ADDITIONAL INFORMATION AND COMMENTS ON DISEASE CONDITIONS AND PARASITES OF BARREN-GROUND CARIBOU

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by

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Federal government concern for the migratory barren-ground caribou, Rangifer tarandus groenlandicus (L.), in Canada's northern areas goes back to nearly the beginning of the present century. However, systematic investigations prompted by the alarming decline in total numbers were undertaken much later, initially by the Canadian Wildlife Service in 1948, and subsequently until 1958, and between 1966-1968, under the aegis of an Administrative Committee for Barren-Ground Caribou Preservation including federal, territorial, and provincial agencies.

One of the objectives of these investigations was to secure information on the diseases and parasites

affecting barren-ground caribou and to assess their significance. Banfield (1) and Gibbs (4) reported on observations made during studies conducted between 1948 and 1958. The present report deals with additional information obtained during the Kaminuriak Barren-Ground Caribou Population Study conducted in 1966-68 by the Canadian Wildlife Service (Eastern Region) in collaboration with the Northwest Territories and Manitoba governments. The Service's Pathology Section assisted in that study.

Field investigations were begun in April 1966 and continued until July 1968. Nine hundred and ninety-nine caribou, 436 males and 563 females of various ages, including 97 calves with 50 of them a few days old, were taken during that period. The animals were examined as thoroughly as possible under field conditions prevailing in northern Manitoba and the District of Keewatin at various times of the year. Taking into account the number of persons involved and the probable variation in thoroughness in the conduct of postmortem examinations, we are satisfied that the information secured under these conditions represents fairly well the health status of the barren-ground caribou population under study.

Two hundred and fifty-three animals were autopsied by a veterinary pathologist (E.B.); the others were examined by biologists* and technicians** who recorded the presence or collected for laboratory examinations, parasites or tissues they deemed abnormal. Partly because limited information was already available, and mostly because of the relative lack of field facilities and the logistic problems involved in collecting and shipping to the laboratory bulky viscera and portions of animals from a significant number of caribou, the digestive tract, lungs, brain, and cranial cavity were not examined for parasitic worms. However, the lungs of each animal were examined for hydatid cysts. Samples of blood were collected for serological studies.

INFECTIOUS DISEASES

Brucellosis

Brucellosis is the disease condition in animals and man resulting from exposure to bacteria of the Brucella group. It occurs in many parts of the world.

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The clinical disease or evidence of exposure to its aetiological agent has been reported from many species of wildlife and semi-domesticated species, mostly ruminants, in several parts of the world. In Canada, brucellosis has been reported in bison, elk, moose, and reindeer.

Gibbs reported that 64 barren-ground caribou, 20 males and 44 females, taken between July 1957 and August 1958, serologically examined for evidence of brucellosis were negative to the test, except in one case in which the reaction was questionable. In 1967 and 1968, blood samples from 321 barren-ground caribou, 200 females and 121 males, were tested for brucellosis. The sera were tested at serum dilutions of 1:25, 1:50, 1:100, and 1:200. A reaction was secured in eleven cases (3.5%).

As shown in Table I, three of the sera reacted at a serum dilution of 1:50; one, at 1:100; and seven, at 1:200. All reacted at 1:25. On the basis of the criteria used in interpreting results in reindeer and caribou testing in Russia and Alaska, the result of the test was interpreted as "positive" in the eleven cases. As also shown in Table I, two of the reactors were

