SEASONAL INCIDENCE AND GEOGRAPHICAL DISTRIBUTION OF GASTROINTESTINAL HELMINTH PARASITES OF CATTLE IN OKLAHOMA

By

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in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
May, 1968

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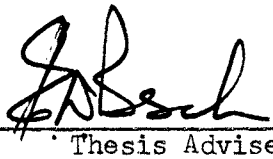
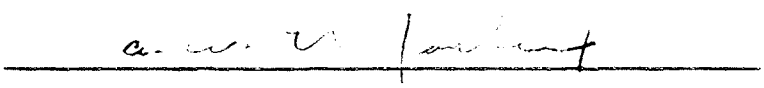
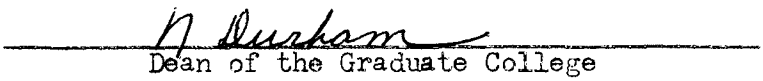
Thesis Approved:



Thesis Adviser





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ACKNOWLEDGMENTS

In appreciation for the valuable counsel and helpful criticisms throughout the entire study, the writer wishes to express his sincere gratitude to Dr. Everett D. Besch. To the members of the Committee: Dr. E. D. Besch, Department of Veterinary Parasitology and Public Health; Dr. D. E. Howell, Department of Entomology; and Dr. A. W. Monlux, Department of Veterinary Pathology, the writer wishes to extend his appreciation for their helpful criticisms, corrections and suggestions. To his wife, Patricia, the author wishes to acknowledge his indebtedness for her understanding and encouragement during this study and for her hours of patient assistance in producing this thesis. His appreciation is extended to the owners of the abattoirs for their co-operation in allowing the collections of viscera at inopportune times. The writer wishes to thank the Oklahoma Agricultural Experiment Station and the College of Veterinary Medicine for providing financial support.

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CHAPTER I

INTRODUCTION

In the science of veterinary parasitology, the acquisition of knowledge of the ecological factors influencing the parasites presents a constant challenge to the veterinary parasitologists. Aware of the complexities and intricacies associated with problems involving pure science research, the writer undertook the study of the ecology of gastrointestinal helminth parasites of cattle in Oklahoma. Information was obtained concerning the population and the morphology of helminth species as well as geographical distribution and seasonal incidence of helminth parasites. Moreover, experience in helminthological research and in helminthological techniques was acquired.

Ecological studies of gastrointestinal helminths of cattle in Oklahoma are limited. The data summarized in the investigations by Cooperrider, et al. (1948), Besch (1962, 1967) and Miller, et al. (1966) informed awareness of the incidence and occurrence of gastrointestinal helminth species of cattle in Oklahoma. The results of the biological experiments with Cooperia punctata (v. Linstow, 1907) Ransom, 1907, by Besch (1965) in Oklahoma were comparable to the findings of this thesis. Therefore, to acquire further information concerning the gastrointestinal helminth parasites of range cattle in Oklahoma, an investigation in Northeastern, Southeastern, and Southwestern areas of Oklahoma during three different time periods, winter, spring, and summer, was made.

The objectives to be attained in this study were as follows:

1. To determine the gastrointestinal helminth species of cattle in Oklahoma.

2. To determine the population of gastrointestinal helminth species of cattle in selected areas of Oklahoma.

3. To determine the geographical distribution and the seasonal incidence of gastrointestinal helminth species of cattle in Oklahoma.

4. To determine species variation by comparing morphological characteristics of particular gastrointestinal helminth species of cattle in selected areas of Oklahoma.

5. To gain experience in research and in techniques related to helminthology.

CHAPTER II

REVIEW OF LITERATURE

The available references applicable to an ecological study of gastrointestinal helminths of cattle in the South Central Plains States of the United States are limited. However, a considerable amount of work and a number of reports concerning the study of gastrointestinal helminth parasites of cattle in the United States and in other areas of the world have been completed. It is beyond the scope of this study to include the literature in its entirety; therefore, only pertinent references are included in this historical review.

