Manual of Common Diseases and Parasites of Wildlife in Northern British Columbia

Second Edition






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Second Edition

Credits and Acknowledgements

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- We are grateful to Alex Hawley for encouraging us to initially undertake this project, and to Tony Redford for providing comments on a previous draft of the Second Edition of the manual.
- We also thank Brett Elkin for giving us permission to use Common Wildlife Diseases and Parasites in the NWT and Nunavut as a template for this project.

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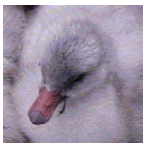

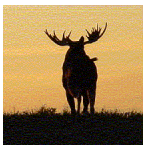


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General Information

Audience:

- This manual was designed to be used by persons in northern British Columbia who encounter anomalies in wildlife. We hope it is particularly useful for groups that use wild animals as a food source, such as First Nations people or hunters, and for trappers and wildlife professionals that are in direct contact with wildlife. It is anticipated that this resource will provide information on specific wildlife health issues, and heighten awareness of wildlife diseases in general.

How To Use This Manual:

- Information on specific diseases can be accessed in several ways: users may choose to view information about a particular disease from a list sorted according to the region of the body affected, or they may access information on specific diseases from a list sorted according the agent or factor responsible for the disease.
- In each disease summary, many terms are linked to a Glossary; clicking on the term will open a new window where the definition of the word is displayed. Links are also provided in most disease summaries to other web sites with further information about the disease. Pages are also provided with a list of wildlife or human health agency contacts. Finally, a form is available to provide appropriate information to wildlife health agencies should you submit carcasses or other samples for testing.

					
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Explanation of Icons

In the disease summaries in this manual, the following icons highlight where caution must be exercised both for human and animal health.

	**Thoroughly wash and sanitize equipment and surfaces that have come into contact with the diseased animal or parts of the animal.**
	**Disease is potentially *zoonotic* - transmissible to humans either through contact or consumption. Take appropriate precautions.**
	**Disease is potentially transmissible to pets. Do not feed affected parts of the animal to dogs or cats.**
	**Cook thoroughly.**
	**Do not eat affected parts.**

					
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Diseases Classified According to Causative Agent

Viruses

Bacteria

Prions

Other

Protozoa

Flatworms

Roundworms

Fungi

External Parasites

[Malnutrition & Starvation]
[Trauma]

					
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Diseases Classified According to Region of Body Affected

General

Abscesses
Anthrax
Brucellosis
Chronic Wasting Disease
Chytridiomycosis
Distemper
Electrocution
Epizootic Hemorrhagic Fever
Exertional Myopathy
Foot Abnormalities
Giardiasis & Cryptosporidiosis
Hantavirus
Lead Poisoning
Lyme Disease
Malnutrition & Starvation
Papillomavirus
Parvovirus
Plague
Rabies
Ranavirus
Ringworm
Toxoplasmosis
Trauma
Tuberculosis
West Nile Virus

Skin

Anthrax
Avian Pox
Besnoitiosis
Chytridiomycosis
Contagious Ecthyma
Electrocution
Lice
Lyme Disease
Maggots / Flies
Malignant Catarrhal Fever
Papillomavirus
Psoroptic Mange
Ranavirus
Ringworm
Sarcoptic Mange
Warbles
Winter Tick
White-Nose Syndrome

Head

Anthrax
Antler Deformities
Aspergillosis
Avian Pox
Besnoitiosis
Chronic Wasting Disease
Contagious Ecthyma

Muscle / Meat

Abscesses
Bear Filarial Worm
Besnoitiosis
Exertional Myopathy
Echinococcosis & Taeniasis
Guinea Worm
Lead Poisoning
Malnutrition & Starvation
Muscle Worms
Sarcocystosis
Trichinellosis

Internal Organs

Anthrax
Aspergillosis
Avian Pox
Baylisascaris
Brucellosis
Distemper
Echinococcosis & Taeniasis
Epizootic Hemorrhagic Fever
Giardiasis & Cryptosporidiosis
Lead Poisoning
Liver Flukes
Malignant Catarrhal Fever
Parvovirus
Rabies

[Distemper](#)
[Epizootic Hemorrhagic Fever](#)
[Lumpy Jaw](#)
[Malignant Catarrhal Fever](#)
[Maggots / Flies](#)
[Nasal Leeches](#)
[Rabies](#)
[Salmonellosis](#)
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[Salmonellosis](#)
[Trichinellosis](#)
[Tuberculosis](#)
[Tularemia](#)






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Wildlife Disease Links

- BC Ministry of Environment – Wildlife Heath
- BC Ministry of Environment – Diseases You Can Get From Wildlife, Online Version
- BC Ministry of Environment – Diseases You Can Get From Wildlife, PDF Version
- BC Ministry of Environment – Wild Animal Disease Fact Sheets
- Alberta Environment and Sustainable Resource Development – Common Wildlife Diseases and Parasites
- Canadian Wildlife Health Cooperative – Wildlife Health in Canada
- USGS National Wildlife Health Center – Wildlife and Ecosystem Health
- USGC National Wildlife Health Center – Field Manual of Wildlife Disease: General Field Procedures and Diseases of Birds
- Alaska Department of Fish and Game – Parasites and Diseases
- Michigan Department of Natural Resources – Wildlife Disease Manual

					
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Contact Information

- **BC Conservation Officers** – Contact Information
- **BC Health Services** – General Information
- **BC Centre for Disease Control** – General Information
- **BC Ministry of Forests, Lands and Natural Resource Operations: Wildlife Health** – General and Contact Information
- **RCMP in BC** – Contact Information
- **Animal Health Centre, BC Ministry of Agriculture** – Specimen Submission Information
- **Canadian Cooperative Wildlife Health Centre** – General Information on Wildlife Health Issues
- **Centers for Disease Control and Prevention** (US government) – Human Health Topics

					
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Comments

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Glossary

Unless indicated, terms are abridged from "Baillière's Comprehensive Veterinary Dictionary". Hyperlinks indicate terms that are individually defined in the Glossary.

Acute: having severe signs and a short course of 12 to 24 hours. Associated terms: peracutely - excessively acute; a duration of a few hours only.

Anemia: a reduction in the number of red blood cells or in the amount of the oxygen carrying component of blood, hemoglobin.

Arthritis: Inflammation of joint.

Arbovirus: a virus that replicates in an arthropod. The arthropod acts as a vector and transmits the virus to a suitable vertebrate host where replication also occurs.

Arthropod: group of related invertebrate animals with a hard, outer exoskeleton. These include insects, crustaceans, millipedes, centipedes, spiders, ticks, mites, etc.

Bacteria: single-celled organisms, larger than viruses. Bacteria can be free-living or parasitic, disease-causing or living in symbiosis with another organism (mutual benefit to both organisms). Some bacteria can produce spores. Associated terms: bacterial disease, bacteriological.

Biopsy: removal and examination of tissues from the living body.

Capsule: a structure made up of fat, cartilage, membranous or fibrous tissue, enveloping another structure, organ or part. Associated terms: encapsulation.

Carrier: an animal that harbours a disease-causing organism in its body, and which appears healthy and does not exhibit outwards signs of disease, thus acting as a carrier or distributor of the disease agent.

Cervidae: the family of ruminants containing deer, elk, caribou and moose.

Corvidae: the family of birds containing jays, crows, ravens, and magpies.

Chronic: persisting for a long time.

Cloaca: common duct for the passage of feces, urine and reproductive products in birds and reptiles. Also called a vent.

Conjunctiva: the delicate membrane lining the eyelids and covering parts of the eyeball.

Connective tissue: body tissue that supports and connects internal organs, forms bone and walls of blood vessels, attaches muscle to bone, and replaces tissues of various types following injury.

Contagious: capable of being transmitted from animal to animal.

Crustacean: a class of arthropods including lobsters, crabs, shrimps, barnacles, etc.

Cyst: a closed sac or capsule containing liquid or a semi-solid substance. Associated terms: encyst.

Clinical sign: observable evidence of abnormalities of structure or function in animals with disease. Associated terms: clinically affected.

Definitive host: the host in which a parasite passes its adult and sexual stages.

Dermatitis: a general term referring to inflammation of the skin. Skin affected by dermatitis may blister, ooze, develop a crust or flake off.

Disease: any impairment that interferes with or modifies the performance of normal functions of an organism (Wobeser G. 1994. *Investigation and Management of Disease in Wild Animals.* Plenum Press. New York.).

Edema: abnormal accumulation of fluid in regions of the body.

Emaciation: excess leanness; a wasted body condition.

Emerging disease: a disease that has appeared in a population for the first time, or that may have existed previously but is rapidly increasing in incidence or geographic range. (http://www.who.int/topics/emerging_diseases/en/)

Endemic: present at all times.

Epidermis: the uppermost layer of the skin.

Epizootic: a disease that occurs at a time or place where it normally does not occur, or with a frequency that is substantially greater than that expected for the time period (Wobeser G. 1994. *Investigation and Management of Disease in Wild Animals.* Plenum Press. New York.). Synonym to epidemic in humans.

Exudate: a fluid emitted by an organism through pores or a wound, consisting of sweat, blood, or microbial substances. The fluid generally includes water and can contain plasma proteins, white blood cells, platelets, or red blood cells.

Fibrous: tissue composed of or containing threadlike fibres. Often associated with scar tissue or chronic reactions.

Flatworms: flattened, leaf-like worms (Platyhelminthes), some of which parasitize blood, eyes, liver, reproductive tract, respiratory system, skin and urinary system.

Fomite: an inanimate object that is capable of carrying disease-causing agents and transmitting them to a new host.

Fungus: organisms that lack chlorophyll (the pigment of plants), reproduce via spores and are either parasites or feed on decaying organic material. Fungal diseases generally develop slowly, are difficult to diagnose and are rarely fatal.

Gastrointestinal: pertaining to the stomach and intestines.

Hemorrhage: the escape of blood either externally, internally into the skin or other tissues from a ruptured blood vessel.

Immune: being highly resistant to a disease, due to the formation of specialized proteins in blood serum called antibody that is produced in response to foreign antigens. An antigen is any substance that is capable, under appropriate conditions, of inducing a specific immune response.

Immune response: the specific response to substances interpreted by the body as non-self.

Immunity: the condition of not being susceptible to the adverse effects of microorganisms, parasitic worms or to the toxic effect of substances (antigens – see above, Immune) such as bacterial toxins, foreign proteins, etc. Also, security against a particular disease.

Inflammation: localized response of the body to injury or destruction of tissues that serves to “wall off” the injured tissue or keep out pathogens. Signs of inflammation include swelling, redness, heat, and pain.

Intermediate host: the host in which a parasite passes its larval and nonsexual stages.

Lagomorph: hares, rabbits and pikas of the Order Lagomorpha.

Lesion: tissue damage caused by disease or trauma. Associated terms: wound, injury, sore, ulcer, etc.

Lethargy: a condition of indifference or drowsiness.

Lymph node: accumulations of lymph tissue found in locations throughout the body of mammals and birds where noxious substances such as bacteria and toxins are removed. Lymph nodes play a role in the formation of antibody – specialized proteins produced by the immune system that respond to foreign substances introduced into the body.

Malaise: non-specific symptom, a feeling of general discomfort or uneasiness, often the first indication of an infection or other disease.

Mechanical transmission: transmission of a disease-causing agent through a contaminated object. Commonly, insects may transfer disease through contaminated body parts rather than being infected themselves.

Mesentery: a thin, membranous sheet attaching various organs to the body wall.

Microfilaria: the larvae of filarial worms. See also Nematode.

Mite: a small, often microscopic, spider-like parasite that commonly affects the tissues of the skin.

Mucous membrane: the thin, moist layer of skin overlying areas of the body such as the inner portions of eyelids (conjunctiva), nose and mouth.

Mustelid: a family of carnivorous mammals that live in both aquatic and terrestrial habitats. Species include: otter, sea otter, ferrets, weasels, skunk, badger, mink, ferret, wolverine, etc.

Necrosis: tissue damage caused by cell death.

Necropsy: examination of the body after death to determine the actual cause of death. Also called a postmortem examination, or in humans an autopsy.

Neurotoxin: a substance that is poisonous or destructive to nerve tissue.

Nodule: a small mass of tissue in the form of a swelling, knot or protuberance that can be detected by touch.

Paralysis: loss or impairment of muscle function due to a lesion in nervous or muscular tissue, trauma or toxins. Also by analogy, impairment of sensory function.

Passerine: birds belonging to the Order Passeriformes, a large group of “perching birds” that include sparrows, finches, buntings, cardinals, crows, jays, ravens, warblers, blackbirds, etc.

Pathogenic: capable of causing disease.

Plaque: a patch or flat area.

Pneumonia: inflammation of lung tissue.

Protozoan: a single-celled organism, often capable of producing disease.

Pus: a protein-rich liquid containing a thin to thick fluid mixed with white blood cells and damaged cells produced in association with inflammation.

Pustule: a small pus-filled lesion of the skin, usually thin-walled and easily ruptured.

Reservoir host: an animal that is infected by a parasite or disease agent, and serves as a source of infection for another species. Associated terms: reservoir of infection.

Roundworm (Nematoda): elongated, cylindrical, unsegmented worms, tapered at both ends. Some species are free-living and non-parasitic while others are parasites, often inhabiting the lower gastrointestinal tract of animals. Associated terms: filarial worm – a type of nematode.

Ruminant: mammals with four chambered stomachs that “chew their cud”.

Septicemia: disease throughout the body associated with disease-causing organisms or the toxins they produce in the blood.

Shock: acute failure of the peripheral circulatory system due to alteration of circulatory control or loss of circulating fluid; marked by low blood pressure, body coldness, and rapid heartbeat.

Spore (bacterial): a dehydrated life-stage of certain bacteria that is highly resistant to prolonged exposure to chemical disinfectants, ultraviolet light and high-energy radiation such as X-rays, as well as extremes in pH, temperature or aridity (dryness).

Spore (fungal): the reproductive elements of fungi produced either sexually or asexually.

Subcutaneous: beneath the layers of the skin.

Sylvatic: pertaining to the forest; loosely, “wildlife” or “wild area”.

Tapeworm (Platyhelminthes): long, flattened, segmented parasitic worms that inhabit the gastrointestinal tract of animals.

Tick: blood-sucking parasite closely related to spiders.

Trauma: wound or injury caused by external force.

Tumor: a new growth of tissue in which cell multiplication is uncontrolled and progressive.

Ulcer: a localized removal of dead or inflamed tissue in the upper layers of tissue of an organ or tissue, often circular.

Ungulate: hoofed mammals.

Vector: a “carrier” animal (often an Arthropod) that transfers an infective agent from one host to another.

Virus: infectious agents, smaller than bacteria, that invade the cells of hosts and alters their functioning in order to begin replication of virus particles. Viruses are essentially inert outside of a host, and consist solely of genetic material surrounded by a protein coat. Associated terms: viral disease

Zoonosis: infectious diseases of animals that can be transmitted to humans. Associated terms: zoonotic.






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DISEASE SURVEILLANCE AND SPECIMEN HISTORY FORM

Reporting the occurrence of wildlife disease is important. Complete this form and submit to the nearest Ministry office. Please also submit a copy of a completed form if biological samples are collected.

Submitter's name: _____

Affiliation: _____

Address: _____

_____

Collector's name: _____

Affiliation: _____

Address: _____

_____

Telephone: _____ E-mail: _____

Date collected: _____

Specific die-off location: _____

_____

Region: _____

UTM *or* Latitude/Longitude: _____

Legal description: _____

Method of collection: (found dead, euthanized [describe method] etc.) _____

_____

Environmental factors: (Record conditions such as storms, precipitation, temperature changes, or other factors that may contribute to stress) _____

_____

_____

Disease onset: (The best estimate of when the outbreak started) _____

_____

Species affected: (The diversity of species affected may provide clues to the disease involved.)_____

_____

_____

Age/sex: (Any selective mortality related to age and sex) _____

_____

Morbidity/mortality: (Ratio of sick animals to dead animals) _____

Known dead: (Actual pickup figures) _____

Estimated dead: (Consider removal by scavengers or other means) _____

Clinical signs: (Any unusual behavior and physical appearance of affected animals) _____

_____

_____

_____

Population at risk: (Number of animals in the area that could be exposed to the disease)_____

_____

_____

Population movement: (Recent changes in the number of animals on the area and their source or destination, if known) _____

_____

Problem area description: (Land use, habitat types, and other distinctive features) _____

_____

_____

Comments: (Additional information/observations that may be of value such as past occurrences of disease in area) _____

_____

_____

_____

The above adapted from: U.S. Department of the Interior and U.S. Geological Survey. 2001. *Field Manual of Wildlife Diseases: General Field Procedures and Diseases of Birds*. M. Friend, J.C. Franson (Tech. eds.), E.A. Ciganovich (ed.). Biological Resources Division Information and Technology Report 1999–001. U.S. Department of the Interior and U.S. Geological Survey. Washington, DC

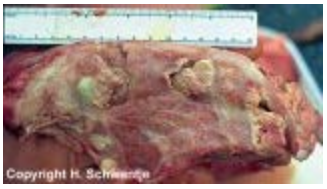
Abscesses

Causative Agent

- An abscess is a pus-filled pocket situated within animal tissues surrounded by a wall of scar tissue. An abscess may form after a wound is infected by bacteria and cannot drain.
- Abscesses may form as a result of external injuries or from internal infections.

Images

Click on image to enlarge.



Abscesses and pus within caribou muscle.

Distribution

Geographic and Seasonality:

- Abscesses may occur in wildlife throughout the year and throughout British Columbia.

Species Affected

- Abscesses can occur in a variety of species in northern British Columbia.

Signs and Symptoms

- Abscesses are usually characterized by a whitish, soft to firm *lump* that contains thick white, or yellowish-green, often foul-smelling, pus.
- Animals with abscesses may appear healthy without any outwards signs of disease.
- Most abscesses are found during the butchering process and can be found throughout the body.
- The severity of an abscess is dependent on the location in the body, the pressure it may exert on nearby tissues, the amount of tissue destroyed, its age and amount of bacterial toxins that are produced.

Meat Edible?

- Portions of meat that contain abscesses should not be eaten. If numerous abscesses are present throughout many organs, the animal may not be suitable for human consumption.
- If a single abscess is present, it can be trimmed out and the remainder of the carcass is usually suitable for human consumption.

