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SEROLOGIC SURVEY FOR SELECTED MICROBIAL PATHOGENS IN ALASKAN WILDLIFE

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ABSTRACT: Antibodies to *Brucella* spp. were detected in sera of seven of 67 (10%) caribou (*Rangifer tarandus*), one of 39 (3%) moose (*Alces alces*), and six of 122 (5%) grizzly bears (*Ursus arctos*). Antibodies to *Leptospira* spp. were found in sera of one of 61 (2%) caribou, one of 37 (3%) moose, six of 122 (5%) grizzly bears, and one of 28 (4%) black bears (*Ursus americanus*). Antibodies to contagious ecthyma virus were detected in sera of seven of 17 (41%) Dall sheep (*Ovis dalli*) and five of 53 (10%) caribou. Antibodies to epizootic hemorrhagic disease virus were found in sera of eight of 17 (47%) Dall sheep and two of 39 (6%) moose. Infectious bovine rhinotracheitis virus antibodies were detected in sera of six of 67 (9%) caribou. Bovine viral diarrhea virus antibodies were found in sera of two of 67 (3%) caribou. Parainfluenza 3 virus antibodies were detected in sera of 14 of 21 (67%) bison (*Bison bison*). Antibodies to Q fever rickettsia were found in sera of 12 of 15 (80%) Dall sheep. No evidence of prior exposure to bluetongue virus was found in Dall sheep, caribou, moose, or bison sera.

INTRODUCTION

The agricultural industry in Alaska is small but appears to be on the verge of major expansion. In an effort to determine which diseases are present in wildlife populations prior to this expected agricultural expansion, a serologic survey was initiated. All of the etiologic agents which were included in this survey have been detected in various species of wildlife in North America by means of isolation of the agent or by serologic tests (Neiland et al., 1968; Murray and Trainer, 1970; Reilly et al., 1970; Rieman et al., 1979; Dieterich, 1981b; Lance et al., 1981).

MATERIALS AND METHODS

Figure 1 shows the location of collection sites for all species. All of the blood samples from black bears and most of those from grizzly bears were collected in the southcentral portion of Alaska. The remaining samples came from animals from various areas in the northern half of the state. Samples from bison were collected from animals killed by hunters during 1979–1980 near Delta Junction. All other blood samples were collected from 1978 to 1981 by biologists of the Alaska Department of Fish and Game during various studies which entailed capture of free-ranging animals. Blood samples were allowed to settle for 18–36 hr at ambient or refrigerated temperatures. Sera were collected by aspiration and frozen. All serologic tests were performed at the National Veterinary Services Laboratory (United States Department of Agriculture, Ames, Iowa 50010, USA).

Sera were tested for evidence of antibodies to: (1) *Brucella* spp. by means of the standard plate test and card test (Alton and Jones, 1967), (2) *Leptospira* spp. by the microscopic agglutination test (Cole et al., 1973), (3) contagious ecthyma virus by the complement fixation test (Erickson et al., 1975), (4) epizootic hemorrhagic disease virus and bluetongue virus by the immunodiffusion test (Pearson and Jochim, 1979), (5) infectious bovine rhinotracheitis virus and bovine viral diarrhea virus by the serum neutralization test (Thorsen and Henderson, 1971), (6) parainfluenza 3 virus by the hemagglutination inhibition test (Thorsen and Henderson, 1971), and (7) Q fever rickettsia by the complement fixation test (Erickson et al., 1975). The following *Leptospira interrogans* serovarieties were included in the tests: *pomona*, *ballum*, *canicola*, *icterohaemorrhagiae*, *wolffi*, *grippotyphosa*, *hardjo*, *autumnalis*, *bataviae*, *tarassovi*, *australis*, and *pyrogenes*. For the card test and the immunodiffusion test, specimens were considered either positive or negative. For all other tests, minimum titers were established (Table 1) based upon natural or experimental infection of the host species in question or a selected domestic animal species. Sera which met or exceeded these titers (plus those designated "positive" in the card or immunodiffusion tests) were considered to contain evidence of past infection by the agent in question. Differences in prevalence based upon sex and age were tested for significance by means of the chi-square test (Johnson, 1980).

