Survey for Antibodies Against Various Infectious Disease Agents in Muskoxen (Ovibos moschatus) from Jamesonland, Northeast Greenland

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these hosts and the persistence of such infections. The observations of Locke et al. (1974, op. cit.) on salmonellosis in a captive heron colony suggest that these possibilities are likely. The extent to which *Salmonella* spp. infections may limit natural populations of wading birds requires further study.

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Survey for Antibodies Against Various Infectious Disease Agents in Muskoxen (*Ovibos moschatus*) from Jamesonland, Northeast Greenland

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Knowledge of diseases in free-living muskoxen in general is very limited, and nothing is known about the disease condition among the 15,000–20,000 muskoxen living on the northeastern coast of Greenland.

Testing for serum antibodies is often the first step in disease investigation in a population. Thus when nearly 500 muskoxen were immobilized and tagged as a part of a biological study (Clausen et al., 1984, J. Wildl. Dis. 20: 141–145), blood samples were taken from the tarsal vein of 132 apparently healthy muskoxen. There were 35 males and 53 females more than 3 yr of age, five males and five females 2 yr of age and eight males and 11 females born the previous spring.

The blood samples were kept at 0 C in a hole in the ground just over the permafrost. Due to inadequate separation of the serum, heparin was in most cases added to the blood container. Plasma was separated 2–3 days later; streptomycin (about 50 μg/ml) was added for preservation. After the expedition the samples were flown to the State Veterinary Serum Laboratory (SVS) and kept at −20 C until they were tested for antibodies against 16 diseases known to occur among domestic and wild ungulates in the northern hemisphere (Davis et al., 1981, Iowa State Univ. Press, Ames, Iowa, 446 pp.).

No antibodies for any of the following pathogens were detected in the blood samples from the muskoxen.

Blue tongue (BT) virus (126 samples) was tested by an antibody blocking ELISA test using a polypeptide antigen (purified BT virus structural protein p 7 from BT type 10) which is a cross-reacting antigen shared by various serotypes. The reaction is produced by a) the above-mentioned antigen, b) rabbit antiserum for purified BT type virus, and c) peroxidase conjugated antibody for rabbit IgG. Test sera were introduced between steps a and b in a dilution of 1:4. Sera giving an inhibition of the specific reaction of 50% or more were considered positive.

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Bovine leukemia virus (132 samples) was tested by an agar gel immunodiffusion test (Hoff-Jørgensen et al., 1978, Ann. Rech. Vet. 9: 879–883).

Bovine virus diarrhea (BVD) was tested by a microtiter test (Frey et al., 1971, Zentralbl. Med. 18: 61–71).

Contagious ecthyma (CE) virus (121 samples) was tested by a neutralization test for antibodies against CE virus of the ovine type. Equal amounts of plasma (inactivated at 56 C for 30 min) and virus (100 $TCIC_{50}$/0.1 ml) were mixed and left for neutralization at 37 C for 60 min, whereafter, 0.2 ml of the plasma virus mixture was inoculated on two cultures of ovine plexus choriodeus cells. The cultures were examined for cytopathogenic effect with final reading after 7 days. Apart from brucellosis, CE is the only disease in the present investigation that has been detected in muskoxen. CE occurred among domesticated muskoxen in Norway (Kummeneje and Krogsrud, 1978, Acta Vet. Scand. 19: 461–462). The muskoxen had been introduced from northeastern Greenland some years before, but it was concluded that they were probably infected by contact with sheep in Norway. In Alaska CE, apparently of the ovine type, was diagnosed in muskoxen and Dall sheep (*Ovis dalli*) (Dietrich et al., 1981, J. Am. Vet. Med. Assoc. 179: 1140–1143).

Foot-and-mouth disease, types A, O and C (126 samples) was tested by an ELISA antiblocking test (Have and Jensen, 1983, FAO Report No. M/q 5522/e/12.83/1/250, FAO, Rome, Italy).

Infectious bovine rhinotracheitis virus (IBR), parainfluenza 3 (P3) and bovine herpes mammilitis virus (BHM) (30 samples for each test) were tested by a serum neutralization test (Bitsch, 1978, Acta Vet. Scand. 19: 497–505).

Maedi-visna virus (132 samples) was tested by an agar gell immunodiffusion test (Valder et al., 1978, Dtsch. Tierärztl. Wochenschr. 85: 368–370). Maedi-visna was eradicated in 1965 from sheep in Iceland, which is the nearest livestock area about 600 km east of Jamesonland.

