

NECROPSY FINDINGS IN DESERT BIGHORN SHEEP

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Abstract: This work was done as a part of the U. S. Public Health Service radiation surveillance study of wildlife ruminants in the Nevada Test Site environs. Occurrence, gross appearance, cause and significance for five spontaneous lesions of the desert bighorn sheep (Ovis canadensis nelsoni) are reported. Lesions that are discussed include serous atrophy of pericardial fat, amyloidosis, pyometra, adhesive pleuritis, and hemangiosarcoma.

INTRODUCTION

The Off-site Animal Investigation Project was originally established to provide background information regarding various claims, complaints, and inquiries arising among livestock raisers, wildlife management personnel, and other groups concerned with animal welfare.*

* The Off-site Animal Investigation Project inaugurated in July 1957, was authorized by the assistant manager for test operations, Albuquerque Operations Office, U. S. Atomic Energy Commission, with permission of the Director, Division of Military Application, Washington, D. C. On June 1, 1964, the project was transferred from the operational control of AEC Nevada Operations Office, Las Vegas, Nevada, to the U. S. Public Health Service, Southwestern Radiological Health Laboratory, Las Vegas, Nevada.

The primary objectives were: to enhance the Nevada Test Site (NTS)/off-site rancher relationship through an investigative project in the ranchers' interest, and to provide information as to the status of the off-site animals in their environment with special emphasis on the radioactive isotope uptake from fallout in ruminants. The concept of the original objectives were retained and expanded following transfer of the project to the U. S. Public Health Service (USPHS) and are as follows:

1. To maintain veterinary public relations with the off-site population.
2. To investigate alleged damage to domestic animals from AEC activities.
3. To determine tissue concentrations of fission products in biological samples obtained from bovine on off-site ranches, University of Nevada Experimental Stations and the Nevada Test Site.
4. To develop and conduct wildlife studies on and near the NTS in cooperation with State and Federal wildlife agencies in order to assess radionuclide content of various edible wildlife species.

This report will serve a twofold purpose; it will contribute to the studies of spontaneous lesions of the desert bighorn sheep (Ovis canadensis nelsoni) and give the USPHS background information for investigating alleged damage to the desert bighorn from AEC activities. Detailed discussions of the occurrence, gross appearance, cause and significance for five spontaneous lesions are given rather than a brief description of many lesions. Scientific terms used in this report are defined in a glossary to make the report more meaningful (Hoerr 1956).

SEROUS ATROPHY OF PERICARDIAL FAT:

Occurrence: This condition is the most conspicuous alteration accompanying ordinary starvation, a low protein diet, and/or cachectic diseases in their later stages. The condition parallels fairly closely the reduction in body weight, notably in the lack of proper nutrition. There is active mobilization of depot fat,

which includes that beneath the epicardium. As the fat vacuoles are reduced in size, they are replaced by fluid. The original depots appear as greyish gelatinous masses which may be flecked by small white foci of fat necrosis.

Gross Appearance: The fat of the heart is translucent and watery beneath its shiny overlying membrane. When mingled with adipose tissue, as is usual, the whole process is obviously an area of degenerated watery fat.

Significance: The condition, when observed, is probably only important for what it indicates, i.e., general health. It has little effect upon local function and is a change which is entirely reversible (Smith and Jones 1961).

AMYLOIDOSIS:

Occurrence: In this disorder, various tissues are infiltrated or replaced by a firm solid substance called amyloid. While the name means starch-like, it is now known that amyloid is a protein rather than a starchy substance (Smith and Jones 1961). Amyloidosis tends to become generalized and widespread. The spleen, liver, and kidneys, are usually the sites of the earliest and most extensive formation although lymph nodes and adrenal glands are commonly involved. In the liver, amyloid first accumulates around the vessels of the hepatic triads and in advance cases spreads along the sinusoids of the lobules. Amyloid deposition always begins in the immediate vicinity of the smaller blood vessels, if not actually in their walls. Among the domestic animals, amyloidosis is rare except in the dog and horse. However, in our studies we have found amyloid deposits in the adrenal, spleen, liver, and kidneys of the desert bighorn.