Human Health Concerns and Risk Reduction

- Care should be taken to not cut into an abscess as bacteria in pus can spread to other locations and contaminate other parts of the carcass.

Samples for Diagnosis

- The entire abscess should be collected as well as any surrounding tissue; samples can be frozen.

Further Reading

- Alberta Environment and Sustainable Resource Development – Abscesses (PDF file)
- Alaska Department of Fish and Game – Abscesses
- Michigan Department of Natural Resources, Wildlife Diseases – Abscesses
- Utah Division of Wildlife Resources, Wildlife Diseases – Abscesses
- Elkin B., Zamke R.L. 2001. *Common Wildlife Diseases and Parasites in Alaska*. Alaska Department of Fish and Game. Anchorage, AK.



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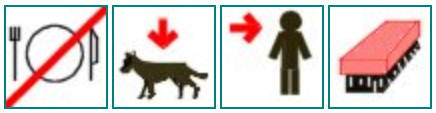
Anthrax



Causative Agent

- A zoonotic disease caused by infection with the bacteria *Bacillus anthracis*.
- *B. anthracis* bacteria are highly effective at causing disease because of several factors:
  - highly resistant, infectious spores that are capable of surviving outside of the host may be produced;
  - toxins are released in the blood of the host organism while the bacteria are undergoing rapid reproduction.
- *Anthrax is highly infectious to humans.*

Images

Click on image to enlarge.

Bison killed by anthrax are often found on their back or side with their legs in a "saw-horse position".

Distribution

Geographic:

- Worldwide distribution; may be common in specific geographic locations.
- In Canadian wildlife, anthrax has been reported in wood bison (*Bison bison athabascae*) in the Northwest Territories and in northeastern Alberta.

Seasonality:

- May occur throughout the year, but most often in the late summer.

Hosts, Transmission and Life Cycle

Hosts:

- Mammalian herbivores have a higher susceptibility to anthrax than carnivores, likely due to a more effective response from the immune system of carnivores.
- Wild mammals in North America that have been confirmed to be susceptible to anthrax include:
  - wood bison;
  - white-tailed deer (*Odocoileus virginianus*);
  - moose (*Alces alces*);
  - bobcat (*Lynx rufus*);
  - cougar (*Felis concolor*);
  - raccoon (*Procyon lotor*);
  - mink (*Mustela vison*).

Humans are also susceptible to anthrax.

Transmission:

- Transmission in wildlife and in humans occurs in one of three ways:
  - cuts in the skin (cutaneous)
  - inhalation;
  - ingestion;
- Infected animals as well as carriers of the disease can shed spores in urine and feces.
- In wildlife, anthrax outbreaks typically occur in dry summers following periods of rain.
- Dry weather usually forces grazing animals to feed closer to the ground where spores are often concentrated. Exposure typically occurs through inhalation or ingestion of spore-laden dust.
- Transmission among susceptible animals may also occur through flies and mosquitoes.
- Humans can contract anthrax from contact with infected animals through either:
  - cuts or scratches in the skin;
  - the eyes, nose or mouth;
  - inhaling spores from contaminated objects such as hides of infected animals;
  - eating undercooked meat from an infected animal.

Life Cycle:

- The oxygen and nutrient-rich blood of warm-blooded hosts represent ideal conditions for anthrax bacteria, and other types of bacteria within the host are outcompeted by anthrax bacteria for resources.
- When a host dies and oxygen is no longer transported in the blood, *B. anthracis* bacteria become dormant.
- Other types of bacteria from the gastrointestinal tract of the host animal begin the process of decomposition and can destroy remaining *B. anthracis* bacteria if the carcass remains intact.
- Scavenging birds and mammals may open the carcass, dispersing anthrax bacteria which, given the correct environmental conditions, form spores that are infectious to other animals or humans.

Signs and Symptoms

Animals:

- Within hours or days after exposure, infected animals may show signs of fever, debilitation, breathing difficulties, disorientation, and ultimately death.
- Toxins produced by bacteria in the blood are transported throughout the body. These toxins cause a reduction in oxygen in the blood, edema, kidney failure, shock, and ultimately death.
- A frothy discharge may be observed from the nose in addition to bloody discharges from other body orifices.

Humans:

- Signs of gastrointestinal (ingestion) anthrax include:
  - fever, loss of appetite, vomiting and diarrhea.
- Signs of inhalation anthrax include:
  - fever, sore throat and general ill-feeling that may be followed by breathing difficulties; this is the most serious type of anthrax infection.
- Signs of cutaneous (skin) anthrax include:
  - a small painless bump that often appears on the skin, which becomes a blister and then an ulcer with a black centre. In humans, this is the most common type of anthrax infection and can be treated with antibiotics.

Meat Edible?

- Meat from infected animals should not be consumed or fed to dogs. Carcasses should not be opened or otherwise cut into.

Human Health Concerns and Risk Reduction

- Anthrax is a potentially fatal zoonotic disease; all appropriate precautions should be taken to avoid exposure.
- The carcass of a dead animal suspected of having anthrax **SHOULD NOT BE OPENED OR TOUCHED!** Wild bison are the most likely to harbor anthrax; however, cattle are occasionally reported as well.
- **REPORT ANY SUSPECTED CASES OF ANTHRAX TO THE NEAREST CONSERVATION OFFICER OR HEALTH AUTHORITY.**
- For further information on human health concerns and anthrax, please refer to anthrax information provided visit the websites of the Canadian Food Inspection Agency or US Centres for Disease Control and Prevention and follow the appropriate links.
- Anthrax is a reportable disease in Canada, and under the Health of Animals Act, all cases must be reported to the Canadian Food Inspection Agency (CFIA).

Further Reading

- Alberta Environment and Sustainable Resource Development – Anthrax (PDF file)
- Public Health Agency of Canada – Anthrax
- Manitoba Wildlife Branch – Anthrax
- Pennsylvania Game Commission Wildlife Disease Reference Library – Anthrax
- US Centers for Disease Control and Prevention – Anthrax
- Gates C.C., Elkin B., Dragon D. 2001. Anthrax. Pp. 396-412 in E.S. Williams, I.K. Barker (eds.), *Infectious Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.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Government of the NWT - Resources, Wildlife and Economic Development

Antler Deformities

Risk Factor

- The size and shape of antlers depends on sex, food, age, and heredity.
- Some of the reasons that antlers exhibit abnormal growth include:
  - inadequate nutrition;
  - injuries to antler-growing regions on the skull;
  - metabolic or hormonal deficiencies;
  - abnormal fetal development;
  - genetic predisposition;
  - injuries to velvet;
  - leg injuries.

Images

Click on images to enlarge.

Abnormal antler growth in cervids.

Distribution

Geographic:

- Antlers are unique to cervids (deer family), and deformities are commonly reported by hunters and wildlife professionals throughout North America.
- Anecdotally, they are more commonly reported in white-tailed deer (*Odocoileus virginianus*) than mule deer (*Odocoileus hemionus*).

Seasonality:

- Deformities are reported throughout the period of the year when they are present.

Signs and Symptoms

- Abnormal antler growth has been described variously as:
  - oddly shaped or located points;
  - more points than normal;
  - points not originating from “normal” positions on the rack;
  - pronounced asymmetry.

Meat Edible?

- Discounting other disease conditions, meat from deer with abnormal antler development is

considered just as edible as from deer with normal antler development

Human Health Concerns and Risk Reduction

- There are no public health concerns associated with free-ranging cervids with abnormal antlers.

Samples for Diagnosis

- Photos of antlers showing abnormal growth or appearance can be submitted to the nearest branch of the British Columbia Conservation Officer Service.

Further Reading

- University of Florida – Deer Antler Abnormalities
- University of Missouri – Antler Development in White-tailed Deer: Implications for Management
- Karns G.R., Ditchkoff S.S. 2013. Trauma-induced malformed antler development in male white-tailed deer. *Wildlife Society Bulletin* 37: 832-837.
- Rue III L.L. 1978. *The Deer of North America*. Outdoor Life, New York. 463 pp.
- Stewart D. 2002. Antlerogenesis: antler growth and associated abnormailities. *Alabama's Treasured Forests* 21: 28-29. (PDF file)
- Veeramachaneni D.N.R., Amann R.P., Jacobson J.P.. 2006. Testis and antler dysgenesis in Sitka black-tailed deer on Kodiak Island, Alaska: sequela of environmental endocrine disruption? *Environmental Health Perspectives* 114: 51-59.

					
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Photo Credit: MIssissippi State University

Photo Credit: Mississippi State University

Apergillosis

Causative Agent

- A disease of the respiratory tract, primarily occurring in birds. It is caused by a fungus, *Aspergillus*, usually *A. fumigatus*.
- *Aspergillus* fungi live on dead or decaying matter that are closely related to human activities such as decaying vegetation and feed grains.

Images

Click on images to enlarge.

Labored breathing and 'gaping' are often observed in birds suffering from aspergillosis.

Lung of bird with chronic aspergillosis showing cheese-like fungal plaques (at arrows).

Distribution

Geographic:

- Worldwide.

Seasonality:

- Outbreaks of aspergillosis in waterfowl occur usually in the fall and early winter.
- Individual cases of aspergillosis can occur throughout the year, particularly among birds undergoing stress such as malnutrition or suffering from another disease.

Hosts, Transmission and Life Cycle

Hosts:

- Aspergillosis is most often encountered in birds; rarely in mammals. All birds are susceptible to aspergillosis. It is most commonly observed in colonial waterbirds (gulls), waterfowl, ravens and crows (corvids), and captive birds of prey.
- In young birds, particularly in species of northern waterfowl (eiders, mergansers), infection may spread (become generalized) and affect the brain.

Transmission and Life Cycle:

- *Aspergillus* spores are ubiquitous in the environment and are frequently inhaled by vertebrates.
- Spores travel through the upper respiratory tract to the lungs where they may colonize and produce a fungal pneumonia. The lungs become obliterated with debris and fungal filaments.
- Air sacs, parts of avian respiratory systems located primarily in the abdomen and long bones of wings, may also become infected. Dispersal of fungi to organs adjacent to air sacs may

also occur.
- Aspergillosis is not usually considered contagious.

Signs and Symptoms

- Typically, birds infected with *Aspergillus* will be emaciated, exhibiting severe difficulty in breathing. Infected birds also appear *unthrifty* and weak, their wings may droop, and they may fail in attempts to escape if pursued.
- Infection that has reached the brain can result in loss of muscular coordination and twisting of the head and neck so they are held in unnatural positions.
- Variably sized lesions in the lungs and air sacs are often visible in chronic infections of aspergillosis, occurring as flattened, yellow plaques with a cheese-like appearance and consistency.
- Similarly, large masses of fungal growth resembling bread mold may line air sacs.

Meat Edible?

- Birds with aspergillosis should not be considered edible because they are often in poor body condition. While it is not possible for humans to contract aspergillosis from eating the meat of an infected bird, it is possible for humans to contract this disease from inhaling the spores that are present in the air sacs and lungs. Because of this, infected birds should be discarded and not consumed.

Human Health Concerns and Risk Reduction

- Aspergillosis is considered a zoonotic disease. If resistance to infection is impaired, inhalation of *Aspergillus* spores may lead to fungal pneumonia or a serious allergic reaction to the fungus.

Samples for Diagnosis

- The whole carcass should be submitted for necropsy. The presence of fungal infection can be confirmed microscopically in the laboratory.

Similar Diseases

- Field signs are similar to those described for lead poisoning.

Further Reading

- Michigan Department of Natural Resources – Aspergillosis
- Pennsylvania Game Commission Wildlife Disease Reference Library – Aspergillosis
- Friend M. 2001. Aspergillosis. Pp. 129-133 in *Field Manual of Wildlife Diseases: General Field Procedures and Diseases of Birds*. M. Friend, J.C. Franson (Tech. eds.), E.A. Ciganovich (ed.). Biological Resources Division Information and Technology Report 1999-001. U.S. Department of the Interior and U.S. Geological Survey. Washington, DC. (Chapter in PDF Format)






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A
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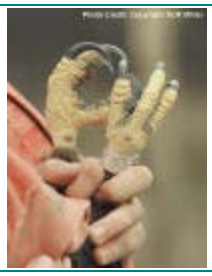
Avian Pox

Causative Agent

- A disease of the skin of birds caused by infection with the Avipoxvirus group of viruses.

Images

Click on images to enlarge.



Avian pox lesions are typically found on the featherless regions of the body. As the disease progresses, pox lesions become more extensive, potentially impairing sight, breathing and feeding, such as in this immature bald eagle.

Suspected avian pox in a young-of-the-year bald eagle. A nostril has been completely occluded with a pox-like lesion. The legs and feet of the same eagle show lesions characteristic of avian pox.

Distribution

Geographic:

- Avian pox has been reported worldwide.
- Avian pox is usually considered an endemic disease in birds. Because of increased frequency of reported cases involving new species, it is also viewed as an emerging disease.
- Mosquitoes and birds acting as carriers can spread the disease at bird feeders and through migratory flyways.

Seasonality:

- Infection with avian pox can occur throughout the year.
- Environmental factors, the activity of mosquitoes, and the habits of the species affected by avian pox can influence when outbreaks occur.

Hosts, Transmission and Life Cycle

Hosts:

- Avian pox has been reported in approximately 60 species of free-living birds.
- It is most commonly reported in songbirds, upland game birds, marine birds and birds of prey.

Transmission and Life Cycle:

- The virus stimulates the upper layers of the skin to grow rapidly; this new tissue soon dies.
- Avian pox can be acquired through:
    - transfer from infected hosts via infected mouthparts of mosquitoes;
    - direct contact with surfaces or air-borne particles contaminated with poxvirus, resulting in infections when the virus enters through abraded skin or though mucous membranes.
- Avian pox virus can survive considerable aridity (dryness); therefore, dust particles containing the virus can remain infective for extended periods of time.

Signs and Symptoms

- There are two forms of avian pox: *cutaneous* (involving the skin) and *wet* (involving internal organs).
- The cutaneous form is more commonly reported in wild birds:
    - birds with wart-like nodules on the featherless areas of the body, including the feet and legs, margins of the eyes, and base of the beak should be considered suspect cases of avian pox;
    - birds may appear weak and emaciated if the nodules have interfered with feeding;
    - labored breathing may be observed in birds where air passages have been blocked;
    - birds can fully recover provided they are able to feed. The disease usually is self-limiting and leaves only minor scars;
    - growths can spread and increase in size, forming clusters which may impair sight, breathing and feeding;
    - secondary bacterial and fungal infections of pox lesions are common with cutaneous forms of avian pox infection.
- Wet avian pox is commonly reported in domestic chickens and turkeys and less commonly in wild birds, likely because it is less visible than the cutaneous form:
    - wet pox involves lesions of the mucous membranes of the mouth and upper digestive and respiratory tracts;
    - wet pox may contribute to mortality and sickness leading to the removal of infected birds by predators and scavengers.

Meat Edible?

- Meat from an infected animal is suitable for human consumption if the affected parts are trimmed and discarded. Do not consume the lungs or associated tissues.

Human Health Concerns and Risk Reduction

- There is no evidence that avian pox virus can infect humans.
- If birds with suspected avian pox are handled and other live birds are to be handled in the future, any surface that infected birds have come in contact with should be cleaned with a 10% household bleach solution to prevent the spread of the disease to other birds.

Samples for Diagnosis

- A tentative diagnosis of avian pox can be made based on the appearance of wart-like lesions on the body; however, this must be confirmed with microscopic examination and virus isolation.
- Submission of the whole bird or affected body parts are needed for virus isolation.
- Specimens should be frozen if held for more than a day before shipment to a diagnostic laboratory.

Further Reading

- Alberta Environment and Sustainable Resource Development – Avian Pox (PDF file)
- BC Wildlife Health Fact Sheet – Avian Pox (PDF file)
- Michigan Department of Natural Resources – Avian Pox
- Pennsylvania Game Commission Wildlife Disease Reference Library – Avian Pox
- USGS National Wildlife Health Center – Avian Pox
- Hansen W. 2001. Avian pox. Pp. 163-169 in *Field Manual of Wildlife Diseases: General Field Procedures and Diseases of Birds*. M. Friend, J.C. Franson (Tech. eds.), E.A. Ciganovich (ed.). Biological Resources Division Information and Technology Report 1999-001. U.S. Department of the Interior and U.S. Geological Survey. Washington, DC. (Chapter in PDF Format)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Baylisascaris (Raccoon Roundworm)

Causative Agent

- Parasitic and zoonotic disease of mammals and birds caused by infection with the roundworm (Nematode), *Baylisascaris procyonis*.
- Immature (larval stages) of the worm migrate through tissues and may cause extensive damage in susceptible hosts. This is a trait shared by other roundworms.

Images

Click on image to enlarge.

Raccoon roundworms are found in the small intestines of infected animals.

Distribution

Geographic:

- The distribution of *B. procyonis* mirrors that of raccoons (*Procyon lotor*).
- Raccoons are regularly found in the Lower Mainland, southern BC and Vancouver Island, although their range is expanding.
- A recent study in southwestern BC indicated that the number of raccoons infected with *B. procyonis* was 61%.
- As raccoons are increasingly being brought as pets to new locations, the geographic range of *B. procyonis* will continue to expand.

Seasonality:

- New infections begin in young raccoons that have ingested infective eggs of *B. procyonis* in late spring and early summer.

Hosts and Life Cycle

- Two alternate life cycles occur: one in raccoons, and the other in susceptible, incidental (abnormal) hosts.
- For a visual description of life cycles described below, please visit the US Centre for Disease Control and Prevention.
- **Definitive Host:**
  - Adult worms are found in the small intestine of the raccoon.
  - Disease resulting from migrating larvae is rarely observed in raccoons. Although, when disease is detected, it is seen in young raccoons more often than adults.
  - Adult worms produce eggs that are shed in the feces. This can amount to millions of

eggs released per day/raccoon.
    - Within a month in the external environment, larvae develop within the eggs, which are then infective.
    - Eggs may persist in the environment for years and are resistant to common disinfectants. Burning is said to be the most effective method of destroying the eggs.
    - Infective eggs are ingested by susceptible young raccoons OR infection may occur after eating another animal that has larvae in its tissues. Larvae migrate via the bloodstream through the liver to the lungs.
    - The larvae are then coughed up, swallowed, and mature into adults in the small intestine.
- **Abnormal Host:**
    - Many mammals and birds have been reported as abnormal hosts, including humans, woodchucks, red and grey squirrels, porcupines, cottontail rabbits, and a number of species of ground-foraging birds.
    - Ingestion of larvae or eggs results in infection.
    - Raccoons use communal sites for defecation; other animals that forage in these areas, as well as humans coming into contact with such sites, are potentially at risk for *Baylisascaris* infection.
    - Larvae hatched in the gut of abnormal hosts may migrate erratically through tissues, such as lung, liver, heart and, most notably, in the eyes and central nervous system.
    - Larvae encyst in muscle, liver or the lungs.
    - Larval migration through the brain of susceptible hosts causes extensive tissue damage, resulting in severe neurological signs that include imbalance, circling and abnormal behavior.
    - Central nervous system damage has been reported in humans and a large number of wild and domestic mammals and birds.