Cooperrider, et al. (1948) reported the helminth parasites collected from the gastrointestinal tracts of 57 cattle obtained from 14 locations in Oklahoma. The number of gastrointestinal parasites recovered and the percentage of animals infected are discussed. Their results indicate that the predominant helminths, in order of importance, were: Ostertagia spp., Haemonchus spp., Cooperia spp. and Trichostrongylus spp. Besch (1962) cites a number of nematode species which had not been reported previously from cattle in Oklahoma, namely: Ostertagia lyrata Sjoberg, 1926; Cooperia mcmasteri Gordon, 1932; Trichostrongylus longispicularis Gordon, 1933 and Cooperia bisonis Cram, 1925. Roundworm infection of cattle in 14 states as indicated by fecal egg counts were reported by Miller, et al. (1966). Rates of infection between and within herds were relatively consistent over a

wide geographical area. The incidence of herds infected as well as the percentage of positive samples in Oklahoma was 100 per cent; however, only a small number of herds were studied. Becklund (1964) included in the host check list of parasites of domestic animals the reported gastrointestinal helminths of cattle in Oklahoma.

Bell, et al. (1959) examined the viscera from 100 cattle in Northcentral and Northeastern areas of Texas. Their results indicate that the predominant helminth parasites, in order of incidence, were: Cooperia spp., Trichostrongylus spp., Ostertagia spp. and Haemonchus spp. The yearling age group had a higher incidence of parasitism than the younger calves and the adult age groups except for Haemonchus spp. and Ostertagia spp. for which the adult age group had a higher incidence.

Interpretation of the results presented by Bell (1957) in a survey of gastrointestinal helminths of cattle in North Carolina shows that the yearling age group had a higher incidence of parasitism. The report, which is applicable to this study, includes information concerning the numbers and species of gastrointestinal parasites of cattle in relation to the geographical areas of that state.

A review of the literature of the studies of Ostertagia ostertagi (Stiles, 1892) Ransom, 1927, revealed that a considerable amount of work has been conducted. Pertinent literature included the studies concerning strain variation, Armour, et al. (1967) and Michel (1967); inhibited development, Anderson, et al. (1965) and Armour, et al. (1965); and morphology of this species, Skrjabin et al. (1954), Yamaguti (1961), LaPage (1962) and Besch (1967).

The references used in identification of the gastrointestinal

helminth species of cattle included: Skrjabin, et al. (1954), Yamaguti (1961), LaPage (1962), Besch (1967), Sommerville (1956), Becklund et al. (1967) and Roberts, et al. (1954).

CHAPTER III

MATERIALS AND METHODS

The gastrointestinal tracts of 56 range cattle, representing five different breeds, were obtained from slaughter houses located in the Northeastern, Southeastern and Southwestern areas of Oklahoma. Cattle were selected from those raised on pasture native to the area, and collections were made during the winter, spring and summer seasons. Small privately owned abattoirs were solicited since their predominant trade consisted of custom slaughter of local range cattle. The lined geographical areas in Figure 1 indicate the locations where collections were made.

