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Septicemic Pasteurellosis in Elk (*Cervus elaphus*) on the United States National Elk Refuge, Wyoming

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ABSTRACT: Septicemic pasteurellosis caused by *Pasteurella multocida* is believed responsible for the deaths of 48 elk (*Cervus elaphus*) on the National Elk Refuge near Jackson, Wyoming (USA) during 1986 and 1987. Clinical signs included depression and salivation; necropsy findings included congestion and petechial and ecchymotic hemorrhages in lymph nodes, diaphragm, lungs and endocardium. *Pasteurella multocida* was isolated from femur marrow of eight carcasses and a variety of tissues from eight others.

Key words: Septicemic pasteurellosis, *Pasteurella multocida*, elk, *Cervus elaphus nelsoni*, National Elk Refuge, epizootic, case history study.

Septicemic pasteurellosis is an acute disease of wild and domestic ruminants caused by *Pasteurella multocida*. Clinical signs described in domestic animals include fever, profuse salivation, submucosal petechiation, severe depression, and death in about 24 hr (Blood et al., 1979). Septicemic pasteurellosis is endemic in southern Europe, parts of Africa, the Near East and southern Asia and causes considerable economic loss in cattle and water buffalo (Bain et al., 1982).

Septicemic pasteurellosis is uncommon in the United States but has been reported from dairy cattle (Kradel et al., 1969) and several species of free-ranging wildlife. An epizootic of pasteurellosis occurred in bison (*Bison bison*) at Yellowstone National Park in 1922 (Gochenour, 1924). Heddleston and Gallagher (1969) reported that sera from bison at the National Bison Range, Montana; Custer State Park, South Dakota; Wichita Mountains National Wildlife Refuge, Oklahoma; and Roosevelt National Park, North Dakota had significant levels of antibody to *P. multocida* strain M-1404 which was isolated from a bison that died in 1922. A 2-yr-old female elk died of septicemic pasteurellosis in Carbon County, Wyoming in 1960 and several cases have been reported from pronghorn antelope (*Antilocapra americana*) elsewhere in Wyoming (Thorne, 1982). Murie (1951) indicated that *P. multocida* was isolated from one elk in the Jackson Hole herd, but it is unclear whether the animal died of septicemic pasteurellosis. We report here septicemic pasteurellosis in elk on the National Elk Refuge near Jackson, Wyoming in 1986 and 1987.

During the winter of 1985–1986, 120 elk mortalities (36 adult bulls, four spike bulls, 45 cows and 35 calves) were recorded on the United States National Elk Refuge (43°28′ to 43°38′N, 110°35′ to 110°45′W) from a peak population of 6,430 animals. Scavenging by coyotes (*Canis latrans*) prevented necropsy examination of most carcasses, but septicemic pasteurellosis is believed to be responsible for 38 mortalities (24 calves, 2 yearling cows, 12 adult cows) during January, February, and March. These animals died after exhibiting severe depression with head held low and ears drooping for a period of ≤24 hr. Profuse salivation was noted in several cases and tremors were observed in two animals. All animals examined were in good body condition, based on gross physical appearance and presence of fat deposits. Necropsy findings in six carcasses (one cow, two male calves, three female calves) included enlarged, congested lymph nodes; petechial hemorrhages on surfaces of the diaphragm, lungs, and coronary fat; ecchymotic hemorrhages on the endocardium; and splenic enlargement. Histopathologic observations included congestion and

hemorrhage in heart, lung, spleen, and lymph nodes; acute suppurative lymphadenitis; and bacteremia. *Pasteurella multocida* was isolated according to standard microbiological methods (Weaver et al., 1985) from two or more of the following tissues from each carcass: liver, spleen, kidney, lymph node, lung, myocardium, trachea and brain. Isolates from three animals were identified as serotype 3 by the use of a gel diffusion precipitin test (Heddleston et al., 1972).

A yearling cow died of severe pneumonia caused by concurrent *P. multocida* and *Corynebacterium pyogenes* infection. This animal had been observed depressed and separated from the herd for 5 days before it died. Gross lesions included extensive fibrinous adhesions between the lungs, pleura, pericardium, and thoracic wall. Lungs contained abscesses consisting of yellow, cheesy exudate. *Brucella abortus* was also isolated from the uterus.

Of the remaining 81 deaths, psoroptic mange was likely a contributing factor in 28 (19 adult bulls and nine cows) based on clinical observations and recovery of *Psoroptes cervinus* from skin samples. Incisors were collected for aging (Keiss, 1969) from 35 of the 38 suspected pasteurellosis mortalities and from 69 of the other 81 dead elk. The age ($\bar{x}$ = 2.0 yr; SE = ±0.4) of those dying of pasteurellosis was significantly lower than the age ($\bar{x}$ = 5.4 ± 0.5 yr) of non-pasteurellosis mortalities (t_s = 4.78; df = 102; $P < 0.001$).