Gross Appearance: Small amounts of amyloid are not detected grossly. When accumulations are in significant quantities to be detected, the substance appears white, opaque and resembles lard. The term lardosis has been used as a synonym in some quarters. In the spleen, there are tiny nodules of white, firm material that give the suggestion of a spleen sprinkled with tapioca grains

Organs other than the spleen usually exhibit slight changes in their general appearance rather than in a form of individual amyloid deposits. The liver, for instance, when extensively involved, is larger, paler, and firmer than normal. Microscopic confirmation is essential. On fresh slices of tissue, the application of an aqueous solution of iodine, such as Lugol's results in the reaction of the iodine with the amyloid to produce a distinctly brown color (Smith and Jones 1961).

Cause: Amyloidosis is almost always concomitant to long standing infections, such as tuberculosis, and suppurative processes commonly observed in osteomyelitis of the frontal and maxillary bones of the desert bighorn. Corynebacterium pyogenes which has been incriminated most often in the latter lesion may metastasize from the primary focus in the bone to other sites in the body. Such cases are frequently complicated by secondary amyloidosis (Jubb and Kennedy 1963). Amyloidosis is also found in human patients with rheumatoid arthritis, which itself has been suspected of being an autoimmune disorder (Gresham and Jennings 1962). The fundamental causative mechanism was once believed to involve interaction of some antibody with its antigen; however, we are by no means certain that this is the cause. In humans, amyloid deposition occurs secondary to chronic diseases such as chronic suppurative osteomyelitis, malignant tumors, and chronic tuberculosis of bones.

Significance: Most examples are encountered at autopsy incidental to other diseases, such as renal insufficiency, tuberculosis and suppurative processes. However, if death does not intervene from other causes, amyloidosis progresses to the point where vital functions are destroyed and it is fatal. The condition is included in this discussion because of the relatively common appearance of the condition in desert bighorn sheep. By implication, it appears that the bighorn has a high incidence of C. pyogenes infections.

PYOMETRA:

Occurrence: Inflammation of the uterus is termed metritis, while the milder and more frequent inflammation which involves only the mucosa is endometritis. Septic metritis is a severe condition due ordinarily to infection introduced at or shortly after



FIGURE 1.

A LONGSTANDING CASE OF PYOMETRA IS SHOWN. THE UTERUS IS THIN WALLED AND FILLED WITH PURULENT MATERIAL.



FIGURE 2.

ADHESIONS OF THE UTERUS TO THE VENTRAL ABDOMINAL WALL WERE A RESULT OF PYOSALPINXITIS.

