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A SURVEY OF THE HELMINTH PARASITES OF CATTLE AND SHEEP IN UTAH VALLEY[1]

J. Carl Fox[2], Ferron L. Andersen, and Keith H. Hoopes

Introduction

Very little information is available on the prevalence of gastrointestinal helminths in domestic animals in Utah. Hammond and Hamilton (1941) reported 3 genera of parasitic helminths which they observed in sheep in the vicinity of Logan, Utah, and Andersen, Hoopes, and Fox (1969) indicated 7 genera of helminths in sheep at Provo, Utah. Apparently no other published information is available on the incidence of these parasites in domestic animals in the Utah area.

Studies were conducted at Brigham Young University during 1967 through 1969 to determine the incidence and distribution of helminth parasites in cattle and sheep in Utah Valley, Utah County, Utah. This information was necessary in order to assess the importance of parasitological problems to the animal industries in the intermountain area.

Meteorologic data were obtained to indicate the relationship of the climate in the central Utah area to the presence of gastrointestinal nematodes in domestic ruminants.

Materials and Methods

Fecal samples were collected from 209 cattle at 14 locations and from 351 sheep at 10 locations in Utah Valley. Sampling areas within the valley are indicated on Fig. 1. Fresh feces were taken directly from some animals, while other samples were obtained from the pasture as soon as possible after the animals had defecated. The samples were taken to the laboratory for subsequent examination.

The number of helminth eggs per gm (EPG) of feces in each sample was determined by using a modified McMaster sugar flotation technique. This consisted of mixing 2 gm of feces with 28 ml of 50% Sheather's sugar solution. The feces-Sheather's mixture was crushed through a tea strainer into a 70 ml evaporating dish to remove the fibrous material. A portion of the mixture was immediately transferred to a McMaster counting chamber for microscopic examination with a Swift SRL binocular microscope equipped with 10 X wide-field oculars and using the 10 X objective.

Cestode eggs were identified in the McMaster chambers by their specific morphological characteristics. Since eggs of trematodes do

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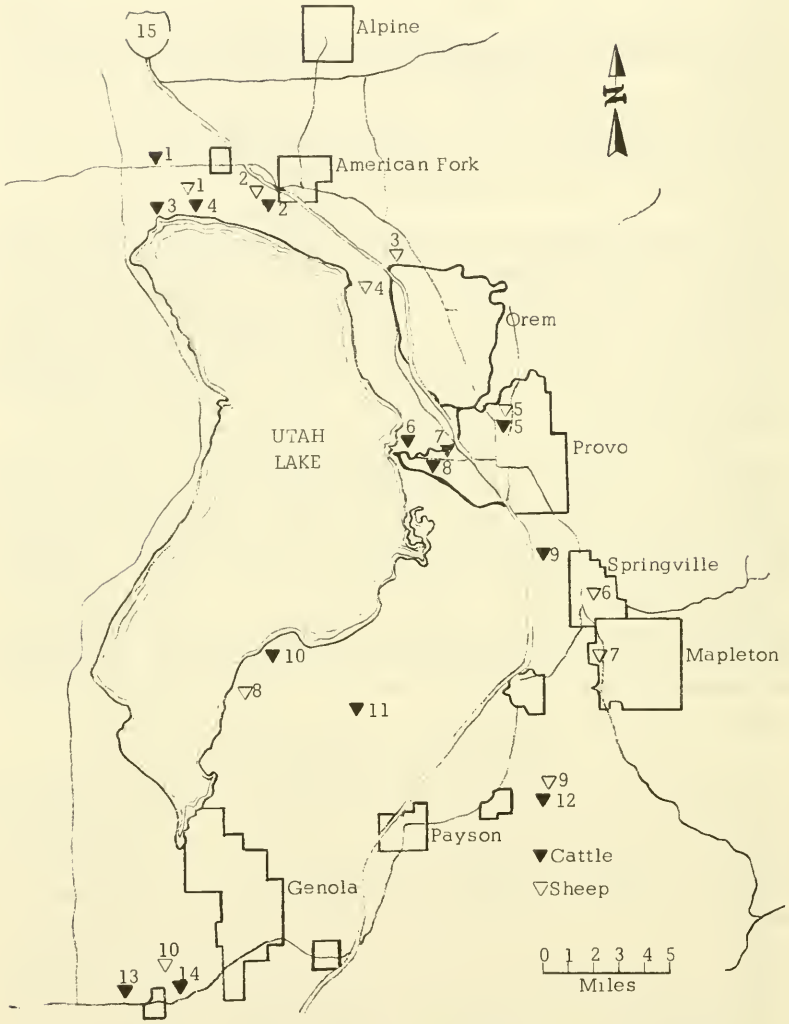

