

Conflicts Between Domestic Reindeer and Their Wild Counterparts: A Review of Eurasian and North American Experience

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ABSTRACT. Experience in the Soviet Union and Alaska indicates that the major potential conflicts between domestic reindeer and their wild counterparts (both caribou and reindeer are of the same species, *Rangifer tarandus*) are: (1) Loss of domestic reindeer to wild herds. Although this can be reduced under close herding, it is still a serious problem wherever wild reindeer or caribou and domestic reindeer coexist. Domestic reindeer joining wild herds appear to have low breeding success and therefore probably have little genetic influence on the larger wild populations. (2) Competition for forage between domestic reindeer and wild herds, which is primarily restricted to the winter range. Herded reindeer feed more intensively than the wild, free-ranging animals and therefore their effect on range forage is greater. (3) Diseases and parasites may be readily transmitted between domestic reindeer and their wild counterparts. However, most diseases and parasites common to the species are endemic to both wild and domestic herds.

RÉSUMÉ. L'expérience de l'Union Soviétique et de l'Alaska montre que les conflits majeurs qui peuvent survenir entre le renne domestique et sa contrepartie sauvage (le caribou et le renne appartiennent à la même espèce, *Rangifer tarandus*) sont de trois ordres: 1. le bilan négatif pour le renne domestique par rapport aux troupeaux sauvages. Bien que l'on puisse réduire cette perte en rassemblant le troupeau de façon serrée, le problème restera posé partout où le renne et le caribou coexistent. Cependant, les rennes domestiques, en se joignant aux troupeaux sauvages, se reproduisent difficilement. Ainsi, ils ont probablement une influence génétique faible sur les populations sauvages, plus nombreuses; 2. la compétition entre les rennes domestiques et les caribous pour la nourriture, surtout en hiver. Les rennes, rassemblés en troupeaux, se nourrissent plus intensivement que les animaux sauvages, libres. Leur influence est donc plus grande sur l'étendue des pâturages; 3. les maladies et les parasites sont facilement transmis entre les rennes domestiques et leurs contreparties sauvages. Cependant, la plupart des maladies et des parasites propres à l'espèce sont endémiques dans les deux troupeaux, sauvages et domestiques.

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INTRODUCTION

Caribou (*Rangifer tarandus*) are native to North America but were never domesticated there by aboriginal people as they were in Eurasia. Caribou have been hunted for food and hides by native peoples since man's arrival in North America and they continue to provide a subsistence base for a large proportion of northern peoples.

In Eurasia, domestication of reindeer dates back about 2000 years (Zeuner, 1963). Domestic reindeer were first introduced to North America from Siberia in 1891 when they were brought to the Seward Peninsula of Alaska by Reverend Sheldon Jackson, then General Agent for Education in Alaska (Lantis, 1950). These animals, plus additional introductions, subsequently increased to about 600 000 by the early 1930's and had become widespread throughout northwest-

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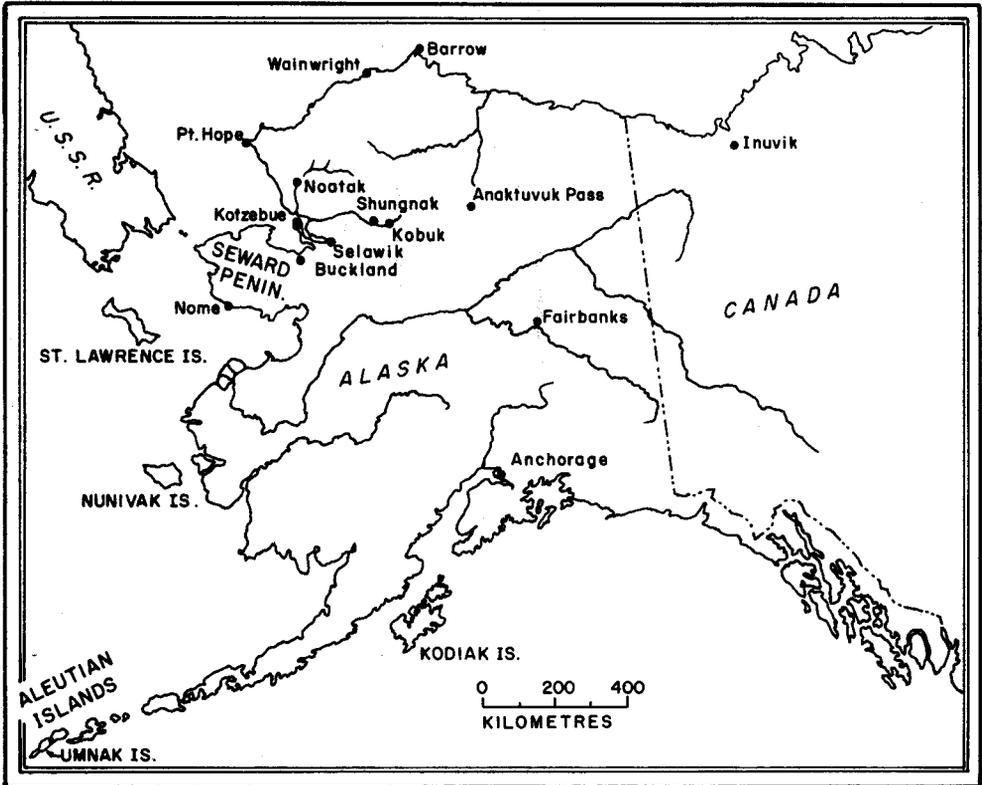


FIG. 1. Locations in Alaska and Canada referred to in the text.

ern Alaska, the north and southwest coastal areas, on Bering Sea islands, Kodiak Island, and the Aleutians, and herds were even present in interior Alaska (Fig. 1). A rapid decline in numbers followed this peak population and in recent years active reindeer husbandry has been restricted largely to the Seward Peninsula where there are about 20 000 reindeer. Other reindeer presently in Alaska occur on Bering Sea islands, Kodiak Island, and Umnak and Atka islands in the Aleutians. On Nunivak Island, an indigenous population of caribou was apparently shot off prior to the turn of the last century before the introduction of reindeer (Murie, 1935).

