FURTHER OBSERVATIONS ON RANGIFERINE BRUCELLOSIS IN ALASKAN CARNIVORES

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FURTHER OBSERVATIONS ON RANGIFERINE BRUCELLOSIS IN ALASKAN CARNIVORES

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Abstract: Antibodies against rangiferine brucellosis, *Brucella suis* type 4, are commonly found in the serum of various domestic and wild Alaskan carnivores which feed on caribou, *Rangifer tarandus granti,* in arctic Alaska. Sled dogs from five native villages on the range of the Arctic caribou herd, but not from two villages on the range of the Porcupine caribou herd, are commonly infected. Wolves (*Canis lupus*) and red foxes (*Vulpes fulva*) are less commonly infected.

About 90% of the grizzly bears (*Ursus arctos horribilis*) associated with the Arctic caribou herd and 30% of those associated with the Porcupine caribou herd show serologic signs of exposure to *Brucella,* presumably the enzootic strain present in Alaska caribou. This is the first evidence of natural *Brucella* infection in bears.

It is concluded that infection of predators by enzootic strains of *Brucella* present in prey species (e.g., ruminants) is common to many areas of the world. Evidence from the literature and unpublished experimental data suggest that such infections may interfere with reproduction in wild species, but additional study is needed to clearly resolve this question.

INTRODUCTION

Several Alaskan herds of caribou are commonly infected by *Brucella suis* type 4, for which caribou and reindeer evidently serve as reservoir hosts.[4] Serologic evidence from sled dogs and wolves and isolation of the organism from the former demonstrated that *B. suis* type 4 also infects these naturally exposed carnivores.[8] It was suggested that rangiferine brucellosis might also occur in other carnivores (e.g., bears) which feed on infected caribou. In this paper we report the results of additional serologic studies on wild and domestic carnivores.

MATERIALS AND METHODS

The procedures used to determine tube agglutination and complement fixation titres are those described by Alton and Jones[1] as employed in the laboratory of Dr. David T. Berman, Department of Veterinary Science, University of Wisconsin, Madison. All serology, unless otherwise noted, was performed under the supervision of Dr. Berman by his technical staff under a contract between the Alaska Department of Fish and Game and the University of Wisconsin.

Serum samples from grizzly bears were obtained from animals tranquilized with phenycyclidine[1] 1 mg/kg, administered with projectile syringes[2] fired from a helicopter. Serum from wolves and red foxes was harvested from whole blood samples collected by Nunamiut subsistence hunters of Anaktuvuk Pass, Brooks Mountain Range, Alaska. Blood samples were taken from sled dogs under the restraint of their masters. In each case serum was obtained from whole blood samples which had been allowed to clot and stand overnight at room temperature. Serum was preserved by freezing.

[1] Sernylan, Bio-Ceutic Laboratories, St. Joseph, Mo. 64502.

[2] Palmer Chemical and Equipment Company, Douglasville, Ga. 30134.

RESULTS

Sled Dogs

Data on the prevalence of serologic titres in sled dogs from a number of native villages in arctic Alaska are shown in Table 1. The location of these villages in respect to the Arctic and Porcupine caribou herds is shown in Fig. 1. With the exception of Gambell on St. Lawrence Island in the Bering Sea, Ft. Yukon on the Yukon River, and Arctic Village and Old Crow within the range of the Porcupine herd, the remainder of the villages are all within the normal range of the Arctic caribou herd. It is noteworthy that only villages associated with the Arctic caribou herd had dogs with *Brucella* titres.

TABLE 1. Occurrence of brucellosis reactors in Alaskan sled dogs.[1]

