hypobiosis) within the host (Urquhart, 1985). In the present study, gastrointestinal nematode prevalence in cattle sampled began to increase in the summer sample period. Prevalence levels remained high through the fall and late fall sampling periods, at which time peak prevalence was noted. The manner by which nematode eggs and larvae persisted on farms positive for nematodes was not determined in this study. A study of greater duration which focuses on this objective is necessary to clarify this point.

Gibbs (1979, 1980) noted that Cooperia spp. and Ostertagia spp. larvae remained infective on Maine pastures for at least 12 months, whereas Nematodirus spp. were able to survive at least 23 months under similar conditions. Similar findings have been reported in western Europe (Euzéby, 1981), Switzerland (Eckert et al., 1981), Sweden (Nilsson, 1981), Quebec (Fréchette and Gibbs, 1971) and Ontario (Randall and Gibbs, 1977). Dikmans (1952) reported that infective larvae of Haemonchus spp., Oesophagostomum

spp. and Trichuris sp. were able to survive on Florida pastures from November until the following April. Lungworms were ascertained to survive on pasture through the winter in England despite temperatures falling to  $-7^{\circ}$  C ( $19.4^{\circ}$  F) (Oakley, 1982). Dictyocaulus viviparus overwinter on pasture in Northern Ireland and Scotland (Duncan et al., 1979; Lyons et al., 1981) and Denmark (Jorgensen, 1980) as well. In the United States, Lyons and coworkers (1981) found that lungworm overwintered on central Kentucky pastures, while Winters and Worley (1975) noted overwinter survival of lungworm on Montana pastures. Research in Europe and in the United States has demonstrated that nematodiasis in susceptible cattle, primarily young calves and yearlings, is initiated each spring by these infective larvae that have survived the winter on pasture (Armour and Urquhart, 1974; McKenna, 1983; Newby, 1985). In the present study, the increase in EPG counts of infected animals which occurred during May and June may also be attributed to overwinter survival. Species of nematodes which contributed to this rise in EPG counts were generally those of the group I complex.

Since overwinter survival of lungworm larvae has been reported in Montana beef herds (Winters and Worley, 1975), it is very likely that dairy heifers that were positive for lungworm also obtained infections by ingesting infective larvae which had overwintered on pasture.

When conditions are unfavorable for the transmission of infective larvae, these larvae may increase their survival potential by undergoing hypobiosis (inhibition or arrested larval development) whereby cessation of development occurs in the larvae at an early or intermediate phase of existence within the host (Anderson and Waller, 1983). In this manner, the parasites are able to synchronize or modify their developmental and reproductive patterns to insure that infective larvae are available at the most appropriate times and locations for host-to-host transfer (Thomas et al., 1983). The mechanism for hypobiosis is still uncertain but the hypothesis that physiological changes occurring in hosts and/or parasites in various seasons may explain this phenomenon (Malczewski, 1970). Other researchers have speculated that larvae have an innate mechanism whereby they can be programmed to stop development for a period of time with resumption at a later stage (Malczewski, 1970; Armour, 1974; Smith, 1974; Gupta and Gibbs, 1975; Randall and Gibbs, 1977). Such developmental behavior, which is analagous to facultative diapause in insects, could be triggered by external environmental stimuli such as photoperiod and environmental temperatures, as well as host stimuli such as rhythmic hormonal and physiological changes associated with normal circadian or seasonal rhythms thought to be mediated by the pineal or pituitary glands (Malczewski, 1970; Gupta and Gibbs, 1975). Hypobiosis creates problems in assessing

parasitism based upon fecal egg counts. Because arrested larval worms don't produce eggs, they may be present in large numbers in the host but show no external evidence in the form of egg counts (Gibbs, 1982). The extent to which hypobiosis existed in the present study is unknown. Further studies involving post-mortem examinations of dairy cattle in Montana are necessary to determine if hypobiosis is a factor in the survival and persistence of these parasites.

It is currently felt that hypobiosis, being triggered by host and environmental factors, occurs at different times of the year in different geographic locations. In northern climates, nematode larvae appear to undergo arrested development in late fall and winter (Herd and Heider, 1985) in response to possible cold-conditioning (Duncan et al., 1979; Gibbs, 1982; Herd, 1983b). In the south, inhibition occurs from spring until early fall as a protective measure from desiccation on hot summer pastures (Gibbs, 1982; Herd, 1983b). Similar trends have been noted in the Netherlands (Borgsteede and van der Burg, 1981), southeastern United States (Porter, 1942) Maine, (Randall and Gibbs, 1977), Australia (Overend, 1984), Sweden (Nilsson, 1981), Britain (Armour, 1974) and Poland (Malczewski, 1970). In the present study, EPG counts in infected animals decreased considerably after the late fall (September/October) sampling period. At this time, lungworm larvae also were no longer noted in fecal samples. Analysis of questionnaires

revealed that the use of anthelmintics was not a routine management practice and that management practices on the ten farms remained relatively constant throughout the duration of the study. For these reasons it is felt that decreases in EPG/LPG counts in these dairy cattle may be explained by arrested development of nematode larvae in response to decreasing temperatures.