Signs and Symptoms

- Like other roundworms, *B. procyonis* are cylindrical and taper at both ends. Adult worms are tan-white in color, measure 9-22 cm in length and 1 cm in thickness.
- **In raccoons:**
    - Larval migration may cause localized areas of inflammation and tissue damage or cause damage due to blockage of the small intestine by adult worms. *B. procyonis* infection otherwise seems to have no detrimental effects on raccoons.
- **In abnormal hosts:**
    - There are usually no symptoms if the larval parasite does not enter the brain.
    - Effects are usually correlated with the number eggs ingested, the number of larvae entering the brain, extent of migration within the brain, and size of the brain relative to the size of the larval parasite.
    - Larvae may become encapsulated in tissues; these cysts are usually visible as light-colored spheres, which are 1-2 mm in diameter.
        - **Clinical signs in small mammals include:**
            - depression;
            - lethargy;
            - nervousness;
            - rough coat;
            - tremors in the front paws;
            - head or body tilts: slight at first, progressing to worse;
            - falling over;
            - circling;
            - posterior paralysis;
            - blindness;
            - laying on its side.
        - **Clinical signs in birds include:**
            - poor grip reflexes;
            - incoordination;
            - inability to fly or loss of flight control;
            - falling;
            - wing and leg paralysis.
        - **Clinical signs in humans include:**

- skin irritation from larval migration within the skin;
- eye and brain tissue damage due to the random migration of larvae;
- individuals may experience nausea, a lethargic feeling, incoordination and loss of eyesight.

Meat Edible?

- Raccoon meat is generally not consumed by humans. If a raccoon is to be skinned, proper protective gear should be worn (gloves, coveralls) and good hygiene should be practiced.

Human Health Concerns and Risk Reduction

- *Baylisascaris* infection in humans may cause severe damage in the eyes and brain, and in extreme cases, death.
- Minimizing the potential exposure of people to raccoon feces is the best risk reduction measure.
- Exclusion of raccoons from areas of human habitation is warranted, as is careful attention to hygiene, particularly of children, in high-risk areas.
- Wildlife rehabilitators, animal shelter workers and others who may come in contact with raccoon feces on a regular basis need to take particular care in the handling and disposal of raccoon feces. Additionally, these organizations should deworm all raccoons that come under their care, although this is not guaranteed to remove all parasites.

Samples for Diagnosis

- Infection with *Baylisascaris* may be confirmed by finding eggs in the fecal material of live raccoons.
- Roundworms found in the intestines of raccoons should be submitted to determine if they are *B. procyonis*.
- Tissues of hosts other than raccoons that contain small cysts should be submitted to determine if *B. procyonis* larvae are present.

Similar Diseases

- Neurological symptoms are very similar to rabies and other wildlife diseases that affect the central nervous system.
- Other disease agents which may elicit similar neurological symptoms include:
  - pesticides;
  - trauma;
  - sarcosystosis;
  - bacterial and viral inflammation of the brain.

Further Reading

- BC Centre for Disease Control – Raccoon Roundworm
- Canadian Medical Association Journal – Raccoon Roundworm
- Canadian Cooperative Health Centre – Raccoon Roundworm (PDF file)
- Michigan Department of Natural Resources – Raccoon Roundworm
- Canadian Cooperative Wildlife Heath Centre. 1995. *Baylisascaris procyonis* Larval migrans. Pp. 45-47. *Health Risks to Wildlife personnel: Hazards from Disease-causing Agents*. Canadian Cooperative Wildlife Heath Centre, Western College of Veterinary Medicine, University of Saskatchewan. Saskatoon, SK.
- Ching H.L., Leighton B.J., Stephen C. 2000. Intestinal parasites of raccoons (*Procyon lotor*) from southwest British Columbia. *Canadian Journal of Veterinary Research* 64: 107-111.
- Coates J.W., Siegert J., Bowes V.A., Steer D.G. 1995. Encephalitic nematodiasis in a

Douglas squirrel and a rock dove ascribed to *Baylisascaris procyonis*. *Canadian Veterinary Journal* 36: 566-569.

- Kazacos K.R. 2001. *Baylisascaris procyonis* and related species. Pp. 301-341 in W.M. Samuel, M.J. Pybus, A.A. Kocan (eds.), *Parasitic Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.

					
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Michigan Department of Natural Resources

Bear Filarial Worm

Causative Agent

- Parasitic disease of bears (Ursidae) caused by infection with the long, hair-like nematode or filarial worm, *Dirofilaria ursi*.

Images

Click on image to enlarge.

Distribution

Geographic:

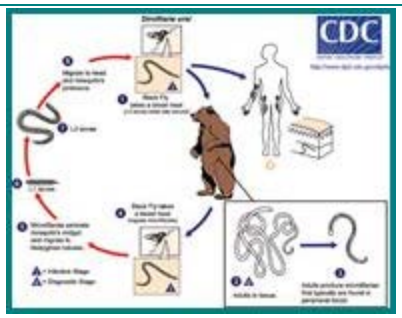
- Bear filarial worms have been reported in black bears (*Ursus americanus*) in both Canada and the United States.

Seasonality:

- Throughout the year.

Hosts, Transmission and Life Cycle

Click on image to enlarge.



During a blood meal, an infected black fly (genus *Simulium*) introduces third-stage filarial larvae of *Dirofilaria ursi* onto the skin of the ursine definitive host (although humans may also serve as hosts), where they penetrate into the bite wound ❶. In subcutaneous tissues, the larvae develop into adults, which commonly reside in subcutaneous connective tissues ❷. Adult females are usually 115-225 mm long by 0.46-0.70 mm wide; males are usually 50-90 mm long by 0.33-0.48 mm wide. Adults can live for 5 - 10 years. In the subcutaneous tissues, the female worms are capable of producing microfilariae over their lifespan. The microfilariae are found in peripheral blood ❸. A black fly ingests the microfilariae during a blood meal ❹. After ingestion, the microfilariae migrate from the black fly's midgut through the hemocoel (cavities containing blood) to tubules in the lower regions of the gut (Malpighian tubules) ❺. There the microfilariae develop into first-stage larvae ❻ and subsequently to third-stage infective larvae ❼. The third-stage infective larvae migrate to the black fly's mouthparts (proboscis) ❽ and can infect another definitive host when the fly takes a blood meal ❶. Humans are not common hosts, but may become infected after being fed upon by infected black flies ❾.

Transmission and Life Cycle:

- See above figure from the US Centers for Disease Control for a complete description of the life cycle of *D. ursi*.
- Adult *D. ursi* worms tend to occur beneath the skin in the area of the neck and groin, and in the connective tissues around the aorta, kidneys, and rectum.
- Adult female worms produce motile larvae called microfilaria measuring 0.19 to 0.29 mm in length that enter the circulatory system of the bear where they remain until ingested by a black fly.
- Following a 2-week period within the black fly, larvae become infective to bears. Larvae enter the new host as the fly begins taking a blood meal.
- Larvae migrate to preferred locations within bears where they mature and eventually mate.
- A 7-month period of time is required for the female worms to produce microfilaria and complete the life cycle.

Signs and Symptoms

- Adult *D. ursi* worms are white and slender and can range in size from 5 to 22 cm long.
- *D. ursi* does not appear to cause disease in bears or other species.

Meat Edible?

- Infection with *D. ursi* does not affect the quality of the meat.

Human Health Concerns and Risk Reduction

- There are no reports of any adverse reactions in humans bitten by black flies containing microfilaria.
- While rare, infection with *D. ursi* has resulted in the formation of small, subcutaneous nodules, in humans.

Samples for Diagnosis

- *D. ursi* infections can be diagnosed either by examining blood smears for microfilariae or by finding the adult worms in preferred locations beneath the skin or surrounding internal organs of bears.
- Because microfilaria of other types of filarid worms may be present, identifying the adult worms as *D. ursi* is the most accurate method of diagnosis.

Further Reading

- Michigan Department of Natural Resources – Bear Filarial Worm
- US Centers for Disease Control – Dirofilariasis
- Elkin B, Zamke R.L. 2001. *Common Wildlife Diseases and Parasites in Alaska*. Alaska Department of Fish and Game. Anchorage, AK.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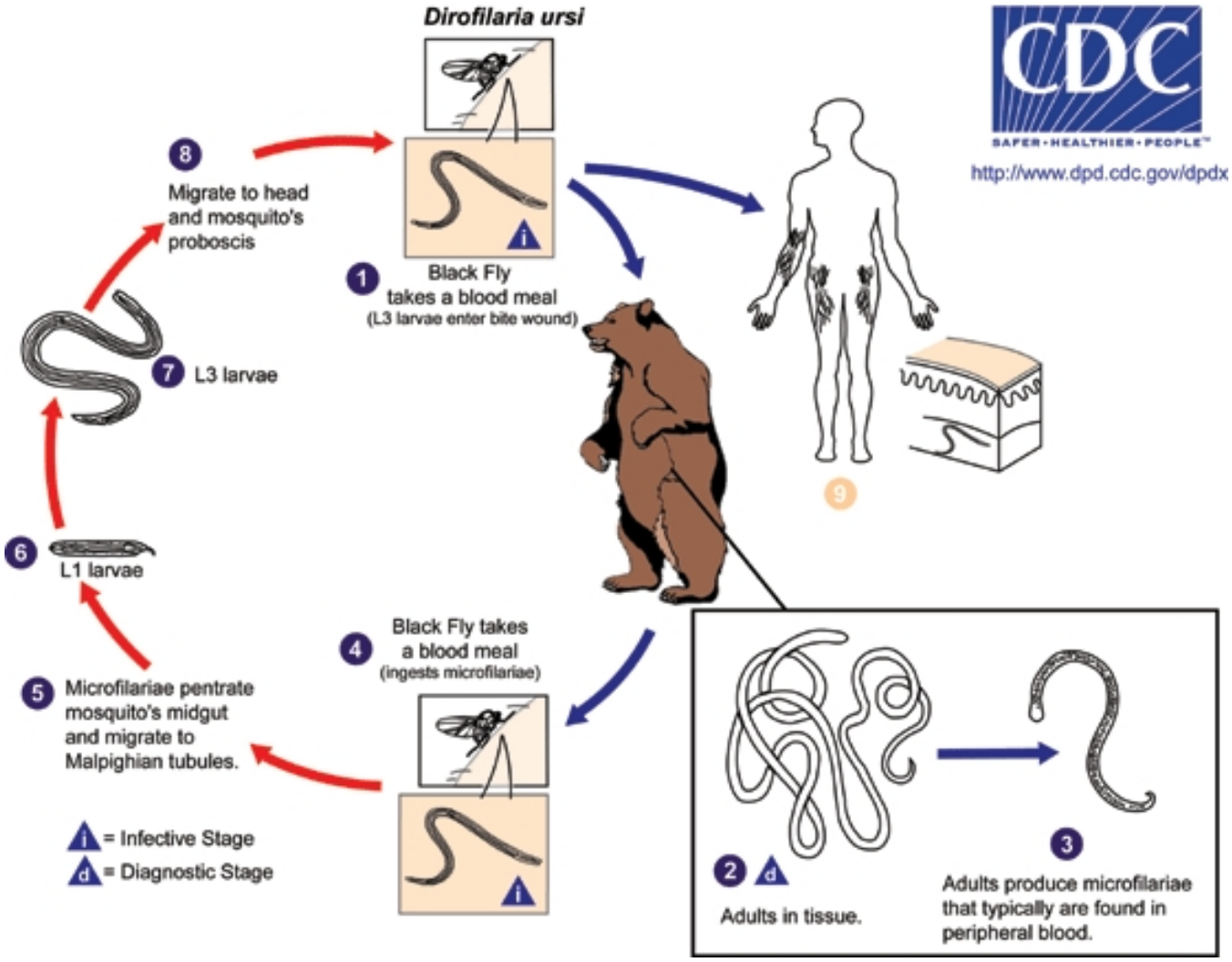
Dirofilaria ursi
CDC
SAFER·HEALTHIER·PEOPLE™
http://www.dpd.cdc.gov/dpdx
8
Migrate to head and mosquito's proboscis
1
Black Fly takes a blood meal
(L3 larvae enter bite wound)
7
L3 larvae
6
L1 larvae
4
Black Fly takes a blood meal
(ingests microfilariae)
5
Microfilariae pentrate mosquito's midgut and migrate to Malpighian tubules.
i = Infective Stage
d = Diagnostic Stage
9
2
Adults in tissue.
3
Adults produce microfilariae that typically are found in peripheral blood.

Besnoitiosis

Causative Agent

- Besnoitiosis is caused by the unicellular protozoan parasite *Besnoitia tarandi*.

Images

Click on image to enlarge.

***Hair loss and crusty skin on the face of a caribou infected with* Besnoitia.**

Distribution

Geographic:

- Several species of *Besnoitia* are found around the world that can infect both wild and domestic herbivores. *B. tarandi* is known to occur in BC.

Seasonality:

- Warmer months of the year; eggs passed in the feces of carnivores require a warm and moist environment to become infective.

Hosts, Transmission and Life Cycle

Hosts:

- Requires both an intermediate host (in BC *Besnoitia* has only been seen in caribou, but elsewhere has been reported in mule deer) and definitive host (carnivore: species in BC not known).

Transmission and Life Cycle:

- An intermediate host ingests eggs that mature within the gastrointestinal tract.
- Within host cells, generations of asexual reproduction occur beginning first in the walls of blood vessels followed by reproduction in various organs and tissues forming relatively large cysts (up to 1 mm in diameter).
- When cyst-containing tissues are ingested by a definitive carnivore host, cysts break open within the intestine and eventually differentiate into female and male components and invade the tissues of the intestinal wall.
- Eggs are produced and are excreted in the feces and become infective once in the external environment. Contaminated vegetation is ingested by the herbivorous intermediate host and the cycle repeats.
- Transmission between intermediate hosts, independent of definitive hosts, may occur through biting insects.

Signs and Symptoms

- Clinical signs are observed only in intermediate hosts and never in definitive hosts.
- Infected animals usually appear healthy and signs can vary. Cysts observed in eyes of caribou may not be present several days later.
- A high density of cysts on the skin can increase the thickness of the skin while decreasing its elasticity, resulting in the formation of cracks, allowing for bacteria to enter and cause infection.
- Severe lesions have been seen in captive animals with localized hair loss, fluid seepage and hemorrhage, especially when large numbers of cysts are observed on joints of the lower limbs, face and nasal cavity, and less often in the eye. Skin, subcutaneous tissue and the white of the eye may look like sandpaper.
- Thickening of skin within the nasal passages can obstruct breathing.
- Blockage of blood vessels may be observed in *B. tarandi* infections.
- The severe signs described above have not been observed in wild ungulates in BC.
- When skinning the lower legs of an infected animal, the cysts can be observed as small clear to white spheres. Cysts are hard and have a slight roughness that gives the underlying connective tissue the appearance of being sprinkled with corn meal.

Meat Edible?

- Meat is edible, cook well. **DO NOT FEED INFECTED MEAT TO DOGS**.

Human Health Concerns and Risk Reduction

- There are no known human health concerns with *Besnoitia* infection.

Samples for Diagnosis

- Submission of lower limb can be used for diagnosis, or examination of the white of the eye.

Similar Diseases

- Lesions from severe Besnoitiosis may resemble sarcoptic mange, bacterial dermatitis or ringworm.

Further Reading

- Alaska Department of Fish and Game – Besnoitiosis
- Elkin B., Zamke R.L. 2001. *Common Wildlife Diseases and Parasites in Alaska*. Alaska Department of Fish and Game. Anchorage, AK.
- Leighton F.A., Gajadhar A.A.. 2001. *Besnoitia* spp. and Besnoitiosis. Pp. 468-478 in E.S. Williams, I.K. Barker (eds.), *Infectious Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.






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Brucellosis

Causative Agent

- A potentially zoonotic disease of ungulates and the carnivores that feed on them. Caused by the bacteria *Brucella abortus* and *Brucella suis* type 4.
- *Brucella* bacteria generally cause chronic infections.

Images

Click on image to enlarge.

Swollen knee joint of caribou due to brucellosis.

Distribution

Geographic:

- *Brucella* once occurred worldwide, but now has limited distributions due to government-sponsored eradication programs.
- In Canada, there are two forms of the disease associated with the two species of bacteria listed above: specifically in Wood Buffalo National Park, northeastern Alberta, affecting primarily wood bison (*B. abortus*), and barren-ground caribou and reindeer (*B. suis* type 4) elsewhere.
- There is no reported occurrence of brucellosis in BC in any species. The greatest risk is if an infected wood bison from Wood Buffalo National Park disperses to northeastern BC and contacts a native or captive bison population.

Seasonality:

- Risk of exposure increases prior to and during calving season due to the presence of large numbers of bacteria in fetal fluids.

Hosts, Transmission and Life Cycle

Brucella abortus

Hosts:

- Bison and potentially other ungulates.
- Sexually mature animals are more susceptible than immature animals.
- *B. abortus* has also been found in wolves, fox and moose within Wood Buffalo National Park, Alberta.

Transmission and Life Cycle:

- Transmission rates are greater in highly social animals.
- Bacteria enter the body through mucous membranes and are spread through the lymph

nodes and spleen.