The rapid decline of the reindeer population from the peak in the 1930's was primarily a product of over-stocking of ranges and mismanagement, although other factors contributed to the decline, including mixing and loss to caribou herds, a succession of severe winters, predation by wolves (*Canis lupus*), and disease (Lantis, 1950). Near the base of the Seward Peninsula reindeer herders continue to suffer losses of reindeer to migrating caribou and to experience other problems associated with caribou in the vicinity of their reindeer.

By the late 1940's reindeer herds were still in existence at Barrow, Wainwright, Pt. Hope, Noatak, Shungnak, Kotzebue, and Selawik; however, all of these herds were within the range of the Western Arctic Caribou Herd which was

apparently on the increase at that time (Hemming, 1971). Each of these reindeer herds subsequently went out of existence, mostly due to poor herding practices and associated straying, but many reindeer were lost to migrating caribou, especially in the Kotzebue-Selawik area (Lantis, 1950).

There are now strong incentives for expansion of the reindeer industry owing to the availability of both capital and lands as a result of the Alaska Native Claims Settlement Act, the increased need for meat by the expanding human population in northwestern Alaska, and the high prices paid for raw reindeer antlers by Oriental peoples. Additionally, the Western Arctic Herd, which had reached a peak population of 242 000 in 1970, declined to 75 000 in 1976 and was no longer able to sustain a large human harvest (Davis *et al.*, 1980). Caribou from this herd have traditionally been hunted for subsistence purposes by Eskimos and Indians from more than 20 villages representing several thousand people. A major concern of both the reindeer herders and the state and federal agencies responsible for management of the lands and wildlife of the area is the potential conflict between domestic reindeer and caribou.

Reindeer have also been established from Alaskan stock near Inuvik in the Mackenzie River delta area of the Northwest Territories of Canada. Here a herd, presently numbering about 4000 animals, has existed since 1935. Other attempts to establish domestic reindeer herding in Canada were made in the early 1900's in Newfoundland, Labrador, near Great Slave Lake in the Northwest Territories, and on southern Baffin Island (Scotter, 1972). With the exception of the Mackenzie delta project, all of these attempts failed within a few years of their inception. Reindeer were introduced in 1952 from Norway to the Godthaab area of West Greenland. In both Canada and Greenland there have been conflicts with adjacent herds of caribou.

The potential conflict between caribou and reindeer should be examined in detail in order to provide a basis for land use and management decisions which will assure opportunity for development of viable reindeer husbandry without loss of caribou as a subsistence base to villages where use of caribou has been traditional.

EXPERIENCE IN THE SOVIET UNION

In Siberia and the north of European Russia, there is a long history of conflicts between domestic reindeer and their wild counterpart ("wild reindeer" is used synonymously with caribou in discussing Eurasian populations). Reference to problems that herders have from wild reindeer is common in the Soviet reindeer literature.

It has not been possible for both domestic and wild reindeer to coexist free of strife in the same general areas throughout much of the Soviet Union. In most regions of well-developed reindeer husbandry, wild reindeer were eliminated in prerevolutionary times. The pattern of transition from subsistence hunting to reindeer husbandry in the Chukotka region of far eastern Siberia (Fig. 2) is described in the following quotation from St. John (1979):

"The Chuckchee had evolved as an ancient caribou hunting people of the continental areas in the extreme north-east of Eurasia. They led a nomadic

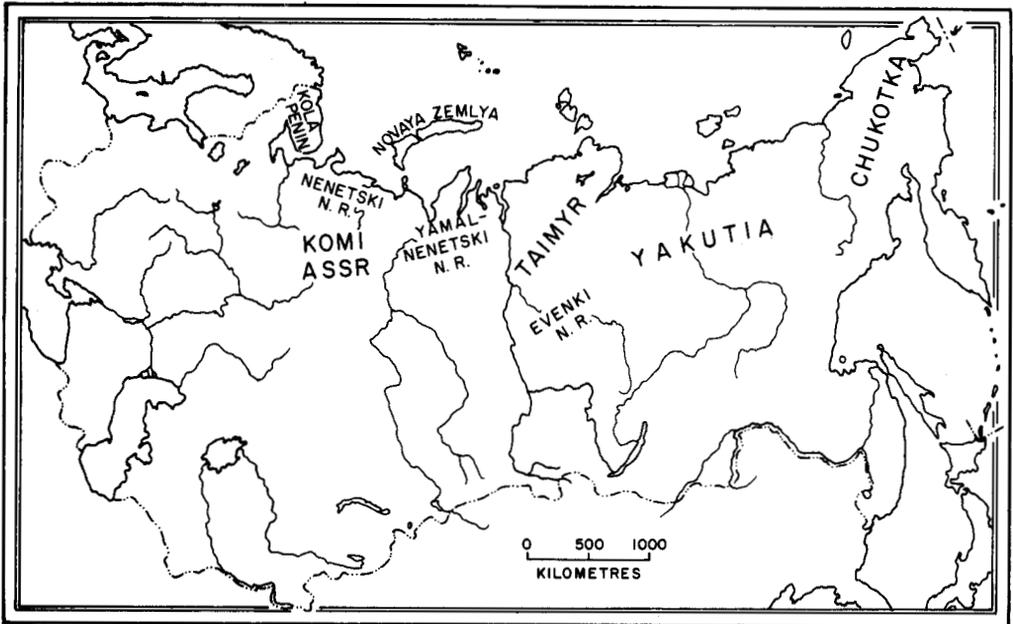


FIG. 2. Location of areas in the Soviet Union referred to in the text.

