

## **Diseases and Pathology of Cervids (Deer)**

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Cervids are hoofed mammals, even-toed ungulates (Artiodactyls), and ruminants. There are 36 to 46 existing species, depending on the classification used. World-wide distribution, except for Antarctica, Australia, and most of Africa, however, they are introduced and widespread throughout Australia. There are 5 naturally occurring species in North America: White-tailed deer, Mule deer, Wapiti or Elk, Reindeer or Caribou, and Moose.

### **Viral Diseases**

**Bluetongue and Epizootic Hemorrhagic disease:** Orbiviruses; SE to NW US & Canada  
Syndromes: peracute, acute and chronic forms; peracute/acute: swollen face, hyperemic skin, diarrhea, hemorrhages, oral ulcers, respiratory distress, lameness, death: chronic: overgrown hoof walls, cracks in hoof wall, sloughing of hooves  
Infection: *Culicoides* midge vector  
Species: white-tailed deer, mule deer, pronghorn  
Histopath: DIC, petechial, ecchymotic or suffusive hemorrhages anywhere esp. gi tract, heart, pulmonary artery, pylorus of abomasums

### **Adenoviral-associated Hemorrhagic Disease**

-*Odokoileus hemonius* (OdAdV-1)  
-Mule deer, white-tailed deer, moose  
Syndromes: systemic infection, local & systemic hemorrhage, pulmonary edema, hemorrhagic enteropathy, stomatitis, glossitis, rumenitis, vasculitis  
-Histopath: associated with intranuclear inclusions in endothelial cells

### **Vesicular Diseases**

-Foot-and-Mouth, Aphthovirus, foreign animal disease  
-Deer highly susceptible  
-Major outbreak in Mule deer, in CA, during 1924, >20,000 deer  
-Vesicular Stomatitis, Vesiculovirus  
-endemic in US, deer highly susceptible, few natural cases reported  
-High morbidity, low mortality, predominately feet and oral cavity lesions  
-Histo: Papules, Vesicles, Pustules, Ulcers

### **Deer Cutaneous Fibromas: Papillomavirus**

Syndromes: cutaneous wart-like growths  
Infection: direct contact  
Species: white-tailed deer, mule deer  
Histopath: dark pigmented exophytic fibromas; proliferative epidermis forming papillomas, fibropapilloma or fibromas, occasional intranuclear inclusions

**Eastern Equine Encephalomyelitis:** Alphavirus carried by mosquitoes, endemic eastern US

Syndromes: subclinical, encephalitis

Infection: mosquito bite

Species: birds, humans, horses; various wild mammals serologic positive, especially rodents; spontaneous mortality restricted to white-tailed deer

Histopath: mononuclear meningoencephalitis, admixed with lesser numbers of neutrophils, gliosis, neuronal degeneration, perivascular hemorrhage

### **Bacterial Diseases**

#### **Bovine Tuberculosis**

-Deer more susceptible than cattle

-aerosol or oral ingestion

-Associated with infected cattle, high deer density, supplemental feeding

-Syndromes: subclinical infection, cranial lymph nodes lungs, disseminated

Histopath: caseogranulomas, partial mineralization, multi-nucleated giant cells, rare

Acid-fast bacilli

#### **Other Bacterial Pneumonia**

-*Pasteurella multocida*, *Hemophilus somnus*, *Mannheimia* not reported

-More common in captivity, rare in wild

-Lesions: fibrino-suppurative bronchopneumonia

#### **Johne's Disease**

-*Mycobacterium avium* subsp. *Paratuberculosis*

-Primarily captive species: axis, fallow, red, roe, sika, and white-tailed deer, elk, moose

-Infection: fecal-oral, massive fecal shedding, early age infection

-Syndrome: diarrhea, weight loss, chronic

-Lesions: thickened ileum & cecum, enlarged ileo-cecal lymph node, histiocytic or granulomatous infiltrate with numerous acid-fast bacilli

#### **Brucellosis**

-*Brucella abortus*, *B. suis* in caribou

-Species: Moose, elk, red, white-tailed, mule, fallow, sika deer, caribou

-Syndromes: abortion, retained placenta, metritis, orchitis, epididymitis

-Infection assoc. with cattle, Greater Yellowstone Area with supplemental feeding, circumpolar in caribou

#### **Abscesses & Bacterial Infection of CNS**

*Staphylococcus*, *Streptococcus*, *Arcanobacterium pyogenes*: These pyogenic bacteria are commonly associated with subcutaneous abscesses