- If a pregnant animal is infected, the bacteria invades the uterus and placenta, restricting the transfer of nutrients to the fetus as well as producing toxins, potentially leading to fetal death or the birth of an infected offspringfetus.
- In social ungulates, bacteria are spread from direct contact with infected animals. This includes:
  - discharge from the vagina;
  - aborted fetuses;
  - sexual intercourse;
  - mechanical transmission through flies;
  - inhalation of bacteria;
  - contaminated food.
- Carnivores are thought to be exposed through the consumption of infected animals, the placenta or aborted fetuses.
- Moose are unusually susceptible to *B. abortus* and often die of the infection.

Brucella suis type 4

Hosts:

- Barren-ground caribou (*Rangifer tarandus*) and reindeer (*Rangifer tarandus*).
- May also spill-over into wolves (*Canis lupus*), domestic dogs, and bears (Ursidae).

Transmission and Life Cycle:

- Very similar to that of *B. abortus* except different species are involved.

Signs and Symptoms

Wildlife:

- Wildlife may not show signs of the disease and instead appear healthy.
- Signs of disease in infected animals vary according to species but are primarily found in the reproductive tracts of both sexes. These include:
  - inflammation of the testicles or uterus;
  - retained placentas;
  - fluid-filled swellings of the forelegs.
  - abortion occurring during late pregnancy;
  - calves that are born may be weak.
- Less commonly, infection with *Brucella* bacteria may cause arthritis, formation of abscesses in lymph nodes, and inflammation of mammary tissue.

Humans:

- Disease begins within a week or up to several months after exposure.
- *B. suis* type 4 elicits more serious effects in humans than *B. abortus*.
- Blood becomes infected and is accompanied by a fever. Symptoms include:
  - chills;
  - profuse sweating;
  - weakness and fatigue;
  - joint pain.
- *Brucella* bacteria localize in the lymph nodes and spleen.
- If untreated, the disease may persist from weeks to months with the potential for serious effects on the brain, joints, bones or heart.

Meat Edible?

- Do not cut into diseased parts or meat that has had fluid from the uterus spilled on it.
- Meat can be safely consumed if cooked thoroughly; however, freezing, smoking, drying or pickling will not kill the bacteria.
- *Brucella* bacteria may be found in the bone marrow and liver.
- Meat from an infected carcass or a carcass thought to be infected **SHOULD NOT BE FED TO DOMESTIC CATS OR DOGS**.

Human Health Concerns and Risk Reduction

- People at risk of contracting brucellosis include: abattoir workers, veterinarians, farmers and wildlife personnel.
- Hunters are not perceived as being at high risk of exposure to *Brucella* bacteria as the timing of hunting relative to the breeding season limits exposure.
- Humans may contract the infection through inhalation, skin abrasions, mucous membranes, or the conjunctiva of the eyes when they handle infected animals during activities such as:
  - butchering;
  - handling fetuses or afterbirth;
  - contact with raw meat or the secretions and excretions of the genital system;
  - ingestion of infected animals.
- Brucellosis is a reportable disease in Canada, and under the Health of Animals Act, all cases must be reported to the Canadian Food Inspection Agency (CFIA).

Samples for Diagnosis

- Tissues to be collected for diagnosis include: lungs, stomach contents, spleen (of fetus or calf), affected joints, reproductive tract, and lymph nodes.
- Appropriate safety precautions (protective clothing, eyeware, gloves) should be used if cutting into an animal suspected of being infected with *Brucella* bacteria.
- Hands, knives, clothes and cutting surfaces should be thoroughly cleansed with hot soapy water after handling an animal suspected of having the disease.
- Immunological tests of live animals can also determine the presence of *Brucella* bacteria.

Further Reading

- Alberta Environment and Sustainable Resource Development – Brucellosis (PDF file)
- Alaska Department of Fish and Game – Brucellosis
- Michigan Department of Natural Resources – Brrucellosis
- OIE World Organisation for Animal Health – Brucellosis (PDF file)
- Canadian Cooperative Wildlife Heath Centre. 1995. Brucellosis. Pp. 15-17. *Health Risks to Wildlife Personnel: Hazards from Disease-Causing Agents*. Canadian Cooperative Wildlife Heath Centre, Western College of Veterinary Medicine, University of Saskatchewan. Saskatoon, SK.
- Elkin B., Zamke R.L. 2001. *Common Wildlife Diseases and Parasites in Alaska*. Alaska Department of Fish and Game. Anchorage, AK.
- Thorne E.T. 2001. Brucellosis. Pp. 372-396 in E.S. Williams, I.K. Barker (eds.), *Infectious Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.


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Chronic Wasting Disease

General Information: Description and Symptoms

- Chronic Wasting Disease or CWD, is a progressive, degenerative disease of the brain affecting deer and elk (Cervidae) in North America.
- CWD is similar to other nervous system diseases known as transmissible spongiform encephalopathies (TSE). These include scrapie in sheep, bovine spongiform encephalopathy (BSE) in cattle, and Creutzfeldt-Jakob disease (CJD) in humans. Although the exact cause of CWD is unknown, it is associated with the presence of an abnormal protein called a prion. There is no treatment or vaccine currently available for the disease.
- There is currently no scientific evidence that CWD affects humans, but we must exercise caution since there is some evidence to suggest that BSE, or “mad cow disease”, can affect humans.
- It is not clear how CWD is transmitted but, based on experience with the disease in captive deer, both animal to animal and mother to offspring transmission may be possible; however, the most likely means of transmission is between animals that are in close contact with each other. In addition, elk and mule deer became infected after being placed in paddocks that had previously housed infected cervids, even though there were no other cervids presently on the premises, leading to the assumption that the agent could survive in the environment and cause disease.
- Symptoms of infected animals may include lack of coordination, separation from other animals in a herd, excess salivation, depression, unusual behavior, paralysis, weight loss, difficulty swallowing, increased thirst and urination, and pneumonia. Signs usually last for weeks to months before the animal dies; however, some animals may not show clinical signs except for an acute pneumonia. Animals are usually 3- to 4-years of age before clinical signs appear, but may be as young as 18 months or as old as 13 years. The disease is tentatively diagnosed based on clinical signs, and is confirmed by isolating abnormal prion proteins during postmortem examination of the brain stem or from samples of lymphoid tissue from the affected animal. Current research, however, suggests that biopsies of palatine tonsils or rectal lymphoid tissue could be used to determine the presence of prion proteins in live animals.

Distribution and Surveillance

Click on image to enlarge.

Current distribution (2013) of chronic wasting disease in North American cervids. Map courtesy of the Chronic Wasting Disease Alliance (www.cwd-info.org).

- CWD is an emerging disease. That is, the number and distribution of infected wild and

captive cervids has been steadily increasing since its discovery in the late 1960s at a research facility holding captive deer in Colorado.

- In addition to several US states, many Canadian provinces have initiated surveillance programs to monitor CWD in free-ranging cervids.
- British Columbia initiated a CWD surveillance program of deer and elk in 2001. The program primarily focuses on random surveys of road kills and hunter-killed deer and elk. As of January 2014, CWD has not been detected in BC.

BC Assessment and Surveillance Program

Please click on the above thumbnails to download information from the BC Ministry of the Environment CWD Surveillance Program.

Further Reading

- Alberta Environment and Sustainable Resource Development – Chronic Wasting Disease (PDF file)
- BC Chronic Wasting Disease Fact Sheet (PDF file)
- BC Chronic Wasting Disease Program (Ministry of Environment Wildlife Health Program)
- BC Chronic Wasting Disease Risk Assessment (PDF file)
- Chronic Wasting Disease Alliance - summary of findings from a variety of scientific sources
- USGS - National Wildlife Health Center - CWD Surveillance and Research in the United States

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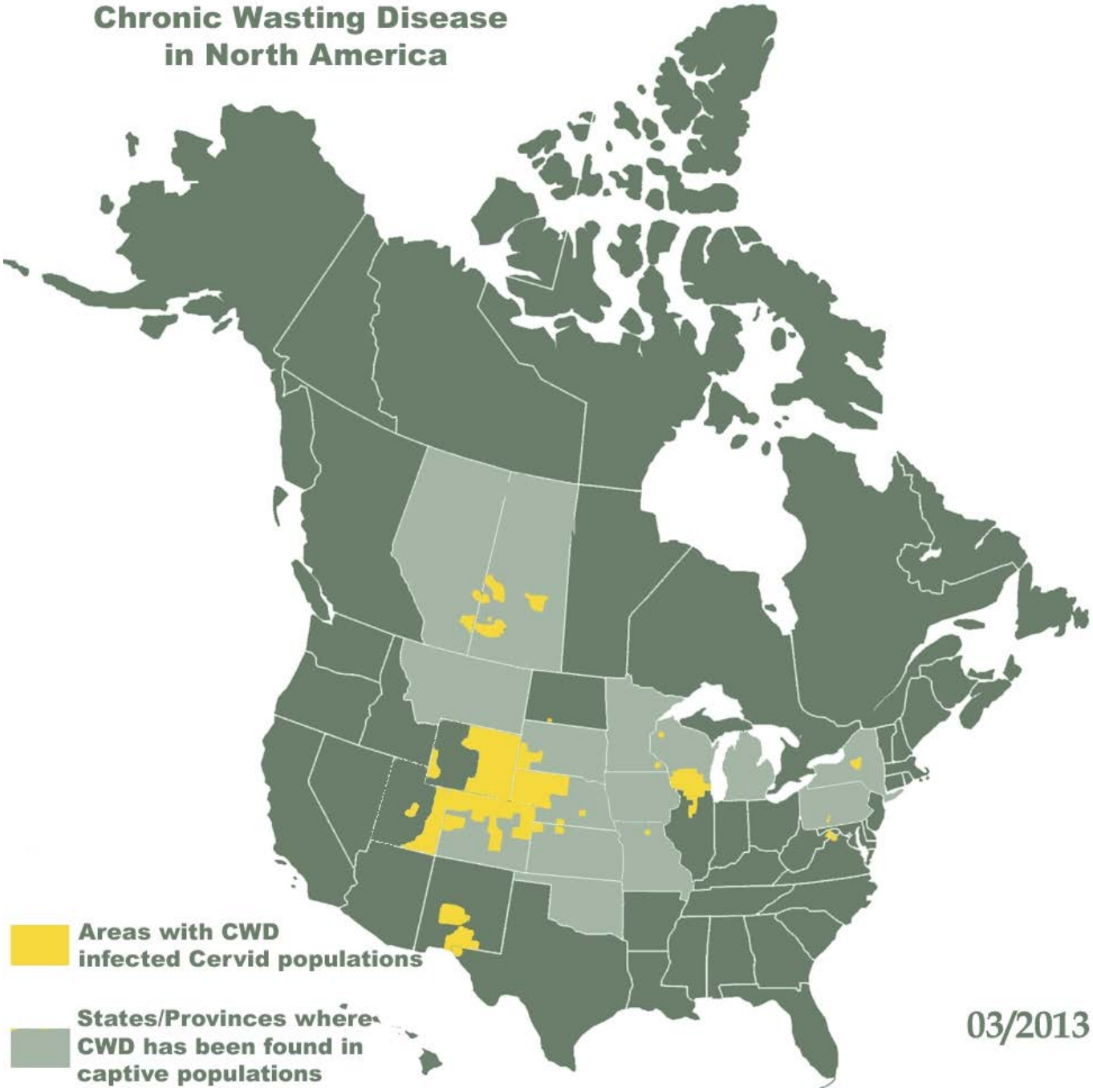
Chronic Wasting Disease
in North America
Areas with CWD
infected Cervid populations
States/Provinces where
CWD has been found in
captive populations
03/2013

Amphibian Diseases: Chytrid Fungus (Chytridiomycosis) and Ranaviruses

Causative Agents

Chytrid fungus:

- Chytridiomycosis is a skin disease of amphibians that is caused by the chytridiomycete fungus, *Batrachochytrium dendrobatidis*, which seems to be specific to amphibians.
- In general, chytrids are a group of fungi that are found ubiquitously in soil, water, and even in the rumen of cattle.
- It has been documented in various species of frogs, toads, and salamanders both in captivity and the wild.
- Infection can be lethal in some amphibian species, including boreal toads, but the mode of death is unknown, but it has been speculated that this fungus may produce a toxin, although this idea has not been confirmed.

Ranavirus:

- *Ranavirus* is a genus within the Iridoviridae family of viruses.

Images

Click on image to enlarge.

Mountain yellow-legged frogs killed by chytrid fungus (August 2008 - California, USA). Photo © by Vance Vredenburg

Distribution

Chytrid fungus

Geographic:

- Worldwide.
- Opportunistic surveys for chytrid fungus in 2008-2009 indicated that it is widely distributed in all regions of British Columbia and in all of the frogs and toads tested.

Seasonality:

- Prevalence of Chytridiomycosis has been reported to be seasonal in temperate areas, with a higher incidence during cooler months and a lower incidence during warmer months.

Ranaviruses

Geographic:

- Americas, Asia and Pacific, Europe.

Seasonality:

- As mortality events due to ranaviruses mostly affect larval amphibians, die-offs associated with ranaviruses occur in spring and summer amphibian when larvae are present.

Hosts, Transmission and Life Cycle

Chytrid fungus

Hosts:

- Amphibians.

Transmission and Life Cycle:

- Chytrid spores are motile (zoospores) but have limited swimming ability (distances often less than 2 cm) and the fungus appears to depend on water flow or host movement for long-distance dispersal.
- The fungus grows best between 17 and 25°C and cannot grow at air temperatures higher than 28°C.

Ranaviruses

Hosts:

- The USGS National Wildlife Health Center has isolated amphibian ranaviruses from 16 species of frogs, one species of toad and six species of salamanders. Mortality events due to ranaviruses occur most commonly in larval amphibians such as mole salamanders (*Ambystoma* spp.), true frogs (*Lithobates* spp. and *Rana* spp.) and chorus frogs (*Pseudacris* spp.).

Transmission and Life Cycle:

- Transmission is via direct contact, ingestion of virus or infected animals and water exposure.

Signs and Symptoms

Chytrid fungus

- The waterborne spores of this fungus have been found to affect a variety of tissues, including the skin of post-metamorphic individuals and the mouthparts of tadpoles.
- In post-metamorphic individuals, chytridiomycosis causes a marked thickening of the skin and excessive skin sloughing (shedding), which can impair respiration through the skin and osmoregulation (water balance), resulting in death.
- Adult amphibians infected with chytrid fungi also have exhibited symptoms such as extended back legs, lethargy, and loss of righting reflex.
- In larvae, jaw sheaths and tooth rows of tadpoles lack pigment or appear deformed, which may impede feeding activity.
- Overall, it appears that chytrid infection disrupts the ability of amphibians to maintain fluid and electrolyte balance, impacting proper muscle and nerve function.

Ranaviruses

- Field signs of a ranaviral epizootic event include sudden or explosive onset of illness in amphibians in a wetland, often with hundreds or thousands of sick and dead amphibians found in a 1 to 5 day period.
- Overall mortality rates in juvenile frogs and salamanders in a wetland can exceed 90%.
- Affected individuals usually present with subtle to severe hemorrhages in the ventral (belly) skin, especially at the base of the hind limbs and around the vent opening. Hemorrhages may be present from tip of chin to tip of tail ventrally and may be pinpoint or irregular patches.
- Other clinical signs include lethargy, swimming erratically, weakly, or on their sides, and mild to severe fluid accumulation under the skin (in lymphatic sacs) of the abdomen and proximal hind limbs.
- Internally, there may be fluid accumulation (clear or red-tinged) in the body cavity (called hydrocoelom), and hemorrhages on the surfaces the heart, stomach and liver.
- Occasionally, white, pinpoint areas of dead tissue are evident in the liver or spleen. Ulcers of the skin and palate tend to be randomly scattered.

Meat Edible?

- Meat from amphibians is generally not consumed.

Human Health Concerns and Risk Reduction

- No risk of human zoonoses has been reported in relation to infection of amphibians with chytrid fungus or ranaviruses.

Samples for Diagnosis

- Fresh, intact carcasses. Photos of affected animals.

Further Reading

- American College of Veterinary Pathologists – Ranaviruses
- Amphibian Ark – Chytrid Fungus
- Amphibiaweb – Chytrid Fungus
- Canadian Cooperative Wildlife Health Centre healthywildlife.ca – Chytrid Fungus
- OIE – Ranaviruses (PDF file)
- USGS Northern Rocky Mountain Science Center – Amphibian Diseases
- USGS Patuxent Wildlife Research Center – Amphibian Diseases
- USGS National Wildlife Health Center – Ranaviruses
- Voordouw M.J. et al. 2010. Prevalence of the pathogenic chytrid, *Batrachochytrium dendrobatidis*, in an endangered population of northern leopard frogs, *Rana pipiens*. *BMC Ecology* 10: 1-10. (leopard frogs in BC)






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Contagious Ecthyma (Orf)

Causative Agent

- A viral disease of sheep and goats (wild and domestic) caused by infection with the parapoxvirus or orf virus.
- Disease is also referred to as *soremouth*.

Images

Click on image to enlarge.

Typical signs of contagious ecthyma include extensive scabbing of the face and lips.

Distribution

Geographic:

- Present in areas of southern BC in some populations of bighorn sheep (*Ovis canadensis*) and mountain goats (*Oreamnos americanus*).

Seasonality:

- Usually reported during the rut when these species are in more close association, and during the winter when these animals are using road salt or salt blocks. Contagious ecthyma also is likely to be reported during the hunting season when humans see animals more closely.

Hosts, Transmission and Life Cycle

Hosts:

- Contagious ecthyma may be more likely to be transmitted to wildlife when there is contact with domestic sheep and goats.
- It is considered to be endemic in some populations of bighorn sheep and mountain goats in BC.
- Experimental infections in moose (*Alces alces*), white-tailed deer (*Odocoileus virginianus*), and elk (*Cervus canadensis*) showed that the effects were mild. Not observed in these species in the wild.

Transmission:

- Likely following a similar pattern in domestic animals, transmission occurs as a result of direct contact with infected animals or when cuts and abrasions are in contact with contaminated objects, such as salt blocks.
- The virus can survive outside of the host for extended periods, perhaps years. Scab material lying in places of habitual use may serve as recurring reservoirs of infection.

Life Cycle:

- Presence of contagious ecthyma in bighorn sheep and mountain goats most likely is the result of transmission of orf virus from domestic sheep or goats.

