Brief Communication Communication brève

Long distance spread of malignant catarrhal fever virus from feedlot lambs to ranch bison

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Abstract — Malignant catarrhal fever (MCF) caused by OvHV-2 occurred in ranch bison herds separated by significant distances from feedlot lambs. Mortality rates correlated with distances: 17.5%, 6.1%, and 0.43% at approximately 1.6, 4.2, and 5.1 km, respectively. The study further defines the importance of distance of species separation for MCF control.

Résumé — Transmission sur de longues distances du virus du coryza gangreneux par des agneaux en parc d'engraissement à des bisons d'élevage. Le coryza gangreneux (CG) causé par OvHV-2 est apparu dans des troupeaux de bisons d'élevage séparés par des distances significatives d'un parc d'engraissement d'agneaux. Les taux de mortalités corrélés avec les distances étaient de 17,5 %, 6,1 % et 0,43 % à approximativement 1,6, 4,2 et 5,1 km, respectivement. De plus, cette étude précise l'importance de la distance de séparation des espèces dans le contrôle du CG.

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Malignant catarrhal fever (MCF) is a devastating disease for the highly susceptible American bison *(Bison bison)*. It is becoming one of the most important infectious diseases for bison producers in North America (1,2). Though most cases occur sporadically, large outbreaks that result in significant mortality have recently been seen in bison feedlots and ranches: 6.6% MCF-associated mortality in a feedlot in the midwestern USA was reported by O'Toole et al (3); 27.6% of bison died from MCF after being exposed to sheep for less than a day at an auction barn in Saskatchewan (4); over 800 (52%) bison from a feedlot in southern Idaho developed MCF after exposure to an adjacent sheep flock for 19 d (1); and nearly all animals in a small bison herd pastured 1.6 km from a sheep feedlot died from MCF over a 2-year period (2). Virtually all bison MCF cases in the USA and Canada are caused by ovine herpesvirus 2 (OvHV-2), for which domestic sheep serve as the subclinical reservoir. Long distance spread of OvHV-2 from sheep to clinically susceptible species has never before been documented. There has been much confusion in the past about MCF outbreaks in bison that lacked direct contact with or exposure over a short distance to sheep, raising the question of whether bison-to-bison transmission occurred (2). We report herein the spread of OvHV-2 from lambs in a feedlot to separate herds of bison on a neighboring ranch, in which some of the cases occurred over distances of up to 5 km, resulting in a total of 60 (7.9%) out of 761 bison developing MCF over a 6-month period. The mortality rate in the different herds was proportional to the distance from the sheep feedlot.

The MCF outbreak occurred on a bison ranch located in the western USA. No MCF losses had been observed on the ranch for the past several years, prior to the establishment of a sheep feedlot with a capacity of 60 000 head nearby (Figure 1). In early November, approximately 20 000 lambs, aged 6 to 7 mo, were moved into the feedlot for fattening. Meanwhile, a total of 761 bison in 3 herds were grazed in separate, well-fenced locations within the ranch: herds 1 (n = 234), 2 (n = 293), and 3 (n = 234) were approximately 1.6, 4.2, and 5.1 km north and northeast from the feedlot, respectively (Figure 1, Table 1). In the middle of December, approximately 40 d after lambs were first installed, 2 bison deaths from suspected MCF occurred in herd 1. Tissue samples were collected and sent to the Washington Animal Disease Diagnostic Laboratory for diagnostic confirmation. In both cases, observed microscopic lesions were compatible with MCF (3) and PCR specific for OvHV-2 (5) was positive. In late December, all the bison in this herd were moved to another pasture (a) (Figure 1) about 2.5 km from the feedlot. In January, 4 bison developed MCF from this herd. In February, all bison in herd 1 were again moved about 0.8 km farther to the northeast (pasture b) (Figure 1). Between February and March, 17 additional bison died from MCF in herd 1. The remaining bison in this herd were relocated approximately 4.2 and 5 km to the north (pastures c in April