Syndromes: subcutaneous abscesses; brain abscesses & meningoencephalitis

Infection: dermal abrasions and wounds; direct extension from retrobulbar; hematogenous

Species: all cervids susceptible

Histopath: suppurative cellulitis and abscesses, with bacterial colonies

### **Listeriosis**

*Listeria monocytogenes*: Ubiquitous environmental bacteria found in soil, plants, water

Species: Moose, white-tailed, roe and fallow deer, more captivity

Syndromes: Encephalitis, septicemia, placentitis/abortion

Infection: not transmissible; ingested and gains access through mouth wounds or gi tract

Species affected: rodents, lagomorphs, ruminants, carnivores

Histopath: Meningoencephalitis, microabscesses brain stem, gliosis

### **Dermatophilosis**

*Dermatophilus congolensis*: Gram-positive filamentous chains of cocci

Species: reported in mule and white-tailed deer

Syndromes: dermatitis

Infection: direct contact, splashing, mechanical transmission by birds, flies, ticks

Species: all mammals are susceptible

Histopath: The skin is alopecic, hyperkeratotic, heavily crusted, with an underlying bed of pink weeping tissue. The organism shows classic Gram-positive hypha-like chains or "train-track" appearance, associated with epidermal hyperkeratosis and suppurative exudate.

### **Wooden Tongue**

Species: Cattle, sheep & goats, rarely seen in white-tailed deer

-*Actinobacillus lignieresii*, common in soil, water, oral cavity

-Gains entry by wounds by sharp forage

-Lesions: swollen distal tongue, pyogranulomas, Splendore-Hoeppli material, gram-negative filamentous bacilli

### **Parasitic Infestations**

#### **External Parasites**

#### **Fleas, ticks and lice:**

Many genera and species of biting & sucking lice, ticks, fleas

Syndromes: incidental, clinical anemia and debilitation, secondary infections

Species: all deer susceptible, more severe in neonates, seasonality

Histopath: none, to mild eosinophilic dermatitis surrounding bite wounds, to patchy edema and dermatitis/cellulites

#### **Ticks**

-*Amblyomma*, *Ixodes*, & *Dermacentor* spp.

-Local irritation and swelling, heavy infestation anemia

-May carry Lyme Disease

#### **Lyme Disease**

-*Borrelia burgdorferi*, spirochete

- Tick-borne
- Deer susceptible, not evidence of illness
- Primary wildlife host white-footed mice, *Peromyscus* spp.
- Human disease: skin rash, flu-like, arthritis, chronic neurologic or cardiac problems

### **Sarcoptic Mange**

*Sarcoptes scabiei*: Contagious burrowing skin mite of man and animals, worldwide

Syndromes: Mange, immunosuppression, debilitation, death

Infection: direct and indirect contact

Species: Moose, elk, caribou, not reported white-tailed

Histopath: pruritis, crusts, hyperkeratosis, epidermal hyperplasia, intracorneal tunnels containing myriads of adults, larvae, eggs

### **Demodectic Mange**

*Demodex odocoilei*

-Hosts: white-tailed deer

-Syndromes: subclinical, alopecic dermatitis, marked subcutaneous edema distal muzzle, Bullwinkle J. Moose syndrome

Infection: Not considered contagious, normal skin inhabitant to dermatitis

-Histopath: low numbers of organism in hair follicles or sebaceous glands are incidental; alopecia, folliculitis, furunculosis, granulomatous cellulitis, lymphadenopathy, associated with high numbers of classic cigar-shaped, stubby limbed intra-follicular adult and larval mites

### **Besnoitiosis**

*Besnoitia tarandi*

Hosts: caribou, rare in mule deer

-Life cycle: unicellular protozoa, definitive host carnivore in gi tract; intermediate host lives in fibroblasts in many tissues

-Lesions: hair loss and dermal crusting over face and limbs, small firm white cysts (1 mm) in subcutaneous tissues, sclera, nasal mucosa

### **Psoroptic Mange**

*Psoroptes cuniculi*: Ear mite

Syndromes: otitis externa

Infection: direct and indirect contact

Species: deer

Histopath: ear droop, head shaking & scratching, thick crusts and excessive wax, numerous parasites, sarcoptiform, can lead to otitis media, circling, secondary infection

### **Internal Parasites**

#### **Toxoplasmosis**

*Toxoplasma gondii*: Apicomplexan protozoa

Syndromes: encephalitis, ocular disease, other generalized or tissue localized infections, abortions, subclinical infection is most common

Infection: oral ingestion of matter contaminated by oocysts

Species: all felids are definitive hosts that shed oocysts; all deer susceptible

-Histopath: necrotizing encephalitis, chorioretinitis, other tissues, associated with variable numbers of tachyzoites in groups, or bradyzoites in cysts (only in CNS) which can be intracellular or extracellular; generally minimal to mild inflammatory cell response.