life, using domesticated caribou as draft animals . . . the penetration of the Yukagir into the Koyma and Anadyr Basins just prior to the arrival of the first Russians and seizure by the Yukagir of the seasonal caribou hunting areas for reindeer husbandry stimulated the Chuckchee to develop pastoral reindeer herding.

The expansion of domesticated deer seriously eroded the pasturage of the wild caribou and their final extinction on the Chuckchee Peninsula occurred in the mid-19th century."

Most Soviet authorities emphasize the difficulty of carrying out successful reindeer husbandry when wild herds are present in the area. Andreev (1975) stated that "keeping in mind the perspective of the further development of reindeer and the raising of the northern reindeer to full use of the pastures present, we should think of how to clear the areas of wild reindeer which are already used by domestic reindeer, as well as those which are intended for future use." He suggested that wild reindeer should be restricted to areas which cannot be used efficiently by domestic reindeer and they should be fenced into these areas to eliminate conflict with domestic herds in adjacent areas. It should be borne in mind, however, that in the Soviet Union, emphasis has been placed on controlled productivity of the land; consequently harvest of wild populations is considered by many an antiquated and inefficient land use practice. Currently there are about 2.5 million domestic reindeer and 900 000 wild reindeer in the Soviet Union (Kuzyakin, pers. comm.). Andreev (1975) pointed out that, "In a planned socialist society, as a rule, the forage resources on natural forage lands are used much more intensively and rationally under the direction of society than

by populations of wild animals." Geller and Vostryakov (1975), in discussing wild reindeer management stated, "It is well known that this type of commerce is not marked by its continuity, and its profitability is up to this time insignificant." The situation may have changed, however, at least in the Taimyr region where the largest population of wild reindeer currently exists. There, efficient slaughter operations have been established at major rivers which intercept the fall migrations of wild reindeer (Kuzyakin, pers. comm.). The harvest from this herd was 55 000 in 1978, and a quota of 75 000 was set for the 1979 harvest. The herd numbered about 475 000 animals in 1979. Helicopters are also used in the harvest of wild reindeer in Yakutia and in forested areas of the Soviet Union.

On Novaya Zemlya, an indigenous subspecies of wild reindeer (*R. t. pearsoni*), which numbered in excess of 20 000 at the beginning of the 19th century, has been classified as rare in the recently published Soviet *Red Data Book* of rare and endangered species (Borodin, 1978). Domestic reindeer were established on the island complex during 1928 through 1930. They reached a peak population in the mid-1930's and this coincided with the decline of the wild reindeer. Although the wild reindeer were hunted by reindeer herders, Soviet authorities believe that competition for the sparse forage on the islands was also a cause of their decline. Reindeer husbandry has been discontinued there and the wild reindeer are now protected from hunting and have apparently begun to increase in recent years.

Major concern in the Soviet Union over wild reindeer in relation to domestic reindeer centers on 1) the problem of loss of domestic reindeer to wild herds and associated herding problems, 2) competition for range forage, 3) disease, parasites, and predators which use the wild populations as host reservoirs, and 4) interbreeding.

LOSSES OF REINDEER TO CARIBOU AND ASSOCIATED HERDING PROBLEMS

In the Soviet Union, the greatest numbers of domestic reindeer are lost to wild reindeer in autumn. This loss occurs during the fall southward migration and during the breeding season, when the wild reindeer return from summer ranges in tundra areas to the edge of the forests where winter ranges of wild and domestic reindeer may be adjacent to one another. The Evenki domestic reindeer area, lying southeast of the Taimyr region and adjacent to the largest wild reindeer herd in the Soviet Union, consistently suffers the heaviest losses of domestic reindeer. Geller and Vostryakov (1975) cited an average annual loss of domestic reindeer "without cause" in Evenkia of 8300 or 15.7% of the total population. In this region most of the reindeer in the "lost without cause" category are believed to have joined the wild herds. The Murmansk region of the Kola Peninsula loses about 7300 domestic reindeer, or 10%, annually, and in this region there are about 20 000 wild reindeer. However, there is more overlap of range use there than in the Evenki region. Losses of 9200 or 7.9%, 6600 or 3.8%, and 6600 or 2.4% are recorded for the Taimyr national region, the Nenetski national region, and the Yamal-Nenetski region, respectively (Fig. 3). Although these figures reflect losses to wild reindeer they also include other unexplained losses which may be caused by predation, poaching, straying, or other factors.



FIG. 3. Reindeer herding in the Taimyr region of north central Siberia where losses of reindeer to wild populations are a major problem.