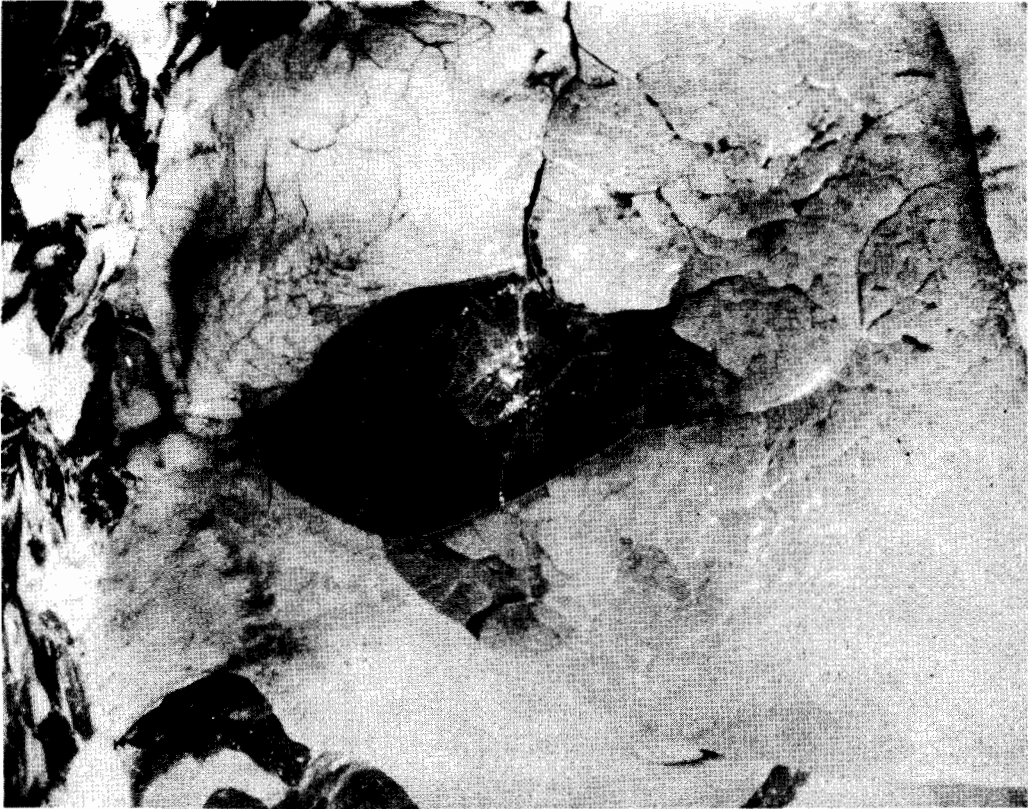


FIGURE 3.

BRONCHOPNEUMONIA OF THE LEFT CARDIAC LOBE OF THE LUNG IS MANIFESTED AS FIRM DARK PURPLE LUNG TISSUE.



FIGURE 4.

METASTATIC NODULES OF A HEMANGIOSARCOMA ARE PRESENT THROUGHOUT THE ABDOMINAL CAVITY ESPECIALLY EVIDENT IN THE REGION OF THE ILIAC CHAIN.

parturition. The parturient uterus is an especially susceptible structure for microorganisms because decomposing bits of fetal membranes and discharges remain in the lumen of the uterus. Pyometra is an acute or chronic suppurative infection of the uterus with accumulation of purulent exudate in the uterine lumen in the presence of a closed cervix (Jubb and Kennedy 1963). The definition is usually extended to include those cases in which discharge is prevented by an acquired or congenital stenosis. Due to the effect of gravity, exudates are not easily expelled from the uterine lumen in the quadrupeds. The constant weight and pressure of accumulating exudate sometimes produce a gradual distention of the lumen or impede normal involution. The result after some days or weeks is pyometra.

Gross Appearance: Gross features include edema and swelling of the areas of placental attachment in the presence of more or less seropurulent exudate, which in acute cases is likely to contain blood. If parturition was a recent event, shreds of placental membrane may remain adhered to the swollen areas of the uterus. The uterine wall may exhibit only mild inflammatory changes or there may be edema and hyperemia. The amount of purulent material varies from a few ounces in a sheep to more than a gallon in a large animal such as a cow. The material is thick in consistency, rather mucinous, and cream to greyish green in color. The wall of the uterus is thick and doughy; however, in long-standing cases the walls are thin and fibrosed (Figure 1). Coexisting with the pyometra may be pyosalpinxitis and perimetritis. This usually results in peritonitis terminating either in death or adhesions (Figure 2).

Cause: The pathogenic organisms most likely to gain entrance into the uterus and to thrive are the various species of streptococcus or staphylococcus. Pyometra may be associated with mechanical obstruction of the discharge as sequela or to prolonged endometritis in association with functional obstruction to the discharge. The majority of cases of pyometra fall into this category and provide the basis for the definition of pyometra given above. Pyometra in farm animals is usually a sequela to parturition and imperfect involution of the uterus.

In the desert bighorn, it appears that the cause is difficult parturition manifested by long labor and inadequate discharge of the fetal membranes. A similar condition was noted in one of the pen sheep at Corn Creek, Nevada. Pyometra may also accompany Trichomoniasis or other genital tract infections which cause complete absorption of the embryo or young fetus.

Significance: No significant extra-genital signs of the disease are usually observed, as the disease for the most part is asymptomatic. However, if the condition is not treated the ewe usually becomes sterile and may die.

