

merozoites were present (Figs. 3-6). Mature schizonts were up to 12 μm in diameter and contained up to 20 merozoites (Fig. 6). The merozoites were 4-5 μm x 1 μm in size, banana shaped, and contained a central to subterminal nucleus. Occasionally, merozoites appeared to form rosettes around a central residual body (Fig. 6). Sexual stages of coccidia were not seen. Schizonts and merozoites were PAS negative. Protozoa did not stain with *T. gondii*, *N. caninum*, and *S. cruzi* antisera.

Additional microscopic lesions included intracytoplasmic viral inclusion bodies within biliary epithelial cells in the liver, intranuclear viral inclusion bodies in splenic macrophages, and multifocal splenic necrosis. Intestine was not available for histopathologic examination.

Coccidia of the genera *Toxoplasma*, *Neospora*, *Hammondia*, *Sarcocystis*, *Cryptosporidium*, and *Isospora* infect dogs.² Of these, *Toxoplasma*³ and *Neospora*² occur in the lungs of dogs. *Cryptosporidium* can occur in the respiratory tract of birds⁶ and in the trachea and bronchioles of rhesus monkeys infected with simian immunodeficiency virus.¹

The coccidium in the bronchial epithelium of this dog was not *Toxoplasma*, *Neospora*, or *Hammondia*; these organisms multiply by endodyogeny⁵ and do not form multinucleated schizonts as were observed in this case. The organism was not *Cryptosporidium* because *Cryptosporidium* is located just inside the cell membrane, but outside the host cell cytoplasm, and is found along the apical border of host cells.⁶ The organism was not *Sarcocystis* because schizonts were located within cytoplasmic vacuoles, whereas *Sarcocystis* schizonts are found free in the host cell cytoplasm.²

The light microscopic characteristics of the organisms in this case were similar to those of coccidia described in the

intrahepatic biliary epithelium of a dog.⁵ The structure and intracellular location of the protozoa in both cases were consistent with those seen for *Isospora* and *Eimeria*. Members of the genus *Isospora* have never been reported from bronchiolar epithelium; members of the genus *Eimeria* are not known to infect dogs. The identity of this coccidian parasite could not be determined.

Infection with canine distemper virus may have been a factor in the development of pulmonary coccidiosis in this dog. Immunosuppression due to canine distemper virus may play a major role in intercurrent toxoplasmosis and canine distemper in dogs;³ similar factors may have influenced the dual infection with coccidia and canine distemper virus in this case.

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Lymphosarcoma in a desert bighorn sheep

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Lymphosarcoma is a common neoplastic disease of bovine lymphoid tissue but is extremely rare in wildlife ruminant species. In the adult bovine and in experimentally infected ovine,^{1,8,9} the disease is caused by a virus that belongs to the Retroviridae family, subfamily Oncornavirus, genus *Leukovirus*.^{3,5,6,10} In cattle, this disease has 4 clinical manifestations: the adult form (which is caused by bovine leukemia virus), thymic form, calf form, and skin form. Vertical and horizontal transmission have been reported in bovine.² This paper describes the clinical signs and gross, microscopic, and

ultrastructural lesions of lymphosarcoma found in a desert bighorn sheep.

A 9-year-old female desert bighorn sheep (*Ovis canadensis mexicana*) housed at the Arizona-Sonora Desert Museum had several enlarged subcutaneous lymph nodes. A biopsy of the left superficial cervical lymph node, which was 4 x 2.5 x 3 cm, was fixed in 10% neutral buffered formalin and submitted to the Arizona Veterinary Diagnostic Laboratory. Sections of this lymph node were embedded in paraffin, sectioned at 5 μm , and stained with hematoxylin and eosin (HE). An impression smear made from the cut surface of the same lymph node revealed the presence of many neoplastic lymphoid cells and many mitotic figures. The diagnosis of lymphosarcoma was made after histopathologic study. Sections of the formalin-fixed lymph node were postfixed in osmium tetroxide and processed for transmission electron micros-

