**J. E. Lagerquist** and **W. J. Foreyt,**[1] Department of Veterinary Microbiology and Pathology, College of Veterinary Medicine, Washington State University, Pullman, Washington 99164-7040

# Prevalence of *Sarcocystis* in Elk (*Cervus elaphus*) in Oregon

## Abstract

The prevalence of *Sarcocystis* spp. in free-ranging elk (*Cervus elaphus*) has been reported in Canada, and in the United States in California, Montana, Washington and Wyoming. Most of these reports involve a relatively small sample size and limited age class of elk. To determine the prevalence of *Sarcocystis* spp. in free-ranging elk in Oregon, heart and/or tongue tissues from 184 elk were examined histologically. The samples were collected from August 1991 to February 1992 from elk ranging in age from 5 days to 12 years. Sarcocysts were present in 178 (97%) of the samples, including 142 of 149 (95%) heart samples, and 115 of 124 (93%) tongues. Tissues from 96% of the males (n=54) and 100% of the females (n=29) contained sarcocysts (101 elk with sex unrecorded). This first report of the prevalence of *Sarcocystis* spp. in elk in Oregon indicates a high infection rate among elk of all ages. Although little is known concerning the pathogenicity of *Sarcocystis* in free-ranging elk and other wild ungulates, the high rate of infection we report in elk, and the widespread and frequent occurrence of this parasite in free-ranging herbivores reported elsewhere in North America, indicate a potential impact on population dynamics and should be considered a potential factor in declining elk populations.

## Introduction

*Sarcocystis* spp. are protozoan parasites which are detected commonly in the muscles of most species of wild and domestic herbivores, and require a predator-prey two-host life cycle. In the intermediate herbivore host (prey), asexual reproduction (schizogony) occurs, and in the definitive carnivore host (predator), sexual reproduction (gametogony) occurs. Coyotes, dogs, foxes, raccoons and wolves are the usual predators, and they become infected by ingesting tissues of an herbivorous intermediate host containing mature sarcocysts. An herbivore becomes infected by ingesting oocysts or sporocysts shed in the feces of an infected predator, resulting in the development of sarcocysts in striated muscles of the heart, tongue, esophagus, diaphragm and skeletal muscles. *Sarcocystis* spp. have been reported in free-ranging elk (*Cervus elaphus*) in North America (Schwartz and Mitchell 1945, Sayama 1952, Pond and Speer 1979, Mahrt and Colwell 1980, Speer and Dubey 1982, Jolley 1982, Dubey *et al.* 1989), with up to 100% infection rate among the animals sampled. Although the percentage of elk infected with *Sarcocystis* spp. was high in these earlier reports, the small sample sizes do not indicate the overall prevalence of *Sarcocystis* spp. in a specific population of elk or in a defined area.

Presently, no information is available on the prevalence of natural infections of *Sarcocystis* spp. in elk in Oregon. To determine the prevalence of *Sarcocystis* spp. in the state, we histologically examined heart and/or tongue tissues of elk harvested by hunters.

## Materials and Methods

Between August 1991 and February 1992, heart and/or tongue tissue samples from 183 elk harvested by hunters and 1 elk found dead from four counties in Oregon (Union, n=161, 45° 30′ N, 118° W; Harney, n=11, 43° N, 118° 30′ W; Lake, n=10, 43° N, 120° 30′ W; Klamath, n=2, 43° N, 121° 30′ W) were submitted to the College of Veterinary Medicine Parasitology Laboratory at Washington State University (Figure 1). The elk ranged in age from 5 days to 12 years, with the majority between 1 and 3 years of age. There were 29 females, 54 males, and 101 with sex unrecorded. Tissues were fixed in 10% buffered formalin upon arrival to the laboratory. Approximately 1.5 cm² section of each tissue was embedded in paraffin, sectioned, stained with hematoxylin and eosin, and examined microscopically at 40x for the presence of sarcocysts.