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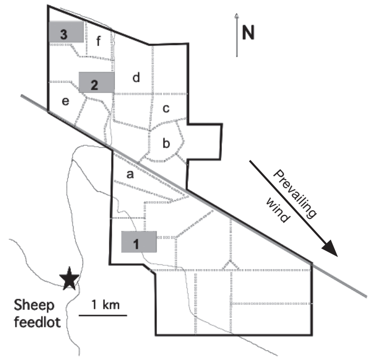

Figure 1. A schematic diagram of sheep feedlot location (star) in relation to 3 bison herds (grey squares with the numbers). Herd 1 was initially approximately 1.6 km from the sheep feedlot, but it was moved to pasture 'a' (late December and January), 'b' (February and March), 'c' (April), and 'd' (May). Herd 2 was initially approximately 4.2 km away from the sheep feedlot; subsequently, it was moved to pasture 'e' in March and then returned to the original pasture in April. Herd 3 was initially approximately 5.1 km away from the sheep feedlot, but it was relocated in pasture 'f' in April. The relative distances of the sheep feedlot from pastures 'a', 'b', 'c', 'd', 'e', and 'f' were approximately 2.6, 3.3, 4.2, 4.8, 3.9, and 5.0 km, respectively. Thin curved lines represent gravel roads. The north end of the road connects with a major highway that is used in shipping sheep in, from north to south, and out, from south to north; heavy straight line represents a railroad track. The prevailing wind is from northwest to southeast, as shown by the arrow.

and d in May, Figure 1). Mortality due to MCF in herd 1 continued: 12 deaths in April, and 6 in May, reaching a total of 41 (out of 234). During the 6-month period, herd 2 was moved to pasture (e) (Figure 1) in March and returned to its original pasture in April. Herd 3 was relocated to pasture (f) (Figure 1) in April. The relative distances from the sheep feedlot to these 2 herds did not change significantly during the 6-month period. Mortality due to MCF also occurred in bison herd 2: 12 died in March and 6 died in April (a total of 18 out of 293). Only 1 of the 234 bison in herd 3 died; this occurred during April. The presence of OvHV-2 DNA was confirmed by PCR in peripheral blood, tissues, or both, from all of the 60 bison with suspected MCF. The remaining bison from all 3 herds were moved to a bison feedlot in late May, where there were no sheep within at least 24 km. Malignant catarrhal fever continued to occur in the bison feedlot, but only in those bison from the ranch in question. Thirty (unconfirmed) MCF cases were reported in the bison that originated from the ranch in this study, but none in animals originating from other locations. The percentages of mortality among the different original herds were not available, since all bison from the 3 herds were mixed into a single group in the feedlot. Not considering the additional MCF cases that occurred in the aforementioned bison feedlot, the percentages of MCF mortality in the 3 different bison herds at the ranch were 17.5%, 6.1%, and 0.43%, respectively (Table 1).

Herpesvirus transmission generally is associated with close contact or short distance separation. However, there have been reports of airborne transmission of pseudorabies in swine over significant distances (6,7). The present report is the 1st to

Table 1. Summary of malignant catarrhal fever cases occurring in bison at various distances from a sheep feedlot

Herd	1	2	3	Total
Approximate distance (km) from the sheep feedlot	1.6	4.2	5.1	
Number of bison in herd	234	293	234	761
Number of MCF cases	41	18	1	60
% Mortality	17.5	6.1	0.43	7.9

MCF — Malignant catarrhal fever

document that OvHV-2 can be transmitted from sheep to bison, even against the prevailing winds, over a significant distance (up to 5 km). These cases occurred in the absence of any travel between the 2 operations by individual workers, as the 2 enterprises had no connection whatsoever. However, the possibility that virus could have been shed from trucks that occasionally hauled lambs on the road that traversed pastures or bordered the fences in places (Figure 1) cannot be ruled out, although it was unlikely, since the mortality rates in the bison herds were highly related to their distance from the sheep feedlot rather than the truck route.