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Figure 1. Marked enlargement of the right submandibular and left cervical anterior lymph nodes of a desert bighorn sheep.

copy. On April 16 and April 27, the ewe received 20,000 units of L-asparaginase IM and 30 mg of doxyrubicin IV, respectively. Twelve days after this treatment, the peripheral lymph nodes were no longer visible, except for the right submandibular node, which was 3.5 cm in diameter. During that time, the animal had good clinical condition and was eating and drinking normally. Doxyrubicin treatment was repeated 21 days later. Fifty-six days after treatment was initiated, the sheep's condition deteriorated and all peripheral lymph nodes were visible and palpable again; she was euthanized on June 11.

At necropsy, all subcutaneous lymph nodes (submandibular [Fig. 1], cervical anterior and inferior, prescapular, prefemoral, and popliteal) and mediastinal, hepatic, splenic, renal, mesenteric, and inguinal internal lymph nodes were enlarged. The spleen was increased to 2.5 times its normal size, and the splenic corpuscles were 3-5 mm in diameter (Fig. 2).



Figure 2. Cut section of the formalin-fixed spleen of a desert bighorn sheep; neoplastic splenic follicles are prominent.

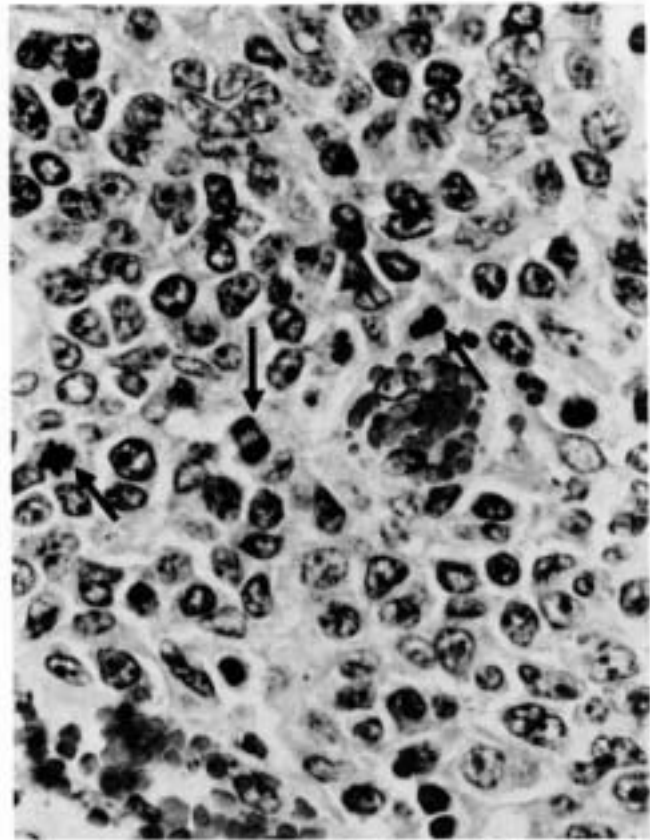


Figure 3. Photomicrograph of a section of the right submandibular lymph node of a desert bighorn sheep, containing neoplastic lymphoid cells and several mitotic figures (arrows). HE, 400 \times .