ADHESIVE PLEURITIS:

Occurrence: The ordinary forms of pleuritis, inflammation of the pleura, belong to the acute exudative inflammations, usually being either serous, fibrinous or purulent. If the pleuritis accompanies bronchopneumonia (Figure 3), the pleuritic area overlies the solidified portions of lung parenchyma, and the condition is then called pleuropneumonia. There are many cases of pneumonia without pleuritis, and it is entirely possible for pleuritis to exist without pneumonia.

Gross Appearance: The pulmonary pleura is first involved, as a rule, but the infection and inflammatory reaction promptly spread to the contiguous areas of parietal pleura. The usual attack of pleurisy begins with acute hyperemia and swelling of the thin covering membrane. Various stages are observed: after two days, a serous exudate appears which lubricates and separates the two surfaces; the exudate may remain serous or it may become fibrinous or purulent. Often all forms coexist resulting in a sero-fibrino-purulent pleuritis. With the lapse of a few days, the amount of seropurulent exudate collecting in the pleural cavity may become so great as to seriously interfere with the expansion of the lungs. The layers of fibrin on each of the two opposing surfaces tend to become organized by immigrating fibroblasts and the two surfaces often become tied together by strands of fibrous connective tissue. These are known as adhesions, and the entire inflammatory process is then called adhesive pleuritis. It is not unusual to find large areas of lung surface inseparably joined to the chest wall. The two surfaces are intimately tied together by strands of tough, fibrous connective tissue which is usually a white to cream in color. Most animals so affected die while the

inflammatory process is still active. Some survive the initial infection; however, after recovery there are adhesions of limited extent which may cause pain during respiratory movements.

Cause: Pleuritis is usually due to extension of inflammation from the pneumonic lung to the pleura during the course of pneumonia. Other pathways for pleural infections are traumatic, either through the thoracic wall or diaphragm, and by direct extension as from a pleural abscess or esophagitis. As a rule, direct extension from pneumonia is the primary cause; however, hematogenous spread may be the cause of local or disseminated lesions.

Significance: Most animals die while the process is still active; some do survive if the causative infection is localized and the extent of the adhesions is limited. The latter seems apparent in the desert bighorn sheep because localized areas of pleural adhesions, especially in the right cardiac lobe, have been noted in nearly all animals on which we have had the opportunity to do complete post mortems. To date, we have not obtained a fresh culture of the agent as most of the lesions we have observed have been chronic.

HEMANGIOSARCOMA:

Occurrence: Hemangiosarcoma is a malignant neoplasm of endothelial cells. It occurs mostly in dogs, but has been found in other domestic animals, usually in the adult animals. There is no known breed or sex predilection (Moulton 1961). It is a highly malignant neoplasm that readily metastasizes and often recurs after surgery. It is found in the same regions as its benign counterpart particularly in the skin and spleen. Metastatic nodules are regularly found in the lungs, peritoneum, omentum, and heart.

Gross Appearance: The neoplasm varies considerably in size, is poorly circumscribed and non-encapsulated. The neoplasm as a rule is rubbery or spongy in consistency, and greyish red in color with large dark red areas.

Cause: The tumor is characterized by the abnormal proliferation of endothelial cells. These cells generally form vascular spaces in the tumor tissue, often as small clefts, but on occasion the spaces may be cavernous.

Significance: This type of neoplasm has been found in only one desert bighorn sheep; possibly because the condition is more characteristic of old animals. Neoplastic tissue was found throughout the body of a seventeen-year-old desert bighorn sheep that had been penned in the Corn Creek station for many years. It is interesting to note that the masses metastasized throughout the thoracic and abdominal cavity (Figure 4).

CONCLUSION:

A definite diagnosis of many lesions requires microscopic examination by a trained histopathologist; therefore, adequate observations and accuracy by the technician doing the necropsy will aid a great deal in observing lesions that are spontaneous within the desert bighorn sheep population (Engel 1966). The more spontaneous lesions observed and diagnosed in the sheep population, the more will be added to the knowledge of sheep range management. It is hoped that interest in spontaneous lesions found in the desert bighorn sheep is stimulated.