Barren-Ground Caribou Brucellosis Test Reactors

	Animal Number	Sex	Age	Weight	Locality	Date	Titre 1/25	1/50	1/100	1/200
1.	(403)	F	22 mo.	104 lbs.	N.W.T.	17/4/67	~~++++~~	~~+++~~	~~+++~~	~~++~~
2.	(553)	F	99 mo.	196 lbs.	N.W.T.	18/9/67	~~++~~	~~++++~~	~~++++~~	~~+++~~
3.	(794)	M	58 mo.	185 lbs.	Man.	14/4/68	~~+++~~	~~++~~		
4.	(830)	F	108 mo.	188 lbs.	N.W.T.	13/6/68	~~++++~~	~~++++~~	~~++++~~	~~++++~~
5.	(837) (dam of next)	F	108 mo.	159 lbs.	N.W.T.	13/6/68	~~+++~~	~~++~~		
6.	(838)	F	calf	14 lbs.	N.W.T.	13/6/68	~~+++~~	~~++~~	~~+~~	
7.	(869)	F	108 mo.	180 lbs.	N.W.T.	15/6/68	~~+++~~	~~+++~~	~~+++~~	~~++~~
8.	(890) (dam of next)	F	120 mo.	155 lbs.	N.W.T.	16/6/68	~~+++~~	~~++++~~	~~++++~~	~~++++~~
9.	(891)	F	calf	10 lbs.	N.W.T.	16/6/68	~~+++~~	~~++++~~	~~++++~~	~~++++~~
10.	(901)	F	120 mo.	179 lbs.	N.W.T.	16/6/68	~~++~~	~~+~~		
11.	(933)	F	61 mo.	175 lbs.	N.W.T.	17/7/68	~~++++~~	~~++++~~	~~++++~~	~~++~~

female calves a few days old. The others were eight females varying in age from slightly less than two to twelve years of age, and one male slightly less than five years old. Most of the reactor serum samples had been collected on the herd's calving grounds. Four of these were cow-calf sera with the calf serum closely reflecting that of its dam.

Results of the brucellosis test conducted in Alaska on more than 1,200 caribou during 1962-65 indicate seasonal variations in reactor rates for males and females, with male reactors being more common in the fall than female reactors, the reverse being true in the spring. In the present study, the number of animals sampled in the fall and winter months (45 females and 52 males) and of reactors (one female only) is too small to draw any conclusion in this respect.

Abortion, placental retention, metritis, sterility, orchitis and epididymitis, arthritis, bursitis (hygromas) associated with brucellosis have been reported in reindeer in Russia and caribou in Alaska. In Canada, observation of relatively large numbers of barren-ground caribou over a two-year period, except during the months of January, February,

and March, and the postmortem examination of 500 "mature" animals, failed to reveal any significant evidence of the above-mentioned conditions. Orchitis-epididymitis has not been reported by Banfield or by Gibbs, who also observed and examined a number of male caribou between 1948 and 1958.

The only records we have that possibly could relate to the occurrence of bursitis as a result of brucellosis in barren-ground caribou are those of Banfield and of Gibbs, who each reported one observation of adult animals with articular involvement, and that of Mr. E. Kuyt, Canadian Wildlife Service, who photographed tumefactions of both carpal joints in a barren-ground caribou taken in the Thelon River in 1966. In none of these three instances were the tumefactions examined to determine their nature nor the animals examined serologically. While bursitis is said to be common in infected reindeer in Russia, this does not seem to be the case in caribou in Alaska or in Canada, where it is also uncommon in reindeer.

As for metritis-abortion, in 1958 Gibbs reported that one of the 44 females he examined showed evidence of chronic endometritis which could not be related to

brucellosis. In the test conducted in 1968, one of the positive females (869) had a partially involuted uterus but no calf. It is possible that this animal had aborted as a result of brucellosis. However, preservation of the uterus in formalin precluded its bacteriological examination. The rate of pregnancy recorded in the females taken during that study would indicate that infertility does not appear to be a problem in the Kaminuriak population.

Humans are susceptible to infection by the Brucella organisms, and such infection may result from butchering and handling Brucella-infected animals, from contact with afterbirths and placental fluids from an abortion, or from eating raw meat or the marrow, or drinking the blood of an infected animal after the kill.

Between 1953 and 1966, clinical cases of brucellosis were recorded in Eskimos in Canada and in Alaska. Of the seven cases recorded in Canada during that period, five were from the Bathurst Inlet area, one from Cambridge Bay, and one from Coppermine. Five of the seven individuals had not been out of the Arctic. It was speculated that caribou and/or reindeer

were likely reservoirs of infection. The isolation of a strain of Brucella from caribou and epidemiological studies in Alaska showed the caribou to be an important reservoir of infection. The present report is the first confirming the existence of brucellosis in caribou in Canada. It is of interest to note that the clinical cases recorded in Canadian Eskimos in the western Arctic occur in areas where the basic diet is caribou.

