Incidence and distribution of helminth parasites and coccidia in Montana cattle
by Richard Hilding Jacobson

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
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Abstract:
A survey was conducted to determine the identity, incidence and distribution of internal parasites in Montana beef cattle. Fecal samples were collected from 486 calves less than 18 months of age and 479 adult cattle at five intervals during 1965-66 from six sampling stations representing major climatologic and geographic areas of the state.

The results showed that 85.6% of the calves harbored gastrointestinal nematodes, while 59.1% of the adult cattle were similarly infected. The Cooper-ia-Triahostrongytus-Ostevtagia group was the most prevalent type of infection (69.7%), followed by NematodirUs (11.3%), Haemonahus (4.8%), Triahuris (2.0%), Strongyloides (1.3%) and Capillaria(0.3%). Nematodirus and Haemonahus were about ten times as prevalent in calves as in adult cattle. Ten and one-tenth percent of the calves and 4.2% of the adult cattle were positive for Moniezia.

Nematode egg counts from 0-49 eggs per gram of feces (EPG) occurred in 88.1% of the calves and 98.3% of the adult cattle. Three and four-tenths percent of all animals sampled had counts over 100 EPG.

Seven and one-tenth percent of 422 calves were positive for Dictyocaulus larvae. All of 299 adult cattle similarly examined were negative. Dictyocaulus occurred in calves located in five of the six areas studied, varying from semi-arid sagebrush-grassland range to sub-humid intermountain valley grassland ecosystems.

Fasciola ova were present in feces of 1.7% of 59 calves and 20.2% of 88 adult cattle in western Montana. With the exception of one positive sample from the southwestern station, the remaining 644 fecal samples examined for flukes were negative.

Of 907 fecal samples, 64.9% contained one or more of nine Eimeria species identified during the survey.

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ABSTRACT

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INTRODUCTION

Although data on incidence and distribution of parasites are a prerequisite to effective parasite control, relatively few comprehensive surveys on parasitism of North American cattle appear in the literature (Dikmans, 1945, 1952; Becklund, 1964). Only scattered references to outbreaks of verminous gastroenteritis were reported prior to 1942, when Porter published data on incidence of gastrointestinal nematodes in cattle from Alabama, Florida, Georgia, Mississippi and Louisiana. Dikmans (1945) compiled a check list of parasites of domestic animals in North America but data on geographical distribution of the parasites were limited. A preliminary study by Ward (1946) lists results of 133 fecal and eight post-mortem examinations of cattle in Mississippi. Gastrointestinal parasitism of cattle in Oklahoma was surveyed by Cooperrider *et al.* (1948) and found to be a state-wide problem.

A check list of parasites of domestic animals in Georgia was compiled by Cooperrider (1952). Andrews *et al.* (1953) published a paper stressing the economic importance of cattle parasitism in the southeastern United States and listing parasite species recovered from 14 animals. A study by Bailey (1955) revealed clinical parasitism in 11.1% of 422 cattle necropsied at the Auburn University Diagnostic Laboratory. Hitchcock (1956) examined 2,180 fecal samples collected from cattle located in 46 counties of South Carolina and listed the incidence of gastrointestinal parasites. The viscera of 181 North Carolina cattle were examined by Bell (1957) for gastrointestinal parasites.

Surveys of bovine endoparasitism were conducted in Illinois by Levine and Aves (1956), Mansfield (1958) and Szanto *et al.* (1964). Scott (1957)

studied parasitism of cattle from Illinois, eastern Iowa and northeastern Missouri. All of the Illinois studies, including Scott's survey, based their results on fecal egg counts. Another report from the midwest was that of Petri (1958) who studied seasonal fluctuations of gastrointestinal nematodes in 80 Hereford calves imported to Iowa from South Dakota. In a preliminary report on helminths of beef cattle in Arizona, Dewhirst *et al.* (1958) found 94% of 865 fecal samples positive for helminth ova. Becklund and Allen (1958) presented data on worm parasites of cattle in New Mexico and Arizona and in so doing published one of the few surveys on cattle parasites west of the Mississippi River. Becklund (1959), in a survey of Georgia cattle, encountered most of the parasites reported in an earlier study by Porter (1942). Zimmerman and Hubbard (1961) studied gastrointestinal parasitism in 1,750 Iowa cattle representing 19 herds, and found trichostrongyle ova in more than 50% of the fecal samples examined. Twenty apparently healthy calves from northern Florida were examined by Becklund (1961) and found to be infected with 16 species representing nine genera of helminth parasites. Helminthiasis in 32 clinically infected cattle from Georgia was reported by Becklund (1962).