A number of researchers have studied the phenomenon of hypobiosis with reference to Ostertagia spp. in cattle (Anderson et al., 1965; Brunsdon, 1969; Brunsdon, 1983; McKenna, 1983). Infection with Ostertagia spp. is characterized by two types of response designated as type I and type II ostertagiasis. Type I disease occurs in calves or cattle less than one year of age which are placed on pasture for the first time and become infected with Ostertagia spp. (Anderson et al., 1965; Brunsdon, 1969; Brunsdon, 1983; McKenna, 1983). Most of the ingested larvae develop to maturity in approximately three weeks (Anderson et al., 1965). Type II ostertagiasis occurs in animals over twelve months of age that have grazed infected pastures in late autumn and are maintaining populations of inhibited larvae. Clinical signs become apparent as much as six months after initial infection and coincide with the development to maturity of large numbers of inhibited larvae (Brunsdon, 1969). In the present study, EPG counts in cattle increased during the summer, fall, and late fall sampling

periods. Eggs of group 1 nematodes were found in the feces of sampled cattle in higher percentages than any other type of helminth eggs or larvae. If Ostertagia spp. composed the majority of group 1 nematode eggs found in the feces of these cattle, it could be postulated that the rise in EPG counts noted in these cattle could be explained by Type I ostertagiasis. Because necropsy and post-mortem data were not available, it was not possible to determine if the cattle sampled were maintaining populations of inhibited larvae.

Inhibition of lungworm (D. viviparus) development has been reported in Austria and Canada (Duncan et al., 1979). In Montana, Winters and Worley (1975) found that the onset of patent lungworm infections followed a seasonal pattern which began in July or August, peaked in late September or early October, and continued through November or December. Spontaneous reactivation of dormant infections appeared to take place in some yearling animals three to five months after initial calfhoo d infections became nonpatent. A June / July lungworm peak was noted in yearling beef cattle in another study in southwestern Montana (Worley, personal communication). In the present study, D. viviparus larvae were found in the feces of infected B and C group heifers during the summer and fall sampling periods. Larval counts in infected animals on several farms were first noted in

May, appeared to peak during the months of July and August and subsided in September.

In Australia, lungworm disease is a clinical problem of major importance in cattle (Anderson and Waller, 1983). In North America, infection with D. viviparus is usually associated with areas of high moisture and moderate temperatures but is widely, though sporadically, distributed (Bennett, 1981). In both Washington state (Malczewski et al., 1975) and most Great Plains states (Bergstrom, 1973), lungworm infection is a minor problem. Winters and Worley (1975) reported that bovine lungworm, as it occurs in Montana beef cattle, is a high prevalence / low intensity infection, while Jacobson and Worley (1969) noted that lungworms inhabited Montana ecosystems varying from semi-arid sagebrush grassland range to subhumid intermountain valley grassland. They reported a widespread distribution of lungworms in Montana beef cattle. The present study revealed that five of ten dairy herds sampled were positive for D. viviparus. Winters and Worley (1975) determined that the mean rate of larval excretion in feces of all infected cattle was .37 LPG (range 0.01-5.5). In the present study, only B and C group heifers were infected with lungworms. These infected cattle indicated a much higher rate of larval excretion in infected dairy cattle with a range of 2.0 to 92.0 LPG and a mean rate of 39.6 LPG.

The specific study of hypobiosis was not within the scope of the present study. However, it was noted that the group I nematodes (Cooperia-Trichostrongylus-Ostertagia) were the most commonly found genera of gastrointestinal nematodes, accounting for 21.8% of infections in all cattle in the study. Cattle parasite survey data from states other than Montana have been accumulated in Arizona and New Mexico (Becklund and Allen, 1958), Texas (Smith, 1967), Oklahoma (Cooperider et al., 1948), Louisiana (Craig, 1979), Georgia (Hitchcock 1956; Ciordia, 1975), Maine (Yazwinski and Gibbs, 1975; Randall and Gibbs, 1977), Washington (Malczewski et al., 1975) and Wisconsin (Grisi and Todd, 1978). In these studies, Ostertagia spp. were among the more commonly found species of gastrointestinal nematodes. Jacobson and Worley (1969) indicated that the potential for outbreaks of bovine parasitic gastritis attributable to Ostertagia spp. existed in Montana beef herds.

A comparison of group II nematode species (Haemonchus-Oesophagostomum) incidence figures for cattle revealed that considerable moisture and moderate temperatures may be required by Haemonchus spp., thereby limiting its ability to survive in areas with cold climates (Bergstrom, 1973; Randall and Gibbs, 1977). The inability of group II nematodes to overwinter on pasture in regions where prolonged subfreezing temperatures occur may explain the low incidence of these genera in Maine dairy cattle (Randall

and Gibbs, 1977). These parasites, likewise, were not commonly found in Montana beef cattle (Jacobson and Worley, 1969). In the present study, group II nematodes accounted for 11.6% of infections in all cattle sampled, indicating that the Haemonchus-Oesophagostomum complex is also a minor component of Montana dairy cattle parasite infections.

Nematodirus spp. were not commonly found in Montana dairy cattle, accounting for 5.6% of infection in all fecal samples examined. Similar findings were reported by Jacobson and Worley (1969) in Montana beef herds, as well as in New Hampshire (Stoddard, 1971) and Washington (Malczewski et al., 1975) dairy cattle. None of the D group adult cattle in the present study were infected with Nematodirus spp. Infections with this species occurred most frequently in the B and C groups of cattle sampled (Figure 9). Studies with cattle in the Great Plains (Bergstrom, 1973) have also reported that Nematodirus spp. were common only in calves and yearlings and decreased in numbers as the bovine reached one and one-half to two years of age.

Jacobson and Worley (1969) reported that 7.2% of the beef cattle surveyed were positive for Moniezia sp. Two and five-tenths percent of dairy cattle sampled in the present survey were found to harbor this cestode. Moniezia sp. eggs were not found in Arizona cattle and were infrequently encountered in New Mexico (Becklund and Allen, 1958). Maine

records indicated that 25.1% of dairy cattle surveyed harbored Moniezia sp. (Yazwinski and Gibbs, 1975).