Geller and Vostryakov (1975) pointed out that the magnitude of loss is dependent on the herding methods employed; greatest losses are associated with loose herding practices. Where domestic reindeer are under continual surveillance, as in Chukotka, Yakutia, and the Komi A.S.S.R., losses are small. It also seems likely that these figures are inflated as a certain percentage of "lost" animals may subsequently rejoin the domestic herds.

A major factor in the increased losses of domestic reindeer to wild herds in recent years has been the increased protection that has been given wild reindeer and their subsequent increase throughout the entire northern region of European Russia and Siberia. The expanding herds of wild reindeer also benefited from abandonment of rangelands by subsistence reindeer herders following collectivization of herds in the 1930's and 1940's (Webber and Klein, 1977). As wild reindeer herds increased, they expanded their ranges, often appearing unexpectedly in areas which had been little used by them previously.

The loss of large numbers of domestic reindeer to wild herds apparently has had little impact on the wild populations. In 1967 in the Taimyr region, a herd of 250 000 wild reindeer absorbed domestic reindeer to the equivalent of 2.8% of the total population, and similar large additions of domestic reindeer to this herd occurred in succeeding years (Geller and Vostryakov, 1975). However, domestic reindeer were not encountered in this proportion in the wild herd. In a sample of 225 animals shot in 1969 only 0.8% were domestic reindeer, and of 938 shot in

1970 only 0.4% were domestic animals. The reindeer could be identified by the herd markings in their ears. Geller and Vostryakov suggested that the majority of domestic reindeer that join up with wild herds die from predation and hunting, because they are less wary than the wild reindeer, or they succumb to the rigors of the long migrations and the difficult winter foraging conditions that are characteristic of wild reindeer.

In most cases it also seems unlikely that there would be appreciable genetic exchange as a result of large-scale interbreeding between wild reindeer or caribou and the domestic animals that join them. This is explained on the basis of several factors. Male domestic reindeer are usually substantially smaller than their counterparts in adjacent wild populations (Palmer, 1934; Klein, 1970; Mukhachev, 1975) and therefore they presumably would be less effective in competing with wild bulls and in breeding wild female reindeer or caribou. Among most wild reindeer and caribou herds, breeding takes place during fall migration from the summer to the winter ranges. Domestic reindeer accompanying these herds, because of their weaker migratory urge and smaller stature, would mostly be at the rear of, or stragglers to, the main aggregation of breeding adults. Further, the breeding season in domestic reindeer herds precedes that of wild reindeer and caribou by two to four weeks; thus, if female domestic reindeer accompanying wild reindeer were bred at their first ovulation as might be expected, by either domestic or wild bulls, they would likely give birth two to four weeks earlier than the rest of the cows in the herd. This would presumably occur during spring migration when the majority of pregnant cows were still enroute to the calving grounds; the consequences would be extremely detrimental to the newborn calves of the domestic reindeer cows, and most likely for the cows as well. Synchronous mating and calving appear to be strongly selected for among caribou (Dauphiné and McClure, 1974). These factors would therefore work strongly against the successful reproduction of both sexes of domestic reindeer among wild herds.

In Alaska, several authors have suggested that the influx of large numbers of domestic reindeer into caribou herds in the 1930's may have led, through interbreeding, to a deterioration in the quality of caribou (Bailey and Hendee, 1926; O. J. Murie, 1935; A. Murie, 1944). It is also commonly believed by older Eskimos in the Kotzebue Sound area that caribou decreased in size following the loss of several thousand domestic reindeer to caribou in that region during the 1940's through 1960's. Rausch (1951) reported that ear-notched animals, thought to be reindeer, were killed among migrating caribou by Nunamiut Eskimos from Anaktuvuk Pass in the central Brooks Range, and that white reindeer were also seen running with caribou there.

Doerr (1979) reported on reindeer shot or observed among caribou of the Western Arctic Herd during 1975 and he summarized data on reindeer lost from herds in northwestern Alaska that might have joined the Western Arctic Caribou Herd. During 1944-1976, a minimum of 19 000 reindeer were lost from eight different reindeer herds in this region. Certainly not all of these lost reindeer joined the Western Arctic Herd, and the total numbers involved over the 32-year

period are small in view of the large size of the Western Arctic Herd during this time. Doerr concluded that the numbers of reindeer involved were an insignificant influence on the population dynamics of the Western Arctic Herd, and that genetic influence would also have been minimal.

Skoog (1968) came to a similar conclusion for all major caribou herds in Alaska with the possible exception of the Alaska Peninsula Herd, which was at a very low level at the time that several reindeer herds were abandoned in that area. Skoog also concluded that characteristics of reindeer, such as short legs and white pelage, which would reduce the selective fitness of caribou, are probably recessive, whereas morphological counterparts among caribou would likely be dominant, thus minimizing the likelihood of transfer of such reindeer characteristics to caribou through hybridization. Although some characteristics of caribou which increase their fitness over reindeer in the wild may be both dominant and associated with single gene loci, it is most likely that inheritance of such complex characteristics as body size, pelage color, and behavior are polygenic and therefore not subject to simple dominant recessive gene expression.

It seems likely, on the basis of the Soviet experience, as well as that from Alaska, and knowledge of the breeding behavior of caribou and reindeer, that any genetic influence on Alaskan caribou through mixing with domestic reindeer has been minimal in the past. Exceptions may have occurred when entire reindeer herds were lost and mingled with relatively small numbers of caribou, as has been postulated for the Alaska Peninsula. Verification of these assumptions, however, should be possible through the use of recently developed techniques for assessing closeness of genetic relationship by electrophoretic analysis of blood proteins (Soldal and Staaland, 1980). This is an area that requires a coordinated and concentrated research effort in Alaska and adjacent parts of Canada.