Mortality caused by septicemic pasteurellosis corresponded with a period of extreme weather fluctuations. Peak mortality of 17 animals occurred during 12 to 23 February. During this period, 9.5 cm of precipitation (mostly rain) fell and gusty wind conditions prevailed; on 18 February a wind velocity of 184 km/hr was recorded at Jackson Hole airport near the north end of the Refuge. Precipitation and thawing temperatures resulted in extremely muddy conditions, particularly at the Nowlin feedground (43°31'N, 110°44'W) where 32 of 38 septicemic pasteurellosis mortalities occurred. During peak mortality, 2,000 to 3,000 elk were using this feedground, an area of about 162 ha. The adverse environmental conditions probably put additional stress on the elk and contributed to the septicemic pasteurellosis outbreak. Bain et al. (1982) indicate that in tropical countries septicemic pasteurellosis occurs more frequently during the rainy season and that temperature and seasonal changes are thought to influence the prevalence of clinical disease.

During the winter of 1986–1987, 81 elk died on the Refuge. *Pasteurella multocida* (serotype 3 × 4) was isolated from tissues of an elk that exhibited no gross lesions. *Pasteurella multocida* (not serotyped) was isolated also from tissues from a second elk and from femur marrow of eight animals not suitable for necropsy because of scavenging by coyotes. The 10 isolates came from seven adult females, two yearling females, and one adult male. Only two of the deaths occurred at the Nowlin feedground; the rest occurred at the McBride feedground, about 4 km away. Feedground conditions were better during 1986–1987 because of above normal temperatures and below normal precipitation, which may have contributed to lower mortality. The peak elk population on the Refuge during the winter of 1986–1987 was 7,820.

Ages of all the 81 dead elk were determined. There was no significant difference between the age ($\bar{x}$ = 4.1 ± 0.8 yr) of the animals that died of pasteurellosis and the age ($\bar{x}$ = 6.8 ± 0.6 yr) of the remaining 71 animals (t_s = 1.61; df = 79; $P > 0.05$). It is of interest to note that septicemic pasteurellosis affected younger animals in 1985–1986 ($\bar{x}$ age = 2.0 ± 0.4 yr) than in 1986–1987 ($\bar{x}$ age = 4.1 ± 0.8 yr) (t_s = 2.22; df = 43; $P < 0.05$). One might expect very young or very old animals to be more likely to succumb to septicemic pasteurellosis. Perhaps the *P. multocida* was more virulent for younger animals during 1985–

1986, or the adverse feedground conditions may have rendered calves more susceptible.

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LITERATURE CITED

BAIN, R. V. S., M. C. L. DE ALWIS, G. R. CARTER, AND B. K. GUPTA. 1982. Hemorrhagic septicemia. F.A.O. Animal Production and Health Paper No. 33, Food and Agriculture Organization of the United Nations, Rome, Italy, 54 pp.

BLOOD, D. C., J. A. HENDERSON, AND O. M. RADOSTITS. 1979. Veterinary medicine, 5th ed. Lea and Febiger, Philadelphia, Pennsylvania, 1135 pp.

GOCHENOUR, W. S. 1924. Hemorrhagic septicemia studies. Journal of the American Veterinary Medical Association 65: 433–441.

HEDDLESTON, K. L., AND J. E. GALLAGHER. 1969. Septicemic pasteurellosis (hemorrhagic septicemia) in the American bison: A serologic survey. Bulletin of the Wildlife Disease Association 5: 206–207.

———, ———, AND P. A. REBERS. 1972. Fowl cholera: Gel diffusion precipitin test for serotyping *Pasteurella multocida* from avian species. Avian Diseases 16: 925–936.

KEISS, R. E. 1969. Comparison of eruption-wear patterns and cementum annuli as age criteria in elk. The Journal of Wildlife Management 33: 175–180.

KRADEL, D. C., K. L. HEDDLESTON, J. V. RISSER, AND J. E. MANSPEAKER. 1969. Septicemic pasteurellosis (hemorrhagic septicemia) in young dairy cattle. Veterinary Medicine/Small Animal Clinician 64: 145–147.

MURIE, O. J. 1951. The elk of North America. The Stackpole Co., Harrisburg, Pennsylvania and the Wildlife Management Institute, Washington, D.C., 376 pp.

THORNE, E. T. 1982. Pasteurellosis. *In* Diseases of wildlife in Wyoming, 2nd ed., E. T. Thorne, N. Kingston, W. R. Jolley, and R. C. Bergstrom (eds.). Wyoming Game and Fish Department, Cheyenne, Wyoming, pp. 72–77.

WEAVER, R. E., D. G. HOLLIS, AND E. J. BOTTONE. 1985. Gram-negative fermentative bacteria and *Francisella tularensis*. *In* Manual of clinical microbiology, 4th ed., E. H. Lennette, A. Balows, H. J. Hansler, Jr., and H. J. Shadomy (eds.). American Society for Microbiology, Washington, D.C., pp. 309–329.

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