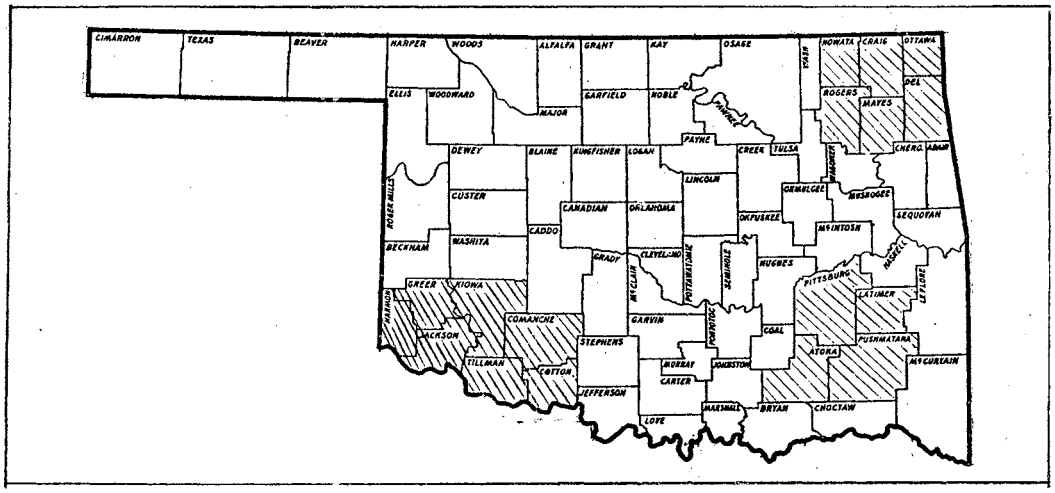

Figure 1. Locations Where Materials Were Obtained

Viscera were obtained from the geographical areas where climatological and geological differences are present. In Northeastern Oklahoma, the annual mean precipitation is 34 inches; the mean temperature, 61 F; and the mean altitude above sea level, 757 feet. In Southeastern Oklahoma, the annual mean precipitation is 41 inches; the mean temperature, 62 F; and the mean altitude above sea level, 710 feet. In Southwestern Oklahoma, the annual mean precipitation is 26 inches; the mean temperature, 63 F; and the mean altitude above sea level, 1274 feet. The range management of cattle operations in these areas include: native pastures, consisting of tall varieties of grasses, and improved pastures in the Northeastern area; native pastures, consisting of low quality tall varieties of grasses, and improved pastures in the Southeastern area; and native pastures, consisting of short and mid-tall varieties of grasses, and improved pastures in the Southwestern area.

Except for only a few gastrointestinal tracts which were obtained from disposal barrels and coolers, the viscera were obtained at slaughter and was handled quickly and carefully to reduce the possibility of mechanical translocation of parasites. The movement of abomasal and intestinal contents was further reduced by tying off the abomasum at the omasal-abomasal junction and at the terminal end of the pylorus of the abomasum. The abomasum and intestines were removed by cutting anterior to the omasal-abomasal tie and severing the mesenteric dorsal attachments.

Records were kept of the breed, sex, age and weight of each animal, the name and location of the slaughter plant and the date. The number of viscera collected from an area during one season ranged from 3 to 7.

The viscera of each animal were placed in galvanized cans and transported via car to the laboratory. If time permitted at the end of the day, a complete parasitological examination was initiated on each; however, on several occasions it was necessary to delay these procedures. In these instances, the contents of the abomasa were removed, the opened organs were submerged in normal saline and with the unopened intestines were placed in a cooler until the following day.

All abomasa were opened along the greater curvature. After the mucosa of the abomasum was washed with normal saline, the entire organ was submerged in normal saline and refrigerated for 12 hours, after which a second wash was made.

Presence of Ostertagia spp. larvae in the tissue phase and the efficacy of the collecting methods used in the examination of the abomasa were determined by the pepsin-hydrochloric acid digestion method described by Herlick (1956). For each abomasal tissue, artificial digestion included five folds and three interfolds of fundic mucosa; a strip of cardiac mucosa, 1 inch in width; and a strip of pyloric mucosa, 2 inches in width. The length of the cardiac and fundic mucosa depended on the size of the abomasum. The viscera-pepsin-hydrochloric acid preparations were incubated at 37 C for 18 hours, after which the digestant was fixed in hot 10 per cent formol-saline solution and was transferred to labeled specimen jars. A record was made of the number, the location and the size of Ostertagia nodules present in the mucosa of each of the abomasa.

During examination of the intestinal tract, a tie was made at the end of the first 30 feet, and at the beginning and end of the last 30 feet of small intestine to prevent further mechanical translocation of

parasites and to compare the determined parasite populations collected from the three sections. The small intestines were washed twice in normal saline by the strip technique. The washings were carefully concentrated by the sedimentation-decanting technique, were fixed in hot 10 per cent formol-saline solution and were transferred to labeled specimen jars. The washings of the abomasa and the designated sections of the small intestines were kept separate throughout the subsequent procedures of the examination.

The contents of the large intestines were examined for gross evidence of parasites of Oesophagostomum radiatum (Rudolphi, 1803) Molin, 1861; Chabertia ovina (Gmelin, 1790) Railliet and Henry, 1909; Trichuris discolor v. Linstow, 1906 and Trichuris ovis Abildgaard, 1795. A record was made of the number, the location and the size of Oesophagostomum nodules present in the intestinal wall of each intestinal tract.