## Results and Discussion

Sarcocysts were detected in the tissues (Figure 2) of 178 of the 184 (97%) elk. Tissues of 96% of the males (n=54) and 100% of the females (n=29) contained sarcocysts. Sarcocysts were not detected in the tissues of six elk: a 5-day-old male found dead (heart only), a 6-month-old calf (heart only), a 1.5-year male (heart and tongue), and 3 elk of unknown age and sex (tongues only). The 1.5-year male was from Harney County, and the other five from Union county. Sarcocysts were detected in 142 of 149 (95%) hearts and 115 of 124

[1]To whom reprint requests should be addressed.

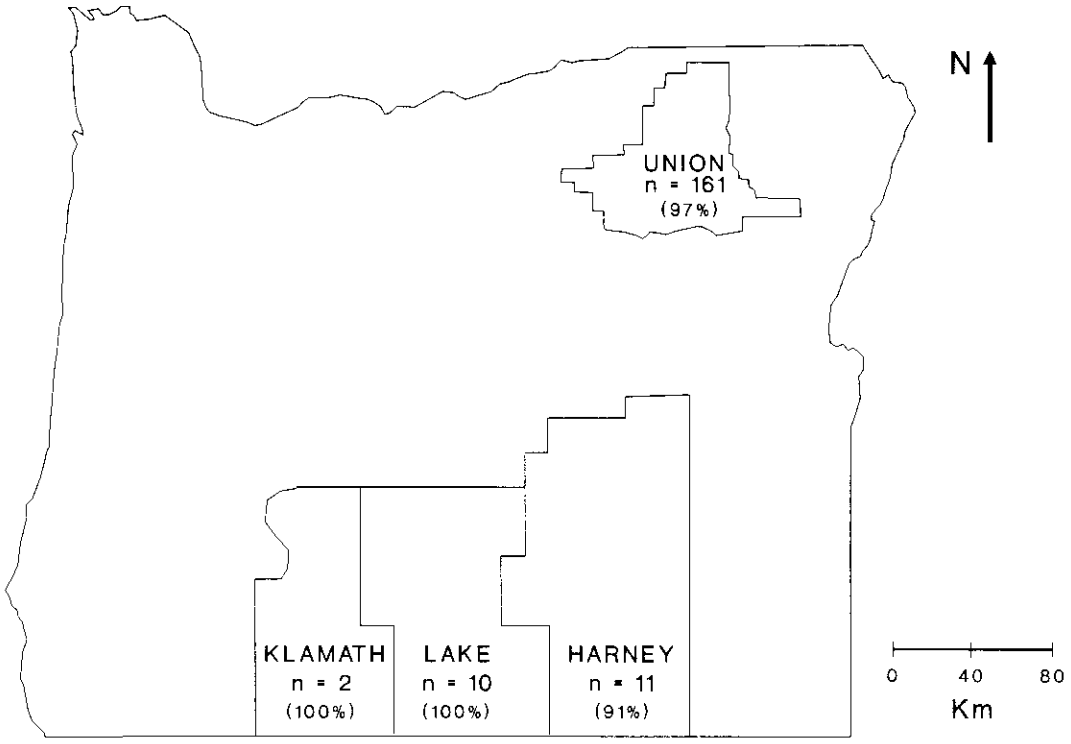


Figure 1. Counties within Oregon from which elk tissues were obtained. Percentage of elk infected with *Sarcocystis* spp. in parenthesis.

(93%) tongues. Of the 89 elk for which tissues of both heart and tongue were submitted, 79 (88.8%) were positive in both tissues and only 1 (1.1%) was found to be negative for sarcocysts in both. Among the 9 elk in which sarcocysts were found in only one of the tissues, 4 (4.5%) were negative in heart and 5 (5.6%) were negative in tongue.

The intensity of sarcocysts present did not appear to be appreciably different between heart and tongue tissues, varying from 1 to approximately 75 per $cm^2$. Mean size of 75 heart sarcocysts was 135.7 x 69.6 $\mu$m (range, 34 to 821 x 14 to 240 $\mu$m), and mean size of 75 tongue sarcocysts was 132.8 x 59.6 $\mu$m (range, 24 to 874 x 17 to 152 $\mu$m).