In a report made to the American Veterinary Medical Association in 1948 by a committee on parasitology (Swales, et al., 1948), coccidiosis was listed as the third most important disease in cattle. Coccidiosis is not consistently prominent in all areas of the United States but has been reported most frequently and caused greater losses in the states west of the Mississippi River (Davis and Bowman, 1951; Peardon et al., 1961; Fitzgerald, 1975). While coccidiosis is responsible for significant mortality and economic losses in calves less than one year old (Conlogue et al., 1984), infections with Eimeria spp. are so common that most cattle will develop infections during their first year of life (Fitzgerald, 1975). Coccidia seem to pose a threat whenever bovines are under the stress of overcrowding, cold and wet temperatures and poor feeding practices (Marsh, 1938; Bergstrom, 1973; Fitzgerald, 1975). Cattle parasite survey data which includes information on coccidia have been accumulated in a number of states. Leland and coworkers (1973) reported that 44.0% of surveyed cattle in Kansas were positive for Eimeria spp. while in Oregon (Nyberg et al., 1967) and New Hampshire (Stoddard, 1971), 72.0% and 67%, respectively, of animals examined were positive for coccidia. Jacobson and Worley (1969) found that 64.9% of Montana beef cattle fecal samples contained

coccidial oocysts, with the most pathogenic species (E. zuernii and E. bovis) present in 5.8% and 46.5% of animals, respectively. In these studies, as well as in Washington (Malczewski et al., 1975) and in Wisconsin (Grisi and Todd, 1978), Eimeria bovis was the most prevalent coccidian species in surveyed cattle. In the present study, 33.4% of all dairy animals surveyed were positive for Eimeria spp. Eimeria canadensis was found to be the the most prevalent species (21.8%), with E. bovis infecting 16.0% of all dairy cattle sampled.

Analysis of the age class of dairy cattle in relation to parasite load revealed that replacement heifers are more heavily parasitized than either young calves or milking cows. Similar observations have been made in New York (Baker, 1949; Kennedy, 1982), Texas (Craig, 1979), Pennsylvania (Rothenbacher et al., 1980), Wisconsin (Cox and Todd, 1962), New Hampshire (Stoddard, 1971) and Wyoming (Honess and Bergstrom, 1963).

The higher percentage of nematode infection in the B group heifers (34.0%) and C group heifers (38.8%), as compared with the adult cattle (22.0%) and younger calves (5.2%) may be explained by immunity and also by variations in management practices among these age groups. Young stock, three to eighteen months of age, are more susceptible and are likely to have higher rates of exposure to parasitic infections than neonatal calves or adult cattle since both

calves and adult dairy cattle are generally kept in a more sanitary environment and on a higher level of nutrition than replacement heifers (Cox and Todd, 1962; Leland et al., 1973; Bond, 1978; Grisi and Todd, 1978). In addition, it is believed that mature dairy cattle develop a resistance to gastrointestinal nematodes which continues for the rest of their lives (Gutierrez et al., 1979; Conlogue et al., 1984). This immunity is produced by continuous exposure to parasites (Jacobson and Worley, 1969; Swisher and McGilliard, 1978; Snijders, 1980). When immunity is established, the parasite infection is not completely rejected but results in the immune animal carrying fewer parasites and the rate of pasture contamination being significantly reduced (Swisher and McGilliard, 1978).

Dairy replacement heifers are particularly susceptible to nematode infection during their first grazing season, since little resistance to nematodes has been developed. During their second and subsequent grazing seasons, these heifers will develop increasing resistance to parasitic disease (Bergstrom, 1973; Gibbs, 1979; Herd, 1983b; Anderson and Waller, 1983; Newby, 1985). Because replacement heifers are susceptible to nematode infections during the first grazing season, it is especially important to monitor parasite levels in replacement heifers and institute control measures as required.

Management is a complex, difficult-to-measure variable responsible for significant production differences among dairies that are otherwise similar. While it was not within the scope of this survey to analyze management and its role in parasitic disease in Montana dairy herds, a few specific management practices were scrutinized to determine if these had an influence on the incidence of parasitism at the farms involved in the survey. Analysis of question forms completed by the dairyherd managers at each of the ten dairy farms revealed that cattle from farms with a lower level of management did not have appreciably higher infection rates or egg counts than cattle from extremely well managed farms. Because most of the pathogenic nematode species e.g. Ostertagia spp. and Dictyocaulus viviparus appeared to be dependent on a pasture environment to complete their life cycle, comparisons were drawn between those farms which pastured the B and C group heifers and those which housed the heifers under drylot conditions. Farms which pastured replacement heifers consistently had higher EPG counts in infected animals than did farms which employed a drylot management system for these heifers.

Application of liquid manure to pastures has been noted as a possible source of contamination with parasite eggs (Fox and Jacobs, 1981). Studies in New York by Baker (1949), by Fox and Jacobs (1980) and by Euzeby (1981) have indicated that slurry spread on pastures was instrumental in

increasing the numbers of infective larvae present on pastures. In the current study, comparisons were drawn between farms that did or did not spread manure on pastures used for grazing. The chi-square test was used to determine if a significant difference existed in the percentage of fecal samples positive for nematode eggs which had been gathered from cattle grazing on slurry-spread pastures versus pastures to which slurry had not been applied. No significant difference existed between these two categories.

Dictyocaulus viviparus was noted in C group heifers on five of the ten farms involved in the present study. All five of these farms pastured the heifers which were found to be infected with lungworm. It has been reported that wet pasture prolongs the life of infective larvae (Schock, 1976) and thus allows for larval build-up to occur (Goda, 1974). Bennett (1981) found that infections specifically with D. viviparus have been associated with areas of high moisture. In the present study, animals infected with lungworm were almost always grazing poorly drained pastures. Therefore, the findings of Bennett (1981) may be useful in explaining the distribution of lungworm in this dairy cattle survey.