The probability for OvHV-2 transmission over significant distances is closely related to the amount of virus available. This has been shown to be a function of the ages and number of sheep. A recent study showed that lambs between 6 and 9 mo of age shed virus more frequently and in much larger amounts than did adults (8). Sheep of this age represent the greatest danger to clinically susceptible species, and it is the age at which most lambs are brought into feedlots for fattening. Therefore, sheep feedlots are particularly rich sources of MCF virus.

The precise means by which OvHV-2 is transmitted from sheep to bison is not yet well defined, particularly that occurring over significant distances. Aerosol probably plays a major mode in the transmission, although other factors, such as climate (wind, temperature, and moisture) and mechanical vectors, such as birds, may also be involved. A previous study has documented that nasal secretions are the predominant vehicle by which OvHV-2 is shed from sheep (8). Nasal secretions from sheep experiencing shedding episodes can reliably infect negative sheep and induce MCF in cattle and bison by experimental aerosolization (9–11), suggesting an important role for aerosol transmission. Prevailing winds can significantly enhance the efficiency of aerosol transmission. Whether or not the morbidity rate would have been higher had the bison been located downwind from the lambs is not known. Birds represent a potential mechanical vector that may have played an important role in this outbreak. During cool wet periods particularly, virus carried in sheep nasal secretions adhering to the feet of birds that walk in the feeders could easily survive to contaminate the feedstuffs of animals residing at a considerable distance. Numerous birds in the vicinity, attracted to the animal feed, could have visited both the sheep feedlot and the bison pastures. Although transmission by birds has not been experimentally documented, individuals considering control measures would be well advised to address this potential source of virus spread.

Bison were hunted almost to extinction in the 19th century, being reduced to a few hundred head by the mid-1880s. Due to a variety of efforts, the bison population has steadily increased in the USA and Canada since that time, particularly in recent decades. The current population of American bison is estimated at 500 000 in North America. Because of profitability and high demand for bison meat, many cattle producers have converted their ranches to raise bison. With an increasing bison population, MCF has been emerging as a devastating problem for North American bison producers, because bison are much more susceptible to the disease than are cattle. In a recently reported MCF outbreak in a southern Idaho feedlot, exposure of 1610 bison and approximately 4000 beef cattle to an adjacent flock of lambs for about 3 wk resulted in a dramatically different rate of MCF mortality between the 2 species: 51.2% ($n = 825$) mortality rate in bison, but only 0.025% ($n = 1$) in cattle (1). Furthermore, experimental studies to define the difference in susceptibility to MCF between bison and cattle by aerosolization of infectious OvHV-2 showed that cattle required at least 1000-fold more virus to develop MCF than did bison (8,10).

No vaccine is currently available for MCF. The only practical control for MCF in bison at present is physical separation from sheep. Simply preventing cross-fence contact between sheep and bison is clearly not adequate. The data from the study herein showed a significant difference in MCF mortality rates among the bison herds at varying distances from the feedlot lambs. The establishment of effective, yet practical, separation distance guidelines represents an important issue facing sheep and bison producers in MCF control programs. Detailed examination of recent MCF outbreaks in bison, as well as data from experimental studies, has permitted us to draw insights into several important epidemiologic factors, such as relationships between distances, numbers and ages of sheep, and the probability of transmission of MCF virus to bison. In the meantime, more widespread awareness, among both sheep and bison producers and involved veterinarians, of currently available information about the disease and the factors influencing virus transmission would be beneficial to both the sheep and bison industries.

Author contributions

Dr. Li designed the experiment, conducted all the laboratory tests, analyzed the data, and wrote the manuscript. Mr. Karney recorded the information needed for publication, collected all of the samples for the study, drew the ranch map for the manuscript, and reviewed the manuscript. Dr. O'Toole was consulted regarding the outbreak, participated in the experimental design, performed all histopathological examinations, and reviewed the manuscript. Dr. Crawford played a major role in the initial experimental design, carried out all communication between the research laboratory and the ranch over the period in study, participated in data analysis, and assisted in the writing and editing of the manuscript.

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