Thus, caribou are considered and are likely to be an important reservoir of infection. However, epidemiological studies in Alaska suggest that species such as moose, Dall sheep, and rodents (muskrat and beaver) may also be involved. It has also been suggested that dogs could possibly be another source of infection in some northern areas.

While the information obtained in 1967-68 indicates the existence of brucellosis in the Kaminuriak population, it is not, however, extensive enough to assess the prevalence of the disease as well as its significance in that particular caribou population and indirectly its possible significance from a public health standpoint. At present, there is

no information with regard to brucellosis in that segment of the Canadian population utilizing the Kaminuriak barren-ground caribou population. Seemingly, brucellosis does not represent a serious threat to the welfare of that particular caribou population. However, its detection certainly warrants efforts to secure further information as to its prevalence to determine its true significance from an animal and from a public health standpoint.

Leptospirosis

This is an acute, chronic or latent infection caused by certain species of microbes of the genus Leptospira. Many mammals, domestic and wild, are susceptible to leptospirosis. Some species, particularly rodents, act as carriers of the germs.

Following infection, the microbes localize in the kidney and persist there for an indefinite period. The organisms are present in the urine as long as kidney infection persists, and susceptible animals may acquire the disease through exposure to the urine of infected animals. Man may become infected from such urine or from butchering animals with acute infection. In some species (e.g. cattle) abortion may occur as a result of the infection. This does not seem to be the case in Cervidae.

Forty-three sera from caribou taken in the Lac Brochet, Manitoba, area were tested by Dr. J.G. Cousineau, Faculty of Medicine, Laval University, Quebec, for leptospiral antibodies. None of the sera tested gave a positive reaction. This is similar to the result reported by Gibbs following the testing of 64 barren-ground caribou sera he collected in 1957-58. From these limited results, it seems that leptospirosis is not at present a problem in the Kaminuriak caribou population.

Actinomycosis and Actinobacillosis

Actinomycosis occurs in cattle the world over and has been reported in wild ruminants in Canada. It is caused by Actinomyces bovis.

In cattle and wild ruminants, it almost always involves the bones of the head, particularly the lower jaw, and is characterized by a bony swelling. A. bovis grows in minute purulent centres surrounded by dense tissue displacing the nearby normal tissue. When the microbe penetrates the bone, it destroys the tissue; this, in turn, stimulates the production of new bone which proliferates to form "lumpy jaw". The affected

part of the jaw may be enlarged considerably and distorted. Usually the swelling breaks through the skin and discharges through one or more openings; sometimes, the fistulas from bone abscesses extend inward and discharge into the mouth.

Banfield reported that the examination of 380 skulls found on the caribou range, as well as of animals that had been killed, indicated that a condition resembling actinomycosis was widespread, though his finding of lesions in 8 of the 380 skulls examined cannot be construed as indicating a widespread infection. However, his photographs of three caribou mandibles showing "lesions of actinomycosis" do not show such lesions, though they indubitably show some anomalies. Similar anomalies were noted in caribou mandibles during the 1966-68 study.

Gibbs reported that he did not see any lesions suggesting actinomycosis in the 150 or more caribou he examined in 1957-58. Mr. F.L. Miller examined the jaw bones of all the 999 animals taken in 1966-68. In no case were lesions indicative of actinomycosis found.

Actinobacillosis is mainly an infectious disease of cattle and is world-wide in distribution. It also occurs in sheep, and we have records of it in bison and moose in Canada. It is due to Actinobacillosis ligneseri. Its gross lesions resemble those of actinomycosis. However, it does not affect the bones and shows a marked tendency to involve the tongue (hence the name "wooden tongue" given to the disease in cattle) and lymph nodes. Lesions may occur in any part of the skin and in the internal organs. Gibbs reported his finding of pulmonary actinobacillosis in one of the caribou he examined in 1957-58, and we identified the aetiologic agent of the disease by special histological stains of a thick-walled subcutaneous abscess in one caribou. It does not seem to be a common infection in caribou. If it were, it is probable that the purulent lesions it produces would have been noted, as they can occur in so many sites in the animal body.