Signs and Symptoms

- Animals may appear restless, nervous and show excessive licking of the lips and nostrils, and scratching of the head.
- Scabby lesions associated with this disease are most commonly found on the lips, skin of the face, udder, within the mouth and above the hooves.
- Lesions range in size from tiny crusts to large merging scabs that may cover the lips.
- If mouth lesions are severe enough, animals will not feed; lameness may ensue due to lesions on the feet in young animals. Both scenarios may lead to loss of condition or death by starvation.
- Generally, affected animals recover uneventfully; however, in severe outbreaks, death may occur in younger animals.
- Initial scabs form 7 days after infection followed by a 10 day cycle of pustules to scabs.
- After 3 weeks, lesions begin to subside and typically do not scar.
- Short-term immunity (up to 5 months) is thought to occur following an infection.

Meat Edible?

- Meat from an infected animal is suitable for consumption; however, trim off affected parts.
- Meat from severely affected animals may be of inferior quality due to the poor condition of the animal.

Human Health Concerns and Risk Reduction

- Orf, or contagious ecthyma, is a zoonosis and, as such, appropriate precautions should be taken when handling an animal suspected of having this disease.
- Orf is an occupational hazard of those who handle domestic goats and sheep.
- In humans, lesions similar to those in animals, including swollen/painful lymph nodes and mild fever, may occur. Skin lesions usually subside within 6 weeks without scarring. Most likely to be contracted by humans during the hunting season when hunters are in direct contact with infected animals.

Samples for Diagnosis

- Scabs and the tissue immediately surrounding the scabs.

Further Reading

- Alaska Department of Fish and Game – Contagious Ecthyma
- BC Ministry of Environment Wildlife Health Fact Sheet – Contagious Ecthyma (PDF file)
- Elkin B., Zamke R.L. 2001. *Common Wildlife Diseases and Parasites in Alaska*. Alaska Department of Fish and Game. Anchorage, AK.
- Robinson A.J., Kerr P.J. 2001. Poxvirus infections. Pp. 179-201 in E.S. Williams, I.K. Barker (eds.), *Infectious Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.


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Distemper

Causative Agent

- Distemper is an infectious and contagious viral disease of many domestic and wild carnivores caused by infection with Canine Distemper Virus (CDV) of the genus *Morbillivirus*.

Images

Click on image to enlarge.

Raccoons are often diagnosed with distemper.

Distribution

Geographic:

- Worldwide in distribution, but usually localized depending on the species involved.

Seasonality:

- Most cases occur in spring and involve young animals not previously exposed to the virus.

Hosts, Transmission and Life Cycle

Hosts:

- Wild and domestic carnivores that can be infected with CDV include dogs (Canidae), cats (Felidae), foxes (*Vulpes*), mustelids, raccoons (*Procyon*), and bears (Ursidae).
- In North America, coyotes (*Canis latrans*) and wolves (*Canis lupus*) are common hosts of CDV.

Transmission:

- Transmission of CDV is primarily through contact with body fluids containing the virus or through inhalation of fine mists (e.g., from an infected animal coughing) containing the virus.
- Because CDV is so fragile in the environment, close association between infected and non-infected animals is necessary for transmission. As such, dense populations of susceptible animals are necessary to sustain an epizootic of canine distemper.

Life Cycle:

- Inhaled virus enters the upper respiratory tract or ingested virus enters the digestive tract and is spread via the lymph throughout the body, causing damage to the immune system.
- Following spread to the lymph nodes, the virus is then often found in parts of the digestive system and liver.
- Widespread infection begins about 1 week after infection and virus may be shed in the environment for several months after the animal recovers.

- CDV is relatively fragile and quickly inactivated in the environment by ultraviolet light, heat, drying and common disinfectants.

Signs and Symptoms

- Signs of canine distemper will vary depending on the species, age and immune status of host, the strain of virus, and environmental conditions.
- Young animals are the most susceptible.
- The incubation period for CDV ranges from 1 week to greater than a month, while the duration of the disease ranges from 1 to 4-6 weeks, ending either in recovery or death.
- Classic signs of infection include:
    - depression and crusting or pus-like discharges from the eyes and nose;
    - coughing, fever, vomiting, diarrhea, lack of appetite and thickening of skin of the nose, lips, eyelids, ears, anus and foot pads, particularly in mustelids.
- Signs of infection of the central nervous system in several species include:
    - abnormal behavior, convulsions, seizures, paralysis, incoordination, aimless wandering.

Meat Edible?

- Meat from carnivores is rarely consumed; however, DO NOT consume meat or feed meat to your pet from an animal that is suspected to have CDV.

Human Health Concerns and Risk Reduction

- CDV is not believed to be a health concern for humans.
- Domestic dogs are a more likely source for CDV than wild carnivores.
- To prevent spread of CDV and other diseases to domestic dogs, they should be vaccinated and not allowed to roam free in areas where they may encounter wild carnivores.
- CDV has been examined as a cause of multiple sclerosis in humans. There is at present no evidence to prove this theory.

Samples for Diagnosis

- Submission of the whole animal is necessary as a variety of tissues must be examined to confirm the disease.

Similar Diseases

- Some of the neurological signs observed in CDV infection are similar to those seen in animals with rabies; however, in addition to being caused by a different virus, CDV infection is caused by inhaling virus particles, while rabies is transmitted through bites.
- Because of the similarity and the potential for human infection with rabies, follow the protocols outlined in the description of rabies in this manual for how to handle an animal or carcass that is suspected of being rabid.

Further Reading

- BC Wildlife Health Fact Sheet – Canine Distemper (PDF file)
- Michigan Department of Natural Resources – Canine and Feline Distemper
- Pennsylvania Game Commission Wildlife Disease Reference Library – Canine Distemper
- Tennessee Wildlife Resources Agency – Canine Distemper
- Williams E.S. 2001. Canine distemper. Pp. 50-63 in E.S. Williams, I.K. Barker (eds.), *Infectious Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.


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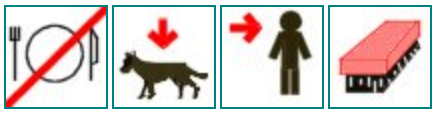
Echinococcosis & Taeniasis



Causative Agent

Echinococcosis:

- Parasitic and zoonotic disease of mammals caused by infection with tapeworms of the genus *Echinococcus*.
- *Echinococcus granulosus* and *E. multilocularis* are found in BC.
- Definitive and intermediate hosts both are mammals.
- Infection with *Echinococcus* causes little or no harm to the definitive host; however, larval stages within intermediate hosts can be highly pathogenic.

Taeniasis:

- Parasitic disease of mammals caused by infection with tapeworms of the genus *Taenia*.
- *Taenia ovis krabbei* is known to be present in BC.
- Definitive and intermediate hosts both are mammals.
- Infection with *Taenia* causes little or no harm to the definitive host; however, larval stages within intermediate hosts can be pathogenic.

Images

Click on images to enlarge.

Cysts of* E. multilocularis *in the liver of a muskrat.

Caribou lungs with hydatid cysts (*E. granulosus*).

Generalized* Echinococcus *life cycle.

Distribution

Geographic:

- *Echinococcus granulosus* is widely distributed across Canada.
- *Echinococcus multilocularis* has a more limited distribution, occurring in AB, MB, SK, and NWT. It recently has been found in BC (PDF link to journal article).
- *Taenia ovis krabbei* is found throughout Canada.

Seasonality:

- Carnivores act as reservoirs all year long; herbivores become infected by consuming contaminated vegetation when it is available.

Hosts, Transmission and Life Cycle

Hosts:

E. granulosus

- Definitive (adult worm): wolves (*Canis lupus*), coyotes (*Canis latrans*), domestic dogs.
- Intermediate (larval worm): Cervids, particularly moose (*Alces alces*), caribou (*Rangifer taradus*), elk (*Cervus canadensis*) and bighorn sheep (*Ovis canadensis*) in western Canada.
- Humans can act as intermediate hosts but are considered to be a *dead-end* host since humans are not usually consumed by carnivores.

E. multilocularis

- Definitive (adult worm): Arctic and red foxes (*Vulpes*), coyotes, sometimes domestic dogs and cats.
- Intermediate (larval worm): rodents, such as voles (Cricetidae), mice (Muridae) and muskrats (*Ondatra zibethicus*).
- Humans again can act as intermediate hosts but are considered to be a *dead-end* host since humans are not usually consumed by carnivores.

Taenia ovis krabbei

- Definitive (adult worm): wolves, coyotes, domestic dogs, cougars (*Felis concolor*), bears (Ursidae).
- Intermediate (larval worm): Cervids such as moose, caribou, and elk, and Rocky Mountain bighorn sheep.

Transmission and Life Cycle:

Echinococcus

- See life cycle diagram above.
- Life cycle is similar between *E. granulosus* and *E. multilocularis*, with the main differences being host species and larval growth characteristics.
- Adult worms occupy the small intestine of infected carnivores and eggs are voided in the feces, usually a month after initial infection.
- Eggs from the feces contaminate vegetation and are subsequently eaten by intermediate, herbivorous hosts.
- Larvae move to preferred sites within the intermediate host, usually lung or liver (or less frequently, the muscle or eyes), where they form often large and obvious fluid-filled hydatid cysts containing many larvae.
- Cysts are consumed by carnivores, breaking open to release immature worms.
- Larvae then mature into adult worms after attaching to the wall of the small intestine of the carnivore, subsequently releasing eggs within the feces.

Taenia ovis krabbei

- Life cycle similar to species of *Echinococcus*.
- Adult worms occupy the small intestine of carnivores as well as omnivorous mammals, and are passed in feces.
- In intermediate hosts (ungulates), larvae form cysts, mainly in the skeletal muscles and associated connective tissues.

Signs and Symptoms

- Adult worms have no detrimental effects on the carnivore host.

E. granulosus

- Larval cysts may cause problems in host tissue because of the continual growth and expansion of the cyst.

- The structure of the wall of the cysts forms a tissue/host barrier enabling tissues of the host to wall off the cysts itself, preventing further spread.
- Subsequent compression of tissues, such as the lung, may cause debilitation due to the animal's reduced ability to breathe if a sufficient number of cysts are involved.

E. multilocularis

- More dangerous than *E. granulosus* as the larval cysts grow rapidly and bud externally, acting very much like an invasive cancer.
- Unlike the cysts of *E. granulosus*, the structure of the wall of the cysts of *E. multilocularis* does not form a tissue/host barrier, allowing the cyst to further invade tissues via the lymph or blood.
- *E. multilocularis* severely debilitates and often kills its rodent host.

Taenia ovis krabbei

- Larval forms have been associated with significant tissue damage and loss of body condition in infected herbivores, but most infections are noted by chance during butchering of hunter-killed animals.

Meat Edible?

- Humans are not capable of harboring adult *Echinococcus* tapeworms and so cannot become infected either by handling or eating hydatid cysts - for aesthetic reasons, cysts should be removed prior to consumption.
- Humans can, however, be infected by consuming the infective eggs passed by the carnivore hosts of *Echinococcus*. For this reason, those who handle live carnivores, their feces, pelts or carcasses should wear gloves and use good hygiene to avoid contamination by tapeworm eggs.
- *Taenia ovis krabbei* is not transmissible to humans during any part of its cycle; cysts noted in meat are not aesthetically pleasing but are killed during normal cooking temperatures and by freezing.
- Meat of animals infected by these parasites should not be fed to dogs since they can be hosts for the adult tapeworms. Also, infected viscera should be destroyed by burning to prevent transmission to domestic dogs.

Human Health Concerns and Risk Reduction

Echinococcus

- In humans, infection with *E. granulosus* is called hydatid disease or cystic hydatid disease.
- In humans, infection with *E. multilocularis* is called alveolar hydatid disease.
- Humans can become infected when feces of infected carnivores or carnivore pelts that are contaminated with feces are handled, or from environments contaminated with carnivore feces.
- *E. granulosus* infection in the lungs of humans may be associated with fever and difficulty breathing.
- *E. granulosus* cysts may also develop in other organs, including the brain, and cause severe problems because of the pressure on normal tissue.
- *E. multilocularis* behaves like an invasive cancer and can cause liver damage resulting in abdominal pain and jaundice; in areas where this parasite is common, 70% of untreated cases become fatal within 5 years.
- Human infections can be treated with antiparasitic drugs or through surgical removal of cysts.
- Domestic dogs can serve as reservoirs for *Echinococcus* infection within communities. They should not be fed carcasses or allowed to scavenge from infected game mammals as this perpetuates the cycle of infection.
- Tapeworm infection in dogs and cats can be treated with anthelmintics (drugs used against

tapeworms).

- **Risk Reduction:**
  - Always wear rubber gloves when handling carnivore pelts, droppings or intestines.
  - Careful personal and food hygiene when in close proximity to dogs is crucial in preventing human infection.
  - Eggs dry out easily and can die within 2 hours in direct sunlight; survival time is increased in damp areas such as watering holes.
  - **DO NOT FEED TISSUES CONTAINING CYCSTS TO DOGS.**

Taenia ovis krabbei

- *Taenia ovis krabbei* is not transmissible to humans.

Samples for Diagnosis

- Tapeworm infection can be verified on the basis of finding eggs in the fecal material of infected carnivores.
- Cystic larval stages can be identified in intermediate hosts on the basis of gross appearance.
- Human infection can be verified by taking X-rays, CT scans, and through a variety of immunological tests.
- Portions of tissues containing cysts can be sent to appropriate diagnostic laboratories.

Further Reading

- Alberta Environment and Sustainable Resource Development – *Echinococcus* (PDF file)
- Alaska Department of Fish and Game – *Echinococcus*
- Alaska Department of Fish and Game – Muscle Tapeworm Cysts
- Michigan Department of Natural Resources – *Echinococcus*
- Peregrine et al. 2012. Alveolar hydatid disease (*Echinococcus multilocularis*) in the liver of a Canadian dog in British Columbia, a newly endemic region. Canadian Veterinary Journal 53: 870-874. (PDF file)
- US Centers for Disease Control – *Echinococcus*
- World Health Organization – *Echinococcus*
- Jones, A., and M. J. Pybus. 2001. Taeniasis and Echinococcosis. Pp. 150-192 in W. M. Samuel, M. J. Pybus, and A. A. Kocan (eds.), Parasitic Diseases of Wild Mammals. 3rd Ed. Iowa State University Press, Ames, IA.
- Canadian Cooperative Wildlife Heath Centre. 1995. Echinococcosis. Pp. 37-38. Health risks to wildlife personnel: hazards from disease-causing agents. Canadian Cooperative Wildlife Heath Centre, Western College of Veterinary Medicine, University of Saskatchewan. Saskatoon, SK
- Elkin, B, and R. L. Zamke. 2001. Common wildlife diseases and parasites in Alaska. Alaska Department of Fish and Game. Anchorage, AK.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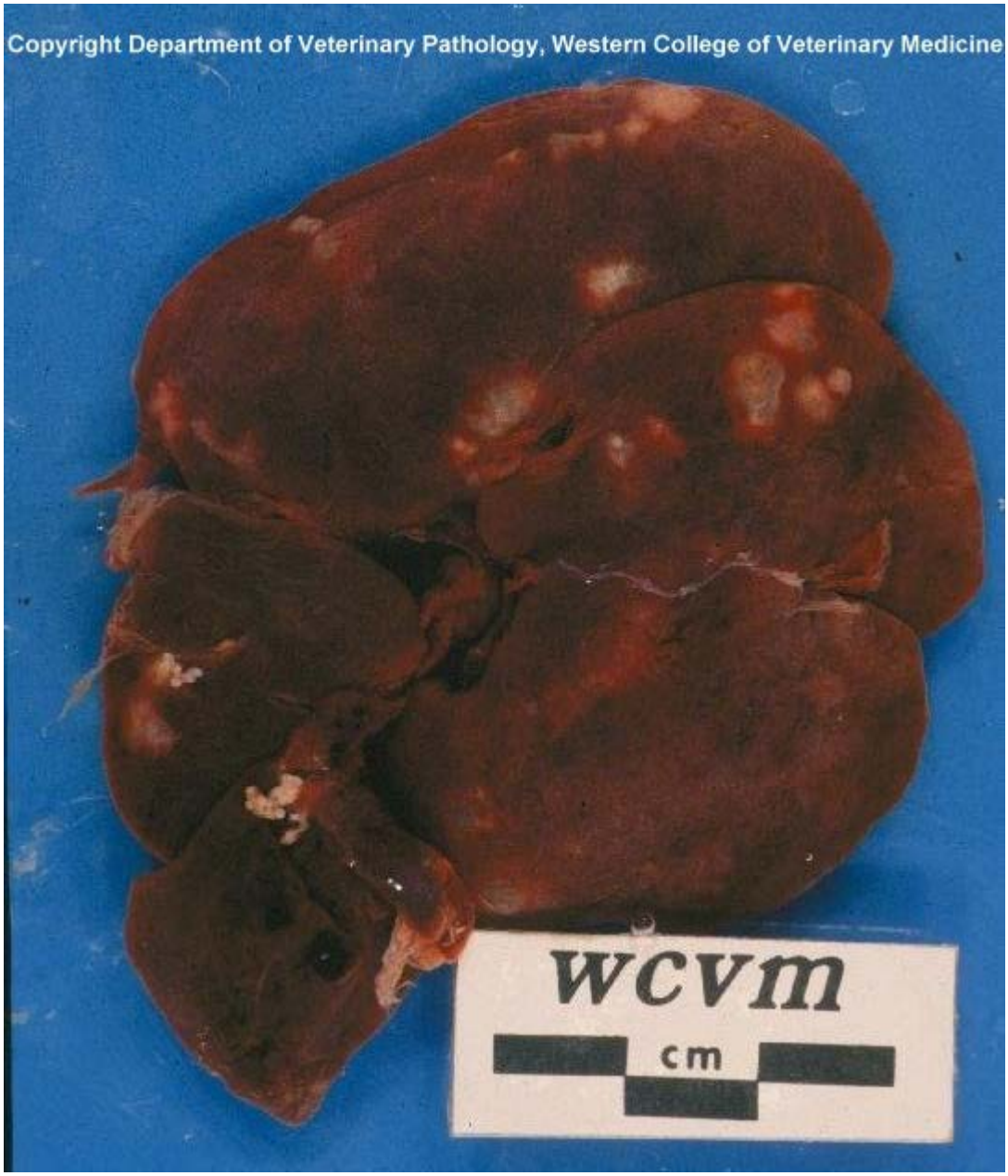