A 10 percent aliquot sample from each abomasal and small intestinal collection was examined, and the sex, the stage of development and the total number of each species of worms were determined and were recorded for each animal. Total worm population was determined by the extrapolation of the results obtained in aliquot samples. Each pepsin-hydrochloric acid digestant was examined in its entirety.

All collected samples initially were examined with the aid of a stereoscopic microscope. Species in the genera Ostertagia, Trichostrongylus, Cooperia and Nematodirus were determined by examining lacto-phenol cleared male specimens. Anatomical characters of lacto-phenol cleared males and females of Ostertagia ostertagi and Cooperia punctata, a maximum of ten of each species from each animal, were

measured. A sample size of ten was calculated by using the procedure described by Stein (1945). The lengths of the worms were determined with the aid of a Trisimplex microprojector. To obtain these measurements, the slides were placed on the stage of the microprojector and the image of each was projected onto a sheet of paper. A pencil line was drawn along the longitudinal axis of the image of each of the worms. The length of this line was determined by the use of a planometer. This result was compared then to a calibrated scale, in millimeters, to secure the length of the worm. The use of this technique allowed the measurement of worms fixed in any position. The remainder of the body measurements were obtained microscopically at 35, 100 and 430 magnifications with the aid of a calibrated ocular micrometer.

CHAPTER IV

RESULTS AND DISCUSSION

Several range cattle in the Northcentral area of Oklahoma were used as a pilot study to determine methods and procedures. The data obtained from these animals are included as part of a survey of gastrointestinal helminths of cattle in Oklahoma.

The mucosa of all gastrointestinal tracts were examined carefully for parasitic lesions. Presence of Ostertagia nodules was observed to occur in the cardiac and fundic mucosa in most of the abomasa examined. Nodules were not observed in the pyloric region of the abomasa. The results of the data, the incidence of Ostertagia nodules, are summarized in Table I.

It is apparent that Ostertagia nodules were present in cattle examined in all areas surveyed during each season except for the cattle from Northeastern Oklahoma. In these animals, lesions were observed to occur only during the spring of 1966. Nodules were found to occur without evidence of adult Ostertagia in a few animals. However, in the majority of the abomasa examined, both the nodules and the adults were present in the same abomasum. Of the 56 abomasa examined, Ostertagia nodules were observed in 26; 12 with a large number, three with several and 11 with only a few. The nodules ranged in size from 0.5 to 6 mm in diameter with the majority, 0.5 to 1.5 mm. Only a few larvae were recovered from the abomasal pepsin-hydrochloric acid digest-

TABLE I

INCIDENCE OF OSTERTAGIA NODULES IN THE ABOMASA FROM RANGE CATTLE IN OKLAHOMA, LISTED BY AREAS AND SEASONS*

	Seasons				
	1965	1966			1967
Areas	Winter	Spring	Summer	Winter	Summer
Northcentral	50.0	**	**	**	**
Northeast	**	85.7	--	--	--
Southeast	**	66.7	**	75.0	100
Southwest	**	57.1	16.6	50.0	33.4

*Incidence expressed as percentage.
**No collection of abomasa was made.

TABLE II

INCIDENCE OF OESOPHAGOSTOMUM NODULES IN THE INTESTINES FROM RANGE CATTLE IN OKLAHOMA, LISTED BY AREAS AND SEASONS*

	Seasons				
	1965	1966			1967
Areas	Winter	Spring	Summer	Winter	Summer
Northcentral	50.0	**	**	**	**
Northeast	**	85.7	--	25.0	--
Southeast	**	100	**	75.0	50.0
Southwest	**	--	33.4	75.0	33.4

*Incidence expressed as percentage.
**No collection of viscera was made.

ants from a few animals and usually no larvae were recovered, even though nodules were present.

As summarized in Table II, the presence of Oesophagostomum nodules in the intestinal wall was observed to occur in most animals, even though no adults were found in the bulky contents of the large intestines.

