The Role of Liver Fluke in Infertility of Beef Cattle

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Introduction

There are two important liver flukes in cattle in the United States, *Fasciola hepatica* and *Fascioloides magna.* Liver flukes are responsible for the condemnation of 1.2-1.5 million bovine livers per year resulting in a loss of approximately 10 million dollars annually (Foreyt and Todd, 1976). However, liver flukes also adversely affect rate of gain, utilization of feed, milk production, weaned calf weights and fertility (Ross, 1970; Contreras, 1976; Hope Cawdery *et al.,* 1977; Kendall *et al.,* 1978; Oakley *et al.,* 1979; Chick *et al.,* 1980; Foreyt *et al.,* 1980).

Economic losses associated with fluke infection have been investigated by several researchers. Hope Cawdery *et al.,* (1977) indicated that infections resulting from administration of 600 or 1000 metacercariae resulted in reduction in weight gains of 9 to 28% over a period of 26 weeks. Even in superimposed infections given 27 weeks after the initial infection and then carried to 54 weeks, there was a 17% reduction in weight gains even though fewer flukes were recovered from these animals when compared to a single infection with fewer metacercariae. He also confirmed the work of Kendall and Parfitt (1975) that the greatest effect on production occurs in the first 16 weeks of infection, and that treatment within 6 months of infection should be provided to minimize losses and improve production. However, this approach ignores the value of therapy in reducing pasture contamination with fluke eggs, a procedure which has proven successful in reducing further infection. Horchner and others (1970) suggest that a prevalence of 20-25% of a herd is indicative of a level of disease that reduces weight gain and production. It is therefore important to estimate the level of infection in livestock herds to determine the amount of prophylaxis needed to prevent the effects of subclinical or clinical fascioliasis. In Africa, anthelmintic experiments conducted by Okao (1975) have indicated that treatment with various fasciolicides against *F. gigantica* in Boran cattle which were on relatively low nutritional diets during part of the year resulted in gains of over 12 kg per treated animal over a 45-week period. Prophylactic treatment may therefore increase weight gains as well as reduce pasture contamination. It has been reported that sheep on a lower protein ration may be more prone to the pathogenic effects of *F. hepatica* (Berry and Dargie, 1976, 1978).

Ross (1970) demonstrated an 8-20% loss of milk production in cattle infected with *Fasciola hepatica.* Other studies in countries other than the United States have demonstrated that treatment of dairy cattle with efficacious faciolicides increased milk production at least 600 lbs per lactation. Detailed studies of milk production in beef cattle, in relation to weaned calf weights, have not been well documented.

Reproductively, fascioliasis has been associated with abortion and a decreased conception rate. Sinclair (1972) demonstrated that abortion, stillbirth and birth of lambs of low weights occurred in ewes infected with *F. hepatica.* In an outbreak of fascioliasis that occurred in sheep in California in 1968, Hjerpe *et al.,* (1971) reported that the lamb crop was reduced 16% and mortality in the ewes was 16%. Hope Cawdery (1977) demonstrated an inverse relationship between fascioliasis and the conception and/or establishment of the fetus in sheep. He suggested that liver damage and blood loss caused by the parasite could lead to physiological and nutritional stress. Contreras (1976) associated a high incidence of abortions with liver fluke infections in cattle in Venezuela. He suggested that liver flukes could cause abortions by affecting fetal circulation through the production of toxins, by liver damage present in the cow, or by prenatal invasion of the fetus or reproductive tract.

This study was initiated to determine the effect of liver flukes on the reproductive performance of beef cattle. Results are based on field studies with naturally infected cattle in Texas and Idaho and a study with experimentally infected cattle. Attention was called to the problem because poor reproduction was a consistent finding in selected herds with liver fluke infections.

Materials and Methods

Idaho Study — A herd of approximately 100 purebred Angus cattle was selected for study in southern Idaho in an area where flood irrigation is a common management practice. The herd was assembled in 1977 and later found to be naturally infected with *Fasciola hepatica.* Observations of cattle in the herd in 1977 including emaciation, watery diarrhea, occasional mortality, depressed growth and poor reproduction. Blood samples were collected for serology, and analyzed for routine hematological values. Fecal samples were analyzed for parasite eggs. Cattle had been vaccinated against clostridial diseases (7 way and red water)

and given vitamin E and selenium. Calves were vaccinated against IBR, BVD, PI3 viruses and vibriosis.