## SUMMARY

A survey was undertaken from January through November, 1986, to determine the identity, prevalence and intensity of helminth parasites and coccidia in southwestern Montana dairy cattle. Fecal samples were collected at five intervals from four specific age groups of cattle at ten dairy farms in Gallatin County. Pre-weaned calves less than three months old were designated as the "A" group. Heifers, three to approximately twelve months of age, comprised the "B" group of cattle. The "C" age group were those heifers that ranged in age from 13 to 24 months, while cattle which had calved at least once and were part of the active milking herd were recorded as the "D" group.

Fecal samples obtained from cattle were assayed for lungworm larvae by using the Baermann technique and for gastrointestinal parasites by using the Lane flotation method.

The identity of helminth parasites and coccidia was ascertained employing the egg classification criteria of Levine (1978). The number of nematode eggs per gram (EPG) and lungworm larvae per gram (LPG) of feces were evaluated in relation to A, B, C and D group cattle.

The present survey was undertaken in a very specific location in Montana. Research in the future will be neces-

sary to determine a statewide evaluation of internal parasitism of dairy cattle. Since the survey was conducted over a one-year period, it was concluded, as well, that observations over a more extensive time period would be necessary to correlate seasonal trends with parasite load. Further research necessary to determine the status of hypobiosis as a factor in nematodiasis in Montana dairy cattle would entail post-mortem examinations.

This report illustrates the levels at which helminths parasitize Montana dairy cattle. Research in the future will be necessary to determine to what extent these levels of parasitism induce economic loss, and which financially sound means are available to the dairy farmer for efficiently controlling helminth parasitism.

## REFERENCES CITED

- AFZAL, M., M. SHAFIQUE, A. HUSSAIN, AND M. SAEED. 1981. A study of helminths of cattle and buffaloes in Lahore. *Pakistan J. Sci.* 33:14-20.
- ANDERSON, N., J. ARMOUR, W.F.H. JARRETT, F.W. JENNINGS, J.S.D. RITCHIE, AND G.M. URQUHART. 1965. A field study of parasitic gastritis in cattle. *Vet. Rec.* 77:1196-1204.
- ANDERSON, N., AND P.J. WALLER. 1983. Lifecycle and helminths of lesser economic importance. In: *The Epidemiology and control of gastrointestinal parasites of cattle in Australia*. N. Anderson and P.J. Waller (Eds.) Commonwealth Scientific and Industrial Research Organization, Australia. Div. of Animal Health. pp. 9-22.
- ANDREWS, J.S., W.L. SIPPEL, AND D.J. JONES. 1953. Clinical parasitism in cattle in the southeast. *Proc. 57th Ann. Meet. U.S. Livestock Sanit. Assoc.* pp. 228-238.
- ARMOUR, J. 1974. Parasitic gastroenteritis in cattle. *Vet. Rec.* 95:391-395.
- ARMOUR, J., AND G.M. URQUHART. 1974. Clinical problems of preventative medicine: The control of helminthiasis in ruminants. *Br. Vet. J.* 130:99-109.
- BAERMANN, G. 1917. Eine einfache Methode zur Auffindung von *Ankylostomum* (Nematoden) Larven in Erdproben. *Geneesk. Tijdschr. Nederl. - Indië.* 57:131-137.
- BAKER, D.W. 1949. Gastrointestinal parasitisms of calves in New York state. *Rep. New York State Vet. Coll.* 27:237-250.
- BARTH, D., D. BERNHARD, AND J. LAMINA. 1981. Das Vorkommen von Magendarmwürmern bei Milchkuhen. *Berl. Munch. Tierarztl. Wschr.* 94:68-71.
- BECKLUND, W.W. 1961. Helminth infections in healthy Florida cattle with a note on *Cooperia spatulata*. *Proc. Helminthol. Soc. Wash.* 28:183-184.
- BECKLUND, W.W. 1962. Helminthiasis in Georgia cattle—a clinical and economic study. *Am. J. Vet. Res.* 23:510-515.

- BECKLUND, W.W., AND R.W. ALLEN. 1958. Worm parasites of cattle in New Mexico and Arizona. *Vet. Med.* 53:586-590.
- BELL, R.R. 1957. A survey of gastrointestinal parasites of cattle in North Carolina. *Am. J. Vet. Res.* 18:292-294.
- BELL, R.R. 1977. Parasites of range cattle in the Southwest. *J. Am. Vet. Med. Assoc.* 171:1087-1088.
- BENNETT, D.G. 1981. Lungworm Infection. In: *Current Vet. Therapy/ Food An. Pract.* J.L. Howard (Ed.) Saunders. Philadelphia. pp.829-831.
- BERGSTROM, R.C. 1973. Coccidia and common worms of cattle in Wyoming. *Wyoming Ag. Exp. Sta. Bull. No. 595* . 7 pp.
- BOND, M. 1978. Coping with parasites in dairy cattle. *Butter-Fat.* 56:15-18.
- BORGSTEEDE, F.H.M., AND W.P.J. van der BURG. 1981. Wormburdens in adult dairy cattle. In: *Epidemiology and control of Nematodiasis in cattle.* P. Nansen, R.J. Jorgensen and E.J.L. Soulsby (Eds.). The Hague, Martinus Nijhoff. Netherlands. pp. 131-141.
- BORGSTEEDE, F.H.M., AND W.P.J. van der BURG. 1982. Worm burdens in cows II. An analysis of the population of nematodes in the abomasa of adult dairy cows. *Vet. Parasitol.* 10:323-330.
- BRUCE, E.A. 1921. Bovine coccidiosis in British Columbia, with a description of the parasite, Eimeria canadensis sp.n. *J. Am. Vet. Med. Assoc.* 58(n.s. 11):638-662.
- BRUNSDON, R.V. 1964. The incidence of gastrointestinal nematodes in cattle in New Zealand. *New Zealand Vet. J.* 12:135-139.
- BRUNSDON, R.V. 1969. Trichostrongyle worm infection in cattle: Ostertagiasis and concurrent infections in dairy calves: Seasonal patterns of occurrence, pathology and diagnosis. *New Zealand Vet. J.* 17:161-172.
- BRUNSDON, R.V. 1983. Control of gastrointestinal nematode infection in dairy cattle. *Proc. of a course in dairy cattle medicine.* R.E. Slaughter (convenor). Foundation for Continuing Educ. of the N.Z. Vet. Assoc. and faculty of Vet. Sci., Massey Univ. pp. 80-102.