PARASITIC INFECTIONS

Warble and Head Maggot Infestations

Banfield, Gibbs and Kelsall (6) have dealt with the occurrence in, and importance to, barren-ground caribou

of the caribou warble fly (Oedamagena tarandi) and the caribou nostril fly (Cephenomyia trompe). The bee-like, non-biting flies are serious pests of caribou during the fly season. Their larvae or maggots invade the skin (warbles) or the nasal passages (head maggots).

Warble infestation is by far the commoner of the two. Kelsall reported that 93 per cent of 132 barren-ground caribou examined between 1948 and 1960 had warbles, while only 19 per cent of 63 animals had head maggots. Field biologists who examined 578 caribou during the 1966-68 study recorded warble infestation in 510 or 87.5 per cent of the animals; very few harboured head maggots. The degree of infestation varied from a few to several hundred warbles in one individual. There was no significant difference between the percentage of males and females infested, though male caribou were usually more heavily infested than females. These data confirm earlier reports on the prevalence of warble infestation.

Larvae of Tapeworms

The wolf and other canids harbour several species of tapeworms whose larval stages develop in mammalian and

other hosts. Because of the relationship (predator-prey) of the wolf and barren-ground caribou, the caribou is an important intermediate host of species of tapeworms occurring in the wolf in northern areas.

Both Banfield and Gibbs commented upon the common occurrence of the large bladder-worm (Cysticercus tenuicollis) stage of Taenia hydatigena, but gave no figure as to incidence. In the 1966-68 study, biologists noted the presence of C. tenuicollis, mostly in the liver and, in a few instances, in the mesentery and in the heart, in 202 of 809 caribou - nearly 25 per cent of the animals examined. In the liver, the number of cysts present varied between one and six. The parasite is not transmissible to humans, and it is unlikely that in most instances it has any significant effect on the health of the host.

The barren-ground caribou also harbour Cysticercus tarandi, the larval stage of another tapeworm of the wolf, Taenia krabbei. The small cyst develops in the muscles, including the heart. Banfield recorded C. tarandi in 28 per cent of 54 caribou he examined. Gibbs also reported that it was common in barren-ground caribou. Because of the small size of

the cyst, it is likely that it is undetected in light infection of the muscular masses. In the 1966-68 study, it was noted in a few instances, mostly in the heart. However, no attempt was made to assess its incidence, as this would have required a thorough, time-consuming examination of the meat which was being salvaged for human use. At any rate, the parasite is not transmissible to man, and does not seem to affect the animal appreciably, although heavily contaminated meat is unattractive for human consumption. The latter might be of some importance in connection with the sport hunting or commercial exploitation of caribou.

The most important parasite of this category in the barren-ground caribou is the hydatid cyst, the larval stage of Echinococcus granulosus. Banfield recorded it in the lungs of a few barren-ground caribou in 1948, and Gibbs reported that it was fairly common but gave no indication of its approximate incidence. During the 1966-68 study, it was recorded in 52 of 828 barren-ground caribou. In all cases except one, the cysts were found in the lungs; in that one, the infection was localized in the liver.

The hydatid cyst is a vesicle varying in size from that of a large marble to that of a grapefruit or bigger. It contains many tapeworm heads which develop to adult tapeworms when the cyst is eaten by a suitable host, such as a wolf or dog. The eggs of the adult tapeworms are evacuated in the faeces of the canine host (e.g. wolf) and, if eaten by an ungulate (e.g. caribou) - for instance on contaminated vegetation, they slowly transform into hydatid cysts.

While several large cysts in the lungs of a caribou may be debilitating, the primary importance of this parasite is that it can also occur in man and cause a very serious condition. There are several records of hydatid disease in man in northwest Canada and in the Northwest Territories, where it has been shown that the main source of infection is dogs which have been fed or have eaten the contaminated viscera of game animals, including barren-ground caribou in some areas.

Intestinal and Pulmonary

As stated previously, neither the digestive nor the respiratory tract was examined for the presence of adult parasitic worms.