Rabies virus (104 samples) was tested by a rapid fluorescent focus inhibition test (Smith et al., 1973, W.H.O. Monogr. Ser. 23: 354–357). Rabies is the only one of the 16 diseases that has been confirmed in Jamesonland. It was diagnosed in 1976 in arctic foxes (*Alopex lagopus*) and Greenland huskies (*Canis familiaris*) near the settlement Scoresbysund in the southernmost part of Jamesonland (Müller, pers. comm.).

Chlamydia infection (131 samples) was tested by a complement fixation test (Friis, 1967, Nord. Veterinaermed. 19: 572–577).

Brucella abortus (132 samples) was screened by an agglutination test (Bendtsen, 1952, Munksgaard, Copenhagen, pp. 1–95). Rangiferine brucellosis (*Brucella suis* biotype 4) has recently been found in a free-living muskox in Canada (Gates et al., 1984, J. Wildl. Dis. 20: 233–234). There have been caribou (*Rangifer tarandus*) in northeast Greenland, but they disappeared in 1900 (Degerboel 1957, Acta Arct. 10: 1–57). It is not known whether they carried brucellosis, but if the muskoxen had been exposed to *B. suis*, antibody should have been detected by the technique used in the present survey.

Mycobacterium species were tested by an agar gel immunodiffusion test as described for bovine leukemia. Antigen was produced from *Mycobacterium paratuberculosis* (Jensen, 1956, Nord. Veterinaermed. 8: 357–367).

Francisella tularensis (121 samples) was tested by a microfluorescent antibody test (Mörner, pers. comm.). Tularemia is known to occur in the Scandinavian lemming (*Lemmus lemmus*) (Olin, 1942, Acta Pathol. Microbiol. Scand. 19: 220–247), and low, probably insignificant serum antibody titers have been found in moose (*Alces alces*) in areas where the disease is endemic (Mörner and Sandstedt, 1983, Nord. Veterinaermed. 35: 82–85).

Leptospira infections (131 samples)

were tested by the microscopic agglutination test for *L. grippotyphosa*, *L. hardjo*, *L. icterohaemorrhagia*, and *L. pomona* (Cole et al., 1973, Appl. Microbiol. 25: 976–990).

Toxoplasma gondii (129 samples) was tested by the dye test (Aagaard, 1960, Human Toxoplasmosis, Munksgaard, Copenhagen, pp. 206–210). Toxoplasmosis is probably the most widespread zoonosis in the world. *Toxoplasma* antibody was not found in any of approximately 200 sheep examined in the southern part of West-Greenland (Bille, 1974, Proc. Symp. III Int. Cong. Parasitol., München, Fed. Rep. Germany, p. 307), nor was it found in any of 21 polar bears (*Ursus maritimus*) in an area about 250 km north of Jamesonland (Clausen, unpubl. data).

The procedure of sampling about 3% of the population should have resulted in the detection of antibodies present for any disease of significance in the muskox population in Jamesonland.

Through observation of tagged animals it is evident that some areas are intensively used for grazing. This results in locally high densities of muskoxen. Tagging also showed that the various groups are not isolated but rather dynamic units with an extensive exchange of individuals taking place among groups. All this would facilitate the spread of contagious diseases if they were present.

Furthermore various possible vectors and reservoir hosts are present in the area, such as mosquitoes (*Aedes* sp.), biting flies (Ceratopogonidae), black flies (Simulidae), lemmings (*Dicrostonyx groenlandicus*), raven (*Corvus corax*) and arctic fox.

Except for CE and brucellosis, muskoxen are not known to be susceptible to any of the 16 diseases covered by this survey, but most of those diseases have a wide range of hosts, and it is believed that the diseases dealt with here could all give rise to antibody formation in muskoxen. It is not known for how long antibodies would persist in the muskox. The negative results do not completely preclude the presence of the 16 diseases in the area. However, any recent large outbreak among the approximately 4,000 muskoxen would probably have been detectable.

A population with no known history of disease and with no evidence of antibodies for 16 fairly common infectious diseases of livestock is likely to be very susceptible and vulnerable to disease challenge. Therefore, the strictest precautions ought to be taken to prevent introduction of livestock and other potential carriers of pathogens to the muskoxen habitats in northeastern Greenland.

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