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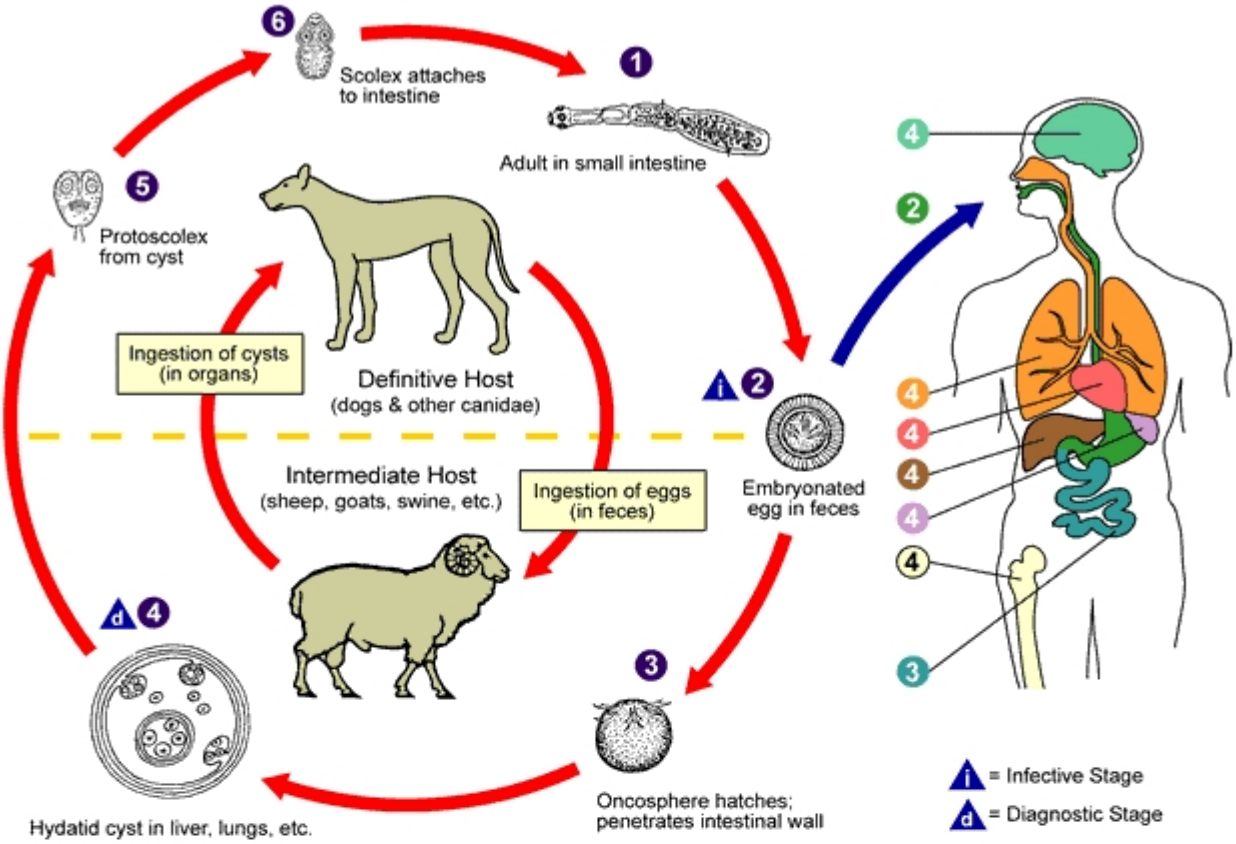

The adult *Echinococcus granulosus* (3 to 6 mm long) ❶ resides in the small bowel of the definitive hosts, dogs or other canids. Gravid proglottids release eggs ❷ that are passed in the feces. After ingestion by a suitable intermediate host (under natural conditions: sheep, goat, swine, cattle, horses, camel), the egg hatches in the small bowel and releases an oncosphere ❸ that penetrates the intestinal wall and migrates through the circulatory system into various organs, especially the liver and lungs. In these organs, the oncosphere develops into a cyst ❹ that enlarges gradually, producing protoscolices and daughter cysts that fill the cyst interior. The definitive host becomes infected by ingesting the cyst-containing organs of the infected intermediate host. After ingestion, the protoscolices ❺ evaginate, attach to the intestinal mucosa ❻, and develop into adult stages ❶ in 32 to 80 days. The same life cycle occurs with *E. multilocularis* (1.2 to 3.7 mm), with the following differences: the definitive hosts are foxes, and to a lesser extent dogs, cats, coyotes and wolves; the intermediate host are small rodents; and larval growth (in the liver) remains indefinitely in the proliferative stage, resulting in invasion of the surrounding tissues. With *E. vogeli* (up to 5.6 mm long), the definitive hosts are bush dogs and dogs; the intermediate hosts are rodents; and the larval stage (in the liver, lungs and other organs) develops both externally and internally, resulting in multiple vesicles. *E. oligarthrus* (up to 2.9 mm long) has a life cycle that involves wild felids as definitive hosts and rodents as intermediate hosts. Humans become infected by ingesting eggs ❷, with resulting release of oncospheres ❸ in the intestine and the development of cysts ❹, ❹, ❹, ❹, ❹, ❹ in various organs.

http://www.dpd.cdc.gov/dpdx/html/Echinococcosis.asp?body=Frames/A-F/Echinococcosis/body_Echinococcosis_page1.htm

Electrocution

Risk Factor

- Injuries or death resulting from the passage of electric current through the body.
- More common in birds, but also in species of climbing mammals.

Images

Click on images to enlarge.

			
Burns are usually visible on the soles of the foot of an electrocuted bird. Burns may vary from subtle red areas to burns where the skin is severely damaged.	***Electrocuted raptors are often found dead underneath electrical transmission wires.***	***Charred feathers or fur are characteristic of electrocuted animals.***	***The greatest hazards for electrocution occur at poles with transformers or grounded metal equipment near the conductors.***

Distribution

Geographic:

- The potential for electrocution exists wherever high-voltage wires are present.

Seasonality:

- Throughout the year.

Mechanism of Action

- If an animal's appendages bridge the gap between two energized components or between an energized component and grounded component, electrical current flows through the gap created by the animal's body.
- Electrical current passing through the body can cause irritation, unconsciousness, burns or immediate death depending on the strength (amperage) of the current, the degree of grounding or earth contact of the animal, duration of the shock, degree of moisture present on the points of contact, and, in the case of birds, whether bare skin, feathers or fur are in contact with conducting wires, the latter being a relatively poor conductor.

Signs and Symptoms

- Animals injured or killed by electrical accidents are often found near power poles or below

power lines.

- Erratic heart rhythm and paralysis in areas of the brain that control breathing and heart rate are usually the cause of death in fatal cases.
- Burning or charring of hair, feathers or skin is often apparent, usually at the point of contact between the animal and the energized or grounded component.
- Distribution of lesions depends on the areas affected (e.g., where the current entered or left the body).
- If an animal initially survives electrical injury, they are often prone to secondary bacterial infections at the site of electrical contact, usually a limb; the function of the infected area may be compromised.

Meat Edible?

- Barring the presence of other diseases, meat taken from an electrocuted animal may be consumed.

Risk Reduction

- Companies supplying electricity are continually working to reduce wildlife mortality and power outages caused by interactions between wildlife and power transmission lines.

Samples for Diagnosis

- In general, a whole carcass is needed to determine if electrocution was a cause of death.

Similar Diseases

- A dead animal found beside or near power poles or power lines cannot immediately be assumed to have been electrocuted; birds often collide with power lines without electrical injury and are often found underneath. See also trauma.

Further Reading

- Cooper J.E. 1996. Physical injury. Pp. 157-172 in A. Fairbrother, L.N. Locke, G.L. Hoff (eds.), *Non-infectious Diseases of Wildlife*. Iowa State University Press. Ames, IA. 219 pp.
- Thomas N.J. 2001. Electrocution. Pp. 357-360 in *Field Manual of Wildlife Diseases: General Field Procedures and Diseases of Birds*. M. Friend, J.C. Franson (Tech. eds.), E.A. Ciganovich (ed.). Biological Resources Division Information and Technology Report 1999-001. U.S. Department of the Interior and U.S. Geological Survey. Washington, DC. (PDF of Chapter)

					
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Epizootic Hemorrhagic Fever

Causative Agent

- Epizootic Hemorrhagic Disease (EHD) is a viral disease of wild ungulates caused by viruses of the genus *Orbivirus*.
- Bluetongue, a viral disease of wild ungulates caused by another *Orbivirus*, has similar signs and symptoms.
- The diseases caused by both Bluetongue and EHD are collectively known as hemorrhagic disease.

Images

Click on image to enlarge.

Hemorrhage in the eyes of a white-tailed deer infected with EHD.

Distribution

Geographic:

- EHD is widely distributed in both temperate and tropical regions of the world, but in free-ranging wildlife has only been reported in North America.
- In BC, it has been reported in bighorn sheep (*Ovis canadensis*) and white-tailed deer (*Odocoileus virginianus*) in the Okanagan Valley.

Seasonality:

- EHD occurs in late summer and early fall. This is thought to be related to seasonal wind patterns moving the insect vector northwards from endemic areas in the USA.

Hosts and Transmission

Hosts:

- Primarily white-tailed deer and mule deer (*Odocoileus hemionus*); less frequently elk, pronghorn antelope and bighorn sheep.
- Severity of EHD is quite variable and may be related to herd immunity.

Transmission:

- EHD is transmitted by various species of Culicoides midges (commonly called *no-see-ums*).
- The virus enters the blood of hosts from the midge. In some species, viral replication may occur in the walls of blood vessels.
- Blood vessels are damaged leading to numerous small and large hemorrhages - hence, the hemorrhagic nature of this disease.

Signs and Symptoms

- Signs are variable, ranging from none to sudden death.
- Sick and dead animals are often found near water.
- Other signs include:
  - swelling of the face, tongue, neck and conjunctiva of the eyes;
  - lack of appetite;
  - weakness and incoordination;
  - excessive salivation, often blood-tinged;
  - nasal discharge, often blood-tinged;
  - bloody diarrhea;
  - lameness;
  - extensive hemorrhaging in many tissues including the skin, gastrointestinal tract, heart, testicles;
  - ulcers in the tissues of the mouth, tongue and stomach;
  - breathing difficulty;
  - recumbancy (lying down);
  - overgrown/cracked hooves.

Meat Edible?

- EHD does not infect humans, and eating venison from deer with EHD is not dangerous; however, secondary infections that may occur as the disease progresses can render venison unfit for consumption.
- The meat should not be fed to dogs.

Human Health Concerns and Risk Reduction

- EHD virus is not associated with human disease.

Samples for Diagnosis

- The whole body should be submitted for post mortem.
- Immunological tests can verify if EHD virus is present in the following tissues, which should be **REFRIGERATED NOT FROZEN:**
  - blood collected with anti-coagulant and the spleen (best);
  - lymph node, lung or bone marrow.

Further Reading

- Michigan Department of Natural Resources – EHD
- Missouri Department of Conservation – EHD
- Washington Department of Fish and Wildlife – EHD
- Howerth E.W., Stallknecht D.E., Kirkland P.D. 2001. Bluetongue, epizootic hemorrhagic disease, and other Orbivirus-related diseases. Pp. 77-97 in E.S. Williams, I.K. Barker (eds.), *Infectious Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.


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Exertional or Capture Myopathy

Risk Factor

- Exertional or capture myopathy (disease of the muscle) is a non-infectious disease of muscles that is characterized by damage to muscle tissues brought about by physiological changes, usually following extreme exertion, struggle and/or stress.

Images

Click on images to enlarge.

Exertion myopathy evident in leg muscle of a pronghorn antelope.

Light colored leg muscle of a sandhill crane represents exertion myopathy.

Distribution

Geographic:

- The potential for this condition can occur anywhere animals are pursued or trapped.

Seasonality:

- All year. Warm weather can exacerbate this condition.

Species Affected

- Both mammals and birds of all ages and sexes are susceptible to this disease.
- Species differ in their susceptibility to exertional myopathy because of physical and behavioral attributes. It is most commonly seen in wild ungulates in British Columbia.

Mechanisms of Action / Signs and Symptoms

- Signs vary depending on species, cause of exertion and the types of biochemical imbalances that lead to muscular damage. It may be seen peracutely (immediately), acutely (within minutes or hours) or chronically (days or weeks).
- Early signs include increased breathing and heart rates, increased body temperature, or sudden death.
- Additional signs include: depression, muscle stiffness, weakness, tremors, incoordination, or shock, which may appear within hours to days following severe exertion. If the animal survives, residual signs may last as long as a month.

Urine of affected animals may be red to brown because of broken down components of muscle moving through the kidneys.

- Animals that do not initially die may be predisposed to kidney failure, predation and accident.
- Muscles may appear pale and wet or very dark red and dry, with variable amounts of hemorrhage and edema present.
- Kidneys may appear swollen, and multiple hemorrhages and edema may be present in the lungs.
- Nutritional imbalances such as selenium deficiency may predispose animal to developing exterional myopathy.
- In severe cases, exertional myopathy results in death of the animal.

Meat Edible?

- Meat from an animal with exertional myopathy is suitable for human consumption, although muscle damage may change the flavor and will decrease the spoilage time of the meat.

Prevention

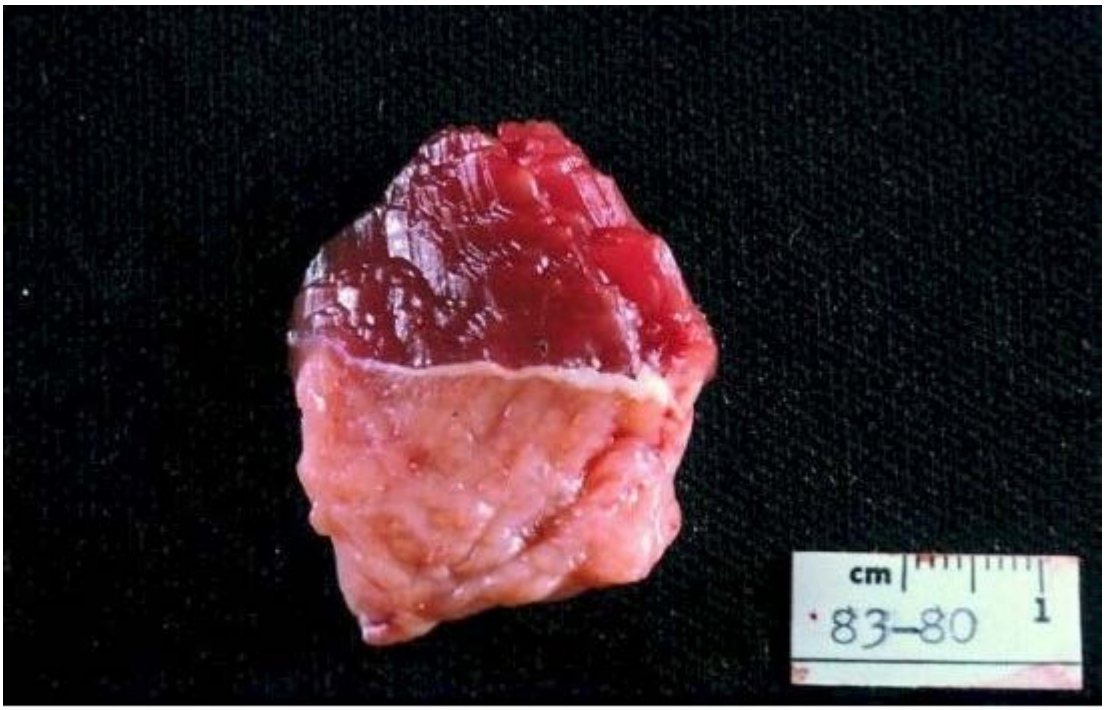
- This condition may occur through normal life-history events, particularly when prey species try to escape predators; however, it is more commonly associated with strenuous use of muscles in the forelimbs and hindlimbs when wild ungulates are captured and handled.
- This condition is extremely difficult to treat and is best to avoid through prevention.
- Prevention relies on methods that reduce stress to animals, minimizing pursuit, struggling and handling time, selecting appropriate weather conditions to handle animals, ensuring proper methods of capture and handling, and ensuring animals are released or placed in less stressful conditions as quickly as possible.

Samples for Diagnosis

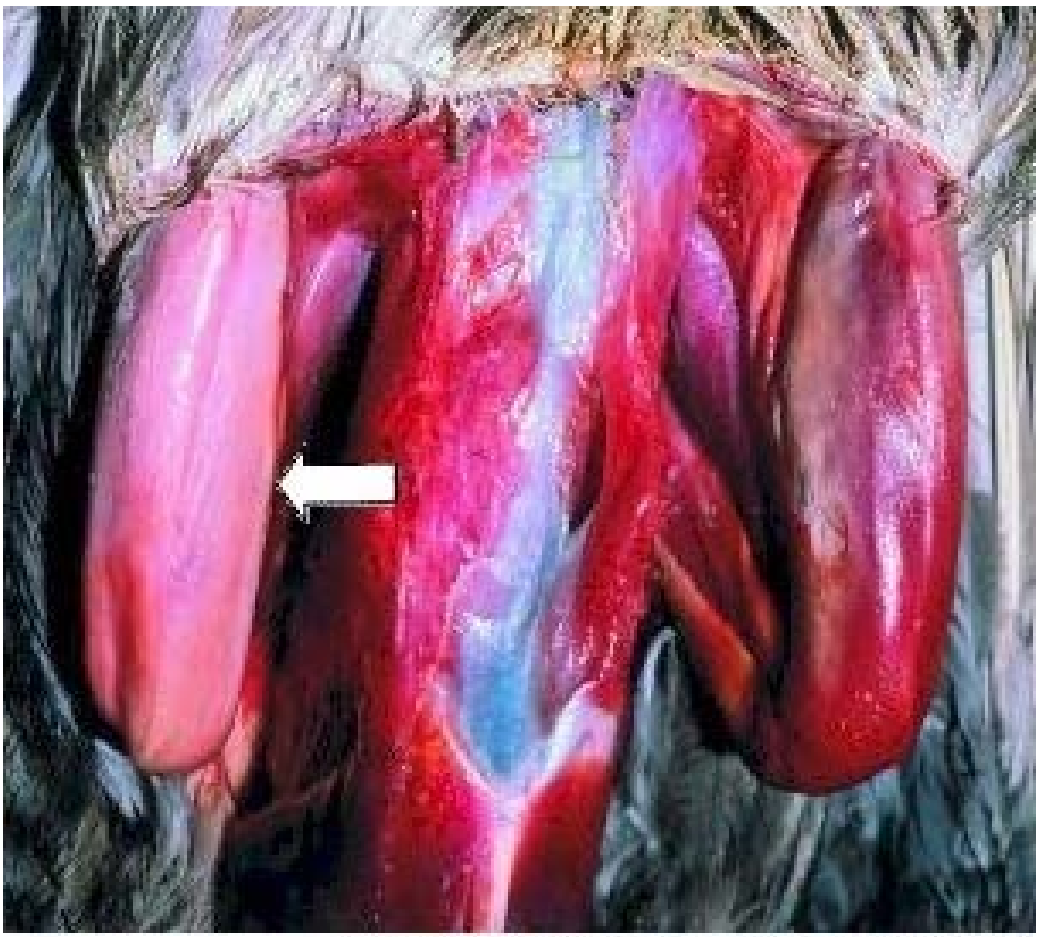
- Portions of affected muscles from different areas of the body as well as sections of heart and kidney tissue should be stored in formalin and submitted for microscopic examination.