On the basis of information obtained from the examination of reindeer by Choquette et al. (2) and of barren-ground caribou by Gibbs, together with the absence of clinical evidence, it is likely that intestinal parasites are not prevalent and that they do not play any significant role in barren-ground caribou. In livestock, particularly herbivores, intestinal parasitism is usually the result of "built-up" infections in animals confined to relatively small areas thus increasing the chances of infection. In animals free to roam over large expanses of land, the chances of infection by the eggs or larvae produced by the parasites are reduced considerably.

Both Banfield and Gibbs reported that the lungworm Dictyocaulus viviparus was common in barren-ground caribou, though never present in great numbers. In Canada, this parasite also occurs in other members of the deer family, in bison, and commonly in cattle. In many parts of the country, verminous pneumonia causes severe losses in cattle, particularly young animals.

In young cattle, the disease is primarily due to the invasion of the lung tissue following ingestion of the parasite's larvae infecting pastures. The response of the lung tissue varies and depends on the number of larvae ingested and whether the animal has been sensitized by previous exposures. Thus, the clinical picture reflects the lung's response to invasion by lungworm larvae, which results in the development of an acute or subacute condition often complicated by secondary bacterial infection, or in an asymptomatic form of the disease. In young cattle, in addition to signs indicating respiratory involvement in various degrees of severity, loss of weight and stunted growth are also observed in the clinical forms of the disease.

The significance of D. viviparus in caribou is not known. Gibbs reported finding lesions of verminous pneumonia in caribou he examined in 1957-58, but considered that none of these could be classified as dangerous to life. Similarly, during the 1966-68 study, the histological examination of the lungs of a small number of caribou showed the presence of lungworm larvae associated with lesions of pneumonia. In either

case, whether these lesions were due to D. viviparus, or to other species of lungworms, was not determined. So far, we have no clinical evidence that verminous pneumonia is a problem in barren-ground caribou. Nevertheless, we propose to investigate this question of lungworm infection to learn the species that might be involved and their significance.

Sarcosporidiosis

Sarcosporidiosis is a condition characterized by the presence of spore-containing cysts of parasites of the genus Sarcocystis (considered as being protozoa) in the striated muscles of many mammals and some aquatic birds. It also occurs in moose and bison in Canada.

Infection shows up as minute, whitish streaks, usually one millimetre or less in length. Minute sarcosporidian cysts were found in the heart muscle of 14 caribou during the 1966-68 study. It is likely that the systematic and meticulous examination of the heart and other muscles would reveal a high incidence of infection.

It is believed that the infective forms of the parasite (sporozoites) are conveyed by the blood stream to the muscles. Gibbs reported that while no sarcosporidian cysts were seen on postmortem examination, spores of a species of Sarcocystis were found in blood smears.

The significance of Sarcocystis is unknown, and unless the infection is an extremely heavy one, it is not likely to cause trouble. The status of sarcosporidiosis from a public health standpoint is not well understood.

Besnoitiosis

Besnoitiosis is caused by spore-forming species of the protozoan genus Besnoitia. The spores are formed within pseudocysts which have an affinity for the connective tissues, including the cardio-vascular system in some species.

In 1922, Hadwen (5) reported the occurrence in Alaskan reindeer and caribou of Fibrocystis tarandi (= Besnoitia tarandi) cysts in the periosteum and on the surface of the tendons. Gibbs recorded similar cysts in the subcutaneous fascia of the legs, belly, and

flank from a number of barren-ground caribou taken in 1957 and 1958 in the District of Keewatin. The diagnosis of besnoitiosis in skin lesions in caribou in the District of Mackenzie in 1963 and in the District of Keewatin in 1966 was reported by Choquette et al. (3) in 1967. The disease was not diagnosed in nearly 200 reindeer slaughtered in January 1967 (Choquette et al. (3); it was not found either in 163 reindeer killed in August 1968. The parasite has been reported as common in reindeer in the U.S.S.R.