In a survey of gastrointestinal parasitism in Wisconsin dairy cattle, Cox and Todd (1962) found 78.3% and 84.9% of 710 animals positive for nematodes and coccidia, respectively. Intestinal helminths in domestic animals from central Missouri were studied by Sharma and Case (1962). Based on 157 fecal samples, "73.2% were positive for one or more species of parasite". In data gathered between 1955 and 1962, Honess and Bergstrom (1963) listed the intestinal roundworms found in Wyoming cattle. Helminth parasites of

121 cattle were reported by Smith (1967) from necropsy cases at the Texas A&M University Necropsy Clinic.

Although a few of the previously mentioned articles listed data for both helminth and coccidian parasites of cattle (Dikmans, 1945; Ward, 1946; Hitchcock, 1956; Scott, 1957; Cox and Todd, 1962 and Szanto *et al.*, 1964), most of the survey data concerning *Eimeria* species parasitic in cattle has been published separately. Early descriptions of bovine coccidiosis outbreaks in the United States and Canada were reported from Washington (Schultz, 1918), Pennsylvania (Lentz, 1919), Kansas (Dykstra, 1920; Muldoon, 1920; Frank, 1926), British Columbia (Bruce, 1921), Ontario (Gwatkin, 1926), North Dakota (Roderick, 1928) and Nebraska (Skidmore, 1933).

Levine and Becker (1933) published a catalogue and host-index of the genus *Eimeria* in which no incidence or distribution data are listed. Christensen and Porter (1939), and Christensen (1941) published descriptions of three new species of coccidia and listed the nine *Eimeria* species found in Alabama cattle. A host-index and check list (Hardcastle, 1943) brought up to date the earlier work of Levine (*loc. cit.*). Fecal samples from 2,492 cattle located in the southeastern United States were examined for coccidian oocysts by Boughton (1945). Davis and Bowman (1951) listed nine species of coccidia found in cattle from the southeastern states and in 1955, Davis *et al.* found 93% of 102 southeastern cattle infected with *E. alabamensis*.

Hasche and Todd (1959) surveyed 355 bovines from 71 counties in Wisconsin and found 83.5% of the animals infected with one or more of ten species of *Eimeria*. In 1962, Fitzgerald studied coccidiosis in calves on winter and summer ranges and in feedlots in Utah. He listed the species

according to seasonal frequency. Nyberg *et al.* (1967) published data on incidence of bovine coccidia, based on 86 fecal samples from cattle in Tillamook County, Oregon, which is an area representative of other Pacific Northwest dairy regions.

The first technical paper concerning parasites of Montana cattle was published by Marsh (1923). He stated that prior to 1919, coccidiosis had been diagnosed microscopically once and clinically several times by Montana veterinarians. By 1923, ten confirmed cases of bovine coccidiosis had been reported from nine counties representing all sections of the state.

In 1932, a case report by Tunnicliff listed the occurrence of *Cooperia oncophora* and *Nematodirus helvetianus* in two moribund calves from northwest Montana. Marsh (1938) stated that mortality in animals affected with coccidiosis can run from 10 to 25% and thus constitutes a cause of considerable loss in young cattle in the northwestern states. A study of disease problems in range livestock (Marsh, 1952) indicated that intestinal parasites of cattle were less serious in northern range cattle than in the midwest or south. Coccidiosis, however, was considered to be a serious cause of losses in 6 to 10 month calves, particularly in northern range areas which are similar topographically to much of Montana range land.

An outbreak of ostertagiosis occurred in range cattle in central Montana during the winter of 1963-64 (Worley and Sharman, 1966). Mortality was limited to two calves but clinical parasitism was diagnosed in about 300 additional calves.

