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DISEASES OF WAPITI UTILIZING CATTLE RANGE IN SOUTHWESTERN ALBERTA

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ABSTRACT: Specimens from 28 wapiti (*Cervus elaphus canadensis*) were collected by hunters in southwestern Alberta in 1984. Various tests were performed to detect infections and conditions that could affect cattle sharing the range or cause disease in wapiti. Serum antibodies were present against leptospiral serovars *autumnalis* (25%), *bratislava* (4%), and *icterohaemorrhagiae* (8%), and the viruses of bovine virus diarrhea (52%), infectious bovine rhinotracheitis (45%), and parainfluenza type 3 (13%). No serological evidence of bovine respiratory syncytial virus, *Brucella*, *Anaplasma*, bluetongue virus, or epizootic hemorrhagic disease virus was found, nor were any lesions of vesicular diseases, necrotic stomatitis or nutritional myopathy evident. Focal interstitial nephritis and sarcocystosis were diagnosed histologically in 40% and 75%, respectively, of the wapiti tested. The prevalence of giant liver flukes (*Fascioloides magna*) was 50% and of lungworms (*Dictyocaulus viviparus*) 32%. Leptospiral serology on cattle in the area did not indicate that wapiti or cattle were a serious source of infection to each other. The giant liver fluke was the parasite most likely to be amplified by wapiti for cattle. Within the limits of this study, the results indicated that wapiti in the Waterton area do not pose a disease threat to the cattle with which they range, but periodic observational studies in these wapiti would be a useful means of early detection of any changes in the interspecies relationship.

INTRODUCTION

Microbial and helminth infections reported in wapiti in the western United States and Canada include brucellosis (Thorne et al., 1978), the fringed tapeworm (*Thysanosoma actinioides*) and the winter tick (*Dermacentor albipictus*) (Worley et al., 1969; Stock and Barrett, 1983), liver flukes (*Fascioloides magna*), lungworms (*Dictyocaulus viviparus*) and *Sarcocystis* (Worley, 1978; Dubey et al., 1983), and epididymal coccidia (Hrudka et al., 1983). Worley and Greer (1976) have reviewed the literature on parasites and diseases of wapiti in North America.

A herd of approximately 250 wapiti (*Cervus elaphus canadensis*) is centered in Waterton Lakes National Park in southwestern Alberta. They compete with a population of cattle numbering about 10,000 animals for forage in the Zone of Cooperation of the Waterton Biosphere Reserve (Stelfox and Tilson, 1985). Another herd numbering over 400 wapiti is centered in Glacier National Park, USA, which adjoins Waterton. These wapiti move out from the mountains and intergraze with the Waterton herd and with local cattle outside the parks. Thus the disease status of the wapiti herd in Waterton is important from the viewpoint of wildlife conservation, health of cattle sharing their range, and protection of Canadian cattle from shared diseases.

A survey was organized to obtain a wide variety of diagnostic specimens from wapiti killed by hunters in Alberta Fish and Wildlife Division (FWD) Zone F300 in September 1984. F300 comprises approximately 65,000 ha of rolling, gravelly moraine covered with rough fescue and aspen groves, threaded by creek systems and by rivers which form wide flats. It is watered also by small permanent lakes and ponds. The ranchland abuts on the Rocky Mountains to the southwest. The 1984 wapiti disease study conducted in this region formed the subject of this paper.

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MATERIALS AND METHODS

Two hundred hunters whose names were drawn for wapiti authorizations (hunting permits) were contacted by mail with the cooperation of FWD, acquainted with the purpose and plan of the project, and invited to participate. Specimen collection kits were mailed out to arrive at hunters' addresses 1 to 2 wk before the hunt began. Kits consisted of heavy duty plastic bags, cord, twist ties and lock fasteners, plastic blood vials, a specimen check list, questionnaire, and a list of four depots. Service station operators on access roads to the hunting area maintained ice chests which were provided and notified the laboratory by phone for sample pick-up. Two FWD offices also served as depots. FWD personnel and a veterinarian qualified in meat inspection participated in the hunt as biological aids and hunters, and assisted hunters in collecting specimens.

The following specimens from a total of 28 wapiti were received: blood (24 samples), respiratory tract (trachea and lungs; 22), heart (22), liver (part or all; 20), kidney (20), reproductive tract (22), esophagus (part or all; 5), gastrointestinal tract (abomasum and first six feet of duodenum; 6), fecal pellets from rectum (16), head (21).