However, it was not until the barren-ground caribou project of 1966-68 permitted field autopsies of large numbers of caribou that the relatively widespread nature of the disease became apparent. Thus, it was found in 26 of 100 caribou autopsied in the Lac Brochet, Manitoba, area in April 1968 and in 14 of 66 adult caribou taken west of Rankin Inlet, N.W.T. in June 1968. At that time, Besnoitia cysts were found in the periosteum and on the tendons as well as in the skin and in the subcutaneous fascia, but not in the cardio-vascular system, though in the latter case they may simply have been overlooked.

In addition to B. tarandi in reindeer and caribou, species of Besnoitia have been reported in other wildlife in various parts of the world (in rodents in the U.S.A., South America, and the U.S.S.R.; lizards in Panama; and antelopes in South Africa). Besnoitiosis is a well-known clinical entity of cattle in some parts of the world (Europe, the Middle East, and Africa). In cattle, it is a chronic, debilitating, and occasionally fatal disease with cutaneous and systemic manifestations. Cutaneous lesions are usually seen as rugose, thickened, hairless areas of skin, particularly on legs, thighs, and scrotum. Invasion of the epididymis and testis resulting in sterility has been reported in both cattle in South Africa and reindeer in Russia. In caribou, the cutaneous lesions were not extensive and consisted in a slight thickening of the affected portion of skin. The male genitalia were not affected, and none of the caribou found infected with B. tarandi showed any evidence of debilitation or loss of condition.

The level of infection indicates that the disease is common in the Kaminuriak barren-ground caribou population. Comparatively little is known

about its significance in caribou. Hadwen expressed the opinion that reindeer and caribou were affected adversely, either mechanically or by toxins produced by the parasite, and suggested that in some cases it could be a serious condition. Toxins are considered to be an important factor in the pathogenesis of the disease in cattle in South Africa.

Considering the seriousness of the condition in cattle and occasionally in reindeer, its diagnosis in barren-ground caribou is, therefore, of more than academic interest and certainly warrants further study to determine its significance in the latter species.

SUMMARY AND CONCLUSION

Brucellosis, which has been detected for the first time in barren-ground caribou, does not seem to be a problem at present from a caribou population standpoint, though it may be a source of infection to humans. The serological examination of a small number of caribou sera failed to reveal any evidence of leptospirosis or exposure to it. Actinomycosis, if it exists at all in that caribou population, is certainly not as widespread as has been suggested, and actinobacillosis appears to be uncommon.

Warble fly infestation is by far the commoner of the two Diptera, the other one being the caribou nostril fly, whose larvae or maggots invade the skin and the nasal passages respectively. The non-biting adult flies are serious pests of the caribou during the fly season, while the larvae of the warble fly depreciate the value of the hide.

Because of the predator-prey relationship of the wolf and barren-ground caribou, the latter is an important intermediate host of species of tapeworms occurring in the wolf in northern areas. Both the bladder-worm, Cysticercus tenuicollis (mostly in the liver), and Cysticercus tarandi (muscles) are common. None of these are transmissible to man. However, extensive contamination of the meat with C. tarandi makes it unattractive for human consumption. The latter might be of some importance in connection with the sport hunting or commercial exploitation of caribou. Hydatid cyst, the larval stage of Echinococcus granulosus, was also recorded in a number of caribou. It can also occur in man and cause a very serious condition. In northern areas, the main source of infection for man is the dog fed or

allowed to eat the contaminated viscera of game animals. Under these circumstances, it is conceivable that the barren-ground caribou can be an important reservoir of infection for man.

There is no evidence, clinical or otherwise, that parasitic infections of the digestive tract and verminous pneumonia are a problem in barren-ground caribou.

Two protozoan infections were recorded: sarcosporidiosis and besnoitiosis. The significance of sarcosporidiosis in caribou, or in other species, is unknown, and its status from a public health standpoint is not well understood. Besnoitiosis is a well-known clinical entity of cattle and reindeer in some parts of the world, and sterility has been reported as a result of the invasion of the epididymis and testis. None of the caribou found infected showed any evidence of debilitation or loss of condition or testicular involvement.

In conclusion, field observations and results of postmortem and laboratory examinations suggest that the health status of the Kaminuriak barren-ground caribou population is generally good at this time.

However, further investigations are certainly warranted to assess the significance of conditions such as brucellosis, verminous pneumonia, and besnoitiosis in caribou.

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