- BURROWS, R.O., P.J. BEST, AND J.M. PRESTON. 1980. Trichostrongylid egg output of dairy cows. Vet. Rec. 107:399-401.
- CARMEL, D.K., AND A.C.TODD. 1979. Distribution of third stage nematode larvae on three Wisconsin dairy farms. Vet. Med./ Sm. An. Clin. 74:1019-1026.
- CHRISTENSEN, J.F. 1941. The oocysts of coccidia from domestic cattle in Alabama (U.S.A.), with descriptions of two new species. J. Parasitol. 27:203-220.
- CIORDIA, H. 1975. Occurrence of gastrointestinal parasites in Georgia cattle. Am. J. Vet. Res. 36:457-461.
- CONLOGUE, G., W.J. FOREYT AND, R.B. WESCOTT. 1984. Bovine coccidiosis: Protective effects of low-level infection and coccidiostat treatments in calves. Am. J. Vet. Res. 45:863-866.
- COOPERIDER, D.E., C.C. PEARSON, AND I.O. KLIEWER. 1948. A survey of the gastrointestinal parasites of cattle in Oklahoma. Oklahoma A. and M. Coll., Vet. Res. Instit., Agric. Exper. Sta. Tech. Bull. T-31:20.
- COX, D.D., AND A.C. TODD. 1962. Survey of gastrointestinal parasitism in Wisconsin dairy cattle. J. Am. Vet. Res. Assoc. 141:706-709.
- CRAIG, T.M. 1979. Seasonal transmission of bovine gastrointestinal nematodes in the Texas gulf coast. J. Am. Vet. Med. Assoc. 174:844-847.
- DAVIS, L.R., AND G.W. BOWMAN. 1951. Coccidiosis in cattle. Proc. 55th Ann. Meet. U.S. Livestock Sanit. Assoc., pp. 39-50.
- DEWHIRST, L.W., AND M.F. HANSEN. 1961. Methods to differentiate and estimate worm burdens in cattle. Vet. Med. 56:84-89.
- DIKMANS, G. 1952. Research on internal parasites of cattle. Vet. Med. 47:199-205.
- DUNCAN, J.L., J. ARMOUR, K. BAIRDEN, G.M. URQUHART, AND R.J. JORGENSEN. 1979. Studies on the epidemiology of bovine parasitic bronchitis. Vet. Rec. 104:274-278.

- ECKERT, J., R. PERL, AND F. INDERBITZIN. 1981. Significance of nematodiasis in cattle grazing on alpine pastures. In: Epidemiology and control of Nematodiasis in cattle. P. Nansen, R.J. Jorgensen and E.J.L. Soulsby (Eds.). The Hague, Martinus Nijhoff. Netherlands. pp. 177-191.
- EUZEBY, J.A. 1981. Epidemiology and control of gastrointestinal helminthosis in cattle - intensive-breeding. In: Epidemiology and control of Nematodiasis in cattle. P. Nansen, R.J. Jorgensen and E.J.L. Soulsby (Eds.). The Hague, Martinus Nijhoff. Netherlands. pp. 457-470.
- FITZGERALD, P.R. 1975. The significance of bovine coccidiosis as a disease in the United States. Bovine Pract. 10:28-30, 32-33.
- FOX, M.T., AND D.E. JACOBS. 1980. Factors influencing uptake of nematode larvae in adult dairy cattle during the grazing season and sources of pasture contamination. Vet. Rec. 107:575-578.
- FOX, M.T., AND D.E. JACOBS. 1981. Observations on the epidemiology and pathogenicity of nematode infections in adult dairy cattle in Great Britain. In: Epidemiology and control of Nematodiasis in cattle. P. Nansen, R.J. Jorgensen and E.J.L. Soulsby (Eds.). The Hague, Martinus Nijhoff. Netherlands. pp. 87-99.
- FRÉCHETTE, J.L., AND H.C. GIBBS. 1971. Studies on the incidence of gastrointestinal helminths of cattle in Quebec. Can. Vet. J. 12:207-210.
- FRÉCHETTE, J.L., AND P. LAMOTHE. 1981. Milk production effect of a Morantel Tartrate treatment at calving in dairy cows with subclinical parasitism. Can. Vet. J. 22:252-254.
- GIBBS, H.C. 1979. Relative importance of winter survival of larval nematodes in pasture and infected carrier calves in a study of parasitic gastroenteritis in calves. Am. J. Vet. Res. 40:227-231.
- GIBBS, H.C. 1980. Persistence on pasture of the infective larvae of nematodes parasitizing Maine dairy cattle. Am. J. Vet. Res. 41:1694-1695.
- GIBBS, H.C. 1982. Symposium: Animal health factors of concern to producers. Gastrointestinal nematodiasis in dairy cattle. J. Dairy Sci. 65:2182-2188.