Fig. 1. Map of Utah Valley showing sampling areas where cattle and sheep were surveyed for gastrointestinal parasites.

not float in Sheather's solution, it was necessary to use sedimentation techniques on the collected feces to detect them.

Sedimentation was accomplished by washing a portion of the fecal sample through a piece of gauze into a 60 mm petri-dish and then adding water until the dish was full. The mixture was allowed to sedimentate, and the supernatant was carefully poured off. This latter process was repeated twice. The remaining sediment was then examined for the presence of fluke ova with a Bausch and Lomb

stereo-zoom dissecting microscope equipped with 10 X wide-field oculars and a 2 X auxiliary lens.

In addition to the examinations for helminth eggs, portions of the fecal samples were placed in 90 mm petri-dishes containing water-saturated paper pads for the purpose of cultivating infective larvae to be used for subsequent identification of parasitic nematodes. Feces were incubated at 30 C and 100% relative humidity for 7 days, during which time the dish covers were removed every 2 days for aeration. If necessary additional tap water was added at that time to maintain the high humidity.

After incubation the larvae were isolated from cultures by the standard baermannization technique (Baermann, 1917). Each sample was baermannized in a 90 mm funnel fitted with a small piece of rubber tubing with an attached hose clamp. The feces were put in the funnel onto a piece of cellulose tissue (Kimwipes) suspended by a ¼ in. mesh wire screen. Water was added until it covered the feces, and the sample was then allowed to stand for 6-8 hrs. at room temperature (approximately 25 C). If nematode larvae were present they passed through the cellulose tissue and settled into the stem of the funnel. After the alloted time approximately 15 ml of fluid were withdrawn from the funnel into a centrifuge tube. The mixture was stored at 4 C until larval identifications were made. At that time the supernatant was aspirated off from each sample, and a drop of fluid was placed on a microscope slide. This was either heated over a low flame or a drop of Lugol's solution was added to kill any larvae present. A cover glass was placed over the drop, and the slide examined under 10 X or 40 X magnification for identification of larvae. Third-stage larvae were identified by correlating the measurements for the total length of the larvae with the length of their sheath tails. Genera, or species whenever possible, were determined from the tables of larval measurements compiled by Dikmans and Andrews (1933), Keith (1953), Hansen and Shivnani (1956), Whitlock (1960), Soulsby (1965), and Levine (1968).

As a futher indication of the parasites in cattle and sheep in the valley, postmortem examinations were periodically made on animals killed at local abattoirs or brought to animal byproduct plants. The viscera of these animals were examined macroscopically for internal helminths, and representative sections of viscera were brought to the laboratory for further microscopic examination. All parasitic helminths detected were identified from descriptions provided by Whitlock (1960), Soulsby (1965), and Levine (1968). Helminth eggs present in feces from necropsied animals and larvae cultured from any of these same samples were identified as described above.

Weather data were collected during 1967 and 1968 to obtain an indication of the type of climate that characterizes the central Utah area. These data were obtained from a weather station located in southwest Provo, Utah. Daily maximum and minimum temper-

Table 1. Results of egg counts from cattle feces and nematode larval cultures.

