Sarcocystis IN WILD UNGULATES IN ALBERTA 1

Authors: MAHRT, JEROME L., and COLWELL, DOUGLAS D.

Source: Journal of Wildlife Diseases, 16(4) : 571-576

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-16.4.571

Sarcocystis IN WILD UNGULATES IN ALBERTA[1]

JEROME L. MAHRT and DOUGLAS D. COLWELL,[2] Department of Zoology, University of Alberta, Edmonton, Alberta, Canada T6G 2E9

Abstract: Muscle samples from 557 wild ungulates in Alberta, comprising seven species, were examined grossly and/or histologically for cysts of *Sarcocystis*. *Sarcocystis* was found in 100, 96, 94, 75, 75, 73, and 49% of the wapiti *(Cervus canadensis)*, moose *(Alces alces)*, bison *(Bison bison)*, mule deer *(Odocoileus hemionus)*, bighorn sheep *(Ovis canadensis)*, mountain goat *(Oreamnos americanus)*, and white-tailed deer *(O. virginianus)*, respectively.

INTRODUCTION

There are only a few published reports of *Sarcocystis* in wild ungulates in predator-prey life cycle[11,15] and demonstrated mortality in cattle and sheep.[2,12] The suspected importance[5,6] of *Sarcocystis* to wildlife has not been confirmed. Experimentally infected mule deer *(Odocoileus hemionus)* died after inoculation with sporocysts of *S. hemionilatrantis*.[6,11]

There are only a few published reports of *Sarcocystis* in wild ungulates in Canada. This parasite has been reported from white-tailed deer *(O. virginianus)* in Ontario,[9] moose *(Alces alces)* in Alberta,[1] and Ontario,[10,18] and caribou *(Rangifer tarandus)* in Saskatchewan.[3] The wealth in numbers and species of big game animals in Alberta, and the paucity of published information, prompted a survey for *Sarcocystis*. Before assessment for disease potential is possible, baseline data are necessary to provide information on the intermediate host species infected, and the prevalence of natural infections.[8] In addition information is needed on the potential definitive host fauna, and their relative abundance. This would provide a better understanding of the epidemiology of *Sarcocystis*. Results of a search for *Sarcocystis* in a big game from Alberta are reported herein.

MATERIALS AND METHODS

Muscle samples were obtained from 557 big game animals, comprising seven species in Alberta from 1970 to 1977. Collection sites of the different host species are shown in Figure 1. Personnel from the Fish and Wildlife Division of the Alberta Department of Recreation, Parks, and Wildlife collected most of the samples from deer at Camp Wainwright (CW). Large numbers of samples were obtained at CW (Fig. 1) in November 1972, 1974 and 1975 because of controlled hunting on a military installation. A herd reduction program at Elk Island National Park (EINP) also provided many samples. During the 1975 collection at CW, samples of thigh and tongue tissue were taken, and histologically compared for prevalence of infection. Tongues from 12 white-tailed deer and one mule deer (also 1975 CW collection) were examined grossly for macrocysts. Tongue and esophagus from deer and moose were examined for macrocysts, and histologically for microcysts. Tissue samples from all other animals were examined only histologically. Striated muscle tissue was fixed in 10% buffered

[1] Supported by National Research Council of Canada Grant A-3908 to the first author.

[2] Present address: Agriculture Canada Research Station, Lethbridge, Alberta T1J 4B1.