Histologically, the lesions in the lymph nodes consisted of a neoplastic proliferation of lymphoid cells that had obliterated the normal architecture and had invaded the node capsule. The neoplastic cell had round and/or ovoid vesicular and indented nuclei, and some showed prominent nucleoli. This cellular morphology is suggestive of the lymphoblastic type of lymphosarcoma. Mitotic figures and necrosis of isolated neoplastic cells were common (Fig. 3). Multifocal cortical hemorrhages and fibrosis were also observed. The spleen presented marked enlargement of the splenic corpuscles due to proliferation of neoplastic cells that also were invading the red pulp. In the lungs, most blood vessels, bronchi, and bronchioles were surrounded by neoplastic cells. Similar cells were seen in the lymphatic vessels along the interlobular connective tissue. Neoplastic cells replaced the normal lymphoid tissue of a hemal node. Small clusters of neoplastic cells were found in the hepatic parenchyma. No lesions were observed in the heart, thyroid gland, rumen, omasum, reticulum, abomasum, small and large intestines, pancreas, kidney, bone marrow, urinary bladder, uterus, cerebrum, cerebellum, eye, and pituitary gland. Ultrastructurally, the sections of superficial cervical lymph node contained large tumor cells with round, ovoid, and indented nuclei that contained marginated chromatin and prominent nucleoli. The cytoplasm was abundant and contained a few long threads of rough endoplasmic reticulum and scarce mitochondria (Fig. 4). These features confirmed the lymphoblastic classification of this neoplasia.

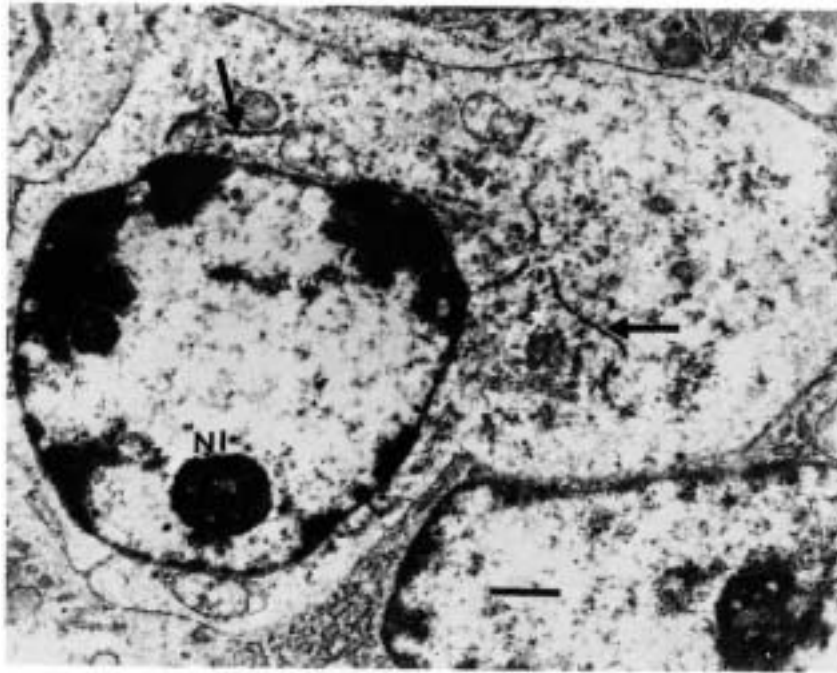


Figure 4. Transmission electron micrograph of a section of the superficial cervical lymph node of a desert bighorn sheep, showing several neoplastic lymphocytes that have prominent nucleoli (NI), distinct marginated chromatin, abundant cytoplasm, long threads of rough endoplasmic reticulum (arrows), and scarce mitochondria. Bar = 1 µm.

Serum antibodies against bovine leukemia virus were not detected using the agar gel immunodiffusion test.

Lymphosarcoma in desert bighorn sheep has not been previously reported. The clinical signs were similar to those observed in cattle with the adult form of the disease. In this sheep, very little information was known about hematologic and blood chemistry changes. Leukemic blood cell counts were not found. Neoplastic involvement of the heart, abomasum, uterus, and kidney, which is common in cattle, was not present in this sheep.^{4,7,12} Leukemic changes and compromise of other internal organs may occur during the final stages of the disease. The specific etiology of this neoplasia was not found. Viral isolation attempts were negative. Antibodies against bovine leukemia virus were not detected in this case,¹¹ and the source and route of infection remain unknown.

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