Specimen Number, Sex	Locality	Date	Antibody Titers [2] AGGL	CF
17 M	Anaktuvuk Pass	6/67	2+, 1:640	———
18 F	Anaktuvuk Pass	6/67	2+, 1:160	———
21 other dogs	Anaktuvuk Pass	6/67	neg.	———
M	Anaktuvuk Pass	5/71	2+, 1:320	4+, 1:160
F	Anaktuvuk Pass	5/71	3+, 1:40	neg.
19 other dogs	Anaktuvuk Pass	5/71	neg.	neg.
10 dogs	Ambler	5/70	neg.	neg.
M	Kobuk	5/70	4+, 1:640	4+, 1:160
7 team members	Kobuk	5/70	neg.	neg.
19 dogs	Ft. Yukon	6/70	neg.	neg.
6879 M	Ft. Yukon	8/70	neg.	neg.
2884 M	Ft. Yukon	8/70	neg.	neg.
28 other dogs	Gambell	9/70	neg.	neg.
1970-54	Pt. Hope	9/70	2+, 1:160	2+, 1:40
26 other dogs	Pt. Hope	9/70	neg.	neg.
1970-67 M	Wainwright	9/70	neg.	1+, 1:40
1970-70 M	Wainwright	9/70	neg.	4+, 1:40
1970-75 M	Wainwright	9/70	2+, 1:640	4+, 1:320
1970-78 M	Wainwright	9/70	2+, 1:40	4+, 1:40
23 other dogs	Wainwright	9/70	neg.	neg.
3004 M	Barrow	10/70	4+, 1:320	neg.
4 other dogs	Barrow	10/70	neg.	neg.
30 dogs	Arctic Village	9/72	neg.	neg.
19 dogs	Old Crow	8/72	neg.	neg.

[1] Additional reactors from Kobuk are shown in Table 2.

[2] AGGL—standard tube agglutination test; CF—complement fixation test; *Brucella abortus* smooth antigen.

The titres of team mates of the sled dog from Kobuk from which *Brucella suis* type 4 was originally isolated[3] were followed for a year. These data are shown separately in Table 2.

Wild Carnivores

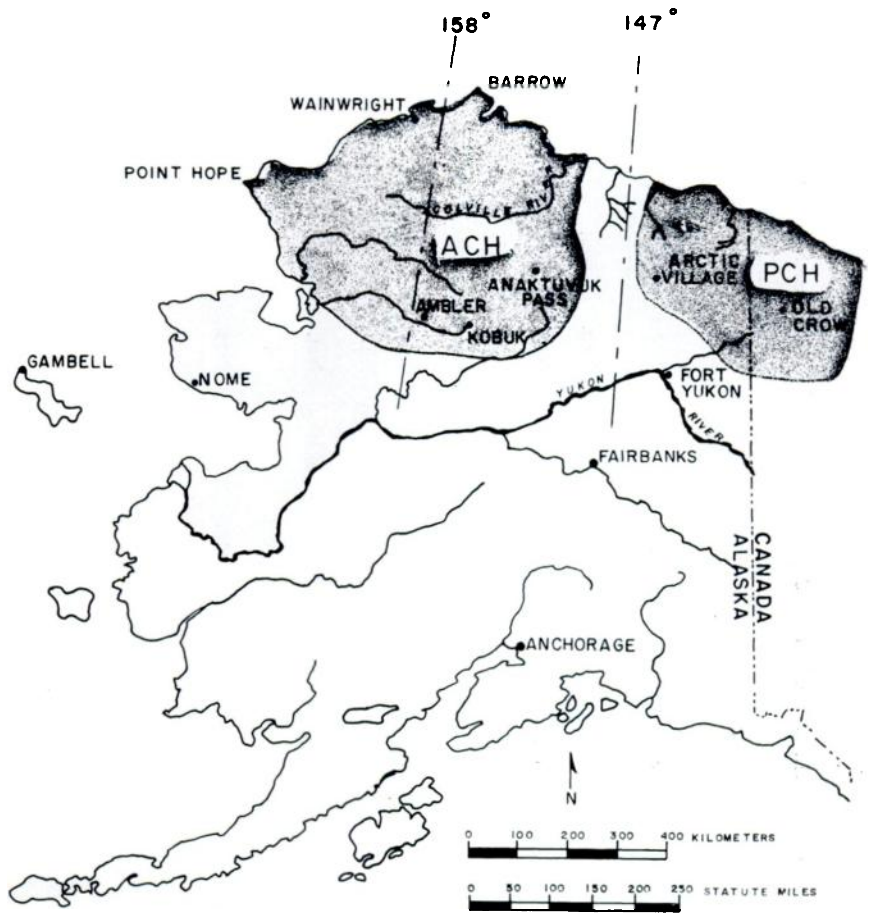
Results of serologic testing of some wild canids are presented in Table 3. Again we note that all reactors are associated with the Arctic caribou herd.

Serologic data on grizzly bears are given in Table 4.