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RESULTS AND DISCUSSION

Results of the serologic tests are presented in Table 1. The single moose with leptospiral antibodies had a titer of 3,200 for serovar *hardjo*. One of the grizzly bears had a titer of 400 for serovar *canicola*. The remaining five grizzly bears, the black bear, and the caribou were positive for serovar *grippotyphosa* with titers ranging from 100 to 800. No statistically significant differences in antibody prevalences based upon age or gender of animals were found except for grizzly bears in which antibodies to *Leptospira*

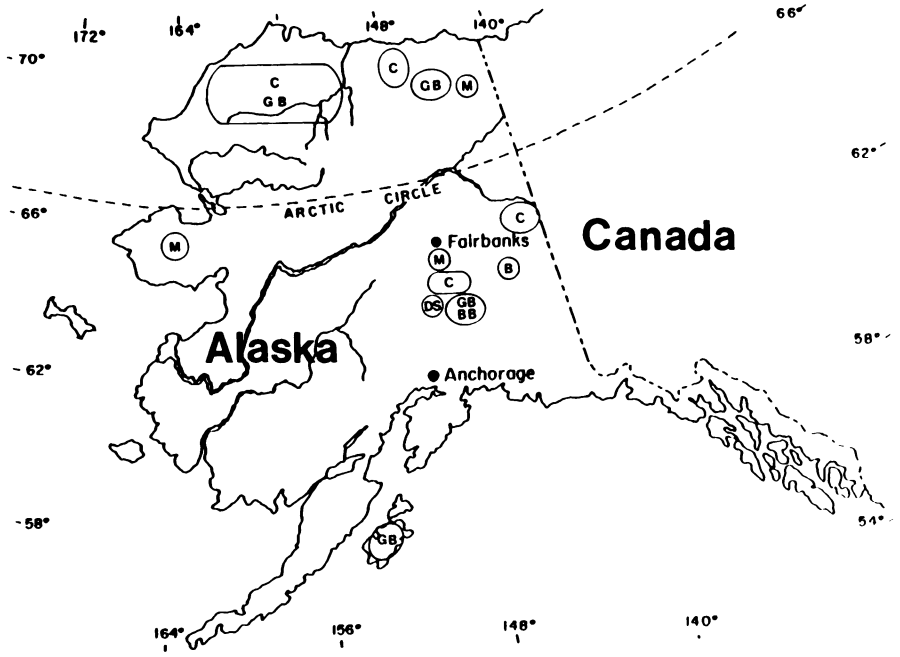

FIGURE 1. Locations at which blood samples were collected from wildlife in Alaska. B = Bison; BB = Black bear; C = Caribou; DS = Dall sheep; GB = Grizzly bear; M = Moose.

spp. were more prevalent in older animals ($P < 0.05$). The average age of grizzly bears with serologic evidence of previous exposure to *Leptospira* spp. was 8.9 yr. The average age for the entire sample was 6.6 yr.

Dall sheep: Evidence of contagious ecthyma (CE) infection in free-ranging Dall sheep has been reported twice previously (Dieterich et al., 1981b; Smith et al., 1982). The samples in the current survey were collected from a population which had serologic evidence of CE as early as 1971 (Zarnke et al., 1983). The disease is believed to be enzootic in this population. Of the eight samples with serologic evidence of past infection, four had titers of 10; one had a titer of 20; one had a titer of 40; and two had titers of 80. In domestic animals, CE infection is most severe in young animals. Recent evidence indicates that this is true for Dall sheep, as well (Dieterich et al., 1981b; Zarnke et al., 1983). The impact of this disease on free-ranging Dall sheep is unknown but it may be capable of limiting population growth by causing mortality in the juvenile cohort.

Epizootic hemorrhagic disease (EHD) virus is closely related (antigenically and morphologically) to bluetongue (BLU) virus (Hoff and Trainer, 1978). The former is primarily a disease of wild animals, whereas the latter is more common in domestic sheep and cattle (Hoff and Trainer, 1978). Bluetongue infection in bighorn sheep (*Ovis canadensis*) has been reported to produce a pneumonia-like syndrome (Marburger et al., 1970). This is the first evidence of EHD infection in Dall sheep. There have been no reports of massive die-offs of Dall sheep, or the dramatic signs which can accompany arthropod transmission of this disease during epizootics. During enzootic periods, overt signs may be absent and oral transmission may play an important role (Hoff and Trainer, 1978). The significance of the current findings for the Dall sheep population is unknown. Presence of EHD in wild animal populations does provide the possibility for spread of the disease.