Area no.	Number samples collected	Nematodes					Trematodes	Cestodes
		Egg counts				Larval cultures		
		Percent positive	EPG[1]			Percent positive	Percent positive	Percent positive
			Max.	Min.	Mean.			
1	12	41.7	250	0	50	91.7	ND[2]	00.0
2	6	33.3	50	0	17	100.0	ND	00.0
3	9	11.1	50	0	6	55.6	00.0	00.0
4	8	12.5	50	0	6	62.5	00.0	00.0
5	39	53.8	850	0	79	ND	ND	05.1
6	14	71.4	200	0	82	92.9	14.3	00.0
7	10	50.0	50	0	25	60.0	ND	00.0
8	17	00.0	0	0	0	41.2	ND	00.0
9	9	33.3	100	0	22	88.9	33.3	00.0
10	9	88.9	50	0	44	88.9	00.0	00.0
11	22	81.0	400	0	68	81.0	ND	00.0
12	33	00.0	0	0	0	12.1	ND	00.0
13	9	55.6	1750	0	239	100.0	00.0	33.3
14	12	75.0	100	0	50	66.7	ND	00.0

[1]Eggs per gram of feces.
[2]Not determined.

atures were recorded with maximum and minimum thermometers in a standard weather shelter, and daily precipitation was measured with a nonrecording rain gauge.

Results

Survey of parasites in cattle

Examination of fecal samples from cattle showed that 149 (71.3%) of 209 animals had helminth parasites. Table 2 gives the number of samples collected at each location; percent positive, maximum, and minimum, and mean egg counts; percent positive larval cultures; and percent parasitized by trematodes and cestodes. Mean EPG counts ranged from 0-239, with 1750 being the highest count observed. The highest percentage of cattle at any location with positive egg counts was 88.9% (area 10), whereas all animals at 2 locations (areas 2 and 13) were shown to harbor nematode parasites by larval culture methods. Cattle at only 6 locations were examined for trematode infections, with flukes being found in animals at 2 of those locations (areas 6 and 9).

Table 2. Helminth parasites identified in 209 cattle by egg or larval examinations.

Parasites identified	Total animals parasitized	Percent animals parasitized	Percent areas where found
Strongyloides papillosus	45	21.5	71.4
Haemonchus placei	20	9.6	64.3
H. contortus	24	11.0	57.1
Ostertagia ostertagi	27	12.9	78.6
Cooperia spp.	28	13.4	50.0
C. oncophora	48	23.0	85.7
Oesophagostomum radiatum	34	16.3	64.3
Bunostomum phlebotomum	3	1.4	14.3
Trichostrongylus spp.	35	16.7	78.6
Nematodirus spp.	1	0.5	7.2
Moniezia benedeni	4	1.9	14.3
M. expansa	1	0.5	7.2
Fasciola hepatica[1]	5	8.6	33.3

[1]Data represent only six sampling areas.

Parasites identified from cattle fecal examinations are listed in Table 2, which shows number and percent of animals parasitized by each species identified and the percent of sampling areas where each parasite was found. Ten genera of helminths were identified in cattle, with *Cooperia oncophora* being found in more animals and at more locations than any other parasite identified.

Survey of parasites in sheep

Examination of sheep fecal samples showed that 315 (89.7%) of 351 animals had helminth parasites. Table 3 gives the number of

Table 3. Results of egg counts from sheep feces and nematode larval cultures.

Area no.	Number samples collected	Nematodes					Trematodes	Cestodes
		Egg counts				Larval cultures		
		Percent positive	EPG[1]			Percent positive	Percent positive	Percent positive
			Max.	Min.	Mean			
1	9	66.7	900	0	311	100.0	44.4	00.0
2	14	92.8	3400	0	1379	100.0	ND[2]	00.0
3	13	61.5	550	0	112	100.0	ND	00.0
4	10	80.0	550	0	150	ND	ND	10.0
5	162	66.9	6700	0	694	73.1	ND	14.8
6	7	85.7	550	0	150	100.0	ND	00.0
7	20	100.0	1750	50	735	100.0	ND	05.0
8	14	92.8	2700	0	636	100.0	00.0	07.1
9	88	81.8	3200	0	199	94.3	ND	01.1
10	14	100.0	1400	50	507	100.0	ND	00.0

[1]Eggs per gram of feces.