Although Montana records go back as far as 1915, specific information on identity, incidence and distribution of cattle parasites is very limited

in scope. The annual report of the Montana State Veterinary Surgeon listed 38 cases of bovine coccidiosis, two of *Dictyocaulus* sp., seven of cysticercosis, one of nodular disease, one of *Stephanofilaria* sp. and several cases of oesophagostomiasis from 1915 to 1942. Since 1942, more complete data have been available from Livestock Sanitary Board Diagnostic Laboratory records. However, with only a few exceptions, confirmed identification of parasites to the specific level has not been accomplished. Therefore, of 414 cases of endoparasitism diagnosed in Montana cattle from 1942-1964, the following genera and number of infected animals have been catalogued: trichostrongylid group (*Ostertagia, Cooperia, Trichostrongylus* and *Haemonchus* species), 258; *Nematodirus*, 125; *Trichuris*, 11; lungworms, 10; liver flukes, 8; tapeworms, 31; and *Eimeria* species, 221. Other confirmed records of helminth parasites reported in Montana cattle include *Cysticercus bovis*, 4; *Stephanofilaria stilesi*, 2; *Bunostomum phlebotomum*, 1; *Oesophagostomum radiatum*, 2; *Cooperia* spp., 2; *Trichostrongylus axei*, 1 and several cases of the filariid worm *Setaria cervi*. Since the histories of animals included in this compilation are mostly unknown, imported cattle could conceivably be responsible for some of these records. As a result, these data may have limited value in enumerating the parasite fauna of native Montana cattle.

Cattle parasite data from 1929 through 1964 have been compiled from records accumulated prior to the onset of this survey at the Montana Veterinary Research Laboratory and are separated into two categories: those originating from post-mortem examinations, and those based upon fecal egg counts. Of 35 animals examined at post-mortem, the parasite species found

and the number of animals infected were: *Cooperia* spp., 3; *C. pectinata*, 3; *C. oncophora*, 2; *Ostertagia* spp., 3; *O. bisonis*, 2; *Nematodirus* spp., 6; *N. helvetianus*, 1; *Dictyocaulus* sp., 3; *D. viviparus*, 3; liver flukes, 3 and *Fasciola hepatica*, 1. Tabulation of 379 fecal egg counts resulted in the following summary of species and numbers of animals infected: trichostrongylid group (*Ostertagia, Trichostrongylus, Cooperia* and *Haemonchus*), 48; *Nematodirus*, 25; *Trichuris*, 11; *Dictyocaulus viviparus*, 1 and *Moniezia*, 2.

Since the above information on endoparasitism in Montana cattle is limited in scope, a survey was designed to determine the identity, incidence, distribution and intensity of helminth parasites and coccidia in Montana cattle, and to relate climatologic factors to parasite distribution in six ecologically distinct areas of the state.

MATERIALS AND METHODS

Six sampling stations were chosen to represent the major geographic and climatologic regions of the state on the basis of four criteria: 1) geographic location, 2) importance as a center of beef production, 3) stability of cattle management practices and 4) availability of weather data (Fig. 1). The western station was a 320-acre ranch six miles southeast of Stevensville, Ravalli County. The area was classified as intermountain valley grassland and was situated in the Bitterroot drainage on irrigated benchland at an elevation of 3,370 feet. *Agropyron spicatum*, *Stipa comata* and *Poa secunda* were the dominant forage plants. The southwestern station was located five miles northwest of Bozeman, Gallatin County, at an elevation of 4,750 feet. This 180-acre ranch was representative of foothills grassland range found in the southeastern section of the Gallatin Valley. Primary forage plants were *Carex* spp., *Poa* spp., and *Phleum pratense*.

The south central station was located at the Huntley Branch of the Montana Agricultural Experiment Station in Yellowstone County. It was situated on the flood plain of the Yellowstone River at an elevation of 2,988 feet and was primarily an *Agropyron smithii* vegetation system. The site of the eastern station was one mile west of Miles City, Custer County. This 56,000-acre Range Livestock Experiment Station was located at an elevation of 2,731 feet in a badlands grassland biotic community which consisted principally of *Agropyron smithii* and *Stipa comata*. The central station was located along the Sun River between Simms and Augusta (Cascade County) at an elevation of 3,560 feet. Vegetation on this 60,000-acre ranch was classified as central grassland range and consisted of *Stipa comata*, *Bouteloua gracilis* and *Agropyron spicatum*. The northern station was situated at the