DISCUSSION

Sled Dogs

The data presented above indicate that wherever sled dogs are fed any appreciable amount of caribou from a herd infected by *Brucella suis* type 4 (e.g., Arctic caribou herd), they will become infected and develop significant serologic titres. Perceptible titres may be maintained for at least 10 months. These limited observations conform with those on maintenance of titres in infections of *B. suis* type 5 reported by others[14] in which percep-



ACH = Arctic Caribou Herd
PCH = Porcupine Caribou Herd

TABLE 2. Serologic observations[1] on a dog team in Kobuk, Alaska infected with rangiferine brucellosis.

	TEST										
	May 1969		July 1969			Sept. 1969		Dec. 1969		May 1970	
Name of Dog	Aggl.	CF	Aggl.	CF	Card [2]	Aggl.	CF	Aggl.	CF	Aggl.	CF
Beaver			Neg.	Neg.	Neg.	Neg.	1:20	Neg.	Neg.		
Fannie	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Harry			Neg.	1:20	Neg.	1:320	1:640	Neg.	?	Neg.	2+, 1:10
Jumbo			1:640	1:640	+	1:20	1:20	1:160	1:160		
King	Neg.	Neg.	1:160	1:10	+	Neg.	Neg.			Neg.	Neg.
Lucy[3]	1:2560	1:640	1:640	1:1280	+						
Mila	Neg.	Neg.	Neg.	1:10	Neg.	Neg.	Neg.				
Moose			1:640	1:1280	+	1:80	1:10	1:160	1:40	1:80	1:10
Nellie			Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Wendy	Neg.	Neg.	Neg.	Neg.	Neg.	1:160	1:80	Neg.	Neg.	Neg.	Neg.

[1] All procedures employed *Brucella abortus* smooth antigen.
[2] Rapid field test developed by the USDA for measuring agglutinins in bovine serum.
[3] *Brucella suis* type 4 isolated when killed, July 1969 (Neiland 1970).

TABLE 3. Brucellosis reactors in some wild Alaskan canids.

Species	Specimen Number,	Sex	Locality	Titre (*B. abortus* smooth antigen) Complement Fixation	Agglutination
Wolf	7354	M	Ambler	neg.	neg.
	7355	F	Ambler	neg.	neg.
	7388	F	Anaktuvuk Pass	1:40	1:20
	7389	F	Anaktuvuk Pass	neg.	1:20
	7390	F	Anaktuvuk Pass	neg.	neg.
	7391	F	Anaktuvuk Pass	neg.	neg.
	7392	F	Anaktuvuk Pass	1:160	1:160
	3160	M	Anaktuvuk Pass	4+, 1:20	neg.
	3161	F	Anaktuvuk Pass	4+, 1:320	4+, 1:160
	A50,658	F	Anaktuvuk Pass	2+, 1:80	neg.
	A50,660	F	Anaktuvuk Pass	3+, 1:160	inc., 1:320
	A50,663	F	Anaktuvuk Pass	neg.	neg.
	A50,665	F	Anaktuvuk Pass	4+, 1:640	3+, 1:640
	A50,666	M	Anaktuvuk Pass	3+, 1:10	neg.
	A50,667	F	Anaktuvuk Pass	neg.	neg.
(pup)	3864	?	Anaktuvuk Pass	neg.	neg.
(pup)	3865	?	Anaktuvuk Pass	neg.	neg.
(pup)	3866	?	Anaktuvuk Pass	neg.	neg.
	3867	F	Anaktuvuk Pass	4+, 1:320	4+, 1:40
	3930	M	Anaktuvuk Pass	neg.	neg.
	3931	M	Anaktuvuk Pass	4+, 1:40	neg.
	3932	M	Anaktuvuk Pass	4+, 1:40	neg.
	3933	M	Anaktuvuk Pass	neg.	neg.
Wolf	3572	F	Sheenjek River	neg.	—
	3573	M	Tanana Flats	neg.	neg.
	3574	M	Tanana Flats	neg.	neg.
	3814	F	Anaktuvuk Pass	neg.	neg.
	3815	F	Anaktuvuk Pass	neg.	neg.
Reactor Prevalence				11 of 28 sera	7 of 27 sera
Red Fox	3164	M	Seward Peninsula	neg.	neg.
	3165	M	Seward Peninsula	neg.	neg.
	3166	F	Seward Peninsula	neg.	neg.
	3167	M	Seward Peninsula	neg.	neg.
	3108	M	Anaktuvuk Pass	2+, 1:20	neg.
	3128	M	Anaktuvuk Pass	neg.	neg.
	A50,659	M	Anaktuvuk Pass	neg.	neg.
	A50,664	F	Anaktuvuk Pass	neg.	neg.
	A50,668	M	Anaktuvuk Pass	neg.	neg.
	A50,669	F	Anaktuvuk Pass	4+, 1:640	inc., 1:320
	3816	F	Anaktuvuk Pass	neg.	neg.
Reactor Prevalence				2 of 11 sera	1 of 11 sera

TABLE 4. Brucellosis reactors in some grizzly bears from the Alaskan Arctic.