### **Sarcocystosis**

-Ubiquitous two-host apicomplexan parasite; gi form in carnivores, encysted sarcocysts in skeletal muscles of herbivores

-Hosts: white-tailed, mule, elk, moose; each has specific species sarcocyst (mule deer = *S. hemionnilatransis*)

Syndromes: subclinical, most individuals affected to some extent

-All muscles including ocular and cardiac muscle can be affected

### **Nasal Bots**

*Cephenemyia* spp.: Nasal/pharyngeal bots of deer; adults free-living

*C. jellisoni*, *C. phobifer*, *C. pratti*, *C. trompe*

Syndromes: subclinical

Species: cervids, deer, elk, moose, reindeer

Histopath: Minimal inflammation of pharyngeal lining

### **Lung Worms**

-*Dictyocaulus viviparus*, high infestation rate

-Hosts: white-tailed, mule, elk, moose

-No intermediate hosts

-Signs: weakness, respiratory distress, patchy consolidation & pneumonia

-Gross: slender white nematodes 3-4 cm in length, filling trachea, bronchi, alveoli

-Histo: bronchointerstitial pneumonia, numerous adults, larvae & eggs

### **Meningeal Worms**

-White-tailed deer: *Parelaphostrongylus tenuis*, Eastern half US

-White-tailed & caribou: *P. andersoni*, Northern Canada & Alaska

-Mule deer: *P. odocoilei*, West coast US & Canada

-Caribou & Moose: *Elaphostrongylus rangiferi*, Scandanavia, Russia, Newfoundland

-Disease: primarily subclinical or mild interstitial pneumonia, however, *P. tenuis* causes major problems occasionally in normal host, and more commonly in abnormal host (elk, moose, mule deer, llamas, domestic ruminants) including incoordination, circling, recumbency, paralysis

-Histopath: malacic tracts, gitter cells, demyelination, lymphocytic, plasmacytic and eosinophilic meningoencephalitis, multiple cross sections of nematode adults/larvae.

### **Arterial Worm**

-*Elaeophora schneideri*, lives in the carotid artery & smaller branches

-Hosts: mule deer (normal); disease in white-tailed and elk

-Syndromes: malformed antlers, blindness, muzzle & ear necrosis, oral impactions, tooth loss, and jaw bone degeneration & fracture

-Life cycle: adults produce microfilariae, go to capillaries in skin, ingested by horseflies, spread to other deer by flies feeding

### **Setariasis**

-*Setaria yehi*, the abdominal worm

-Hosts: white-tailed, mule, moose, caribou, elk

-No clinical signs

-Lesions: mild fibrinous peritonitis, occasional encapsulated dead worms

-Life cycle: produce microfilariae which are transmitted by mosquitoes

### **Liver Flukes**

-*Fasciolodes magna*-

Hosts: white-tailed, mule, red, sambar, sika, roe, fallow deer, elk, moose, caribou

Life cycle: require aquatic intermediates including snails

Aberrant hosts: variety of domestic ruminants

Lesions: thick fibrous capsules in liver, migration tracts, black fluke pigment

### **Echinococcosis- Hydatid Disease**

-*Echinococcus granulosus*- zoonotic disease

-Hosts: Carnivore definitive host: wolf, coyote, fox, small 3-5 mm long adult tapeworm in gi tract

Cervid intermediate host: Moose (up to 80% infested), elk, caribou, white-tailed deer (uncommon)

-Lesions: numerous pale, fluid-filled cystic cavities in lungs and liver

-Histopath: thick-walled fibrous capsule, protoscoleces & hydatid sand

### **Miscellaneous Conditions**

#### **Chronic Wasting Disease**

-Prion associated slow progressive degenerative condition

-Affects the CNS, esp. obex, and the cranial lymph nodes, esp. mprln

-Hosts: white-tailed, mule deer, elk, moose

-Distribution: captive & wild in Co, WY, NE, KS, MT, OK, SD, NM, WI, IL, NY, WV, MN, Alberta & Saskatchewan

-Gross: wasting condition

-Histo: spongiform encephalopathy

-Testing: Immunohistochemistry, ELISA, western blot

#### **Black Leg**

-All cervids susceptible

-*Clostridium chauveii*, *C. Novyi*, *C. Septicum*

-Trauma to muscle mass results in anaerobic environment, growth of bacteria, release of preformed toxins