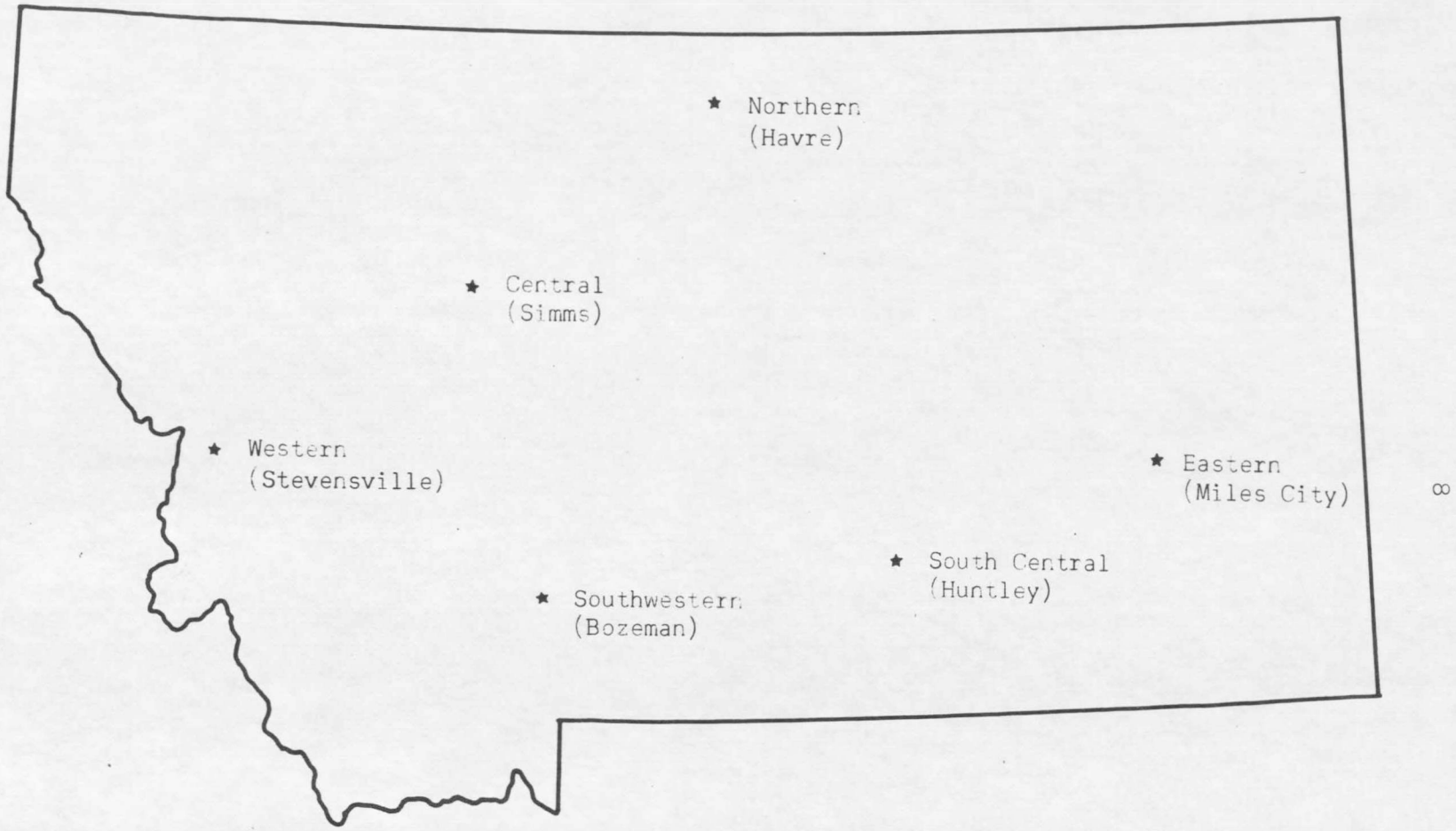

Figure 1. Six sampling stations for survey of helminth parasites in Montana cattle.

North Montana Branch of the Agricultural Experiment Station, Hill County, at an elevation of 2,373 feet. This 2,400-acre ranch was characterized by northern grassland vegetation which is found over much of the northern Great Plains region of the United States and Canada, and consists primarily of *Agropyron* spp., *Festuca* spp., *Bouteloua gracilis* and *Stipa comata*.