				Titre (*B. abortus* antigen)	
Date	Sex	Specimen Number	Locality	Complement Fixation	Tube Agglutination
1971	M	3000	Western Brooks Range[1]	4+, 180	4+, 1:40
	M	3001	Western Brooks Range	4+, 1:40	2+, 1:40
	M	3002	Western Brooks Range	4+, 1:20	4+, 1:20
	M	3004	Western Brooks Range	4+, 1:20	2+, 1:20
	M	3005	Western Brooks Range	4+, 1:20	neg.
	F	3006	Western Brooks Range	——	4+, 1:160
	M	3007	Western Brooks Range	4+, 1:160	3+, 1:80
	F	3008	Western Brooks Range	4+, 1:20	2+, 1:80
	F	3009	Western Brooks Range	4+, 1:320	3+, 1:80
	F	3010	Western Brooks Range	3+, 1:40	3+, 1:20
	M	3011	Western Brooks Range	3+, 1:40	3+, 1:40
	F	3012	Western Brooks Range	2+, 1:160	3+, 1:80
	F	3013	Western Brooks Range	4+, 1:80	3+, 1:20
	F	3014	Western Brooks Range	4+, 1:40	neg.
	F	3015	Western Brooks Range	4+, 1:80	4+, 1:80
	M	3016	Western Brooks Range	neg.	neg.
	F	3017	Western Brooks Range	4+, 1:40	2+, 1:40
Antibody Prevalence			Eastern Brooks Range[2]	15/16 (94%)	14/17 (82%)
	F	3913	Eastern Brooks Range	neg.	2+, 1:40
	M	3916	Eastern Brooks Range	>1:640	>4+, 1:40
	F	3917	Eastern Brooks Range	1:20	neg.
	F	3918	Eastern Brooks Range	2+, 1:20	4+, 1:40
	M	3920	Eastern Brooks Range	neg.	3+, 1:40
	F	3924	Eastern Brooks Range	>1:640	>4+, 1:40
	M	3927	Eastern Brooks Range	4+, 1:40	3+, 1:20
	M	3956	Eastern Brooks Range	3+, 1:20[3]	2+, 1:10[3]
	F	3957	Eastern Brooks Range	neg.[3]	2+, 1:10[3]
	F	3960	Eastern Brooks Range	neg.[3]	4+, 1:10[3]
11 specimens				neg.	neg.
Antibody Prevalence				6/21 (29%)	9/21 (43%)

[1] Arctic Alaska between longitudes 147° and 158°.

[2] Arctic Alaska east of longitude 147°.

[3] These titres were determined by Dr. B. L. Deyoe, National Animal Disease Laboratory, U.S.D.A., Ames, Iowa.

tible titres may be present as much as 30 months post-infection.

The lack of reactors amongst the 49 sled dogs of Arctic Village and Old Crow is unexpected. These animals are fed in part on caribou from the Porcupine herd (see Fig. 1) which inhabits northeastern Alaska and the northern Yukon Territory. While we have no serologic data on the occurrence of *Brucella* reactors in this herd, it comes in contact and may intermix with the Arctic herd ranging throughout northwestern and northcentral Alaska in which reactors do occur. Furthermore, grizzly bears of northeastern Alaska (i.e. the eastern Brooks Range), that also feed on animals from the Porcupine herd, do show a reactor rate of about 30% (see Table 4). Thus, one may conclude that the lack of reactors among sled dogs associated with the Porcupine herd may be simply a matter of sampling error. It is possible that the prevalence of infected animals in the Porcupine herd was lower than in the Arctic herd. It should also be noted that free-ranging grizzlies no doubt eat more caribou than do sled dogs in Arctic Village and Old Crow where dogs are fed almost exclusively on commercial dog food or fish. Thus, it seems quite possible that the relative exposure rates of dogs in Arctic Village and Old Crow is too low, and that larger numbers of animals would have to be tested in order to be reasonably sure of detecting reactors.