[2]Not determined

samples collected at each location; percent positive, maximum, minimum and mean egg counts; percent positive larval cultures; and percent parasitized by trematodes and cestodes. Mean EPG counts ranged from 150-1379, with 6700 being the highest count observed. All animals examined at 2 locations (areas 7 and 10) were shown to be parasitized as assessed by egg counting techniques, whereas all animals examined at 7 locations (areas 1, 2, 3, 6, 7, 8 and 10) were positive using larval culture methods. Sheep at only 2 locations were examined for trematode infections, with flukes being found in animals at 1 of these locations (area 1).

Parasites identified from sheep fecal examinations are listed in Table 4, which shows number and percent of animals parasitized by each parasite identified and the percent of sampling areas where each parasite was found. Twelve genera of helminths were identified in sheep with *Trichostrongylus* spp. being found in the most animals and at 90% of the sampling sites. *Ostertagia circumcincta* and *Nematodirus* spp. were also observed at 90% of the sampling areas.

Distributions of all helminths found by fecal examinations of cattle and sheep within Utah Valley are shown in Table 5. Locations of sampling areas are indicated in Fig. 1, referred to previously.

Additional parasites not listed in Tables 2 and 4 which were found by necropsy were *Thysanosoma actinoides*, found in 2 of 34 sheep examined, and *Echinococcus granulosus*, found in 11 of 34 sheep.

Meteorologic measurements

Mean monthly maximum, minimum, and mean temperatures, and mean monthly precipitations measured in Utah Valley for the

Table 4. Helminth parasites identified in 351 sheep by egg or larval examinations.

Parasites identified	Total animals parasitized	Percent animals parasitized	Percent areas where found
Strongyloides papillosus	123	35.0	70.0
Haemonchus contortus	185	52.7	80.0
Ostertagia circumcincta	115	32.8	90.0
Cooperia spp.	9	02.6	30.0
Cooperia oncophora	35	10.0	80.0
Oesophagostomum columbianum	24	06.8	50.0
Bunostomum trigonocephalum	14	04.0	20.0
Trichostrongylus spp.	229	65.2	90.0
Nematodirus spp.	108	30.8	90.0
Chabertia ovina	121	34.5	80.0
Trichuris ovis	6	01.7	20.0
Moniezia benedeni	28	08.0	60.0
Fasciola hepatica[1]	4	23.5	50.0

[1]Data represent only two sampling areas.

Table 5. Distribution of helminth parasites within Utah Valley by sampling areas.

Parasites identified	Helminths of cattle														Helminths of sheep									
	Sampling area														Sampling area									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10
Strongyloides papillosus	*	*		*		*	*	*	*	*	*		*		*	*	*		*	*	*	*	*	*
Haemonchus placei	*	*				*	*		*	*	*		*	*										
H. contortus	*				*	*	*		*	*	*		*	*	*	*			*	*	*	*	*	*
Ostertagia ostertagi	*		*		*		*	*	*	*	*	*	*	*										
O. circumcincta															*	*	*		*	*	*	*	*	*
Cooperia spp.	*		*		*	*				*	*			*		*	*		*	*				
C. oncophora	*		*		*	*	*	*	*	*	*	*	*	*	*	*	*		*	*		*	*	*
Oesophagostomum radiatum	*		*		*			*	*	*	*	*	*	*										
O. columbianum																	*		*		*	*	*	
Trichostrongylus spp.	*	*	*		*	*	*	*	*	*	*	*	*		*	*	*		*	*	*	*	*	*
Nematodirus spp.													*			*	*	*	*	*	*	*	*	*
Bunostomum phlebotomum	*																							
B. trigonocephalum																			*			*		
Chabertia ovina															*	*	*		*		*	*	*	*
Moniezia benedeni					*								*					*	*		*	*	*	
M. expansa					*																			
Fasciola hepatica						*			*						*							*		
Trichuris ovis															*				*					