A summary of the cattle operations at the six sampling stations in Montana appears in Table I. Cattle at the southwestern and northern stations grazed on summer range in the Bridger Mountains and Bear Paw Mountains, respectively. With the exception of marketed animals, cattle from all other stations remained on the home ranch for the entire survey period. Thirty of 147 cattle sampled at the south central station and 166 of 189 cattle at the northern station were on pasture while the remainder were on nutrition studies in feedlots. Cattle at the eastern station were used in crossbreeding studies, and those sampled for this survey were strictly range animals. All range cattle were fed supplemental feed in the winter months as dictated by climatic conditions.

A total of 965 fecal samples was collected at five intervals from calves, yearlings and cows during the period of 3 February, 1965, to 18 July, 1966 (Table II). Five seasonal sampling dates were chosen for all but the central station where the cattle were sampled on four occasions. Calves and yearlings up to and including 18 months of age were treated as a group which hereafter will be designated as calves. Cows and steers over 18 months old were grouped as adult cattle. The mean number of fecal samples collected from calves at each sampling date was 18.0 (range of 8-31), with 67% of the collections having between 16 and 22

Table I. Ranching Practices at Six Sampling Stations in Montana.

	Western Station	Southwestern Station	South Central Station
Breed	Angus	Hereford	Hereford
Type of operation	Commercial	Commercial	Feedlot primarily - Range
Number of cows	175	75	40 mature steers
Number of calves	175	65	60
Calving season	March to May	Mid-March to Mid-May	Calves purchased
Antiparasitic medication program	Co-Ral Pouron in October	Ruelene Pouron late in October	Co-Ral on pastured yearlings in March and April, 1965

	Eastern Station	Central Station	Northern Station
Breed	Hereford	Hereford	Hereford
Type of operation	Range - Experimental	Commercial	Range - Experimental
Number of cows	1300	2500	200
Number of calves	700	2000	180
Calving season	Mid-March to Early May	March to May	March and April
Antiparasitic medication program	Ruelene Pouron in Mid-August and Lindane at weaning	Steer calves treated with Ruelene Pouron in October	Neguvon Pouron* for all cattle in October

*Experimental drug

Table II. Sampling Dates for Cattle Parasite Survey.

Sampling Station	Season				
	Winter 1965	Spring and Summer 1965	Fall 1965	Winter 1966	Spring and Summer 1966
Western (Stevensville)	15 Feb.	27 July	8 Oct.	1 Feb.	27 June
Southwestern (Bozeman)	3 Feb.	15 June* 28 June**	12 Nov.	25 Feb.	14 June
South Central (Huntley)	17 Mar.	31 Aug.	9 Dec.	24 Mar.	7 July
Eastern (Miles City)	18 Mar.	11 Aug.	10 Dec.	24 Mar.	6 July
Central (Simms)		2 June	23 Sept.	31 Jan.	27 June
Northern (Havre)	28 Mar.	10 Aug.	24 Nov.	23 Mar.	18 July

*Sampling date for calves.
**Sampling date for adult cattle.

fecal samples. All fecal samples were obtained either by direct rectal or more commonly by random lot or pasture sampling methods. The latter were collected within a few minutes after deposition.

Samples were transported to the laboratory where a portion of each (approximately 50 grams) was immediately assayed for lungworm larvae with the standard Baermann technique (Baermann, 1917). Some of the samples were refrigerated for periods of approximately 12 hours before they were baermannized. The remaining portion of the fecal sample was then frozen.

Early in the survey, the Baermann funnels used were long-stemmed (approximately 15 cm.) and had a capacity of about 70 ml. Since the amount of feces one could examine was relatively small, larger 250 ml. funnels were used later. A 20 mesh screen, six cm. in diameter was placed in the funnel approximately four cm. from the top thus allowing the larvae to move more freely toward the bottom of the funnel.

The flotation method of Lane (1928), as modified by Dewhirst and Hansen (1961), was used as an indication of the level of gastrointestinal parasitism in the cattle. This procedure was used for determining the total number of nematode eggs per gram of feces (EPG), the presence or absence of tapeworm ova, and the relative number of coccidian oocysts. Differential worm egg counts were made employing the ovum classification criteria of Dewhirst and Hansen (*loc. cit.*).