Q fever is a disease of domestic sheep, goats, and humans caused by the rickettsia *Coxiella burnetti* (Randhawa et al., 1977). In sheep it can cause an influenza-like syndrome and rarely abortions (Enright et al., 1963). Seven of the sheep sera had titers of 10, one was 20, and four were greater than 20. The high prevalence

TABLE 1. Prevalence of antibodies for nine microbial disease agents in wildlife species in Alaska.

Disease agent	Dall sheep	Caribou	Moose	Bison	Grizzly bear	Black bear
Brucella spp.						
SPT 25[a]	0/17[b]	7/67 (10%)	1/39 (1%)	0/21	6/122 (5%)	0/28
Card (±)	0/17	7/67 (10%)	0/39	0/21	6/122 (5%)	0/28
Leptospira spp.						
MAT 100	0/17	1/61 (2%)	1/37 (3%)	0/21	6/122 (5%)	1/28 (4%)
Contagious ecthyma virus						
CF 10	7/17 (41%)	5/53 (10%)	0/39	0/21	ND[c]	ND
Epizootic hemorrhagic disease virus						
ID (±)	8/17 (47%)	0/67	2/39 (6%)	0/21	ND	ND
Bluetongue virus						
ID (±)	0/17	0/67	0/39	0/21	ND	ND
Infectious bovine rhinotracheitis virus						
SN 16	0/17	6/67 (9%)	0/39	0/21	ND	ND
Bovine viral diarrhea virus						
SN 16	0/17	2/67 (3%)	0/39	0/21	ND	ND
Parainfluenza 3 virus						
HI 10	0/17	0/67	0/39	14/21 (67%)	ND	ND
Q fever rickettsia						
CF 20	5/15 (33%)	ND	ND	ND	ND	ND

[a] Name of test: SPT = standard plate test; Card = standard card test; MAT = microscopic agglutination test; CF = complement fixation; ID = immunodiffusion; SN = serum neutralization; HI = hemagglutination inhibition. Numbers indicate minimum titer necessary to be considered as evidence of past infection. (±) indicates that test is read as simply either positive or negative.

[b] Number positive/number tested (percent positive).

[c] ND = not done.

reported here suggests that the disease may be widespread in the Dall sheep population of the central Alaska Range. In the absence of obvious reproductive problems in the wild and the lack of experimental studies of the disease in captive sheep, it is difficult to assess the significance of this disease on Dall sheep populations.

Caribou: Brucellosis is a common disease in caribou (Neiland et al., 1968). The prevalence of antibodies has ranged from 0 to 25% in various herds around Alaska (Neiland et al., 1968). The prevalence reported here falls between these two extremes and indicates continued transmission of the disease. As measured by the standard plate test, *Brucella* spp. titers were equally distributed from 25 to 200 for the seven "positive" caribou sera. All seven of these sera gave positive card test results. There have been no massive die-offs directly attributable to this disease, but it almost certainly has a detrimental impact on natality and future productivity. A vaccine is being developed for use in reindeer on the Seward Peninsula (Dieterich et al., 1981a), but logistical problems may preclude its use on a routine basis in free-ranging caribou.

Leptospirosis can cause chronic kidney infections and/or abortion. There have been numerous surveys of leptospirosis in wildlife (Reilly et al., 1970). Evidence of leptospirosis has been reported for northern fur seals (*Callorhinus ursinus*) collected in the Bering Sea of Alaska's west coast (Smith et al., 1977). A member of the *ballum* serogroup was isolated from the kidney of a tundra vole (*Microtus oeconomus*) captured on the Alaska Peninsula (157°W longitude, 57°30'N latitude) (Woods, 1974). Whitetailed deer (*Odocoileus virginianus*) are common hosts (Abdulla et al., 1962). This is the first report of serologic evidence of infection in caribou. In the absence of clinical studies in caribou, the significance of the single positive sample is difficult to evaluate.

Of the five caribou samples with evidence of past CE infection, one had a titer of 10; two had titers of 20; one had a titer of 40; and one

had a titer of 80. Naturally occurring evidence of CE in Alaskan wild animals has been limited to muskoxen, Dall sheep, and mountain goats (Dieterich et al., 1981b). The disease is most common and severe in young animals. A single caribou was shown to be susceptible to experimental CE infection and its lesions were mild (Zarnke et al., 1983). On the basis of this limited experimental evidence, it appears as if CE does not pose a significant hazard to healthy caribou. Animals under nutritional, reproductive, predatory, or other types of stress may be less capable of withstanding infection.