Because of the heavy *F. hepatica* infections in these animals, these cattle were chosen to test the efficiency of albendazole. Thirty cattle were treated with albendazole at 10 mg/kg of body weight and ten cattle received placebo only. All cattle were killed 37 or 38 days later and flukes were counted from the livers (see Foreyt *et al.,* 1980).

Texas Study — A clinical and controlled experiment was conducted in southern Texas in a herd of 99 Brahman-Hereford cross heifers which were naturally infected with *Fascioloides magna.* History of this ranch indicated that all cattle acquired infection before they were one year of age. Fifty of these heifers were chosen randomly and administered albendazole paste at 7.5 mg/kg of body weight in April, 1977. Treated animals were retreated with the same dosage of albendazole paste in June and October, 1977; June and November, 1978; and June 1979. Treatment times were based on transmission times of the fluke in this area (Foreyt and Samuel, 1979). Major fluke transmission occurs in May and June, and September and October and is correlated with rainfall, temperature and snail populations (Foreyt and Samuel, 1979). The remaining 49 cattle were untreated controls and were maintained on pasture with the treated cattle. Pregnancy rates were determined by rectal palpation and weights of cattle and calves were obtained on a yearly basis. Nonpregnant cows were killed each year and flukes in the livers were counted.

Experimental Study — In 1977, 52 Angus cross heifers were randomly selected from a herd of approximately 500 cows and heifers in eastern Washington. Thirty heifers were selected randomly and experimentally inoculated with metacercariae of *F. hepatica* and *F. magna.* Ten heifers were given 1000 *F. hepatica* and 350 *F. magna* metacercariae immediately before the breeding season, ten heifers were given the same inoculum during the first trimester of pregnancy, and ten heifers were givent the same inoculum during the last trimester of pregnancy. The inoculum for each animal was divided into two doses and given at 2-week intervals. Metacercariae were administered per os in a gelatin capsule. The remaining 22 control heifers received a placebo only. The same inocula were adminstered to the same animals during the second year of the experiment according to the aforementioned schedule. All cattle were dewormed yearly with thiabendazole and maintained on a routine vaccination program.

Pregnancy rates were determined by rectal palpation and liver necropsy data were determined when cattle died or when surviving cattle were slaughtered in 1981.

Results and Discussion

Idaho Study — Observed clinical signs associated with fascioliasis in this herd were emaciation, fluid diarrhea, recumbency and death of some animals. Poor reproduction (less than 50% calf crop) and poor growth (emaciation) were obvious, even though adequate quality feed was provided. Analysis of feed samples indicated an excellent ration with greater than adequate protein level. Significant laboratory findings included anemia, hypoproteinemia, hypocalcemia, hypophosphatemia and hypoalbuminemia.

Livers from ten untreated cows contained an average 258 *F. hepatica* per liver (range 7-620). Livers from three emaciated calves that died in 1978 contained more than 150 *F. hepatica* each. Livers were characterized by extensive biliary hyperplasia, hemorrhage, and necrosis. Cows treated with albendazole had few adult flukes (see Foreyt *et al.,* 1980) indicating an efficacy greater than 90%. Significant efficacy was also present against immature flukes.

Serological results indicated that a majority of the cattle had antibody against BVD, IBR, PI3 and BT viruses, but disease was not observed. Cattle were negative for *Anaplasma* and *Brucella* antibodies. After evaluating clinical evidence in this herd, it was concluded that fascioliasis in this study was a major contributing factor to the poor production and reproduction in the herd. It is likely that high levels of *F. hepatica* reduced the physiological condition of the cows to a level where energy intake and utilization were reduced, resulting in lowered productivity (Oakley *et al.,* 1979)

Texas Study — Based on eggs in feces, albendazole at 7.5 mg/kg of body weight was approximately 100% effective against nematodes in the treated cattle. No adverse effects were noted. Based on necropsy data, albendazole was approximately 95% effective against *F. magna* (Table I). Only one of 13 treated cattle had flukes at necropsy (4 *F. magna),* compared to 13 of 13 untreated cattle which contained flukes (59 *F. magna)* at necropsy (Table I). Fewer necrotic cystic lesions were detected in treated animals (67 lesions) when compared to untreated controls (164 lesions). Several of the livers from treated animals passed veterinary inspection, whereas all livers from untreated animals were condemned. Assuming all animals were infected at the beginning of the experiment, sufficient liver regeneration occurred after treatment resulting in a normal-appearing liver at necropsy in some of the treated animals. No. *F. hepatica* were detected in any of the cattle.

Weights of treated cows were consistently greater than untreated cattle, ranging from an average of 26.6 kg in favor

TABLE I.