Coccidian oocysts were differentiated on the basis of morphologic features. They were ranked according to frequency so that relative fluctuations in total oocyst numbers could be determined between sampling stations and at the same sampling station on a seasonal basis. When one to several

oocysts were present under a 22 mm. coverslip, the infection was designated as +1. If one to three oocysts were observed per low power field (75X), the infection was classified as +2. Four to seven oocysts per field were ranked as a +3 infection and over seven oocysts per field were designated +4. Although total oocyst numbers were estimated, individual species of *Eimeria* were not ranked according to frequency. The species *Eimeria ildefonsoi* and *E. wyomingensis* were not distinguished from *E. auburnensis* and *E. bukidnonensis*, respectively, on the basis that they have been considered synonymous (Levine, 1961).

After a portion of the fecal sample was utilized for the flotation procedure, the remaining fecal material was refrigerated at about 4° C until it was examined for fluke ova by the sedimentation technique of Dennis, Stone and Swanson (1954). Since *Fasciola hepatica* is known to be enzootic west of the continental divide, all fecal samples from the western station at Stevensville were examined for fluke eggs. Since *F. hepatica* is not considered to be generally established in cattle east of the continental divide in Montana, a screening procedure was employed whereby approximately one-third of the samples from the five remaining sampling stations were examined for fluke ova. Later in the survey, composite samples consisting of 5 to 8 individual fecal samples were examined for fluke eggs.

Climatological data for use in correlating macroclimatic conditions with levels of parasitism were collected from weather stations located at a maximum of ten miles from the sampling station. The western weather station, located at the United States Post Office, Stevensville, was the source for all climatologic factors studied except the snow depth information. The

latter was available at Hamilton, approximately 13 miles south of the western sampling station. The southwestern sampling station is about six miles northwest of Montana State University, Bozeman, where all weather data were available except for snow depth information. It was supplied by the Federal Aeronautics Administration Weather Bureau located about six miles north of the sampling station. Weather bureaus at Havre and Miles City served as sources of data used for the northern and eastern sampling stations, respectively. Weather information for central Montana was obtained from records at Sun River. Personnel of the Agricultural Experiment Station at Huntley operate a weather station which was the source for all data for the south central station except snow depth information. No weather station in the immediate vicinity of Huntley recorded snow depth data, so this information is lacking for this location.

Statistical analyses were performed on worm egg counts as an aid in evaluation of the data. Chi-square tests were used to determine if a significant difference existed for adult cattle and calf incidence data between the six sampling stations. An analysis of variance was calculated for calf and adult cattle worm egg counts using a square root transformation. Duncan's multiple range test (Duncan, 1955) was used to determine whether or not statewide parasite populations were homogeneous.

RESULTS

Of 965 bovine fecal samples from all animals examined during the survey, 70.7% were positive for gastrointestinal nematode ova. An analysis of incidence data by sampling station indicates gastrointestinal nematode infections were most prevalent in cattle from central Montana, with 87.8% infected. (Fig. 2). Seventy-eight and one-tenth percent, 76.9% and 76.0% of the cattle from the eastern, south central and northern stations, respectively, were infected with gastrointestinal nematodes, indicating little differences in prevalence of infection from three contiguous regions in the state. Stomach and intestinal nematode eggs were found in 65.7% of bovine fecal samples from the southwestern station, while less than 40% of the animals from the western station were similarly infected.

Incidence data analyzed by age group revealed 82.1% of 486 calves 18 months and younger were infected with gastrointestinal nematodes, while 59.1% of 479 adult cattle harbored similar infections. At the western station, 3.8 times as many calves were infected as adult cattle, while at the south central station a greater percentage of adult cattle (80.6%) were infected than calves (74.1%).

Tables III and IV list the incidence of gastrointestinal helminth parasites in cows and calves from the six sampling stations. The *Cooperia-Trichostrongylus-Ostertagia* group of ova (classified as group I ova) were found in feces from 67.9% of the cattle examined. Three hundred seventy-eight calves (77.8%) were infected with group I parasites while 277 cows (57.8%) were similarly infected. A higher percentage of cattle from each of the six sampling stations was passing group I ova than any other helminth ovum or larva observed during the study.