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GLOSSARY (Hoerr and Osol 1956)

Adipose: Fatty, fatlike, fat.

Amyloid: A complex protein deposited in tissues, characterized physically by its hyaline structureless nature, and chemically by special staining reactions.

Antibody: One of a class of substances, natural or induced by exposure to an antigen, which have the capacity to react as agglutinins, lysins, precipitins, etc., with the specific or related antigens.

Antigen: Any substance which stimulates the production of antibodies or reacts with them.

Autoimmunization: Immunization obtained by natural processes within the body.

Benign: Not endangering health or life; not malignant, innocent; applied to certain tumors.

Cachexia: Weakness and emaciation caused by some serious disease such as tuberculosis or carcinoma.

Cervix, uterine: The cylindrical lower portion of the uterus opening into the vagina; neck of the uterus.

Diaphragm: A musculotendinous partition which separates the thorax and abdomen and is the chief muscle of respiration and expulsion.

Edema: Dropsy; excessive accumulation of fluid in the tissue spaces; due to disturbance in the mechanisms of fluid exchange.

Endothelium: The simple squamous epithelium lining the heart, blood vessels, and lymph vessels; vascular endothelium.

Epicardium: The visceral layer of the pericardium which forms a serous membrane on the outermost part of the wall of the heart.

Esophagitis: Inflammation of the esophagus.

Exudate: The material that has passed through the walls of vessels into adjacent tissues or spaces in inflammation.

Fibrin: The fibrous insoluble protein, formed by the interaction of thrombin and fibrinogen in the network of which blood corpuscles are enmeshed in the clotting of shed blood.

Fibrosis: Growth of white fibrous connective tissue in an organ or part in excess of that naturally present.

Gelatinous: Containing or of the consistency of gelatin.

Hematogenous: Pertaining to the production of blood.

Hepatic triad: Hepatic artery, hepatic vein, and bile ducts.

Hyperemia: An increased content of blood in a part, with distention of the blood vessels.

Inflammation: The reaction of the tissues to injury. The essential process, regardless of the causitive agent, is characterized clinically by local heat, swelling, redness, and pain.

Involution: The retrogressive change to their normal condition that certain organs undergo after fulfilling their functional purposes, as the uterus after pregnancy.

Lesion: The alteration, structural or functional, due to injury: commonly limited to morphological alterations.

Metastasis: The transfer of disease from a primary focus to a distant one by the conveyance of casual agents or cells through the blood vessels or lymph channels.

Mucin: Nitrogenous substances secreted by the mucous membranes.

Mucoid Glycoprotein: Substance resembling mucin compound in which a protein combines with a carbohydrate group.

Mucosa: Mucous membrane.

Necrosis: The pathologic death of a cell or a group of cells in contact with living cells.

Osteomyelitis: Inflammation of the marrow of bone.

Osteonecrosis: Necrosis of bone in mass.

Parturition: Act of giving birth to young.

Pericardium: The closed membranous sac enveloping the heart.

Perimetritis: Inflammation of the tissues about the uterus.

Peritonitis: Inflammation of the peritoneum.

Pleura: Serous membrane that enfolds the lungs.

Purulent: Containing, consisting of, or forming pus.

Pyosalpinx: An accumulation of pus in an oviduct.

Quadruped: An animal with four feet.

Sequela: A condition following and resulting from a disease.

Sepsis: A general reaction, usually febrile, from the result of action of bacteria or their products or both.

Seropurulent: Composed of serum and pus, as a seropurulent exudate.

Serous: Pertaining to, characterized by, or resembling serum.

Spontaneous lesion: A lesion that occurs without any obvious specific cause.

Stenosis: Constriction or narrowing of a passage or orifice.

Thorax: The chest; that portion of the trunk above the diaphragm and below the neck.

Trauma: A form of injury; commonly, injury by mechanical agents; broadly, injury produced by any physical agent.

Trichomoniasis: Infestation with a parasite of the genus *Trichomonas*.

Uterus: The organ of pregnancy.