PREDATOR INTERACTIONS BETWEEN CARIBOU AND REINDEER

A major problem for reindeer herders occurs when wolves follow caribou into areas adjacent to domestic herds. The wolves readily prey on reindeer if opportunity permits. In Alaska, where close herding is normally not practiced, wolves can cause heavy losses of reindeer through predation as well as scattering them through harassment. Harassment can lead to further loss through straying, and increased herding effort is required to gather the animals.

The Seward Peninsula is relatively free of wolves and when occasional wolves move on to reindeer ranges they are relentlessly hunted by the herders. The Hadley grazing area near Buckland and the now abandoned grazing leases in the Selawik Hills and lower drainages of the Kobuk and Noatak rivers have been particularly vulnerable to influx of wolves from the adjacent wintering grounds of the Western Arctic Caribou Herd.

Wolf control around reindeer herds in the Kotzebue-northwestern Seward Peninsula region by the Predator and Rodent Control Branch of the U.S. Fish and Wildlife Service during the 1960's accounted for kills of at least 25 wolves in some years, but numbers killed varied considerably depending on weather and the proximity of wintering caribou (Predator and Rodent Control Branch, 1964).

In an earlier period when reindeer were much more numerous, wolves were common throughout the reindeer grazing areas. Palmer (1944) suggested that wolves increased in the early 1940's as a result of the easy availability of reindeer owing to lax herding practices and the large numbers of reindeer present, estimated at 250 000 in Alaska in 1940. He cited wolf bounty records from the reindeer grazing areas which increased from 127 bountied in 1940 to 198 in 1943.

Grizzly bears (*Ursus arctos*) also present a hazard to reindeer herding on the Seward Peninsula through predation on newborn calves, but because the bears are in hibernation during winter at the time caribou are present in adjacent areas, there is little opportunity for secondary interaction between the reindeer and caribou through the bears.

COMPETITION BETWEEN CARIBOU AND REINDEER FOR FORAGE

Virtually all Soviet and most Alaskan publications on reindeer range management emphasize the possible detrimental effects of caribou grazing on reindeer ranges. These vary from simple logical statements that forage consumed by caribou will not be available for use by domestic reindeer, to obviously biased and undocumented statements that caribou grazing activities are totally destructive to reindeer forage resources. Andreev (1975) and Geller and Vostryakov (1975) emphasized the detrimental effect on domestic reindeer ranges of grazing by wild reindeer, yet their views appear to reflect a commitment toward reindeer husbandry as the most desired use of these northern rangelands. These authors qualify their comments by emphasizing that wild reindeer are destructive to rangelands and particularly to lichens when populations are "self regulated". The term "self regulated" refers to populations that are not harvested sufficiently to prevent them from increasing to high levels and thereby over-grazing their winter range areas. They point out that the grazing habits of wild reindeer are sufficiently different from those of domestic reindeer to lead to different influences on vegetation under normal grazing conditions.

Wild reindeer are much more selective in their feeding than domestic reindeer, partly by choice but most importantly because they are not restricted through herding, as are domestic reindeer (Klein, 1970). As a result, the diets of wild and domestic reindeer vary considerably: domestic reindeer rely much more heavily on lichens, especially in winter (50-80% of diet), than do wild reindeer (20-40%) (Geller and Vostryakov, 1975). A similar difference between caribou and reindeer feeding habits appears to exist in Alaska although differences in lichen intake levels are also related to variations in the availability of lichens on the ranges involved (Palmer, 1934; Skoog, 1968; Klein, unpublished).

Andreev (1975) also described winter feeding of wild reindeer as being much less intensive than that of domestic reindeer. He cited data showing that wild reindeer typically utilize 25-30% of the lichens available in winter feeding craters and they concentrate on the upper portions of lichens, which allows for fairly rapid recovery of the remaining lichens. Domestic reindeer, on the other hand, usually use up to 50% of the available lichens in craters and take a much larger portion of each lichen podetium grazed, which slows the renewal of lichen forage. Winter cratering by wild reindeer seldom exceeds 5-7% of the total

pasture area while feeding by domestic animals usually results in cratering of 25-35% of the total area. Wild reindeer, according to Andreev, infrequently revisit sites cratered earlier in the winter and often do not return to areas grazed during winter for an interval of several years. In Alaska, however, caribou have been observed by Thing (1977) to re-crater sites used previously during the same winter and in such situations cratering may occupy 40% or more of specific feeding areas. When viewed in the context of the total available pasture area these results become more comparable to Andreev's. Andreev concluded that wild reindeer use up to 3-4% of the food supply of the whole pasture area in winter and less than 1% in summer while domestic reindeer use up to 35-40% in winter and 5-7% in summer. He described large areas of the Soviet North as being too sparse in plant cover to be suitable for domestic reindeer husbandry, and stated that when the range area required for a single reindeer exceeds 0.15 hectares per 24 hours, herding becomes unmanageable. Wild reindeer are much more effective foragers and, according to Andreev (1975), are capable of utilizing areas of low plant cover and forage productivity. He suggested that in such areas wild reindeer present the only potential for conversion of forage resources to meat.