It is apparent that Oesophagostomum nodules developed in cattle examined in all areas surveyed and were present during each season when a collection was made except in animals examined in the Northeastern area during the summers of 1966 and 1967 and in the Southwestern area during the spring of 1966. Oesophagostomum nodules were observed to occur in the intestines of 24 cattle; ten with a large number, nine with several and five with a few. The nodules ranged in size from 0.5 to 14 mm in diameter with the majority, 3 to 8 mm. A variation was observed in the development of nodules, and these, hemorrhagic, purulent and caseous, occurred in the wall of the small intestine as well as in the large intestine. The majority of the nodular lesions were localized in the last 40 feet of the small intestines and throughout the large intestines.

The average numbers of worms by species collected from each area during the three seasons are listed in Table III and Table IV. The results obtained for each season can be compared in Table III; in turn, the results obtained for each area can be compared in Table IV.

The largest population of adult helminths was collected from cattle in all areas during the summer and winter seasons; whereas, the smallest population was collected during the spring. Large numbers of larvae were recovered from animals examined in Northeastern Oklahoma

TABLE III

AVERAGE NUMBER OF GASTROINTESTINAL HELMINTH PARASITES FROM RANGE CATTLE IN OKLAHOMA, LISTED BY AREAS AND SEASONS

Area	Season and year	H. contortus complex	O. ostertagi	O. lyrata	T. axei	C. punctata	C. oncophora	C. mcmasteri	Nematodirus spp.	T. colubriformis	T. longispicularis	B. phlebotomum	S. papillosus	C. bovis	Total Number Nematodes Per Area	M. benedeni	Larva
Northcentral	Winter-67	47	262	4	405	100	197	7	62	2	20	-	-	-	1106	0.5	34
Northeast	Spring-66	25	208	12	82	338	163	8	12	-	-	2	-	-	850	-	43
Northeast	Summer-66	190	495	3	18	1095	373	40	210	-	-	-	5	-	2429	0.5	18
Northeast	Winter-66	45	113	-	3	890	680	60	355	3	-	13	-	-	2162	-	-
Northeast	Summer-67	45	258	-	80	203	705	45	123	5	-	3	-	-	1467	0.25	78
Southeast	Spring-66	147	160	4	107	4	-	-	4	4	-	-	-	-	429	-	5
Southeast	Winter-66	15	160	-	13	93	200	-	10	-	-	8	-	-	499	1	10
Southeast	Summer-66	5	45	-	10	295	1478	-	5	-	-	3	-	8	1849	-	-
Southwest	Spring-66	39	52	-	55	138	40	6	13	2	-	2	-	-	347	0.15	-
Southwest	Summer-66	60	207	-	194	1005	244	9	200	-	-	2	-	-	1921	4	15
Southwest	Winter-66	33	120	-	25	1930	963	45	15	3	-	-	-	-	3134	0.25	20
Southwest	Summer-67	24	74	-	4	170	994	-	134	4	-	-	-	-	1440	-	4

TABLE IV

AVERAGE NUMBER OF GASTROINTESTINAL HELMINTH PARASITES FROM RANGE CATTLE IN OKLAHOMA, LISTED BY SEASONS AND AREAS

Season and year	Area	H. contortus complex	O. ostertagi	O. lyrata	T. axei	C. punctata	C. oncophora	C. mcmasteri	Nematodirus spp.	T. colubriformis	T. longispicularis	B. phlebotomum	S. papillosus	C. bovis	Total Number Nematodes Per Area	M. benedeni	Larva
Winter-65	Northcentral	47	262	4	405	100	197	7	62	2	20	-	-	-	1106	0.5	34
Spring-66	Northeast	25	208	12	82	338	163	8	12	-	-	2	-	-	850	-	43
Spring-66	Southeast	147	160	4	107	4	-	-	4	4	-	-	-	-	429	-	5
Spring-66	Southwest	39	52	-	55	138	40	6	13	2	-	2	-	-	347	0.15	-
Summer-66	Northeast	190	495	3	18	1095	373	40	210	-	-	-	5	-	2429	0.5	18
Summer-66	Southwest	60	207	-	194	1005	244	9	200	-	-	2	-	-	1921	4	15
Winter-66	Northeast	45	113	-	3	890	680	60	355	3	-	13	-	-	2162	-	-
Winter-66	Southeast	15	160	-	13	93	200	-	10	-	-	8	-	-	499	1	10
Winter-66	Southwest	33	120	-	25	1930	963	45	15	3	-	-	-	-	3134	0.25	20
Summer-67	Northeast	45	258	-	80	203	705	45	123	5	-	3	-	-	1467	0.25	78
Summer-67	Southeast	5	45	-	10	295	1478	-	5	-	-	3	-	8	1849	-	-
Summer-67	Southwest	24	74	-	4	170	994	-	134	4	-	-	-	-	1440	-	4