Blood samples were centrifuged to remove clots and debris, and serum was filtered through a membrane of porosity 0.45 μm. The following serological tests were performed: standard buffered antigen plate test for antibodies to *Brucella abortus*, microscopic agglutination (MA) test for antibodies to *Leptospira* (12 serogroups), complement fixation (CF) test for antibodies to *Anaplasma marginale*, agar gel immunodiffusion (AGID) test for antibodies to bluetongue and epizootic hemorrhagic disease (EHD) viruses, and serum neutralization (SN) test for antibodies to infectious bovine rhinotracheitis (IBR), parainfluenza type 3 (PI-3), bovine virus diarrhea (BVD), and bovine respiratory syncytial (BRS) viruses. Serum was diluted two-fold for IBR, PI-3, and BRS tests, and three-fold for BVD tests.

All tissues were examined grossly for parasites and pathological lesions. Lungs were inspected and palpated for cysts, induration, pleuritic and pneumonic lesions. Airways were flushed with water via the trachea, then opened to the terminal bronchi to harvest lungworms. Major thoracic blood vessels were opened and inspected for helminths, and the myocardium was examined grossly for sarcosporidia and myopathy and sectioned from pericardial to endocardial surface for histological examination. Liver was sliced at 10–20 mm thickness, flukes were collected and representative tissues were fixed in formalin. Impression smears of renal cortex were prepared for the indirect fluorescent antibody (IFA) test for leptospiral serovars *pomona, hardjo, grippotyphosa, icterohaemorrhagiae, autumnalis*, and *bratislava*, and sections were fixed in formalin. Vaginal and preputial swabs were placed in Stuart's medium for isolation of *Mycoplasma* and *Ureaplasma*, and samples of epididymis and testicle were sectioned for microscopic examination for coccidia. Abomasal and duodenal contents and fecal pellets were examined for the presence of adult helminths, larvae, eggs, and coccidial oocysts as described below.

The oral cavity and esophagus were inspected for necrotic stomatitis and vesicular lesions. Tongue and masseter muscle were sectioned for microscopic detection of sarcosporidia. Nasal swabs were collected for culture as described above. Ears and neck were palpated for ticks, and deep skin scrapings for detection of mites and ticks were obtained from the ear canal. Heads were sectioned sagittally for examination for fly larvae, meningeal worms, or other pathological changes.

Special methods were used for parasitological examinations. Skin scrapings were digested, concentrated, and examined microscopically (Kennedy, 1982). Feces were held under refrigeration, and tested by the Formalin-Ethyl Acetate Extract Method (Faber, 1984) and the McMaster Flotation Technique (Kennedy, 1982). Gastrointestinal contents were examined grossly and washed thoroughly through a series of sieves, pore sizes 2,000, 850, 355, and 250 μm, with a 15-min interval between each decanting and sieving. Finally the sediment was examined in its entirety under a dissecting microscope with transmitted light. Lung and tracheal washings were allowed to settle for at least 15 min, decanted, and examined under a stereoscopic microscope. Photomicrographs were taken of all microscopic parasites, and helminths were fixed in either alcohol-formaldehyde-acetic acid or glycerol-alcohol solution. Photographs and fixed specimens were submitted to the Assistant Curator, University of Alberta Parasite Collection, for identification. Voucher specimens of lungworms and flukes were deposited in the National Museum of Canada Invertebrate Collection, National Museum of Natural Sciences, Invertebrate Zoology Division, Ottawa, Ontario K1A 0M8.

Elk were aged by personnel of the Department of Energy and Natural Resources, using tooth eruption for calves and yearlings, and an-

nual growth ring counts for older animals (Matson, 1981).

During the winter following the wapiti collection, 117 sera were obtained from cattle in a bluetongue sero-survey from six municipalities within or bordering the study area. These sera were tested for leptospiral antibodies for comparison with the wapiti sera.

RESULTS

Antibodies to leptospiral serovars *autumnalis*, *icterohaemorrhagiae*, and *bratislava* occurred at titers of 1:50 to 1:200 in six, two, and one, respectively, of 24 sera. The IFA test on one of 18 kidneys was positive for *autumnalis* and *bratislava* and was accompanied by interstitial nephritis. Interstitial nephritis occurred in a total of eight of 20 kidneys, corresponding in three of eight cases with antibodies to *Leptospira*. In the 117 cattle tested, antibodies to one or more of the serovars found in wapiti, plus *pomona* and *hardjo*, were present in six (5%) of the sera, at titers between 1:50 and 1:400.

Tests for antibodies to *Anaplasma* (n = 12), bluetongue virus (n = 23), EHD virus (n = 23), *Brucella* (n = 23), *Ureaplasma* and *Mycoplasma* (n = 44) were negative, and no gross lesions of necrotic stomatitis or vesicular diseases were found in 21 heads.