The data in Table 2 on persistence of titres in a naturally exposed team of sled dogs suggest that many of the titres reported in Table 1 may have resulted from exposures as much as a year or so in the past. Thus, while sled dogs may serve as convenient "*Brucella*-sentinels" for caribou herds with which they are associated, they cannot be assumed to necessarily represent current levels of infection in such herds.

The relationship between antibody levels and the course of rangiferine brucellosis infections in dogs suggests that agglutination and complement fixation titres in excess of about 1:300 (perhaps less?) are certainly indicative of active infection.[3] The data in Table 2 show that titres may be intermittent, rising, falling and again rising over a period of time. Rangiferine brucellosis has also been observed in working dogs in the Taimyr and Chukot regions of Siberia.[7] Working dogs also function as "*Brucella*-sentinels" where they are in contact with other host-parasite combinations, e.g. sheep-*B. melitensis*.[2] Further information on the course of antibody levels in dogs will be reported elsewhere.[5]

Wolves and Red Foxes

We have earlier reported the natural occurrence of rangiferine brucellosis agglutination titres of 1:20 to 1:160 in three of seven wolves from the Brooks Mountain Range of northern Alaska.[3] Additional data on the prevalence of titres in wolves of this area are shown in Table 3. Lumping these data with those reported earlier produces a prevalence rate of about 45% (10/22). While the small number of samples restricts us from making broad statements about the exposure of wolves throughout arctic Alaska, it seems clear that the wolf's favorite item of diet in northern Alaska may not be an entirely unmixed blessing. We do not have any field data suggestive of possible effects of rangiferine brucellosis on wolves. However, information on experimental infections presented elsewhere[5] does suggest the possibility of reproductive failure.

The red fox also is susceptible to infection by *B. suis* type 4 under natural conditions (Table 3). It seems probable that such infections occur less often in fox which no doubt, except for occasional aborted or stillborn fetuses, rarely get more than picked-over leavings of caribou killed by wolves or bears.

Infection of wolves and red and arctic foxes with *B. suis* type 4 also has recently been demonstrated on Siberian reindeer ranges.[6,8,9] Twelve of 110 wolves[8] yielded *Brucella* cultures while even fewer red foxes, 3 of 136, were serologic reactors.[9]

Epizootiologically equivalent observations have been made in Africa on transmission of *Brucellae* from various herbivorous reservoirs which serve as prey of predators and/or scavengers.[11,12] In these instances hyenas, jackals and wild dogs have been found to carry antibodies against enzootic strains of *Brucella* which occur in antelopes.

Natural infections in indigenous species of wild foxes have been reported in Argentina where brucellosis is a common disease in range cattle.[13] Rementsova[10] has summarized the information available through 1962 on the occurrence of various strains of *Brucella* in wolves, foxes and other wildlife. A number of instances are noted in which commercially-reared or wild foxes infected by various strains of *Brucella* have aborted or produced stillborn kits.

Grizzly Bears

We believe data presented in Table 4 is the first evidence of *Brucella* infections in bears. Considering the high proportion of reactors we observed, it appears that grizzly bears associated with either the Arctic or Porcupine caribou herds are subject to frequent exposure to infected animals. Experimental data presented elsewhere[5] suggest that grizzlies are readily susceptible to *B. suis* type 4 via contaminated food and produce high antibody levels.

The apparently lower prevalence of rangiferine brucellosis antibodies in bears associated with the Porcupine caribou herd suggests a lower prevalence of infected animals in that herd. As already noted, this hypothesis is further supported by limited serologic data on sled dogs from the Porcupine caribou range (Arctic Village and Old Crow) presented in Table 1.

Current research on the life history of grizzly bears in the Brooks Mountain Range suggests that their reproductive success is comparable to that of grizzlies elsewhere (personal communication, Harry Reynolds, Alaska Department of Fish and Game). Whether or not rangiferine brucellosis may adversely affect bears, particularly their reproduction, is unknown.

GENERAL CONCLUSIONS

On the basis of our data on natural infections, and a considerable array of information presented by others, we conclude that strains of *Brucella* enzootic in various wild, reservoir-host species (principally ruminants) are regularly transmitted to their predators. It also seems likely that whenever infection takes place during the proper stage of pregnancy, reproductive failures may occur. However, much additional field work and experimentation is required to fully evaluate overall effects of brucellosis on predator populations.

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