during the spring of 1966 and summer of 1967. No conclusions can be made concerning the parasitic helminth larvae from the abomasa and small intestines due to the recovery of small numbers; however, the recovery of large adult populations of gastrointestinal helminths during the summer and winter seasons in all areas suggests that the range cattle examined became infected during the preceding season. It is apparent in Table IV that during the spring and summer of 1966 the largest helminth population was recovered from the Northeastern area of Oklahoma; the Southwestern area had the largest during the winter of 1966; and the Southeastern area during the summer of 1967; therefore, in each of the three areas a large helminth population was observed to occur at least one season.

In order of incidence, Cooperia punctata, C. oncophora (Railliet, 1898) Ransom, 1907 and Ostertagia ostertagi were observed to be the predominant species in the Northeastern and Southwestern areas of Oklahoma; and Cooperia oncophora, C. punctata and Ostertagia ostertagi in the Southeastern area. The species of helminths of minor importance but of frequent occurrence in all areas were: Nematodirus spp., Haemonchus contortus complex and Trichostrongylus axei (Cobbold, 1879) Loos, 1905.

The two species of Nematodirus recovered from the small intestines were N. filicollis (Rudolphi, 1802) Ransom, 1907 and N. helvetianus May, 1920. The population of N. filicollis was always larger than the population of N. helvetianus. The population of female helminths recovered from the gastrointestinal tracts of the cattle examined outnumbered the male worm population except for a few instances.

The three sections of the small intestines examined, the first 30

feet, the middle section and the last 30 feet, were compared qualitatively and quantitatively for intestinal helminths. The largest number of nematodes by species were found in the first 30 feet of the small intestines, and the smallest number was recovered from the last 30 feet. Of those collected, Moniezia benedeni (Rudolphi, 1810) R. Blanchard, 1891, was found to occur most frequently in the last 30 feet of the small intestines (17), less frequently in the middle section (13) and least frequently in the first 30 feet (1).

No conclusions can be made concerning the comparison of helminth populations to the breeds, sexes and weights of the cattle examined; however, the majority of large populations of helminths was recovered from the yearling age group of cattle.

The average body measurements of Ostertagia ostertagi obtained from specimens collected in each area and during each season are represented in Table V. Variations of body measurements, other than body length, were not apparent among specimens from animals within an area, among areas during a season or among seasons for an area. The shortest male and female worms of O. ostertagi were collected from animals in all areas in the spring. Usually these were demonstrated from animals in Southeastern Oklahoma. Worms that were longest in length usually were demonstrated from animals in Southwestern Oklahoma and could not be correlated with season.

According to Skrjabin, et al. (1954), the length of the body of O. ostertagi males ranges from 6.5 to 7.5 mm; whereas, the length of the body of females ranges from 8.3 to 9.2 mm. The data summarized in Table V shows the average body lengths of O. ostertagi obtained from all animals to range from 4.68 to 7.88 mm for male worms and from 6.07