The prevalences of antibodies to IBR, BVD, and PI-3 viruses were 45, 52, and 13%, respectively. Titers ranged from 1:2 to 1:729, singly and in combination. All tests (n = 23) for BRS virus were negative.

Sarcosporidia (*Sarcocystis* sp.) were detected in muscle from 18 of 24 wapiti. Lesions present in heart muscle were visible without magnification after hematoxylin and eosin staining. No histological evidence of nutritional myopathy was found in heart or masseter muscle samples from 24 wapiti. Single cases of eosinophilic glossitis, mild interstitial myocarditis accompanied by sarcosporidiosis, and parasitic granulomatous pneumonia accompanied by hepatic fascioliasis occurred.

Lungworms (*Dictyocaulus viviparus*) NMCP Cat. No. 1986-0074, -0075, -0076, and -0077) were found in seven of 22 wapiti. Adult worms were seen by gross inspection in five lungs or washings, and larvae (L1 and L4) were detected microscopically in two additional washings. The giant liver fluke (*Fascioloides magna*) (NMCP Cat. No. 1986-0073) was present in 10 of the 20 livers submitted, in numbers ranging from three to 90 pairs. Animals carrying infections of the highest intensity were in good body condition, although only scattered patches of functional liver tissue remained between the encapsulated trematodes. All eight affected livers for which the age was known were from wapiti 2.5 yr or older. Four negative livers out of a total of eight came from wapiti aged 2.5 to 6.5 yr. No nasal bots were found in 21 heads, but muscid larvae, probably *Musca autumnalis*, were present in the turbinates of one wapiti. The 16 fecal samples and six abomasal and duodenal washings were almost entirely free of parasites. A single trichostrongylid egg and one coccidial oocyst were identified. No coccidia were found in samples of testicle or epididymis. No ticks, psoroptic mites, nor other ectoparasites were found in the heads.

Prevalences of infection by age classes are given in Table 1, with percentages calculated for wapiti 0.5 yr and over 0.5 yr of age, as compared to percentages given above based on total samples. No correlation was obvious between sex and the presence of infection.

DISCUSSION

The response of hunters to the request to participate in the survey was remarkable. Specimens were received from 57% of the 49 wapiti reportedly shot. The early fall hunt was chosen for sampling because the kill was expected to be maximal at

TABLE 1. Prevalence of parasites or antibodies by age classes of wapiti in southern Alberta, September 1984.

Age (yr)[a]	Sample[b] size	Sex ratio F/M	No. positive[c]/no. tested							
			F. mag.	*Sarco.*	*D. viv.*	Lepto.	FIN	IBR	PI-3	BVD
0.5	4	3/1	0/3	0/4	0/3	0/4	0/4	3/4 75%	0/4	3/4 75%
1.5	4	2/2	0/1	3/4	2/3	1/3	2/3	0/3	1/3	2/3
2.5	4	2/2	2/4	3/3	1/4	2/4	2/4	1/4	1/4	1/4
3.5	4	2/2	1/2	3/3	1/2	1/3	0/1	0/1	0/2	1/2
4.5	0									
5.5	5	1/4	3/4	4/5	1/4	0/4	2/4	3/4	0/4	3/4
6.5	3	2/1	2/3	2/2	2/3	1/3	1/3	2/3	1/3	2/3
>0.5[d]	4	2/2	2/3	3/3	0/3	1/3	1/1	1/3	0/3	0/3
>0.5	24	11/13	10/17 59%	18/20 90%	7/19 37%	6/20 30%	8/16 50%	7/18 39%	3/19 16%	9/19 47%
Total all ages	28	14/14 1/1	10/20 50%	18/24 75%	7/22 32%	6/24 25%	8/20 40%	10/22 45%	3/23 13%	12/23 52%

[a] Wapiti were aged by tooth eruption or annual growth ring counts.

[b] Total number of wapiti from which specimens for a given test were submitted.

[c] *F. mag.* = *Fascioloides magna*; *Sarco.* = *Sarcocystis* sp.; *D. viv.* = *Dictyocaulus viviparus*; Lepto. = Leptospiral antibodies at titers 1:50–1:200 against serovars *autumnalis*, *bratislava*, or *icterohaemorrhagiae*; *autumnalis* antibody was common to all positive sera; FIN = focal interstitial nephritis; IBR, PI-3, and BVD = antibodies to the viruses of infectious bovine rhinotracheitis, parainfluenza type 3, and bovine virus diarrhea.