- GIBBS, H.C., T.A. YAZWINSKI, AND C.K. WALKER. 1975. A survey of helminth infections in selected Maine dairy herds. *J. Dairy Sci.* 58:1247.
- GODA, F.F.M. 1974. Incidence of lungworms infestation in sheep and cattle at Benghazi (Libyan Arabic Republic). *Bull. Epizoot. Dis. Africa.* 22:75-78.
- GOLDBERG, A. 1968. Development and survival on pasture of gastrointestinal nematode parasites of cattle. *J. Parasitol.* 54:856-862.
- GRISI, L., AND A.C. TODD. 1978. Prevalence of gastrointestinal parasitisms among milking cows in Wisconsin, Pennsylvania, and North Carolina. *Am. J. Vet. Res.* 39:51-54.
- GUPTA, R.P., AND H.C. GIBBS. 1975. Infection patterns of Dictyocaulus viviparus in calves. *Can. Vet. J.* 16:102-108.
- GUTIERRES, V., A.C. TODD, AND J.W. CROWLEY. 1979. Natural populations of helminths in Wisconsin dairy cows. *Vet. Med./Sm. An. Clin.* 74:369-374.
- HASCHE, M.R., AND A.C. TODD. 1959. Prevalence of bovine coccidia in Wisconsin. *J. Am. Vet. Med. Assoc.* 134:449-451.
- HERD, R.P. 1983a. A practical approach to parasite control in dairy cows and heifers. *The Compendium on Continuing Education. Continuing Education Article #7.* 5:S73-S78.
- HERD, R.P. 1983b. Subclinical effects and control of abomasal worms in dairy cattle. *The Bovine Proceedings No. 15:*85-89.
- HERD, R.P., R.M. RIEDEL, AND L.E. HEIDER. 1980. Identification and epidemiologic significance of nematodes in a dairy barn. *J. Am. Vet. Med. Assoc.* 176:1370-1372.
- HERD, R.P., AND L.E. HEIDER. 1985. Control of nematodes in dairy heifers by prophylactic treatments with albendazole in the spring. *J. Am. Vet. Med. Assoc.* 186:1071-1074.
- HITCHCOCK, D.J. 1956. A survey of gastrointestinal parasites of cattle in South Carolina. *J. Am. Vet. Med. Assoc.* 129:34-35.
- HONESS, R.F., AND R.C. BERGSTROM. 1963. Intestinal roundworms of cattle in Wyoming. *Wyo. Ag. Exp. Sta. Bull.* No. 410, 36 pp.

- HONG, C., M.B. LANCASTER, AND J.F. MICHEL. 1981. Worm burdens of dairy heifers in England and Wales. *Vet. Rec.* 109:12-14.
- JACOBSON, R.H., AND D.E. WORLEY, 1969. Incidence and distribution of helminth parasites and coccidia in Montana cattle. *Am. J. Vet. Res.* 30:1113-1117.
- JORGENSEN, R.J. 1980. Epidemiology of bovine dictyocaulosis in Denmark. *Vet. Parasitol.* 7:153-167.
- KENNEDY, T.J. 1982. Treatment of subclinical parasitism in dairy cattle. In: *Parasites- Their world and Ours*. D.F. Mettrick and S.S. Desser (Eds.). Elsevier Biomedical Press., Amsterdam. pp. 459-463.
- KENNEDY, T. 1983. Deworming does pay. *Dairy Herd Management.* 20:76-78.
- LANE, C. 1928. The mass diagnosis of hookworm infection. *Am. J. Hyg.* 8:1-148.
- LEE, K.B., D.Y. YOO, H.S. KIM, AND J.H. LEE. 1973. An outbreak of lungworm disease in a flock of Korean native cattle. *Korean J. Vet. Res.* 5:29-30.
- LELAND, S.E., H.K. CALEY, AND R.K. RIDLEY. 1973. Incidence of gastrointestinal nematodes in Kansas cattle. *Am. J. Vet. Res.* 34:581-585.
- LEVINE, N.D. 1978. *Textbook of Veterinary Parasitology*. Burgess Publishing Co., Minneapolis, MN. 236 pp.
- LUND, R.E. 1985. *A User's Guide to MSUSTAT: An Interactive Statistical Analysis Package*. Montana State Univ. Bozeman, MT.
- LYONS, E.T., R.D. HEMKEN, AND F.S. BUTTON. 1981. Overwintering of larvae of the cattle lungworm (*Dictyocaulus viviparus*) on pasture in Kentucky. *J. Am. Vet. Med. Assoc.* 179:456-457.
- MALCZEWSKI, A. 1970. Gastrointestinal helminths of ruminants in Poland III. Seasonal incidence of the stomach worms in calves, with consideration of the effect of the inhibition phenomenon on the spring rise phenomenon. *Acta Parasitol. Pol.* 18:417-434.
- MALCZEWSKI, A., R.B. WESCOTT, B.M. SPRATLING, AND J.R. GORHAM. 1975. Internal parasites of Washington cattle. *Am. J. Vet. Res.* 36:1671-1675.