TABLE V

AVERAGE BODY MEASUREMENTS OF MATURE OSTERTAGIA OSTERTAGI FROM RANGE CATTLE IN OKLAHOMA, LISTED BY SEASONS AND AREAS

Season and Year	Area	Male*				Female*				
		Body Length	Body Width	Esophagus Length	Spicule Length	Body Length	Body Width	Esophagus Length	Vulva to Tip of Tail	Anus to Tip of Tail
Winter-65	Northcentral	6.51	0.13	0.64	0.23	8.00	0.12	0.69	1.24	0.13
Spring-66	Northeast	6.28	0.13	0.64	0.23	7.91	0.12	0.68	1.21	0.13
Spring-66	Southeast	5.67	0.13	0.64	0.23	7.75	0.12	0.65	1.11	0.11
Spring-66	Southwest	6.95	0.13	0.64	0.23	7.83	0.12	0.67	1.19	0.13
Summer-66	Northeast	6.77	0.13	0.64	0.23	8.51	0.12	0.69	1.25	0.13
Summer-66	Southwest	7.36	0.14	0.65	0.23	8.89	0.13	0.69	1.24	0.14
Winter-66	Northeast	7.42	0.14	0.65	0.23	9.13	0.13	0.70	1.26	0.14
Winter-66	Southeast	6.57	0.13	0.65	0.23	6.87	0.12	0.65	1.14	0.11
Winter-66	Southwest	6.97	0.13	0.64	0.23	8.84	0.12	0.69	1.26	0.14
Summer-67	Northeast	6.34	0.13	0.64	0.23	7.54	0.12	0.68	1.21	0.12
Summer-67	Southeast	6.51	0.13	0.64	0.23	7.76	0.12	0.68	1.22	0.13
Summer-67	Southwest	7.23	0.13	0.64	0.23	8.60	0.12	0.69	1.27	0.14

*All measurements are in millimeters.

to 9.65 mm for female worms and for all areas to range from 5.67 to 7.42 mm for male worms and from 6.75 to 9.13 mm for female worms. It is apparent that several male and female worms were found to be shorter and several to be longer than those reported by Skrjabin, et al. (1954) for O. ostertagi. An overlap of the ranges of body lengths of both sexes is evident. The data summarized in Table V shows that the averages of body length of the males in an area were always shorter than the averages of the females in the same area.

The average body measurements of Cooperia punctata obtained from specimens collected in each area and during each season are represented in Table VI. The results obtained for each area can be compared. Variations of body measurements were not apparent among specimens from animals within an area, among areas during a season or among seasons for an area.

According to Skrjabin, et al. (1954), the length of the body of C. punctata males ranges from 5.0 to 9.0 mm; whereas, the length of the body of females ranges from 5.7 to 10 mm. Besch (1965) reported the body length measurements of C. punctata obtained from specimens collected from calves in Oklahoma to range from 6.0 to 7.27 mm for male worms and to range from 7.2 to 9.2 mm for female worms. The data summarized in Table VI shows the average body lengths of C. punctata obtained from all animals to range from 4.50 to 6.68 mm for male worms and from 5.14 to 8.92 mm for female worms and for all areas to range from 5.18 to 6.25 mm for male worms and from 6.15 to 8.05 mm for female worms. It is apparent that several male and female worms were found to be shorter than those reported by Besch (1965) and a few to be shorter than those reported by Skrjabin, et al. (1954) for C. punctata. An

TABLE VI

AVERAGE BODY MEASUREMENTS OF MATURE COOPERIA PUNCTATA FROM RANGE CATTLE IN OKLAHOMA, LISTED BY SEASONS AND AREAS

Season and Year	Area	Male*				Female*				
		Body Length	Body Width	Esophagus Length	Spicule Length	Body Length	Body Width	Esophagus Length	Vulva to Tip of Tail	Anus to Tip of Tail
Winter-65	Northcentral	6.05	0.10	0.37	0.16	6.24	0.11	0.37	1.58	0.16
Spring-66	Northeast	5.42	0.10	0.35	0.16	6.15	0.11	0.36	1.55	0.15
Spring-66	Southeast	**	**	**	**	7.50	0.11	0.38	1.65	0.16
Spring-66	Southwest	5.33	0.10	0.36	0.16	6.25	0.11	0.37	1.56	0.16
Summer-66	Northeast	5.70	0.10	0.35	0.16	7.18	0.11	0.38	1.61	0.16
Summer-66	Southwest	6.25	0.11	0.37	0.16	7.82	0.12	0.39	1.67	0.17
Winter-66	Northeast	5.23	0.10	0.35	0.16	7.03	0.11	0.37	1.59	0.16
Winter-66	Southeast	5.46	0.10	0.36	0.16	6.45	0.11	0.37	1.55	0.17
Winter-66	Southwest	6.10	0.10	0.37	0.16	7.16	0.11	0.38	1.58	0.17
Summer-67	Northeast	5.79	0.10	0.36	0.16	7.0o	0.11	0.38	1.60	0.15
Summer-67	Southeast	5.18	0.10	0.35	0.16	6.42	0.11	0.38	1.55	0.16
Summer-67	Southwest	5.19	0.10	0.35	0.16	8.05	0.12	0.40	1.70	0.17

*All measurements are in millimeters.
**No worms were recovered.

overlap of the ranges of body lengths of both sexes coincided with the overlap reported by Besch (1965) but not as great an overlap as reported by Skrjabin, et al. (1954). The data summarized in Table VI show that the averages of body length of the males in an area were always shorter than the averages of the females in the same area.