years 1967 and 1968 are given in Table 6. These data are represented by bioclimatographs shown in Figs. 2 and 3 for those years, respectively. Each bioclimatograph contains a closed curve formed from plots of mean monthly temperatures and total monthly precipitations as illustrated by Levine (1965). Optimum conditions for development and survival of the free-living stages of *Haemonchus* and *Ostertagia* species are delineated by solid and broken lines, respectively. The bioclimatographs show that weather conditions in Utah Valley were optimum in the months of May 1967, April 1968, and August 1968 for the development of *Ostertagia*, while development of *Haemonchus* was favored only in August 1968. Average monthly precipitation for 1967 was 27.42 mm (1.04 in), or about normal for this area, and 45.97 mm (1.81 in) for 1968. The higher amount received during the latter year was accounted for largely by more than average rainfall during April and December 1968 (Table 6).

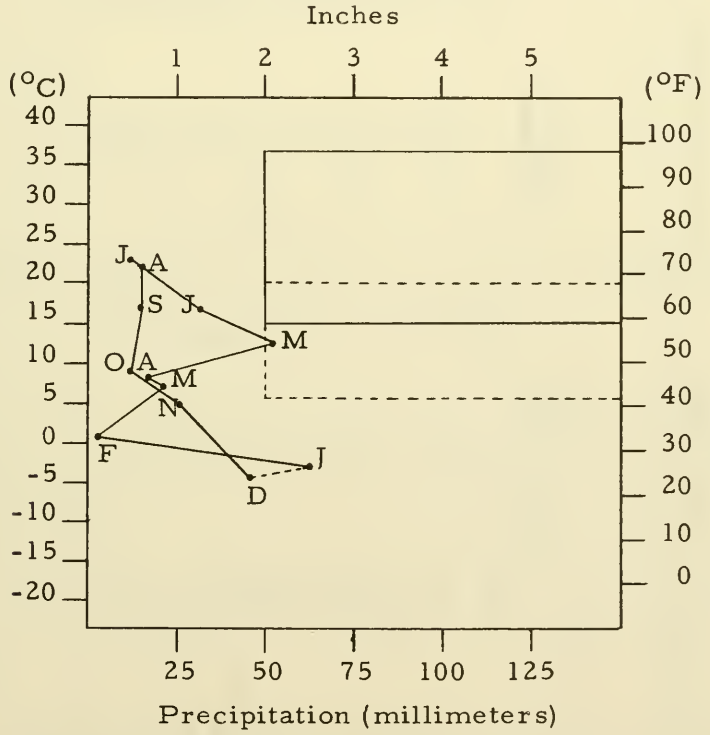

Fig. 2. Bioclimatograph of Utah Valley climate for 1967 in relation to the ecology of gastrointestinal helminths of ruminants. Optimum pasture conditions for *Haemonchus* (solid lines): 5 cm total monthly precipitation and 15-37 C mean monthly temperature. Optimum pasture conditions for *Ostertagia* (broken lines): 5 cm total monthly precipitation and 6-20 C mean monthly temperature.

Table 6. Mean monthly temperatures in a standard weather shelter and total monthly precipitations for the years 1967 and 1968.

Month	1967				1968			
	Mean monthly temperatures (°C)			Precipitation (millimeters)	Mean monthly temperatures (°C)			Precipitation (millimeters)
	Max.	Min.	Mean		Max.	Min.	Mean	
January	3.3	-9.2	-2.9	62.5	2.5	-13.2	5.3	9.9
February	7.4	-6.4	0.5	2.5	9.4	-3.6	2.9	49.0
March	14.4	-1.7	6.4	21.6	12.3	-1.4	5.5	43.2
April	15.6	-0.2	7.7	16.3	14.5	0.1	7.3	101.9
May	20.9	3.4	12.2	54.1	22.0	3.8	12.9	37.9
June	25.8	7.8	16.8	32.0	28.8	8.7	18.7	39.4
July	33.3	12.6	22.9	12.5	32.6	11.8	22.2	13.2
August	33.0	11.8	22.4	14.5	28.0	9.7	18.8	56.1
September	27.6	6.4	17.0	15.2	25.4	3.6	14.6	5.6
October	17.9	-0.3	8.8	11.9	19.2	0.2	9.7	34.5
November	13.3	-3.4	5.0	27.2	9.6	-2.1	3.8	37.3
December	1.2	-10.1	-4.4	46.2	4.2	-9.3	-2.6	123.6