- MARSH, H. 1938. Healthy cattle as carriers of coccidia. J. Am. Vet. Med. Assoc. 92(n.s. 45):184-194.
- McKENNA, P.B. 1983. Parasites as a cause of diarrhea in young cattle. Proc. of a course in dairy cattle medicine. R.E. Slaughter(convenor). Foundation for Continuing Educ. of the N.Z. Vet. Assoc. and faculty of Vet. Sci., Massey Univ. pp. 50-71.
- NEWBY, T.J., M.K. SCHUETTE, J. ZUBA, AND A.C. TODD. 1985. The seasonal pattern of nematode larvae on pastures grazed by Wisconsin dairy cattle. Agri-Pract. 6:6-12.
- NILSSON, O. 1981. Winter ostertagiasis in Swedish cattle. In: Epidemiology and control of Nematodiasis in cattle. P. Nansen, R.J. Jorgensen and E.J.L. Soulsby (Eds.) The Hague, Martinus Nijhoff. Netherlands. pp. 295-309.
- NYBERG, P.A., D.H. HELFER, AND S.E. KNAPP. 1967. Incidence of bovine coccidia in western Oregon. Proc. Helminthol. Soc. Wash. 34:13-14.
- OAKLEY, G.A. 1982. Observations on the epidemiology of Dictyocaulus viviparus in north west England. Res. Vet. Sci. 32:163-169.
- OVEREND, D. 1984. Abomasal trichostrongylidiasis of dairy cattle grazing irrigated pastures. Aust. Vet. J. 61:124-126.
- PEARLON, D.L., M.R. HASCHE, A.C. TODD, AND R.E. HALL. 1961. Clinical coccidiosis in Wisconsin cattle. J. Am. Vet. Med. Assoc. 139:1095-1098.
- PORTER, D.A. 1942. Incidence of gastrointestinal nematodes of cattle in the southeastern United States. Am. J. Vet. Res. 3:304-308.
- RANDALL, R.W., AND H.C. GIBBS. 1977. Occurrence and seasonal behavior of gastrointestinal nematodes infecting Maine dairy cattle. Am. J. Vet. Res. 38:1665-1668.
- RAYNAUD, J.P., C. MAGE, AND J.P. LE STANG. 1981a. Major internal parasites interfering with cattle production in France, and experiments to control them by strategic treatments. Ann. Rech. Vet. 12:143-157.

- RAYNAUD, J.P., L. MAGE, J.P. LE STANG, AND R.M. JONES. 1981b. Recent results on epidemiology of nematode infections in beef and dairy cattle in France. In: Epidemiology and control of nematodiasis in cattle. P. Nansen, R.J. Jorgensen and E.J.L. Soulsby (Eds.). The Hague, Martinus Nijhoff. Netherlands. pp. 193-214.
- ROSE, J.H. 1968. Species of gastrointestinal nematodes of cattle in S.E. England. Vet. Rec. 82:615-617.
- ROTHENBACHER, H., J.P. WIGGINS, AND B.P. SPRANKLIN. 1980. Cattle parasites compared among three-county dairy herds. Sci. Agric. 28:2-3.
- SAUVAGE, J.P., J.R.H. BROWN, J.G. PARKINSON, P.B. ROSSITER, AND P.T. MCGOVERN. 1974. Helminthiasis in cattle in the Ankole District of Uganda. Br. Vet. J. 130:120-127.
- SCHOCK, R.C. 1976. Nematode parasitism in cattle. Mod. Vet. Pract. 57:273-277.
- SHARMA, R.S., AND A.A. CASE. 1962. Intestinal helminths in domestic animals of central Missouri. (Abstr.) J. Parasitol. Suppl. 48:44.
- SMITH, J.P. 1967. Observation of parasitism in necropsy cases at the Texas A&M Necropsy Clinic. Southwest. Vet. 20:107-110.
- SMITH, H.J. 1974. Inhibited development of Ostertagia ostertagi, Cooperia oncophora and Nematodirus helvetianus in parasite free calves grazing fall pastures. Am. J. Vet. Res. 35:935-938.
- SNIJDERS, A.J. 1980. Internal parasites of cattle. Beef Cattle Science Handbook Vol. 17. pp. 272-275.
- STODDARD, J.D. 1971. Incidence of gastrointestinal parasites in New Hampshire dairy cattle. M.S. Thesis, Univ. of New Hampshire., Durham. 68 pp.
- SWALES, W.E., D.W. BAKER, H.E. KEMPER, R.E. REBRASSIER, AND R.D. TURK. 1948. Parasitology (committee report). J. Am. Vet. Med. Assoc. 113:235-239.
- SWISHER, J.M., AND M.L. MCGILLIARD. 1978. Internal parasites can eat your profits. Cooperative Ext. Service Dairy Guide Series 231:1700.00-1700.03.

- TAYLOR, S.M., AND R.J.G. CAWTHORNE. 1972. Species of gastrointestinal nematodes of cattle in Northern Ireland. *Br. Vet. J.* 128:311-315.
- THOMAS, R.J., J. ARMOUR, M.J. CLARKSON, R.J.G. CAWTHORNE, AND J.F. MICHEL. 1983. Animal husbandry, animal populations management systems and the use of anthelmintics in Great Britain. In: *Facts and Reflections IV. Resistance of parasites to anthelmintics: a workshop in the C.E.C. Animal Pathology Programme held at the Central Vet. Inst. F.H.M. Borgsteede, H.J. Henrickson, H.J. Over(Eds.) Lelystad, Netherlands.* pp. 167-173.
- URQUHART, G.M. 1985. Lungworms of ruminants. *Parasites, pests, and predators.* Elsevier Science Publishers, Amsterdam. pp. 289-298.
- WARD, J.W. 1946. A preliminary study of the occurrence of internal parasites of animals in Mississippi. *Proc. Helminthol. Soc. Wash.* 13:12-14.
- WINTERS, J.B., AND D.E. WORLEY. 1975. Distribution and seasonal prevalence of bovine lungworms in selected areas in western Montana. *Am. J. Vet. Res.* 36:327-329.
- YAZWINSKI, T.A., AND H.C. GIBBS. 1975. Survey of helminth infections in Maine dairy cattle. *Am. J. Vet. Res.* 36:1677-1682.
- YAZWINSKI, T.A., AND W. TILLEY. 1980. Gastrointestinal parasitic infections of dairy cattle. *Arkansas Farm Res.* 29:8.
- ZIMMERMANN, W.J., AND E.D. HUBBARD. 1961. Gastrointestinal parasitism in Iowa cattle. *J. Am. Vet. Med. Assoc.* 139:555-559.