Numbers of *Fascioloides magna* Recovered from Cows Treated with Albendazole at 7.5 mg/kg of Body Weight or Untreated Controls

	Untreated Group		Treated Group	
	No. of Lesions	*Fascioloides magna*	No. of Lesions	*Fascioloides magna*
1978	17.8 Avg.	8.2 Avg. (N=5)	5.0 Avg.	0 (N=5)
1979	10.0 Avg.	2.5 Avg. (N=4)	5.6 Avg.	0.6 Avg. (N=7)
1980	8.8 Avg.	2.0 Avg. (N=4)	3	0 (N=1)

of treated cattle in January, 1978, to an average of 12.3 kg for treated cattle in July, 1980 (Table II). The amount of the weight advantage due to removal of nematodes as well as *F. magna* was not determined, however a production and economic advantage from treatment was apparent. Weaned weights of calves from treated cows were heavier than calves from nontreated cows in 1979 and 1980 (+4.5 kg and ,6.4 kg, respectively) (Table III). This may reflect increased milk production in the cows. Weights of the calves in 1979 were taken in June and August. Calves from treated dams in June were an average of 10.2 kg heavier than from untreated dams (Table III). This difference was less (+4.5 kg) when the calves were weaned in August. Birthweights of calves were not obtained, but treated cattle may have had heavier or healthier calves.

TABLE II.

Weights of Cows (kg) in the Texas Study which were Treated with Albendazole at 7.5 mg/kg of Body Weight or Untreated Controls

	Treated	Untreated	Treated Advantage
April 1977	271.8 (N=50)	267.3 (N=49)	+ 4.5
October 1977	375.9 (N=50)	362.3 (n=49)	+13.6
January 1978	396.4 (N=44)	370.4 (N=44)	+26.0
November 1978	495.0 (N=42)	470.4 (N=43)	+24.6
January 1979	409.5 (N=40)	388.6 (N=38)	+20.9
August 1979	383.3 (N=33)	360.9 (N=29)	+22.4
July 1980	429.6 (N=32)	417.3 (N=27)	+12.3

Reproductive rates based on rectal palpation are listed in Table IV. In 1977, 28 heifers were not pregnant. It is likely that many of them were not reproductively mature at the time. Between 1978 and 1980 four cows in the treated group were open compared to 11 open cows in the untreated group (Table (B) indicating a reduced reproductive rate in the untreated, infected cows. It was an original hypothesis that the adverse effects of liver fluke infection are cumulative and that cows are sent to market sooner than normal because of reproductive inefficiency. These data tend to support that hypothesis, but the experiment would have to be continued for additional years to prove the hypothesis. Necropsy data from livers of untreated anumals indicated that liver damage was grossly less severe from 1978 to 1980, suggesting a resistance to additional infection. However, the progressive accumulation of toxins from the hepatic lesions may adversely affect the establishment or maintenance of the fetur (Hope Cawdery, 1976).

TABLE III.

Weights of Calves (kg) in the Texas Study from Cows Treated with Albendazole (7.5 mg/kg) or Untreated Controls

	From Treated Dams	From Untreated Dams	Treatment Advantage
1978	ND	ND	
June 1979	174.2 (N=33)	164.0 (N=29)	+10.2
August 1979	223.5 (N=19)	219.0 (N=16)	+ 4.5
July 1980	203.2 (N=20)	196.8 (N=19)	+ 6.4

Experimental Study — Based on the presence of *F. hepatica* eggs in feces, all 30 incoculated cattle were infected in the experiment. No *F. hepatica* eggs were detected in feces from uninoculated control cattle. Liver necropsy data from inoculated animals indicated all were infected with both flukes. Numbers of flukes are listed in Table V. The numbers of flukes detected decreased throughout the experiment, possibly suggesting a resistance to the second infection superimposed on the first and a general elimination of flukes from infected animals (Doyle, 1973). All controls were negative.

TABLE IV.

Pregnancy Rates in Cows Treated with Albendazole at 7.5 mg/kg of Body Weight or Untreated Cows

	Pregnancy Rates — Texas Study	
	Treated	Untreated
	Pregnant/Open	Pregnant/Open
1977	33/17	38/11
1978	43/ 1	43/ 1
1979	42/ 2	38/ 6
1980	40/ 1	33/ 4

Mortality rates were high in both infected and uninfected groups. Between 1977 and 1980, 21 of 52 (40%) died or were

removed from the experiment (Table VI). Bloat was the major accidental cause of death.