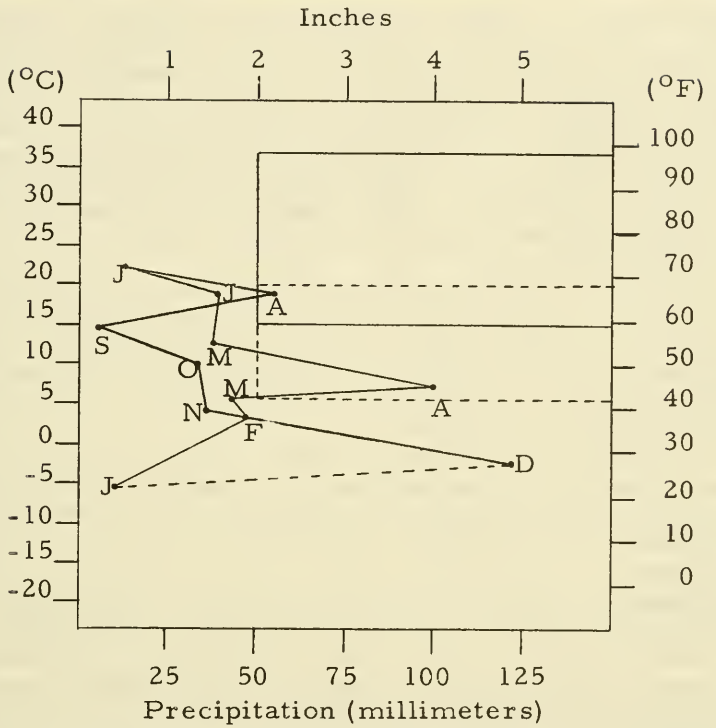

Fig. 3. Bioclimatograph of Utah Valley climate for 1968 in relation to the ecology of gastrointestinal helminths of ruminants. See Fig. 2 for explanation.

Discussions and Conclusions

The survey of parasites herein reported showed that 71.3% of 209 cattle and 89.7% of 351 sheep at various locations within the valley were parasitized by gastrointestinal helminths. The levels of parasitism in cattle were quite low (Table 1), with mean EPG counts ranging from 0-239. The only cattle found to harbor gastrointestinal helminths in this study were beef cattle which were allowed to graze on irrigated pastures, whereas all examinations of dairy cattle kept in feed lots were negative. Levine and Aves (1956) and Zimmerman and Hubbard (1961) also observed that helminth parasitism was usually lower in dairy cattle, which probably relates to their being kept on pasture only a minimum amount of time.

Even though the levels of parasitism by helminths in cattle did not indicate a serious problem, nevertheless, there were 10 genera of helminths identified in them (Table 2). The most common species of worm found in cattle in the valley was *C. oncophora.* This parasite is also common in such states as Georgia (Andrews, Jones and Sippel, 1953; Becklund, 1959, 1962) and Florida (Beck-

lund, 1961a). In addition, Tunnicliff (1932) reported massive infections by this parasite in cattle at Bozeman, Montana. Other helminths found in this current study correspond closely to those mentioned in reports of parasites in cattle from Arizona and New Mexico by Becklund and Allen (1955, 1958) and from Arizona by Dewhirst, Trautman and Pistor (1958). Many of the same genera identified in the present study were also reported in Montana cattle by Jacobson and Worley (1969). Some of these authors, however, also found *Capillaria, Setaria,* or *Dictyocaulus,* none of which were encountered in this study.

In contrast to the results from cattle, the levels of parasitism in sheep were considerably higher (Table 3). Sheep from 10 locations in the valley had mean EPG counts ranging from 150-1379. Several animals located at the BYU farm (area 5) had EPG counts above 2000, and at least 2 animals, 1 of which died (Andersen, et al., 1969), had clinical infections.

The incidence of nematodes identified in sheep around the valley varied slightly from the incidence in animals at the BYU farm (area 5). At all areas other than the farm, *Trichostrongylus* spp. were most prevalent, while at the BYU farm *H. contortus* was more common.