The high prevalence of *Sarcocystis* infection we found in this study of elk in Oregon is in accordance with previous reports of *Sarcocystis* in free-ranging herbivores in other areas of North America (Sayama 1952, Pond and Speer 1979, Mahrt and Colwell 1980, Dubey *et al.* 1989). Keem (1974) found over 90% of the elk in Wyoming to be infected by 1 year of age. During the period of this study, our laboratory also received heart and tongue tissues from elk harvested by hunters in Meagher County in central Montana (n=4), and Asotin County in southeastern Washington (n=7), and all 11 samples contained *Sarcocystis*.

There are three named species of *Sarcocystis* in elk, and two, *Sarcocystis wapiti* and *S. sybillensis*, have been reported from North America (Dubey *et al.* 1989). *Sarcocystis wapiti* (Speer and Dubey 1982) has a thin (< 1 $\mu$m) sarcocyst wall with villar protrusions and has been classified as a Type 2 cyst wall (Dubey *et al.* 1989). The coyote (*Canis latrans*) (Dubey 1980) and the dog (*Canis familiaris*) (Margolin and Jolley 1979) are known definitive hosts. *Sarcocystis sybillensis* (Dubey *et al.* 1983) has a thick (up to 8 $\mu$m) and hairy sarcocyst wall with villar protrusions and has been classified as a Type 8 cyst wall (Dubey *et al.* 1989). The dog is a definitive host (Dubey *et al.* 1983). Based on electron microscopy, at least two species of *Sarcocystis*, including *S. wapiti*, were present in these elk from Oregon. Definitive identification of the second species was not determined.

The significance of *Sarcocystis* infections in free-ranging herbivores has not been determined.

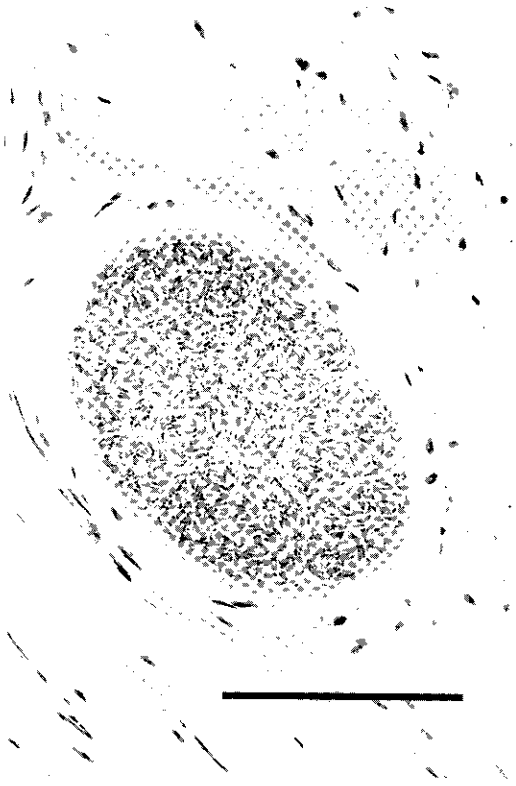

Figure 2. Photomicrograph of *Sarcocystis* sp. in elk heart tissue. Bar = 100$\mu$m.

Hudkins and Kistner (1977) proposed that high fawn mortality and declining mule deer (*Odocoileus hemionus*) populations in Oregon might be attributed to *Sarcocystis*. They experimentally inoculated 11 mule deer fawns with large numbers of sporocysts of *Sarcocystis hemionilatrantis*, and 9 fawns died between post-inoculation days 27 and 63. Pond and Speer (1979) suggested that a decline in the number of deer fawns on the National Bison Range in Montana may be partially due to *Sarcocystis* infections. The 97% *Sarcocystis* infection rate we found in elk in Oregon, along with reports of high prevalence in free-ranging herbivores elsewhere, suggests investigations should be conducted to determine the pathogenicity of this parasite in free-ranging herbivores, and its impact upon their populations.

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