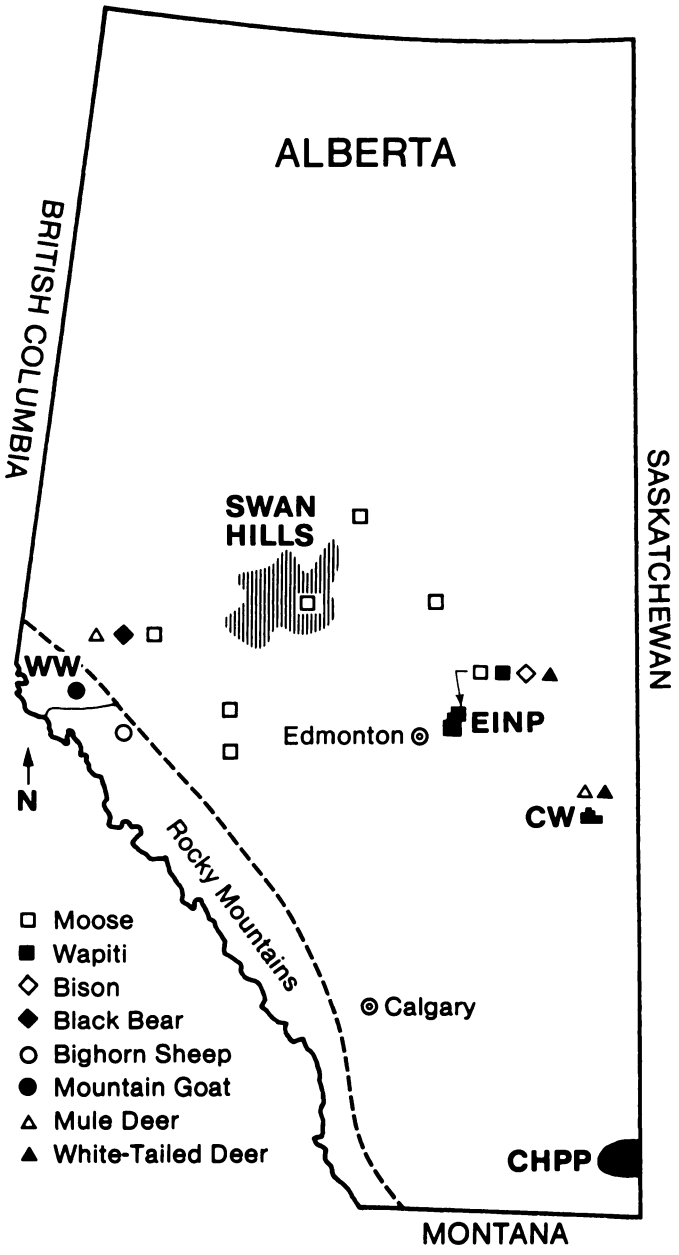

FIGURE 1. The location of collection sites of big game animals in Alberta. WW = Willmore Wilderness Park; EINP = Elk Island National Park; CW = Camp Wainwright; CHPP = Cypress Hills Provincial Park.

neutral formalin, embedded in paraffin, sectioned at 7 μm, and stained with Harris' hematoxylin and eosin. Approximately 2 cm^2 sections of tissue were examined microscopically at 43× and 125× for microcysts, or to confirm the presence of macrocysts. The distinction between macrocysts and microcysts was based only on size. Those visible with the naked eye were macrocysts, whereas cysts visible only with magnification were classed as microcysts. Erroneous results could occur if a host animal harbored immature cysts (microcysts) which would later become macroscopic in size. Correlation of cyst size to host age, and a comparison of cyst morphology between host species is under investigation.

Statistical analysis utilized the G-test (with Yates' correction).[17] Data were considered significant at the $P<0.05$ level.

RESULTS AND DISCUSSION

Seventy-one percent of 557 wild ungulates of seven species examined from 1970 to 1977 were infected with *Sarcocystis* (Table 1). The high prevalence of infection and wide distribution in Alberta's big game animals is not unusual and confirms what previous investigators have found in other geographic areas. Pond and Speer[14] found *Sarcocystis* in mule deer, white-tailed deer, wapiti, and bison in Montana. Kaliner *et al.*[7] reported sarcocysts in a wide range of East African game animals. Karstad and Trainer[9] found 79% of 208 white-tailed deer from Ontario, Texas and Wisconsin infected with *Sarcocystis*.

Moose were more widely sampled than other big games species in this survey. For comparison of data, collection sites were grouped into three regions: Cypress Hills Provincial Park (CHPP), EINP, and the Swan Hills district (Fig. 1, Table 2). Barrett[1] reported 13 of 19 moose from contiguous moose range of Northern and Western Alberta were infected with *Sarcocystis* sp. The reported location was incorrect since these moose were part of a herd reduction program (February 1970) in the CHPP. There was no significant different in prevalence of infection between moose from CHPP and the Swan Hills district; however, moose from both of these areas had a significantly lower prevalence when compared to EINP (CHPP vs. EINP, $G = 17.10$; Swan Hills vs. EINP, $G = 12.78$).

The four species of animals examined at EINP had a uniformly high prevalence of infection (Table 3). This finding may have important implications. Heydorn *et al.*[4] stated that no *Sarcocystis* species is known which parasitizes more than one genus of intermediate hosts. Analysis of data from infected animals from EINP casts some serious doubt upon this concept. EINP is a 186 km^2 area of aspen parkland which is enclosed by fence. This strongly restricts big game

TABLE 1. Prevalence of *Sarcocystis* in big game animals in Alberta.

Host Species	No. Infected/ No. Examined	Percentage Infected
Alces alces	196/205	96
Bison bison	17/18	94
Cervus canadensis	2/2	100
Odocoileus virginianus	137/277	49
Odocoileus hemionus	27/36	75
Ovis canadensis	3/4	75
Oreamnos americanus	11/15	73
Totals	393/557	71

TABLE 2. Prevalence of *Sarcocystis* on moose from three regions in Alberta.