Of the 142 females of Haemonchus contortus complex recovered from the cattle examined, observations of the shape of the vulvar flaps revealed that 32.4 per cent had linguiform vulvar flaps; 66.9 per cent possessed knobbed vulvar flaps, and 0.7 per cent were smooth in the vulvar region. Das, et al. (1960) examined 64 females of H. placei from cattle in Oklahoma and reported that 34.4 per cent had linguiform vulvar flaps and 65.6 per cent had knobbed vulvar flaps. The results of the two studies indicate that the majority of H. contortus complex females from cattle examined in Oklahoma had knobbed vulvar flaps.

CHAPTER V

SUMMARY AND CONCLUSIONS

A study of the gastrointestinal helminth parasites of cattle in Oklahoma was conducted from December, 1965 to June, 1967. Collections of viscera from 56 range cattle were made during three different time periods, winter, spring and summer, and from three different geographical areas, Northeastern, Southeastern and Southwestern, to determine the geographical distribution and the seasonal incidence of gastrointestinal helminth species of cattle in Oklahoma. Attempts were made to determine whether species variation could be identified by comparing morphological characteristics of particular species of nematodes. The three areas where collections were made represent distinct geographical and seasonal differences.

No conclusions can be made concerning the comparison of helminth populations to the breeds, sexes and weights of the cattle examined; however, the majority of large populations of helminths was recovered from the yearling age group of cattle.

It was observed that Ostertagia nodules were present in the cardia and fundus of the abomasa, occurred in all the areas surveyed and were present in each area every season when a collection was made, except in Northeastern Oklahoma.

The intestinal nodules, produced by Oesophagostomum radiatum larvae and localized mostly in the last 40 feet of the small intestines

and throughout the large intestines, were observed to be present in all areas surveyed and were present in each area every season when a collection was made except in the Northeastern area during the summer of 1966 and the summer of 1967 and in the Southwestern area during the spring of 1966.

The largest population of intestinal helminth parasites were recovered from the first 30 feet of the small intestines. Except for a few instances, the female worm population of each species outnumbered the male worm population. No conclusions are made concerning the incidence and ecology of helminths from the large intestines.

It is apparent from data collected that in all areas the largest population of adult helminths occurred during the summer and winter seasons; whereas, the smallest population occurred during the spring.

In order of incidence, Cooperia punctata, C. oncophora, Ostertagia ostertagi, were observed to be the predominant species in Northeastern and Southwestern Oklahoma; and Cooperia oncophora, C. punctata and Ostertagia ostertagi in Southeastern Oklahoma. The incidence, population and occurrence of gastrointestinal helminth species by geographical location and season were included and discussed.

The average body measurements of Ostertagia ostertagi obtained from specimens collected in each area are presented and discussed. The shortest male and female worms of O. ostertagi were collected from animals in all areas during the spring. Usually these were demonstrated from animals in Southeastern Oklahoma. Worms that were longest in length usually were demonstrated from animals in Southwestern Oklahoma and could not be correlated with season. Comparisons of the body length measurements of both sexes of O. ostertagi obtained from speci-

mens collected were made and related to those reported by other workers.

The average body measurements of Cooperia punctata obtained from specimens collected in each area are presented and discussed. Variations of body measurements of C. punctata adults obtained from specimens collected in each area by season were very slight and were not considered to be important in this study. These data were compared to body measurements of C. punctata summarized in published reports.

Close observation of Haemonchus contortus complex females recovered from the cattle examined revealed that the majority had knobbed vulvar flaps. These data corresponded with the results obtained by Das, et al. (1960).

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