Corynebacterium pseudotuberculosis and Copper Deficiency in a Male Rocky Mountain Bighorn Sheep (Ovis canadensis canadensis) in Utah, USA

E. Jane Kelly,1,4 Annette Roug,2 Covy Jones,2 Josee Seamons,2 and Jeffery O. Hall3

1Central Utah Branch of the Utah Veterinary Diagnostic Laboratory, 514 W 3000 N, Spanish Fork, Utah 84660, USA; 2Utah Division of Wildlife Resources, 1594 W North Temple, Suite 2110, Salt Lake City, Utah 84116, USA; 3Utah Veterinary Diagnostic Laboratory, 950 E 1400 N, Logan, Utah 84341, USA; 4Corresponding author (email: Jane.Kelly@usu.edu)

ABSTRACT: In 2015, an emaciated Rocky Mountain bighorn (Ovis canadensis) ram was submitted to the Utah Veterinary Diagnostic Laboratory for necropsy. There were numerous thick-walled abscesses subcutaneously and internally, and Corynebacterium pseudotuberculosis was isolated in pure culture. In addition, the ram was severely copper deficient, with a liver copper concentration of 1.6 mg/kg.

In November 2015, the Utah Division of Wildlife Resources submitted an emaciated Rocky Mountain bighorn sheep (Ovis canadensis canadensis) ram found alive in American Fork Canyon, Wasatch Mountains, Utah, US (40°26’01.6152”N, 111°44’46.3277”W), to the Utah Veterinary Diagnostic Laboratory in Spanish Fork, Utah, for necropsy. Respiratory disease has long been suspected in the American Fork Canyon bighorn sheep population (Shannon et al. 2014) and was the anticipated cause of death. Blood and nasal and tonsilar swabs were collected immediately after euthanasia. The ram weighed 66.8 kg and was approximately 7.5 yr old. On post-mortem examination, numerous thick-walled (0.25 cm to 0.5 cm) subcutaneous and internal abscesses were found, ranging in size from 1 cm in diameter to the largest one in the pelvic cavity that was almost 15 cm in diameter (Fig. 1). In addition to the pelvic abscess, two abscesses were found in the retropharyngeal region of the head, two were located subcutaneously in the left inguinal region, and there were numerous abscesses throughout the liver, and numerous abscesses in the mesentery. There was no evidence of pneumonia. The thick, white, caseous exudate from one of the abscesses was cultured aerobically. A pure growth of small, white, dry colonies was obtained on 5% sheep blood agar (Hardy Diagnostics, Santa Maria, California, USA), whereas no growth was seen on MacConkey agar (Hardy Diagnostics). There was a narrow zone of hemolysis on the blood agar after 2 d of incubation. The catalase-positive, Gram-positive, pleomorphic rod-shaped bacterial isolate was identified as Corynebacterium pseudotuberculosis by API Coryne (BioMerieux, Inc., Durham, North Carolina, USA), and it did not reduce nitrate to nitrite, which is typical of isolates from domestic sheep and goats (Brown and Olander 1987). Serum and swabs were submitted to the Washington Animal Disease Diagnostic Laboratory, Pullman, Washington. Antibodies for parainfluenza type 3 virus were detected at a titer >1:512, indicating previous exposure. Antibodies to bluetongue, bovine respiratory syncytial virus, bovine herpesvirus-1, epizootic hemorrhagic disease virus, and Mycoplasma ovipneumoniae were not detected. The PCR analysis for M. ovipneumoniae from nasal swabs, and bacterial culture and leukotoxin A PCR of tonsillar swabs were negative.

In an attempt to identify factors that may have caused immunosuppression in this animal, and because copper and selenium deficiencies in livestock are prevalent in many areas of Utah (Hall and Zobell 2010), a liver mineral analysis was performed, as previously described (Vest et al. 2009). The normal range of liver copper in bighorn sheep is 25 to 100 mg/kg (Puls 1994). The ram was severely copper deficient, with a liver copper concentration of 1.6 mg/kg. There were no significant abnormalities detected in any of the other 29 elements analyzed, including selenium.
Corynebacterium pseudotuberculosis is a pleomorphic Gram-positive bacterial rod that has been associated with suppurative diseases and abscesses worldwide in many species, including humans. Disease caused by C. pseudotuberculosis is perhaps best known in domestic small ruminants and horses. In horses (Equus caballus), the bacterium causes a disease known as pigeon fever or dryland distemper, which causes abscesses in the pectoral region and sometimes internally (Pratt et al. 2005). Cases are more prevalent in the warmer months, and proposed means of transmission include insect vectors. (Barba et al. 2015). In sheep (Ovis aries) and goats (Capra aegagrus hircus), C. pseudotuberculosis causes caseous lymphadenitis. Affected small ruminants may have superficial abscesses as well as internal abscesses in the lung, liver, kidneys, lymph nodes, and spleen (Williamson 2001). Most commonly, breaks in the skin, such as those caused by shearing injuries, castration, or tail docking, allow the bacterium into the body, and it then spreads via lymphatics (Williamson 2001). Cross transmission between horses and domestic small ruminants does not appear to occur (Brown and Olander 1987); however, either biotype of C. pseudotuberculosis (Corynebacterium ovis or Corynebacterium equi) may infect cows (Bos taurus; Yeruham et al. 2003). It is not known if transmission of C. pseudotuberculosis occurs between domestic animals and wildlife.

In Utah, infections with C. pseudotuberculosis have previously been confirmed in farmed elk (Cervus elaphus nelson; Kelly et al. 2012). Cases of caseous lymphadenitis and pigeon fever also occur yearly in Utah.

Copper is a trace mineral needed for collagen synthesis and maintenance, enzyme function, red blood cell maturation, reproduction, and immune response (Suttle 2010). Sheep are susceptible to copper deficiency and toxicosis, with a relatively narrow normal range in between (Kahn 2010). According to Puls (1994), a diet with 0.5 to 3.0 mg/kg copper is deficient, yet >20 mg/kg dietary copper is toxic in sheep. Much less is known about normal mineral concentrations, deficiencies, and toxicity in wild ruminants, though a few cases of mineral deficiency have been reported. For example, clinical copper deficiencies were reported in Tule elk (Cervus canadensis nannodes) showing unthriftiness, poor hair coats, or abnormal rates of antler breakage in California (Gogan et al. 1989; Johnson et al. 2007). Little information is available on liver mineral concentrations in bighorn sheep, and normal reference intervals have not been established for many minerals. Poppenga et al. (2012) measured serum or whole blood concentrations of nine minerals, including copper, in seven populations of bighorn sheep in California and found several animals with serum copper concentrations that would be considered deficient for domestic sheep. It is possible that bighorn sheep are more tolerant of mineral deficiencies than...
domestic sheep as they have evolved in mineral-deficient environments (Poppenga et al. 2012). It is also possible that populations can survive with mineral deficiencies, but with poorer reproductive potential and increased susceptibility to disease.

It is possible that copper deficiency and advanced age may have contributed to immune suppression in this ram and made it more susceptible to severe C. pseudotuberculosis infection and abscessation. However, this cannot be definitively concluded in this case. There are few data on the mineral status of Rocky Mountain bighorn sheep in the Wasatch Mountains. Alternatively, chronic illness and emaciation may have contributed to the copper deficiency in this ram. The liver copper status in Rocky Mountain bighorn sheep in Utah warrants further study because it may be an underlying cause of chronic infectious disease.

LITERATURE CITED


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