Region	No. Infected/ No. Examined	Percentage Infected
Swan Hills District	32/39†	82
Elk Island National Park	164/166	99
Cypress Hills Provincial Park	13/19*†	68

†Significantly lower than in EINP (see text).
*Data previously reported by Barrett.[1]

movement into or out of the Park. Densities of game animals are high and natural predators for moose, bison, and wapiti are absent which necessitates a periodic herd reduction program. The high host densities and high diversity in a "closed area may enhance interspecific and intergeneric adaptations and parasite exchange." All known life cycles of *Sarcocystis* in ungulates involve a predator-prey cycle.[1,3] Coyotes are the definitive host for *S. hemionilatrantis*[6] in mule deer. A limited diversity of definitive hosts (likely only coyotes) combined with a high diversity of infected intermediate hosts suggests a hypothesis that one species of *Sarcocystis* infects all of the big game animals in EINP. Thus, the predator (scavenger) - prey cycle of coyote-deer may serve as the major cycle for *Sarcocystis* transmission. Moose, bison, and wapiti (Table 3) also could become infected by ingestion of sporocysts from fecal contamination by coyotes which had previously eaten infected deer. Coyotes are ineffective predators of moose, bison, and wapiti, but are carrion feeders. Thus, for the most part, infections within these large ungulate hosts would be "dead end." The importance of scavengers and/or carrion feeders to the success of *Sarcocystis* and its transmission needs study. Nothing is known about the survival and longevity of zoites in cysts under natural conditions.

The hypothesis of a single shared species of *Sarcocystis* in the wild ungulates in EINP is further supported since all species of intermediate hosts had macrocysts. However, detailed morphological comparison of cyst structure using electron microscopy and cross transmission experiments will be necessary to confirm or reject this hypothesis. The existence of more than one species of *Sarcocystis* in big game animals in Alberta also is very likely. The best evidence for this was from infected adult deer at CW which had only microcysts, as opposed to deer at EINP having macrocysts.

Potential definitive hosts for *Sarcocystis* which may act as predators on wild ungulates in Alberta are wolves *(Canis lupus)*, coyotes *(C. latrans)*, cougars *(Felis concolor)*, lynx *(Lynx lynx)*, bobcats *(L. rufus)*, grizzly bears *(Ursus arctos)*, and black bears *(U. americanus)*. Bears, although omnivores, might also serve as intermediate hosts for *Sarcocystis*. Two adult black bears collected northeast of Willmore Wilderness Park (Fig. 1) were negative for sarcocysts.

A comparison of prevalence of *Sarcocystis* infection in three age classes of moose at EINP showed no differences.

TABLE 3. Comparison of prevalence of *Sarcocystis* infection in big game animals in Elk Island National Park for December 1977.

Host Species	Prevalence
Moose	127/127 (100)*
Bison	17/18 (94)
Wapiti	1/1 (100)
White-tailed deer	3/3 (100)

*No. infected/No. examined (%).

TABLE 4. Prevalence of *Sarcocystis* in deer at Camp Wainwright.

	1972		1974		1975	
Age Class	W.T.D.*	M.D.**	W.T.D.	M.D.	W.T.D.	M.D.
Juveniles	5/15† (33)	0	7/30† (23)	0	7/30† (23)	0
Yearlings	12/25 (48)	5/5 (100)	13/20 (65)	2/4 (50)	18/26 (69)	6/10 (60)
Adults	20/37 (54)	4/5 (80)	24/46 (52)	4/5 (80)	28/45 (62)	5/6 (83)
Totals	37/77 (48)	9/10 (90)	44/96 (46)	6/9 (66)	53/101 (52)	11/16 (68)

†Juveniles significantly lower than other age classes in all 3 years.
W.T.D. = white-tailed deer
**M.D. = mule deer

In the December 1971 collection, 9/9 juveniles (J), 1/1 yearlings (Y), and 27/29 adults (A), were infected, and in the December 1977 collection, 18/18 J, 15/15 Y, and 94/94 A, were infected. *Sarcocystis* infections also were compared in the three age classes and two species of deer collected in November at CW (Table 4). Of all the combinations analyzed, only juvenile white-tailed deer had a significantly lower prevalence (J vs. Y, G = 17.48; J vs. A, G = 18.90) in all three years when compared to yearlings and adults. The lower prevalence in fawns may be a function of their age.