It should be borne in mind that the values for domestic reindeer quoted above by Andreev are for closely herded reindeer on intensively managed ranges, therefore these values are probably considerably higher than would be true for domestic reindeer in Alaska under the loose herding practices that exist there. Andreev also cautions that when wild reindeer reach peak populations they can have a much greater impact on the vegetation and can account for severe deterioration of lichen ranges. Because of the feeding behavior of domestic reindeer in contrast to wild reindeer and caribou, as pointed out by Andreev, one would expect that caribou in winter would utilize ten times as much range area as an equal number of closely herded reindeer, whereas in summer the area would be 5-7 times as large. The intensity of use of forage on a unit area basis, as pointed out earlier, would be correspondingly lighter for the caribou.

On the Kola Peninsula, where wild reindeer have recovered from a population "low" at the end of World War II to about 20 000 animals in the early 1970's, there have been serious problems of competition with domestic reindeer for available winter forage (Semenov-Tien-Shansky, 1975). In this region the treeless tops of low hills and ridges are considered extremely valuable components of the winter range because they provide moderate amounts of lichens that are readily available throughout the winter. The herders tend to reserve these areas for use in late winter when deep snow seriously hinders feeding by reindeer in the forests. In recent years wild reindeer have begun to utilize these choice grazing areas, depleting the lichens and, through their cratering activities early in the winter, rendering the remaining lichens less available to the domestic reindeer in late winter.

In Alaska, overlap of use of winter range by caribou and reindeer has occurred commonly in the drainages to Kotzebue Sound; however, no quantitative studies have been undertaken to assess the consequences for either reindeer or

caribou. Currently, the only significant competition between caribou and domestic reindeer for forage occurs east of the Buckland River on the Hadley reindeer grazing lease area. Here, several thousand caribou of the Western Arctic Herd have wintered for the past several years (November through March). In consequence, terms of the Hadley grazing lease from the Bureau of Land Management for 1979 and 1980 specify that the reindeer are to be kept west of the main channels of the Buckland River and its West Fork during November through March, when caribou are in the eastern portion of the lease area.

In comparing the effects of grazing by caribou and reindeer, it is important to consider the seasonal patterns of range use for each group. Generally, summer and winter ranges of caribou are widely separated, whereas reindeer are often confined to the same general area year-round. Although many reindeer herders keep their animals in different portions of their range in winter than in summer, there is usually some overlap. Pegau (1968) has described the destruction to lichens that can occur from trampling by reindeer during dry periods in summer. Recent studies in Norway have shown that lichens are more detrimentally affected by grazing reindeer in summer than during winter when the lichens are partially protected by snow (Oksanen, 1978). It seems likely that destruction of lichens through trampling or overgrazing in summer is a much more frequent occurrence on ranges of reindeer than caribou.

EXCHANGE OF DISEASES AND PARASITES BETWEEN REINDEER AND CARIBOU

Reindeer and caribou are of the same species, therefore they can be infected by the same diseases and parasites. In fact, essentially all diseases and parasites commonly found in domestic reindeer are also present among caribou. The levels of infection of diseases and parasites in specific reindeer and caribou herds vary with many factors: health of the host animals, density of animals on the range, sex and age structure of the herds, availability and abundance of intermediate hosts, history of association with the disease or parasite, presence and abundance of scavengers and predators, and climate. When a herd of reindeer or caribou is heavily infected by a disease or parasite it has the potential for transmitting the organism to other herds with which it may come in contact. Therefore, the threat of infection may be from caribou to reindeer or reindeer to caribou.

Because of the close herding involved in domestic reindeer husbandry (which means frequent contact between animals and long presence on a given range area), the often more restricted nutritional regime of reindeer than that of caribou (Klein, 1970) and the lower frequency of scavengers and predators on reindeer range, the incidence of disease and parasites is often higher among reindeer than caribou (Zhigunov, 1968). This condition may not be true, however, under intensive reindeer management where therapeutic practices may be employed to reduce or eliminate diseases and parasites or when caribou populations are at very high levels which may favor the occurrence and spread of disease and parasites.

In the Soviet Union, brucellosis (*Brucella suis* type 4) is considered one of the most serious diseases of domestic reindeer largely because of its effect on their

health and reproduction and because it can be transmitted to humans. A strong effort is made throughout the reindeer herding areas to reduce or eliminate the disease through treatment with drugs of minor infections associated with brucellosis, such as swollen joints or orchitis, or by slaughter of diseased animals (Zhigunov, 1968). Wild reindeer are considered a reservoir for the disease, and when they are present near domestic herds, they are believed responsible for infecting the domestic animals. There has, however, been little documentation of the incidence of brucellosis in wild reindeer in contrast with the domestic herds. Soviet authorities also believe that wolves play an active role in transmitting the disease from wild to domestic reindeer; however, the etiology of its transfer has not been determined.

In Alaska, brucellosis appeared to be on the increase in domestic reindeer in 1973 when herds were tested (Reindeer Herder's Newsletter, 1976). A government herd near Nome showed 11.9% positive reactors in 1973 in contrast to earlier levels of 4.5%, and another herd showed an increase to 8.0% in 1973 from 0.1% before 1973. Brucellosis has increased greatly since 1973 among reindeer on the northern Seward Peninsula (Dieterich, pers. comm.). The *Brucella* organism has also been isolated in wolves, bears, and foxes in the vicinity of reindeer herds. Among caribou of the Western Arctic Herd, the incidence of brucellosis has apparently declined from a higher level that coincided with peak numbers in the mid-1960's. This statement is based on the observed frequencies of retained placentas among caribou on the calving grounds which were 3.4% and 5.0% in 1963 and 1965 respectively (Neiland *et al.*, 1968) but declined to less than 2.0% in years since 1968 (Neiland, 1978). In Alaska, the incidence of brucellosis has fluctuated widely among both domestic reindeer and caribou but it appears to be most prevalent when herd populations are high.