Of the six sera from caribou with evidence of previous exposure to infectious bovine rhinotracheitis (IBR) virus, five had titers of 16 and one had a titer of 32. Of the two specimens with antibodies to bovine viral diarrhea (BVD) virus, one had a titer of 16 and the other was 32. These low titers may represent cross-reactive antibody or nonspecific neutralizing substances. Serologic evidence of IBR virus and BVD virus has been reported for a small sample of caribou from Canada (Elazhary et al., 1981) and antibodies to IBR virus, BVD virus, and parainfluenza 3 (PI3) virus have been detected in reindeer from the Seward Peninsula in Alaska (Dieterich, 1981). Antibodies to all three viruses have also been detected in moose sera (Thorsen and Henderson, 1971). These viruses cause a multitude of respiratory and gastrointestinal ailments in domestic cattle. Infection can be seriously debilitating for short periods of time but is rarely chronic or fatal. Thus, in otherwise healthy, free-ranging animals these infections could result in decreased weight gains and/or increased susceptibility to predation. When coupled with clinical parasitism or other health-related complications, the outcome of respiratory virus infections may be more severe.

Moose: Brucellosis in moose is a rare occurrence (Jellison et al., 1953). Three possible explanations for this situation are that moose are: (1) resistant to the disease, (2) rarely exposed to the disease, and/or (3) so exquisitely susceptible to the disease that all individuals which are exposed inevitably die as a result of the infection and are found rarely by humans. The single animal in the current survey which was considered serologically positive had a very low titer as measured by the plate test. It was negative on the card test. This may have represented cross-reactive antibody to some related agent or nonspecific agglutination. All indications are that brucellosis poses little threat to the moose population, as a whole.

As in caribou, the significance of leptospirosis to the health of the moose population is largely unknown. Cattle can suffer abortions and/or chronic kidney dysfunction as a result of infection (Baker and Little, 1948). Experimental studies are needed to clarify the pathogenesis of this disease in moose.

Serologic evidence of past BLU virus infection in moose has been reported (Hoff and Trainer, 1978). There have been no similar reports for EHD. The effect of natural EHD infection on moose is unknown, but experimental infections have not caused mortality (Hoff and Trainer, 1978). Presence of the agent in moose populations does provide for the possibility of spread of the disease.

Bison: There have been no previous reports of evidence of PI3 virus infections in bison. Results of a recent study indicated that in the absence of other infectious agents, PI3 was only mildly pathogenic to domestic sheep (Davies et al., 1981). On the other hand, in combination with *Pasteurella hemolytica,* PI3 virus was capable of producing a severe and often fatal pneumonia (Davies et al., 1981). Whether a similar phenomenon pertains to bison is open to question. There are no data on the occurrence of this agent in domestic species in the vicinity where the bison were found. Without this information, no conclusions can be drawn regarding the source of infection for bison. The titers in the current study were quite low and may represent cross-reactive antibody to some related agent or nonspecific inhibiting substances. However, the high prevalence (67%) warrants further surveillance.

Bears: Serologic evidence of infection by *Brucella* spp. in grizzly bears in Alaska has been reported previously (Neiland and Miller, 1981). Evidence of infection in black bears has been reported elsewhere in North America (Zarnke and Yuill, 1981). Presumably bears in Alaska are exposed to the disease when preying and/or scavenging on caribou infected with *B. suis* IV. The prevalence in this group of bears from the southcentral part of Alaska is lower than that for bears captured on the North Slope of Alaska's Brooks Range. Perhaps the opportunity for exposure in southern Alaska is not as great

as in the northern portions of the state. As measured by the standard plate test, *Brucella* spp. titers ranged from 50 to 200 for the six "positive" grizzly bears. All six of these sera gave positive card test results. Effects of the disease are probably similar to those which occur in other species, i.e., abortion and sterility.

Leptospirosis in bears is less well understood. The kidney and reproductive tract infections referred to above for moose and caribou could also pertain to bears. Prevalences in the current study agree with those reported previously (Binninger et al., 1980). In the current study, antibodies were more prevalent in older animals. This suggests that the probability of previous exposure is directly related to age.

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