Pond and Speer[14] recently reported the prevalence of *Sarcocystis* in wild herbivores on the National Bison Range (NBR) in Montana. Using gross examination of four tissues (heart, esophagus, diaphragm, and skeletal muscle), *Sarcocystis* was found in 81, 50, 50, and 13% of the mule deer, white-tailed deer, wapiti, and bison, respectively. Their prevalence of infection for both deer species was comparable (no significant difference) to that found at CW. The prevalence in bison was significantly (G = 21.14) higher at EINP (17/18) than at the NBR (2/15). A sample size of two wapiti (Table 1) is too low to make meaningful comparisons of *Sarcocystis* in this host species to other reports.[14,16]

Gross examination of tongues of deer (12 white-tailed deer and one mule deer) at CW was negative for macrocysts, whereas 12 of these same deer had microcysts. The texture of tongue muscle makes observation difficult compared to esophagus. Also macrocysts in deer are considerably smaller than in moose (both from esophagus at EINP) (white-tailed deer, N = 10 cysts; range in length 0.3 to 0.6 mm, $\bar{X}$ = 0.46 ± 0.09 s.d. vs. moose, N = 25; 0.8 to 3.7 mm, $\bar{X}$ = 1.76 ± 0.60 s.d.). Therefore, we recommend microsopic examination of deer, especially if only tongue is available.

Do sarcocysts demonstrate a tissue preference? We examined this question on a limited scale with only two tissue types from deer from the 1975 hunt at CW. When tongue and thigh tissue was examined microscopically, a distinct preference for tongue was found. Fifty of 115 (43%) tongue specimens had microcysts while only 26 of 108 (24%) thigh samples from the same deer were positive. This difference in preference for tongue was significant (G = 8.60). An alternative explanation to tissue preference by a single species of *Sarcocystis* could be the presence of different species of *Sarcocystis* each parasitizing a specific site.

LITERATURE CITED

1. BARRETT, M.W. 1972. A review of the diet, condition, diseases and parasites of the Cypress Hills moose. 8th N. Am. Moose Conf. and Workshop pp. 60-79.

2. FAYER, R. 1973. Development of *Sarcocystic fusiformis* in calves infected with sporocysts from dogs. J. Parasit. 59: 1135-1137.
3. GIBBS, H.C. 1960. Disease investigation of barren-ground caribou. Wildl. Manage. Bull., Can. Wildl. Serv. Ottawa, Ser. 1, No. 15: 119-135.
4. HEYDORN, A.O., R. GESTRICH, H. MEHLHORN and M. ROMMEL. 1975. Proposal for a new nomenclature of the Sarcosporidia. Z. Parasitenk. 48: 73-82.
5. HUDKINS-VIVION, G., T.P. KISTNER and R. FAYER. 1976. Possible species differences between *Sarcocystis* from mule deer and cattle. J. Wildl. Dis. 12: 86-87.
6. HUDKINS, G. and T.P. KISTNER. 1977. *Sarcocystis hemionilatrantis* (sp.n.) life cycle in mule deer and coyotes. J. Wildl. Dis. 13: 80-84.
7. KALINER, G., J.G. GROOTENHUIS and D. PROTZ. 1974. A survey for sarcosporidial cysts in East African game animals. J. Wildl. Dis. 10: 237-238.
8. KALYAKIN, V.N. and D.N. ZASUKHIN. 1975. Distribution of *Sarcocystis* (Protozoa: Sporozoa) in vertebrates. Folia Parasit. 22: 289-307.
9. KARSTAD, L. and D.O. TRAINER. 1969. *Sarcocystis* in white-tailed deer. Bull. Wildl. Dis. Ass. 5: 25-26.
10. KELLY, A.I., L.R. PENNER and R.J. PICKARD. 1950. *Sarcocystis* in the moose. J. Mammal. 31: 462-463.
11. KOLLER, L.D., T.P. KISTNER and G. HUDKINS. 1977. Histopathologic study of experimental *Sarcocystis hemionilatrantis* infection in fawns. Am. J. Vet. Res. 38: 1205-1209.
12. LEEK, R.G., R. FAYER and A.J. JOHNSON. 1977. Sheep experimentally infected with *Sarcocystis* from dogs. I. Disease in young lambs. J. Parasit. 63: 642-650.
13. LEVINE, N.D. 1977. Nomenclature of *Sarcocystis* in the ox and sheep and of fecal coccidia of the dog and cat. J. Parasit. 63: 36-51.
14. POND, D.B. and C.A. SPEER. 1979. *Sarcocystis* in free-ranging herbivores on the National Bison Range. J. Wildl. Dis. 15: 51-53.
15. ROMMEL, M., A.O. HEYDORN and F. GRUBER. 1972. Beiträge zum Lebenszyklus der Sarkosporidien. I. Die Sporocyste von *S. tenella* in den Fäzes der Katze. Berlin Muench. Tieraerztl. Wochenschr. 85: 101-105.
16. SAYAMA, K. 1952. *Sarcocystis* in deer and elk of California. Calif. Fish and Game 38: 99-104.
17. SOKAL, R.R. and F.J. ROHLF. 1969. *Biometry*. W.H. Freeman and Co., San Francisco, pp. 776.
18. de VOS, A. and A.E. ALLIN. 1949. Some notes on moose parasites. J. Mammal. 30: 430-431.

Received for publication 28 January 1980