The skin warble fly (*Oedemagena tarandi*) and nasal bot fly (*Cephenemyia trompe*) are perhaps the two most universally serious parasites of reindeer and caribou. In the Soviet Union and Scandinavia, massive control efforts have been mounted to eliminate these parasites, which harass the reindeer as adult flies in summer and weaken them through larval infestations in their tissues, as well as adversely affecting the quality of the hides. Control methods involve the use of dips and sprays at roundups to discourage attacks by the adult flies and inoculation with drugs which destroy the young larvae. Some drugs are completely effective in eliminating the parasite from individual animals, however, the parasites cannot be totally eliminated from herds as long as a reservoir of uninoculated reindeer or caribou remain in the area. Soviet authorities, as well as Alaskan reindeer managers, have argued that wild reindeer or caribou present in the vicinity of domestic reindeer herds are the major obstacle to the complete elimination of warble and bot flies. This assessment, however, does not appear to be objectively based. In Sweden, an intensive country-wide effort to eliminate warble and bot flies through inoculation of all reindeer met with failure, even in the absence of wild reindeer (Kummeneje, 1980). This failure was attributed to some domestic reindeer that eluded the roundups and the inoculations, and therefore continued to carry the parasites which could reinfect the inoculated

animals in the succeeding summer. Experience in the Soviet Union, as well as in Alaska, is that in virtually every reindeer herd some animals manage to avoid being rounded up and handled each year, thus rendering complete eradication of parasites and diseases through the use of inoculants nearly impossible.

The introduction of reindeer to West Greenland is an example of extremely imprudent action which led to the introduction of both the warble fly and nasal bot fly to the indigenous caribou of the region. The caribou had previously been free of these parasites but they spread rapidly through the widely dispersed herd and have subsequently led to deteriorated condition of the caribou and increased mortality rates (Thing, pers. comm.). Apparently no attempt was made to insure that the reindeer were free of these parasites at the time of their introduction.

High arctic caribou and reindeer in insular situations are normally free of warble and bot flies and may have lost other parasites and diseases due to periods of low populations, climatic conditions adverse to their free living stages, or other factors. These herds nevertheless may be vulnerable to reinfection, and because of the marginally favorable conditions under which they exist, additional stress of hosting new diseases or parasites may take a greater toll on the welfare of the populations than is true with caribou and reindeer on more southern ranges (Klein, 1980).

Several other diseases and parasites common to both reindeer and caribou could conceivably be transmitted when reindeer and caribou come into contact or make use of the same range areas. The likelihood of such exchanges varies with the etiology of the specific disease. For example, the anthrax organism (*Bacillus anthracis*) is extremely resistant to conditions encountered in the environment, and in the Soviet Union, reindeer ranges which became infected could not be used by reindeer for a period of several years unless all animals using the range were vaccinated against the disease (Zhigunov, 1968). The organism causing necrobacillosis (*Spherophorus necrophorus*), on the other hand, will only persist for a matter of days in tundra soils and direct contact between animals appears to be the most common mode of transmittal of the organism.

As is true of several parasites, intermediate hosts are required for completion of their life cycles; therefore, the relative abundance of the intermediate host species may limit the prevalence of the parasite in reindeer and caribou. The lung worm (*Dictyocaulus viviparus*) requires a snail as an intermediate host and the snail varies in abundance with vegetation types and climatic conditions. Likewise larval infections of the tape worms *Taenia hydatigena* and *T. krabbei*, which infect the tissues of all northern ungulates, require the wolf or other members of the dog family as intermediate hosts. These tape worm larvae are normally more common in caribou than reindeer because of the greater frequency of wolves in the vicinity of caribou.

Since most diseases and parasites common to reindeer and caribou are endemic in reindeer and caribou populations at least at threshold levels, the problem of transmission of these organisms between reindeer and caribou is often over-emphasized. The role of diseases and parasites in host animals is perhaps, for the most part, more directly related to the general health and nutritional status of

these animals than to the opportunity for contacting the infecting organisms. Reindeer herders can help keep disease and parasitism down in their herds through assuring proper year-round nutrition for their reindeer, plus the application of direct disease and parasite control methods.

Diseases such as anthrax, which may be introduced to reindeer from other domestic animals, would more likely be transmitted from reindeer to caribou rather than in the reverse direction. The high susceptibility of reindeer and caribou to anthrax is probably due to their having had little previous contact with the organism. Domestic reindeer may pose a similar threat to caribou in the case of other disease organisms normally associated with domestic animals because domestic reindeer are more likely to contact these diseases from domestic animals.

In northwestern Alaska, the possibility exists for caribou and reindeer to come into contact during winter when caribou of the Western Arctic Herd move onto rangelands near the base of the Seward Peninsula. Since spread of disease, and particularly brucellosis, is facilitated through contact, it is fortuitous that the caribou are normally not in this area during breeding or calving, when the likelihood of contact or the dispersal of infected material is highest. The fact that these caribou migrate hundreds of miles to the calving grounds north of the Brooks Range each spring before skin warbles and nasal bots have emerged also virtually eliminates them as a source from which warble and bot flies might infect domestic reindeer in the area.