-Gross: muscles dark red to black, gas-bubbles, spongy, dry

-Histopath: muscle necrosis, large bacterial rods

### **Peritoneal Fibrosis**

- Deer have very reactive peritoneum, similar to domestic ruminants
- Fibrotic response may become excessive, fibrotic encapsulation of abdominal viscera
- Similar to humans undergoing peritoneal dialysis for renal failure prior to modern dialysis machines

### **Tumors and Tumor-like Masses**

#### **Lymphosarcoma**

- Most common internal neoplasm in white-tailed deer
- Sites: Lymph nodes, spleen, liver, kidney, lung heart, retrobulbar area
- No known association with retroviruses
- Uncommon incidence
- No classification system at present

#### **Histiocytic Sarcoma**

- rare; liver, spleen, brain
- CNS form associated with clinical CNS disease

#### **Cranial Osteomas**

- Multiple bony growths
- May interfere with eating when jaw affected

#### **Dermoid Cysts**

- Malformation or hamartoma rather than true neoplasm
- Sites: subcutaneous tissue along dorsal or ventral midline
- Species: all deer, esp. reindeer and white-tailed
- Gross: single, soft slowly enlarging mass; filled with hair and fluid
- Histopath: lined with keratinized & stratified squamous epithelium, normal adnexa include hair follicles and sebaceous glands

#### **Compound Odontomas**

- Malformation, hamartoma, fetal rests
- Species: primarily white-tailed deer; any deer possible
- Site: rostral mandible
- Gross: oral masses with numerous misshapen and mis-directed teeth
- Histopath: denticles, include normal layers of dentin, enamel, dental pulp

#### **Cervids and Antlers**

- Antlers are bony structures, covered with highly vascular velvet during growth, shed and regrown annually
  - Shape varies from spike, branching or palmate
  - Only the water-deer lacks antlers
  - Only the reindeer has antlers on both sexes, otherwise limited to males
- Physiology:
- Pedicle is thickened periosteum and spongy bone from which the antler develops

- Increasing daylight stimulates antler growth
- Antlers are the most rapidly growing tissue of any adult mammalian tissue; completely regenerates annually
- Antlers generally grow over a 3 to 6 month period, depending on species
- Antler Deformities:
  - Genetic causes
  - Injury: directly to the growing antler or pedicle; indirect to contra-lateral hindlimb, or same-side front limb
  - Physiologic/endocrine: testosterone, estrogen, pituitary hormones, thyroid hormones, all play a role in controlling antler growth & development
- Antlers & Testosterone:
  - Castrated fawns never develop antlers
  - Increasing testosterone level results in velvet loss, cessation of growth, and eventual death of antler tissue
  - Decreasing testosterone leads to casting off antlers, and subsequent regrowth
  - Antlered deer which are castrated develop uncontrolled antler growth, never cast
  - In some species (roe, elk) develop sarcoma-like peruke/antleroma growth which can be fatal

### **Antleromas/Peruke**

- Uncontrolled proliferation, “pseudo-tumor”
- Antler growth is partially regulated by testosterone
- Castration or testis destruction occurring once antlers have started growing allows for marked proliferation
- Gross: antlers thick, irregular cystic structures, abnormal points & branches
- Histopath: normal antler bone

### **General References**

- 1) Davidson WR: *Field Manual of Wildlife Diseases in Southeastern United States*, 3<sup>rd</sup> ed., Southeastern Cooperative Wildlife Disease Study, Athens, Georgia, pp. 1-448, 2006.
- 2) Davidson WR, Hayes FA, Nettles VF and Kellogg FE: *Diseases and Parasites of White-tailed Deer*, Southeastern Cooperative Wildlife Disease Study, Athens, Georgia, pp. 1-458, 1981.
- 3) Geist V: *Deer of the World: Their Evolution, Behavior and Ecology*, Stackpole Books, pp. 1-421, 1998.
- 4) Samuel WM, Pybus MJ, Kocan AA. *Parasitic Diseases of Wild Mammals*, 2<sup>nd</sup> ed. Ames, IA: Iowa State University Press, pp. 1-559, 2001.
- 5) Williams ES, Barker IK. *Infectious Diseases of Wild Mammals*, 3<sup>rd</sup> ed. Ames, IA: Iowa State University Press, pp. 1-558, 2001.
- 6) Wobeser, GA. *Essentials of Disease in Wild Animals*. Ames, Iowa: Blackwell Publishing, pp. 1-243, 2006.