Further Reading

- Alaska Department of Fish and Game – Exertional Myopathy
- Pennsylvania Game Commission – Exertional Myopathy
- Spraker T.R. 1993. Stress and Capture Myopathy in Artiodactylids. Pp. 481-488 in M.E. Fowler (ed.), Zoo and Wildlife Animal Medicine. W.B. Saunders and Company, Philadelphia, PA. (PDF file)
- Elkin B., Zamke R.L. 2001. *Common Wildlife Diseases and Parasites in Alaska*. Alaska Department of Fish and Game. Anchorage, AK.
- Williams E.S., Thorne E.T. 1996. Exertional myopathy (capture myopathy). Pp. 181-193 in A. Fairbrother, L.N. Locke, G.L. Hoff (eds.), *Non-infectious Diseases of Wildlife*. Iowa State University Press. Ames, Iowa.



The light area in this piece of leg muscle from an antelope is also due to capture myopathy.



Photograph / Copyright - James Runningen

Light colored muscle of leg (arrow) represents capture myopathy in a sandhill crane.

Flies and Maggots

Causative Agent

- Mammals, birds and livestock are prone both to the bites and larvae of several species of flies that feed on flesh, blood or secretions.
- The main groups that are important for wildlife are:
  - **Calliphorid flies -** common examples include bluebottle and greenbottle flies, and bird blow flies;
  - **Bot and warble flies (Cuterebrinae and Hypodermatinae) -** common examples include bot flies of rodents;
  - **Nasal and pharyngeal bot flies (Oestrinae) -** common examples include the nasal bot fly of caribou (*Rangifer tarandus*).

Images

Click on images to enlarge.

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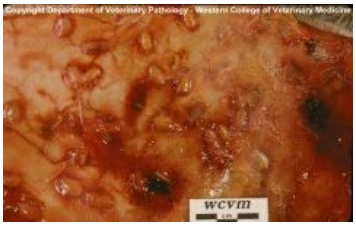
<td>  </td>
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<td>Larval warble fly underneath the skin of a caribou.</td>
<td>Close-up of a larval warble fly.</td>
<td>Larval blow flies that parasitize nestling birds often cling to featherless areas of the bird, while some species embed in tissues.</td>
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Distribution

Geographic:

- In most areas of North America.

Seasonality:

- Dependent on species; throughout the year in southern regions.

Hosts and Life Cycle

Calliphorid flies:

- Eggs are laid on wounded skin, infected skin, or skin soiled with feces.
- Larvae feed within the wounds and then drop to the ground to develop into adults and continue the cycle.
- Female bird blow flies (*Protocalliphora*) lay eggs in nests of birds, and the larvae live within the nesting material, feeding intermittently on the blood of nestlings. One species (*Trypocalliphora braueri*) burrows under the skin of nestling birds, often with detrimental consequences.

Bot flies:

- In North America, bot flies typically parasitize rodents and rabbits.
- Female flies deposit eggs at entrances to burrows and other areas frequented by hosts.
- Eggs hatch in response to cues generated by the host (e.g., increased environmental temperature, carbon dioxide and moisture from the host).
- Hatched larvae gain entrance to the host through the mouth, nasal openings or cuts in the skin. In infected rodents, larvae are commonly located in the region of the groin but may also occur beneath the skin on other parts of the body such as the neck.
- In cervids such as caribou, the adult fly lays eggs on the hairs of the caribou's legs and lower body. Hatched larvae penetrate the skin, and travel under the skin to the caribou's back where they mature.
- Larvae develop under the skin until late summer at which time they emerge from the host through a breathing pore in the skin called a *warble*.
- Newly hatched larvae measure from 2 to 4 mm long and are grayish-white; larvae mature to a dark brown color just prior to emergence from the host. Fully grown larvae will measure from 20 to 42 mm in length and up to 7 to 10 mm in width.
- Pupation (development into the adult stage) occurs in the soil and the fly over-winters in the pupal stage.
- Adults emerge in summer and will mate and lay eggs within a few days.

Nasal bot flies:

- In North America, the larvae of nasal bot flies are found in the nasal passages and throat pouches of cervids such as caribou, moose, elk, white-tailed and mule deer as well as bighorn sheep.
- Female nasal bot flies deposit larvae into the nostrils of the host during hot days of summer where early stages of larval growth take place.
- After a short period, larvae move to pouches that lie on either side of the throat at the base of the tongue where further growth takes place.
- Fully developed larvae are about 25-36 mm in length and, at maturity, are expelled from the throat to pupate in the soil. Adults emerge from the soil 2-3 weeks later.
- Nasal bot flies overwinter in the larval stage within the cervid host.

Signs and Symptoms

Calliphorid flies:

- Fly larvae can cause direct damage to tissues which may also lead to the development of secondary infections from bacteria.

Bot flies:

- The early stages of infection by bot flies are rarely evident from the outside, and often are only detected by touch or after sufficient growth has occurred so that they are visible.
- In smaller mammals, such as chipmunks, the larvae often produce an obvious awkwardness in locomotion, which may render them more susceptible to predation.
- As with Calliphorid flies, wounds made from bot fly larvae may become infected with bacteria.
- Paralysis and death may occur in rodents or rabbits if the larvae migrate through the brain or spinal cord.
- Animals infected with warbles usually appear healthy, although those with heavy infections may appear weak and there may be damage to the hide quality. While laying their eggs, warble flies harass animals and interfere with feeding.

Nasal bot flies:

- Larvae or "bots" can cause inflammation and edema, occasionally leading to local damage or to pneumonia. Difficulty with breathing may result when the infestation is particularly heavy.
- Nasal bot flies cause annoyance to cervids that can lead to loss of body condition due to inadequate feeding. Animals under attack generally cluster, or may become nervous or panic-stricken, even stampeding.
- Larvae often cause local inflammation in the infected pouches.

Meat Edible?

- The meat of animals infected with larvae is considered safe for human consumption following removal of any affected tissue. Animals in poor condition are likely to have poor-quality meat.

Human Health Concerns and Risk Reduction

- Some Calliphorid flies can be annoying pests of humans, and may occasionally invade human tissues.
- There are cases reported worldwide of nasal bot fly larvae infecting the eyes of humans.
- There are occasional reports of bot flies infecting humans. These cases tend to occur during late summer, incidental to outdoor activities, when adult flies are most numerous.

Samples for Diagnosis

- Collection of the flies or pupae is sufficient for diagnosis.

Further Reading

- Alaska Department of Fish and Game – Nasal Bots
- Alaska Department of Fish and Game – Warbles
- Dr. Terry Whitworth's Home Page – Bird Blow Flies
- Michigan Department of Natural Resources – Warbles
- Michigan Department of Natural Resources – Nasal Bots
- Allen S. A. 2001. Flies (Class Insecta: Order Diptera). Pp. 18-45 in W.M. Samuel, M.J. Pybus, A.A. Kocan (eds.), *Parasitic Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.
- Colwell D.D. 2001. Bot flies and warble flies (Order Diptera: Family Oestridae). Pp. 47-71 in W.M. Samuel, M.J. Pybus, A.A. Kocan (eds.), *Parasitic Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.

					
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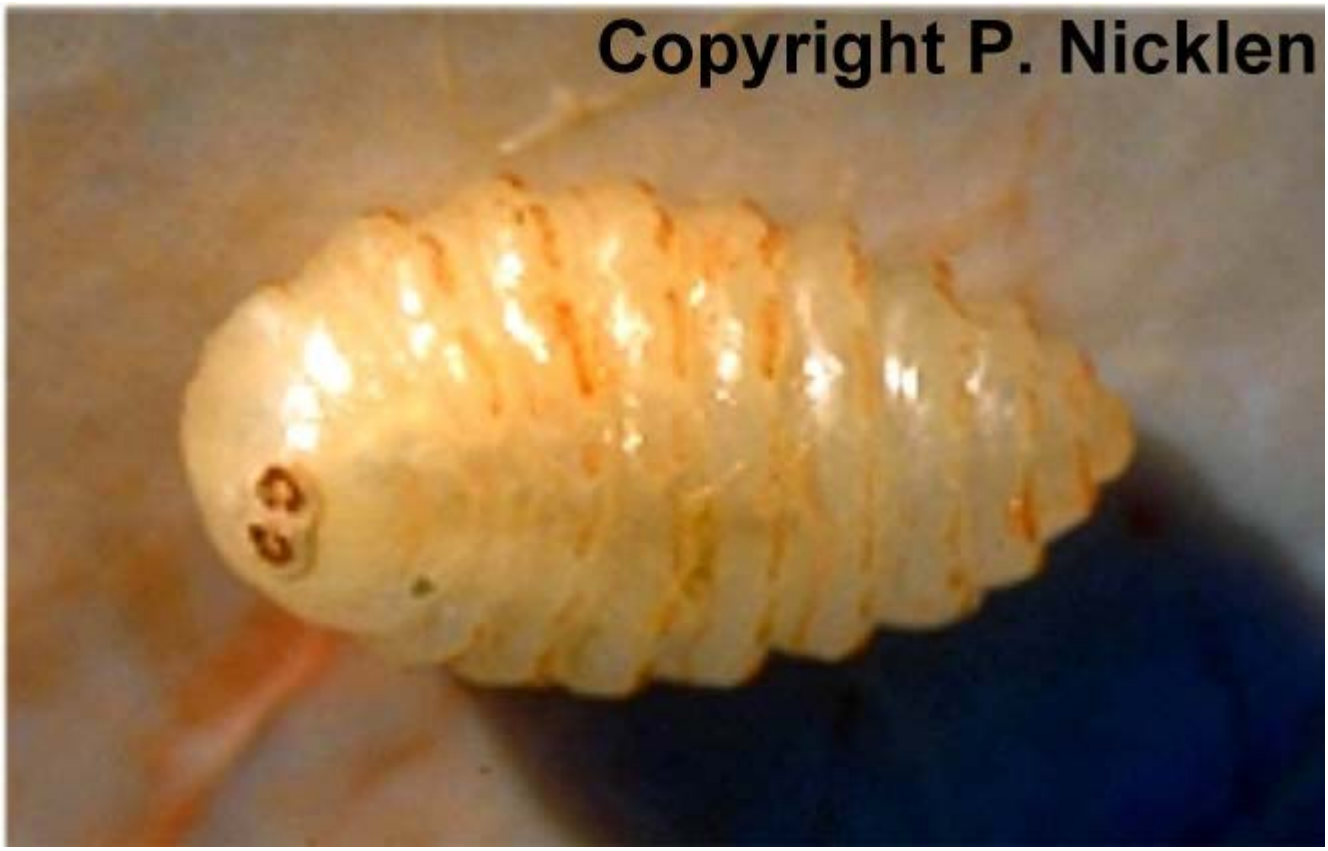
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Foot Abnormailities

Risk Factor

- Most commonly observed in wild deer and moose (*Alces alces*) (Cervidae), and bighorn sheep (*Ovis canadensis*).
- Similar lesions found in domestic animals are referred to as laminitis, “founder” or “slipper-foot”.
- Not often associated with underlying systemic disease, but can be related to:
  - toxicity;
  - nutritional deficiency;
  - recurrent laminitis;
  - ergot toxicity;
  - fescue toxicity;
  - severe copper or selenium deficiency;
  - other infectious and toxic causes that may induce disease in blood vessels (vasculopathy) in the distal limbs.
- A genetic cause may be considered as a remote possibility.

Images

Click on images to enlarge.

Malformed feet in free-ranging cervids.

Signs and Symptoms

- Mild to severe overgrowth and marked deformity of hooves in cervids and bighorn sheep.

Meat Edible?

- Discounting other disease conditions, meat from deer or sheep with abnormal foot development is considered just as edible as that from animals with normal feet.

Human Health Concerns and Risk Reduction

- There are no public health concerns associated with free-ranging cervids or bighorn sheep that have abnormal feet.
- Photos of feet showing abnormal growth or appearance can be submitted to the nearest branch of the British Columbia Conservation Officer Service.

Samples for Diagnosis

- Fresh, intact feet from affected animals.

Further Reading

- Bergsten C. 2003. Causes, risk factors, and prevention of laminitis and related claw lesions. Acta Vet. Scand. (Suppl. 98): 157-166. (PDF file)
- Han S., Mansfield K. Severe hoof deformities in free-ranging elk in western Washington State. Washington State University. (PDF poster)

					
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S. Han and K. Mansfield, Washington State Univ.

S. Wan and K. Mansfield , Washington State University

Giardiasis and Cryptosporidiasis

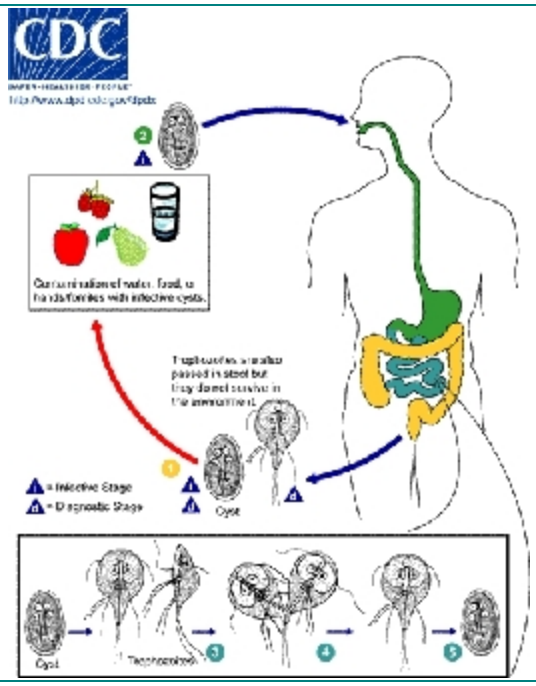
This information was in part summarized from Health Canada (December 2013)

General Information

- *Giardia* and *Cryptosporidium* are microscopic, protozoan parasites that can be found in water contaminated with the feces of infected animals.
- *Giardia* is often found in human, beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), and dog feces. Cattle feces appear to be the primary source of *Cryptosporidium*, although these parasites have also been found in humans and other animals. Drinking water sources become contaminated when feces containing the parasites are deposited or flushed into water.
- In humans, *Giardia* causes an intestinal illness called giardiasis or "beaver fever". *Cryptosporidium* is responsible for a similar illness called cryptosporidiosis.
- *Giardia* and *Cryptosporidium* parasites produce cysts that are very resistant to harsh environmental conditions. When ingested, they germinate, reproduce, and cause illness. After feeding, the parasites form new cysts, which are then passed in the feces. Studies have shown that ingestion of only a few cysts will cause illness in humans.

Life Cycle of *Giardia*

Click on image to enlarge.



Cysts are resistant forms and are responsible for transmission of giardiasis. Both cysts and trophozoites can be found in the feces (diagnostic stages) ❶. The cysts are hardy and can survive several months in cold water. Infection occurs by the ingestion of cysts in contaminated water, food, or by the fecal-oral route (hands or fomites) ❷. In the small intestine, excystation releases trophozoites (each cyst produces two trophozoites) ❸. Trophozoites multiply by longitudinal binary fission, remaining in the lumen of the proximal small bowel where they can be free or attached to the mucosa by a ventral sucking disk ❹. Encystation occurs as the parasites transit toward the colon. The cyst is the stage found most commonly in nondiarrheal feces ❺. Because the cysts are infectious when passed in the stool or shortly afterward, person-to-person transmission is possible. While animals are infected with *Giardia*, their importance as a reservoir is unclear.

Signs and Symptoms

- Gastrointestinal upset, malaise, and weight loss are the most common symptoms caused by

Giardia. Vomiting, chills, headache, and fever may also occur. These symptoms usually surface 6 to 16 days after the initial contact and can continue as long as a month.

- The symptoms of cryptosporidiosis are similar; the most common include watery diarrhea, abdominal cramps, nausea, and headaches. These symptoms occur within 2 to 25 days of infection and usually last one or two weeks; in some cases they may persist for up to a month.