BREEDING OF DOMESTIC REINDEER BY CARIBOU

In the Soviet Union, reindeer herders are advised not to allow breeding of their reindeer cows by wild reindeer bulls because the offspring will tend to be unsuitable as draft animals, difficult to handle, and will tend to wander away from the herd (Zhigunov, 1968). It seems reasonable that since domestic reindeer represent selection over many generations for characteristics which now distinguish them from wild reindeer and caribou, cross breeding with caribou would tend to restore unwanted characteristics. The situation, however, is complex and many Alaskan herders talk of increasing carcass size through introduction of caribou to their herds. In 1925, caribou bulls were introduced to a herd of domestic reindeer on Nunivak Island to increase body size of the animals in the herd, and first generation crosses averaged 50 to 100 pounds heavier as adults than the average reindeer in the herd (Palmer, 1934) (Fig. 4). Experimental crossing of caribou and reindeer at the Reindeer Experiment Station at Fairbanks led to a 30% increase in weight at birth and a 62% increase at 2 months of age (Palmer, 1934) (Fig. 5). The increased body size may be at least partially a result of heterosis.

Perhaps the most important reason for keeping caribou bulls away from domestic herds during the breeding season is the disruptive effect they can have on the herd through fighting and chasing of the reindeer bulls, splitting the herd in attempting to establish harems, and leading off groups of cows. Soviet authorities cite injury to domestic reindeer from wild reindeer bulls, scattering of their herds, and transmission of brucellosis as the main consequences of the presence



FIG. 4. A caribou bull being held by Eskimo boys on Nunivak Island prior to its release into the reindeer herd there, June 14, 1927. (L. J. Palmer Collection — Univ. of Alaska).



FIG. 5. A caribou-reindeer cross trained as a sled deer at the Reindeer Experiment Station, Fairbanks, June 29, 1926. (L. J. Palmer Collection — Univ. of Alaska).

of wild reindeer bulls near domestic herds during the rut (Borozdin, pers. comm). The problem is not a significant one at present in Alaska because caribou are not normally in the vicinity of domestic reindeer during the breeding season. The situation, however, could change in the future with the expansion of reindeer into new areas or with continued growth of the Andreafsky Caribou Herd, which is resident in and adjacent to the drainage of the Andreafsky River near the southeastern Seward Peninsula.

CONCLUSIONS

In the Soviet Union, where there is a long history of coexistence of domestic and wild reindeer, the consensus within the domestic reindeer industry is that wild reindeer are totally incompatible with domestic reindeer husbandry. Government policy is directed toward elimination of wild reindeer and replacement with domestic reindeer wherever rangelands are suitable for the practice of reindeer husbandry. The relatively few remaining areas relegated to wild reindeer are for the most part those where extensive movements are required, either on a short term or seasonal basis, for the animals to obtain adequate forage; in mountainous areas poorly suited for herding; and where domestic reindeer husbandry has not yet been fully developed. These include areas in the far north and on arctic islands where plant density is very low, the northern regions of the Taimyr and Yakutia where summer and winter ranges are widely separated, mountain regions south of areas of traditional reindeer husbandry, and a few wildlife preserves. Fencing is recommended around the wildlife preserves to avoid conflicts with adjacent herds of domestic reindeer.

Losses of domestic reindeer to wild reindeer and caribou herds can be anticipated whenever there is opportunity for contact. This apparently occurs, even under the moderately close herding that is carried out in the Soviet Union. However, under loose herding entire herds of domestic reindeer can be lost to caribou or wild reindeer. Wild reindeer or caribou in the vicinity of domestic herds also leads to increased herding problems associated with harassment of reindeer by wild bulls during the rut and increases in the frequency of wolves and other predators that normally accompany the wild herds.

The influence on wild herds of the domestic reindeer that join them appears to be minimal. Domestic animals are assumed to be relatively ineffective in breeding with their wild counterparts and they suffer high losses to predation and other natural mortality; however, studies are needed to determine the amount of genetic exchange that has taken place between domestic reindeer and specific wild herds.

Competition exists between domestic reindeer and wild reindeer and caribou for forage, particularly on the winter range. Caribou and wild reindeer, however, are less intensive feeders than the domestic animals and therefore require much larger feeding areas. Conversely, domestic reindeer have a much greater impact on forage vegetation as a result of their feeding activity, consuming larger portions of the plants and total forage available in feeding sites. Under most circumstances it appears that domestic reindeer consume a higher portion of lichens in their winter diet than caribou or wild reindeer.

Most diseases and parasites that infect domestic reindeer are also present in wild populations. The potential exists for either domestic or wild populations to serve as reservoirs for diseases and parasites which may be exchanged between populations. Normally, however, the relative effects of diseases and parasites on herd welfare are more dependent on the condition of the animals in the specific herds than on exchange between herds. These conditions include the nutritional status of the animals, their density and frequency of contact, the intensity of use of the range, availability of intermediate hosts, and weather and terrain conditions.

In northwestern Alaska, brucellosis is the disease, and the warble and bot flies are the parasites generally considered to have the greatest potential detrimental effect on both domestic reindeer and caribou. Fortunately, the long seasonal migrations of caribou in that region usually result in the wide separation of the caribou from domestic reindeer at the time when transmittal of brucellosis and the parasitic flies is most likely.

The breeding of domestic reindeer cows by wild reindeer bulls is considered undesirable by reindeer herders in the Soviet Union because the offspring are less manageable than reindeer. Breeding of reindeer by caribou bulls is not currently a problem in Alaska but conceivably could become one either with the expansion of reindeer herding to new areas or through increase in size or altered movements of caribou herds.

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