Over the four-year period (1978 to 1981), infected cows consistently produced fewer calves (80% average calf crop) when compared to the noninfected controls (95% average calf crop) (Table VI). Although the sample size is relatively small (30 infected and 22 noninfected) the data suggests that *Fasciola* and *Fascioloides* may affect reproduction in cattle even though few flukes were present in the majority of the infected animals. The effect may be a mechanical one caused by fluke migration in hepatic tissue or in the reproductive tract. Toxins associated with fluke infections, hepatic necrosis, and possibly other factors associated with fluke infection may also be important in decreased reproduction. Whatever the mechanisms involved, it appears that liver flukes can adversely affect the reproductive rate in cattle. A similar reduction in reproduction in fluke-infected sheep has also been reported (Hope Cawdery, 1976). This effect may change with geographical location, level of infection and reinfection, and other factors relating to the epidemiology of liver fluke infection.

TABLE V.

Numbers of Flukes Recovered from Cows Experimentally Infected with *Fasciola hepatica* and *Fascioloides magna*

	Fasciola hepatica	*Fascioloides magna*
1979 (N=2)	62, 10	20, 4
1980 (N=2)	12, 6	4, 5
1981 (N=13)	4.1 Avg.	1.0 Avg.

All controls were negative.

TABLE VI.

Pregnancy Rate in Cows Experimentally Infected with *Fasciola hepatica* and *Fascioloides magna* or Uninfected Controls

	Infected	%	Controls	%
	Pregnant/Open	Pregnant	Pregnant/Open	Pregnant
1978	25/ 5	(83%)	22/0	(100%)
1979	25/ 3	(89%)	21/0	(100%)
1980	15/ 6	(71%)	14/4	(78%)
1981	13/ 6	(68%)	11/1	(92%)
TOTALS	78/20	(80%)	88/5	(95%)

SUMMARY

In all three studies, the presence of *F. hepatica, F. magna,* or both flukes was correlated with reduced production in infected cattle herds. In the Idaho herd *F. hepatica* apparently was a major factor responsible for poor reproduction, poor growth and mortality. In the Texas herd, *F. magna* contributed to the decreased growth and reproduction of the cattle. In the experimental study, infected cattle reproduced less efficiently than uninfected cattle. These results corroborate those of Ross, 1970; Contreras, 1976; Hope Cawdery *et al.,* 1977; and Oakley *et al,* 1979, who reported that liver flukes adversely affect production parameters in cattle.

Studies have shown that sheep fed a poorer plane of nutrition developed earlier and more severe anemia (Berry and Dargie, 1976, 1978) and died before infected sheep fed a better plane of nutrition. Liver fluke infections also depress appetite and protein intake, which may compound the fluke infection. The Idaho herd was very well fed, but the massive infection probably overwhelmed the erythropoetic system due to excessive loss of blood. Cattle in the Texas study and in the experimental study were pastured animals with average protein intake. Lower numbers of flukes in these animals probably resulted in less pathology and clinical disease.

Chick *et al.,*(1980) demonstrated a reduction in growth of 14-15% in steers administered 1200 metacercariae superimposed on natural infections. Hope Cawdery *et al.,* (1977) demonstrated reduced weight gains of 8-28% in experimentally infected cattle. They suggested the impaired performance appeared to be due to impaired feed conversion at a low level of infection and inappetence at a high level of infection. It is possible that the high levels of infection in the Idaho herd resulted in inappetence which was responsible for emaciation and death.

Recent studies by Oakley *et al.,* (1979) indicated that liver flukes adversely affected reproduction in artificially inseminated cattle. Their results support data in these studies and parallel results of Hope Cawdery (1976) who reported that *F. hepatica* had an adverse effect on reproduction in sheep. However, liver flukes may have an adverse effect on energy input, thus resulting in depressed growth fertility.

Overall major effects of liver fluke infections are probably dependent on numbers of flukes present, immune response and diet of the host (Kendall *et al.,* 1978). Epizootiology of fluke transmission and diet composition differ greatly from one area to another, and these differences are difficult to assess when predicting or measuring the amount of production loss associated with fluke infection.

Albendazole is currently the only fasciolicide available in the United States and is available only on a restricted emergency-use basis against *F. hepatica.* At 7.5 or 10 mg/kg of body weight, albendazole was effective against mature *F. hepatica* and mature and immature *F.magna.* Strategic use

of albendazole or other effective fasciolicides could theoretically increase reproductive rates and production in cattle where liver flukes are prevalent.

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