## APPENDIX

Questionnaire for Study of Helminth Parasites and  
Coccidia in Southwestern Montana Dairy Cattle

FARM \_\_\_\_\_

DATE \_\_\_\_\_

BIRTH

## A. FEEDING

1. Colostrum - how much, how soon after birth?
2. Whole milk or milk replacer - how long is milk fed (i.e., weaning age)?
3. Creep feed - hay and/or grain?
4. H<sub>2</sub>O - free choice
5. Vit/Min supplements?
6. Seasonal variations - does your management of these calves change from season to season; major calving season or period?

## B. HOUSING

1. Calf barn - individual pen or group pen-type?
2. Outdoor hutch
3. Concentration of animals (animal/sq.ft.) in calf barn or spacing of individual pen in calf barn or outdoor hutch?
4. Description of housing - dry; draft-free; ventilation; contact between calves; type of bedding; supplemental heat; sanitation
5. Age when moved out of hutch or calf barn
6. Association with other livestock
7. Seasonal variations

## C. TREATMENTS

1. Vaccinations - frequency, drug
2. Prophylactic use of A.D.E., antibiotics, etc.
3. Deworming - dosages; frequency; drug
4. Other treatments - dosages; frequency; drug
5. Seasonal variations

## D. HEALTH PROBLEMS

1. Diarrhea
2. Pneumonia
3. Other
4. % mortality
5. % morbidity - treatment and recovery
6. History of recent parasitism; diagnosis
7. External parasites
8. Seasonal variations

## E. MISCELLANEOUS

1. Bull calves - cull or keep?

WEANING

## A. FEEDING

1. Roughage
2. Grain-feed bins - clean; off the ground
3. Supplement - Vit-Min-Protein
4. H<sub>2</sub>O
5. Pasture - type of forage; animal density/acres; wet/dry, irrigated; H<sub>2</sub>O source or supply; fertilized with waste; drainage (topography); grazing condition; rotation; seasonal variation; months in use; number of acres
6. Seasonal variation

## B. HOUSING

1. Animal density/concentration
2. Shelter available - bedding; sanitation
3. Age when housed in this group
4. Contact with other livestock or wild ruminants
5. Seasonal variation

## C. TREATMENTS

1. Vaccinations - frequency; drug
2. Deworming - dosages; frequency; drug
3. Other treatments - dosages; frequency; drug
4. Seasonal variation

## D. HEALTH PROBLEMS

1. Diarrhea
2. Pneumonia
3. Other
4. % mortality
5. % morbidity - treatment and recovery
6. History of recent parasitism; diagnosis
7. External parasites
8. Seasonal variation

OPEN AND BRED HEIFERS

## A. FEEDING

1. Roughage
2. Grain-feed bins - clean; off the ground
3. Supplement - Vit-Min-Protein
4. H<sub>2</sub>O source
5. Pasture - type of forage; animal density/acre; wet/dry; irrigated; H<sub>2</sub>O source or supply; fertilized with waste; drainage (topography); grazing conditions; rotation; months in use; number of acres
6. Dry lot - animal density/concentration; wet/dry; H<sub>2</sub>O source; drainage; rotation; months used; size; sanitation
7. Seasonal variation

## B. HOUSING

1. Animal density/concentration
2. Shelter available
3. Age upon entering this group
4. Change in housing with age
5. Contact with other livestock or wild ruminants on pastures?
6. Seasonal variation

## C. TREATMENTS

1. Vaccinations - frequency; drug
2. Deworming - dosages; frequency; drug
3. Other treatment - dosages; frequency; drug
4. Age bred to calve - AI or natural - (calving= entering milking string)
5. Seasonal variation

## D. HEALTH PROBLEMS

1. Diarrhea
2. Pneumonia
3. Other
4. % mortality
5. % morbidity - treatment and recovery
6. History of recent parasitism; diagnosis
7. External parasites
8. Seasonal variations

MILKING HERD

## A. FEEDING

1. Roughage
2. Grain-feed bins - off the ground; clean
3. Supplement - Vit-Min-Protein
4. H<sub>2</sub>O source
5. Pasture - type of forage; animal density/acre; wet/dry; irrigated, H<sub>2</sub>O source or supply; fertilized with waste; drainage (topography); grazing condition; rotation; months in use, number of acres
6. Dry lot - animal density/concentration; wet/dry; H<sub>2</sub>O source or supply; drainage; rotation; months used; size; sanitation
7. Seasonal variation

## B. HOUSING

1. Animal density/concentration
2. Free stall - sanitation; bedding
3. Calving in separate stall?
4. Contact with other livestock species or wild ruminants on pasture?
5. Seasonal variation

## C. TREATMENTS

1. Vaccinations - dosages; frequency; drug
2. Deworming - dosages; frequency; drug
3. Other treatment - dosage; frequency; drug
4. Seasonal variations

## D. HEALTH PROBLEMS

1. Diarrhea
2. Pneumonia
3. Other
4. % mortality
5. % morbidity - treatment and recovery
6. History of recent parasitism; diagnosis
7. External parasites
8. Seasonal variation

## E. MISCELLANEOUS

1. Dry cows - separate management or with milking herd?

MONTANA STATE UNIVERSITY LIBRARIES



3 1762 10020879 0