[d] Age between 1.5 and 6.5 yr; exact age not known.

that time. The prevalence of lungworms would have declined from the predictable late spring peak (Bergstrom and Robbins, 1978) although Schwartz (1942) reported peak prevalences of lungworms in Roosevelt elk (*Cervus elaphus roosevelti*) in late winter and spring. The ectoparasite population in September probably was much lower than it would have been in mid-winter.

The absence of fringed tapeworm (*Thysanosoma actinioides*) contrasted with its high prevalence in wapiti in the Cypress Hills (56% of 186 wapiti) (Stock and Barrett, 1983) and in Yellowstone National Park (41% of 181 wapiti) (Jacobson and Worley, 1969). Flook and Stenton (1969) found *T. actinioides* in wapiti in Waterton National Park at all seasons. All the above authors noted a trend to higher prevalence in young adult wapiti. The sample in the present study was composed of only two animals under 1 yr of age, the other four being 5.5 to 6.5 yr of age.

Data on *Fascioloides magna* in elk sampled from Waterton in 1984 indicated a 50% prevalence, an increase from 1963 (40%) and 1958–1959 (21%) (Flook and Stenton, 1969). A small discrepancy in prevalence during 1984 may have been introduced by hunters retaining normal livers for food. The sarcocystosis prevalence of 75% measured in this study exceeds percentages of 10, 40, and 50 reported for Rocky Mountain elk in Yellowstone National Park (Mills, 1936), Roosevelt elk in Washington (Graf, 1955), and Tule elk (*Cervus elaphus nannodes*) in California (Sayama, 1952). The prevalence of *Dictyocaulus viviparus* was 31.8% in elk from Waterton in September and this value is close to the figure given by Bergstrom and Robbins (1978) for elk in the National Elk Refuge, Wyoming, at the same season. Worley and Barrett (1963), by comparison, reported an average prevalence of 45.5% in September 1962–1963, in the Yellowstone herd.

Epididymal coccidia may have been missed because semen was not extracted for observation (Hrudka et al., 1983), although epididymal tubules were examined histologically. The sample (13 bulls, 12 approaching rut) would have been adequate to detect the parasite at the prevalence reported by the above authors.

The meaning of the leptospiral agglutinins in the wapiti sera, and of the same serovars in contact cattle, is unknown. Demonstration of leptospires in impression smears by IFA test depends on the fortuitous exposure of a focus of infection, and on the correct choice of antisera. Similarly, antibody demonstration depends on choice of correct antigens. A field isolate is suited ideally for use in its area of origin, whereas reference strains may be relatively insensitive to antibodies produced by various species of mammals to local strains. Interstitial inflammation with focal mononuclear infiltration in wapiti kidneys, and one positive IFA test, lend some support to the specificity of the serum reactions, but isolation of leptospires would have been needed to confirm the diagnosis. Transmission of leptospiral serovars *pomona* and *hardjo* from cattle to wapiti in the present study appeared not to have happened. No leptospiral antibodies were found in the studies on wapiti annotated by Worley and Greer (1976).

In the present study, wapiti did not appear to act as a source of infection to cattle. Giant liver flukes are indigenous to the area, and both cattle and wapiti are affected, although wapiti are the more likely host to amplify the fluke population (Swales, 1936). *Sarcocystis* species are highly specific for their intermediate hosts, and therefore species occurring in wapiti are unlikely to infect cattle (Fayer, 1982). *Dictyocaulus viviparus* from wapiti exhibit host-limiting strain differences which exclude cattle and sheep (Presidente et al., 1972). Antibody titers to IBR, BVD, and PI-3 viruses indicated exposure of wapiti, probably from cattle, but there was no evidence of clinical effects. Whether or not latent infection of wapiti, particularly with IBR virus, had occurred was not known, nor can a definitive comment be made on whether stressful circumstances could result in recrudescence and shedding of that virus. The mode of transmission for BVD virus is inadequately understood for cattle populations and therefore for any interacting role that wapiti could play. The absence of *Brucella* reactors in the wapiti sampled from Waterton in 1984 coincides with the negative status of cattle in Alberta. Wapiti are susceptible to brucellosis, which can become enzootic in herds (Thorne et al., 1978). Periodic monitoring of herds of wapiti in Canada for brucellosis should be continued, and the use of a variety of serological tests should be considered (Thorne et al., 1978). The coordination of disease surveillance with range utilization studies such as that of Stelfox and Tilson (1985) is facilitated by the interdisciplinary scientific program of the Waterton Biosphere Reserve.

The current work was observational rather than experimental in nature and therefore does not provide proof of transmission or failure of transmission between wapiti and cattle of the various diseases or agents for which tests were done. Continuation of periodic observational studies is recommended as a means of confirming the present data base and achieving early detection of any changes to disease status.

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