Chabertia ovina was identified in 23.5% of BYU sheep and 43.9% of sheep at the other locations within the valley. This parasite was observed in Montana sheep by Seghetti (1949), but was not encountered there by Jacobson and Worley (1969). It was reported by Swales (1940) as being very common in Canada, and was observed in sheep in Georgia by Cooperrider (1952) and Becklund (1961b).

Ostertagia circumcincta was quite common in sheep in the valley with an incidence of 32.8% of those animals examined. *Ostertagia* spp. were found consistently in Montana cattle by Seghetti (1949), Worley and Sharman (1966), and Jacobson and Worley (1969) and in sheep in California by Baker, et al. (1954).

Two species of cestodes were identified in cattle and sheep by fecal examinations. These were *Moniezia benedeni* and *M. expansa. Moniezia benedeni* was most prevalent in both cattle and sheep, with the highest incidence (14.8%; 24 animals) in sheep at the BYU farm. Porter (1953) summarized reports from 9 states and indicated that cattle were most often parasitized with *M. benedeni* and sheep with *M. expansa.* Results in this study differed, since *M. expansa* was found only in cattle, whereas *M. benedeni* was observed in 4 cattle and 28 sheep surveyed. Swales (1940) and Becklund (1961b) reported *M. expansa* in Canada and Georgia, respectively, but did not list *M. benedeni* in sheep from those areas.

Fasciola hepatica was found in 2 of 6 herds of cattle examined and 1 of 2 herds of sheep. Interviews with abattoir owners and meat inspectors in the valley revealed that up to 50% of livers from cattle are routinely condemned because of fluke infections. Indi-

cations are that liver flukes probably constitute a serious economic problem in the valley.

The distribution of helminth parasites identified in both cattle and sheep (Table 5) showed that *S. papillosus*, *H. contortus*, *C. oncophora* and *Trichostrongylus* spp. were universal with respect to host and distribution throughout Utah Valley. This indicates that transmission of these parasites between cattle and sheep may be quite common in this area. Porter (1953) was able to experimentally infect either cattle or sheep with *H. contortus*, *S. papillosus* and *Cooperia* spp., and Cooperrider (1952) demonstrated that these same organisms parasitized both cattle and sheep which he surveyed in Georgia.

The most significant parasites found by limited necropsy observations were *Thysanosoma actinoides* and *Echinococcus granulosus*. *Thysanosoma actinoides* was found in the bile ducts of only 2 sheep; however, this parasite has been reported as a common parasite of sheep in Montana (Welch, 1930; Seghetti, 1949).

Intermediate stages of the dog tapeworm, *Echinococcus granulosus*, were found in the livers of 11 sheep. This parasite constitutes a serious health hazard for man because of the danger involved in becoming infected while handling diseased sheep livers or by contamination from infected dogs. Further studies need to be conducted to establish how much of a problem *E. granulosus* is in this area.

Climate was used by Gordon (1948) and Levine (1952, 1962, 1963, 1965) as a means of predicting foci of helminthiasis of domestic ruminants in various geographical regions. They found a high correlation between the incidence of gastrointestinal nematodes and the climatic conditions in certain areas. According to bioclimatographs for Utah Valley (Figs. 2 and 3), climatic conditions in this area would be unfavorable for development of ruminant nematodes. This is not the case, however, since nematode species representing 10 genera were identified in cattle and sheep in the valley. (Tables 2 and 4).

Utah Valley is located in a low rainfall region with a normal mean precipitation of approximately 25 mm per month. The fact that nematode parasites are able to develop quite well in the area suggests that factors other than rainfall and temperatures are involved in the development and transmission of these organisms. For instance, irrigation, which is a common practice in this area, is the major source of pasture water rather than precipitation. Although the amount of water put on a pasture during irrigation is difficult to measure, it is estimated that amounts comparable to 20 in. of rainfall may be added to the pasture during the irrigating season (Andersen, et al., 1969). Irrigation seems, therefore, to provide ample moisture for parasite development.

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