Treatment and Risk Reduction

- If water purification is inadequate, drinking water may contain sufficient numbers of parasites to cause illness. Other sources include direct exposure to the feces of infected humans and animals, eating contaminated food, and accidental ingestion of contaminated recreational water. The comparative importance of these various routes of exposure is unknown.
- *Giardia* is usually cleared from healthy people without treatment within a month. Anti-parasitic drugs are available and are particularly helpful for immunocompromised people in whom the illness could otherwise develop into a persistent state.
- *Cryptosporidium* also will usually disappear from healthy people within a month without treatment. Anti-diarrheal drugs and rehydration therapy may be used if diarrhea becomes severe. No drugs to fight the illness have been approved, although many are currently being tested.
- Both parasites, but particularly *Cryptosporidium*, can pose a more serious threat to immunocompromised people, such as those living with AIDS or cancer, or transplant patients receiving immunosuppressive drugs. For these people, the symptoms are more severe and can be life threatening. It is presently unknown whether immunocompromised individuals are at greater risk of contracting giardiasis or cryptosporidiosis than the general public. Nevertheless, immunocompromised individuals should discuss these risks with their physicians.
- **People who wish to take extra precautions can boil their water for one minute to kill any parasites that may be present. This practice will also destroy any other microorganisms that might be of concern to these individuals. As bottled water is not routinely monitored for *Giardia* and *Cryptosporidium*, its suitability as an alternative to boiled tap water is unknown.**
- **If you are suffering from diarrhea and suspect that your symptoms may be due to *Giardia* or *Cryptosporidium*, visit your physician and mention any exposure you may have had to water, food, or feces that could have been contaminated by the parasites.**

Further Reading

- BC Centre for Disease Control – Giardiasis
- BC Ministry of Health - Healthlink BC – *Giardia*
- BC Ministry of Health - Healthlink BC – Water Purification to Prevent *Giardia*
- US Centers for Disease Control and Prevention – Giardiasis



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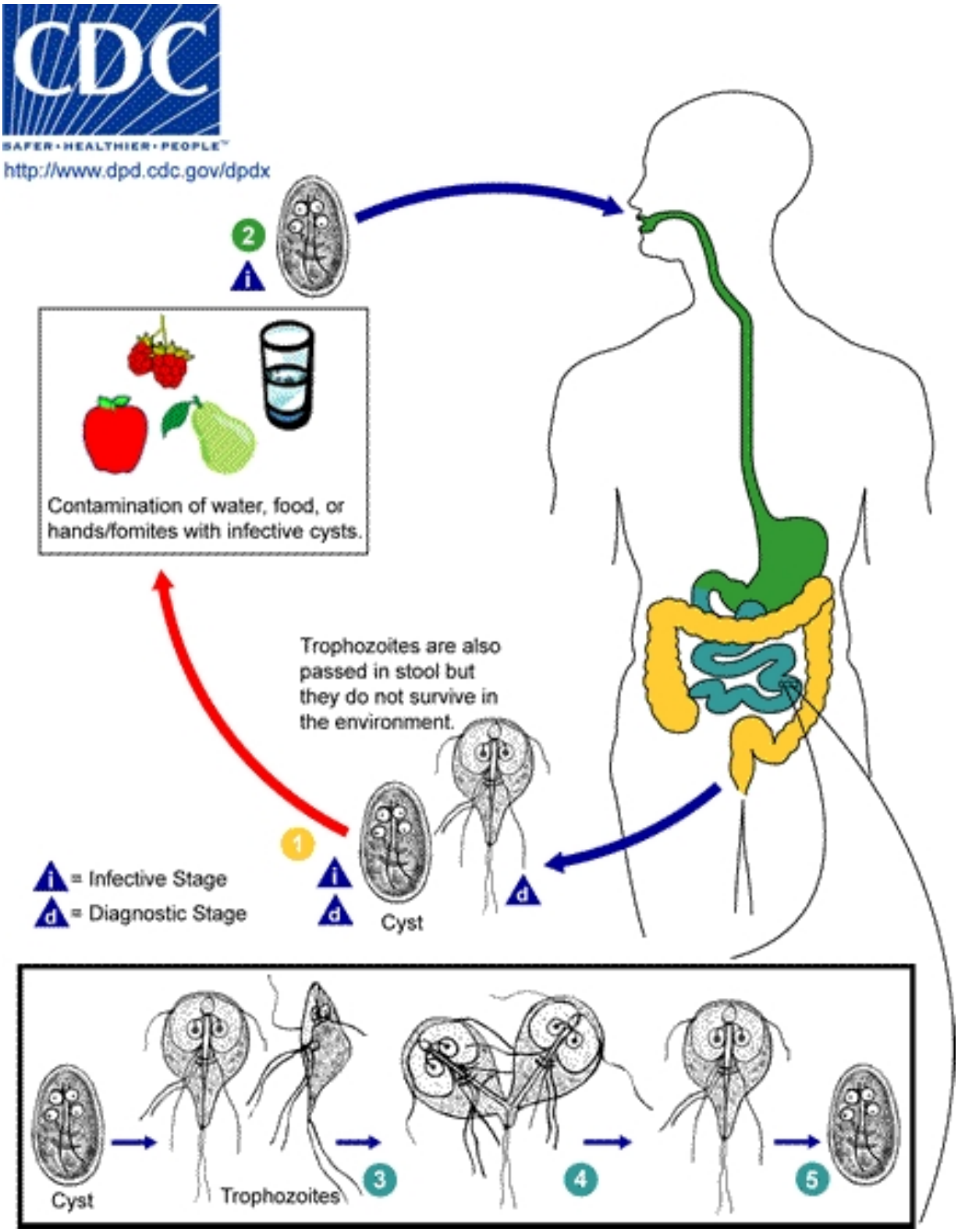
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http://www.dpd.cdc.gov/dpdx
2
i
Contamination of water, food, or hands/fomites with infective cysts.
Trophozoites are also passed in stool but they do not survive in the environment.
1
i
d
Cyst
i = Infective Stage
d = Diagnostic Stage
Cyst
Trophozoites
3
4
5

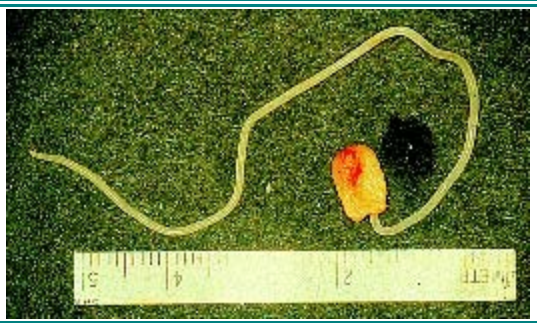
Guinea Worm

Causative Agent

- Guinea worms (*Dracunculus*) are nematodes that parasitize areas beneath the skin of the legs of fur-bearing mammals throughout North America.
- In North America, two species, *Dracunculus insignis* and *D. lutrae*, are recognized under the common name of guinea worm.

Images

Click on images to enlarge.



Distribution

Geographic:

- *D. insignis* has been reported throughout North America.
- *D. lutrae* has only been reported in the east-central portion of the continent.

Seasonality:

- Transmission of *Dracunculus* worms may occur during only a few weeks of the year or throughout the year depending on the diet of the definitive host species.

Hosts, Transmission and Life Cycle

- Female worms are slender and whitish and can be up to 28 cm in length; males appear dark, extremely slender and usually 1.5 to 4 cm long.
- Female worms are located between the skin and muscle on the thorax, abdomen, groin and legs of hosts.
- Male worms, which also occur beneath the skin, are rarely found outside of the thorax, abdomen and groin.
- Pregnant female worms occur just under the skin in the legs. This causes the development of a blister in the skin of the host that eventually ruptures, forming an ulcer.
- Larvae leave through the ulcer when the affected area is immersed in water.
- Intermediate hosts, *Cyclops* sp. (a small freshwater crustacean), ingest the larvae and here they develop until they are infective to the definitive host.
- Some fish or frogs may ingest infected *Cyclops* and serve as reservoir hosts for the parasite.
- The definitive host drinks water containing parasitized *Cyclops* or ingests infected reservoir hosts and *Dracunculus* larvae are released into the intestinal tract.
- Larvae then penetrate the intestine and migrate through the body cavity to connective tissues of the abdomen, thorax and groin. After mating, male worms remain in this location and fertilized females migrate towards the legs.

- After production of larvae, worms may die and be absorbed by the definitive host.

Signs and Symptoms

- Infected animals may raise affected legs off of the ground and occasionally scratch at the site of blisters or ulcers. Hair may be lost and skin damage may occur.
- Ulcers often heal quickly after the female worm has released the larvae and has died.
- Guinea worms are not a significant mortality factor as their infections are generally limited to the subcutaneous spaces of the legs.
- The quality of the pelt is not impaired by the worm's presence, for the ulcerations occur only on the legs.

Meat Edible?

- Since only the limbs are affected, the remainder of the carcass should be edible.
- Dogs and cats are susceptible to *Dracunculus* infection and, as such, should not be allowed to scavenge dead fish or frogs which may contain infected larvae.

Human Health Concerns and Risk Reduction

- Although humans in Africa are susceptible to other species of *Dracunculus*, humans are not able to contract *D. insignis* and *D. lutrae* and therefore, these species of guinea worms are not of public health significance.

Samples for Diagnosis

- Infection with *Dracunculus* worms can be confirmed by finding and identifying adult worms in the subcutaneous space of the legs.
- Finding a *Dracunculus* worm is more likely if both the pelt and carcass are examined.

Further Reading

- Michigan Department of Natural Resources – Guinea Worm
- University of Pennsylvania, School of Veterinary Medicine – *Dracunculus insignis*



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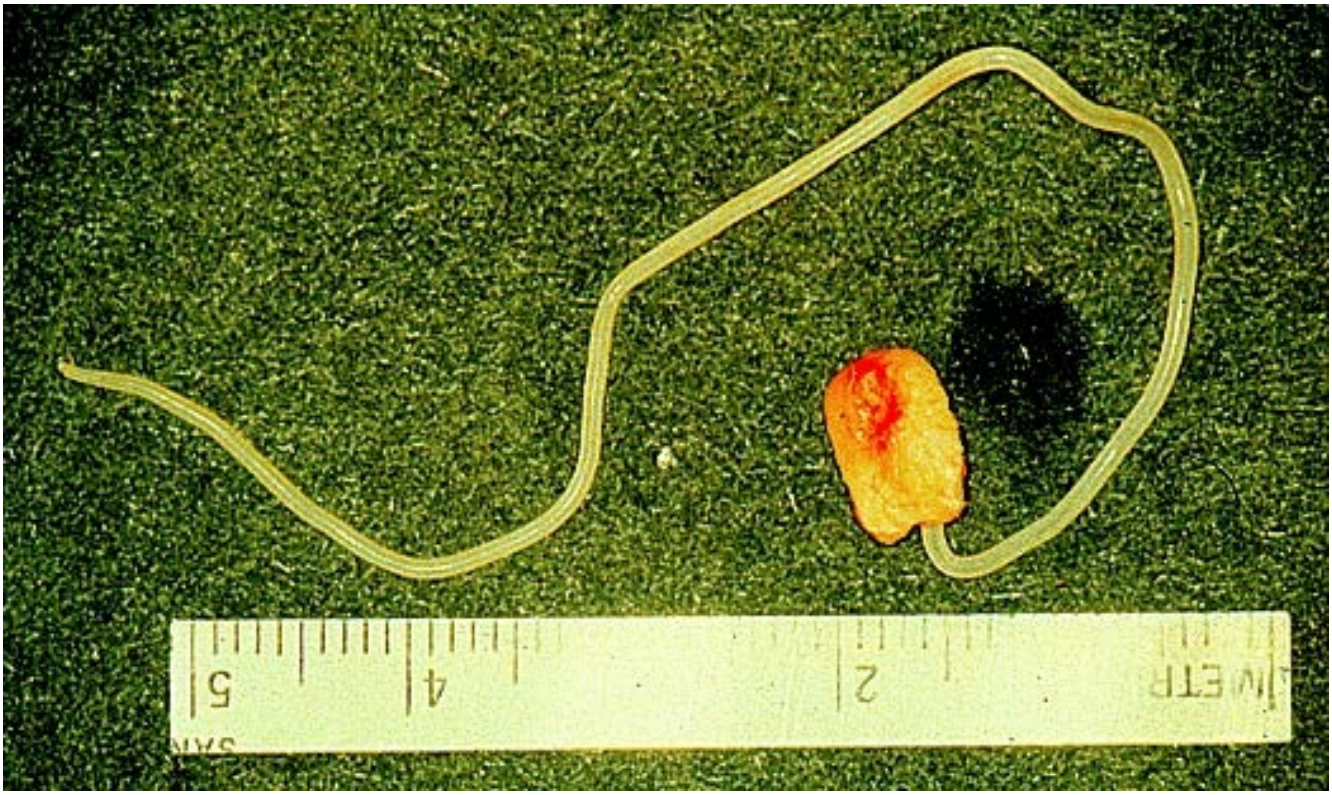
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Hantavirus Pulmonary Syndrome

This information was initially summarized from BC Ministry of Health and Health Canada.

General Information

- Hantaviruses are part of a group of viruses called the *Bunyaviridae*. Exposure to hantaviruses can cause a rare, but often fatal, disease called Hantavirus Pulmonary Syndrome (HPS).
- This rare disease was first described in the southwestern United States in 1993. It is believed that the virus has been present for a long time, but was only just recently recognized.
- The earliest documented case of HPS in Canada virus was in Alberta in 1989. Since then, there have been over 70 confirmed cases. Most of the cases occurred in western Canada (Manitoba, Saskatchewan, Alberta and British Columbia), except for one case in Quebec.
- Hantavirus infections contracted by Canadians outside the country have also been recognized, including two fatal cases from South America.
- In Canada, the virus has been found only in wild deer mice (*Peromyscus maniculatus*).

Signs and Symptoms

- The following flu-like symptoms can result from Hantavirus pulmonary syndrome (HPS) as summarized by Health Canada:
  - fever;
  - chills;
  - muscle aches;
  - headaches;
  - nausea;
  - stomach problems.
- Symptoms can appear within 3 to 60 days after exposure; however, the average time it takes for symptoms to appear is 14 to 30 days following exposure.
- HPS is extremely serious since approximately 30-40% of cases result in death, usually within a few days of the initial symptoms appearing. Those who recover do so rapidly and regain full function of their lungs, but long-term effects, such as fatigue, are common.
- HPS can progress rapidly into serious lung complications and include the following symptoms:
  - abnormal fall in blood pressure;
  - lungs fill with fluid;
  - severe respiratory failure.
- **Humans are most often exposed to the virus by breathing in airborne viral particles. Viral particles can often become airborne after sweeping or vacuuming infected areas. It is also possible to be exposed to the virus through rodent bites, if the skin is broken, or through ingestion.**

Treatment and Risk Reduction

- **Although there is no specific treatment, medication, or cure, many of the symptoms and complications of HPS can be treated. Most patients are admitted to intensive care in a hospital. Some patients may be given anti-viral drugs, and intravenous fluids and other drugs to maintain blood pressure and prevent shock.**
- ***All rodent droppings should be treated as potentially harmful. The primary strategy for minimizing your risk is to ensure rodent control in the home.***
- **There are things you can do to reduce your risk of being exposed:**
  - keep mice out of your home. Block openings that might allow rodents from entering;
  - store human and animal food, water and garbage in containers with tight-fitting lids;
  - keep your yard clean, and store woodpiles above the ground and away from the home;
  - when cleaning your home or other buildings, be aware of animal droppings and nesting materials. If you find any, clean them up safely;

- do not sweep or vacuum rodent droppings; this will release particles into the air where they can be inhaled.

- **How to properly handle and dispose of animal droppings:**
  - wear rubber or plastic gloves;
  - spray droppings with a general purpose household disinfectant or a mixture of bleach and water (1 part bleach, 9 parts water);
  - make sure you get the droppings very wet. Let the area soak for ten minutes;
  - use a paper towel to wipe up the droppings. Dispose of the paper towel immediately;
  - wash gloves in disinfectant and hot soapy water before removing them from your hands, and thoroughly wash your hands after removing gloves;
  - when cleaning areas contaminated by droppings in a confined space, consider wearing a high-efficiency particulate air (HEPA) filtered respirator.

Further Reading

- Alberta Environment and Sustainable Resource Development – Hantavirus (PDF file)
- BC Centre for Disease Control – Hantavirus
- HealthLink BC – Hantavirus
- Public Health Agency of Canada – Hantavirus Pathogen Safety Data Sheet
- WorkSafe BC - Hantavirus Information for Employers and Employees – (with links to PDF files)
- US Centers for Disease Control and Prevention – Hantavirus






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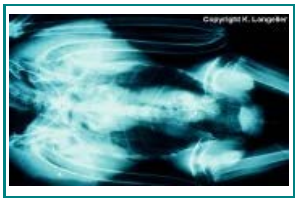
Lead Poisoning

Risk Factor

- Metallic lead is a highly toxic metal that, when ingested, affects many organs and organ systems.
- Wildlife are generally exposed to lead following ingestion of shot pellets, bullet fragments, or lead fishing jigs and sinkers.
- Before laws were introduced in North America to restrict the use of lead in ammunition, annual losses of waterfowl to lead poisoning were up to 3 million birds.
- Compared to mammals and other species of birds, waterfowl and birds of prey are at greater risk of exposure to lead because of feeding habits that involve ingesting lead shot as grit or consuming lead shot from the tissues of prey animals, respectively.
- Lead poisoning has been mainly reported in birds but has also been documented in wild mammals that presumably have fed upon lead-contaminated prey.

Images

Click on images to enlarge.

			
Atrophy of breast muscles and lack of observable fat is commonplace in lead-poisoned birds (at arrow).	***Lead shot may be present within the gizzard of lead-poisoned birds (at arrows).***	***An enlarged heart and metallic lead in the gizzard (and shoulder) is visible in this lead-poisoned bald eagle.***	***The feces of a lead-poisoned bird are often bile-stained - bright green in color. Wings may droop and birds may also appear listless.***

Distribution and Seasonality

- Lead exposure and poisoning has occurred throughout North America and may occur throughout the year.
- Historically, higher rates of exposure and poisoning in birds occurs during the fall and winter coinciding with hunting seasons where large amounts of lead shot were used.

Mechanisms of Action

- In waterfowl, the highly muscular stomach grinds and erodes metallic lead which then is rapidly distributed through the circulatory system to other body tissues. Similar action occurs in birds of prey which have less muscular but more acidic stomachs than waterfowl.
- Once absorbed within the body, lead can interfere with body functions that rely heavily on the activity of calcium.
- Lead interferes with the production of the oxygen-carrying component of blood called hemoglobin, leading to a decreased ability of red blood cells to carry oxygen.
- Lead has also been documented to damage and modify the function of kidneys, bone, nervous system, the circulatory system and gastrointestinal tract.
- If a sufficiently large amount of metallic lead is ingested, death can be rapid (acute poisoning); or, if a small amount of lead is ingested, death may occur after several weeks following chronic ill-health.

Signs and Symptoms

- Outward signs in birds include:
  - emaciation;
  - reduction in the size of breast muscle, with the breast bone becoming prominent (referred to as a hatchet-shaped breast);
  - lethargy and lack of appetite;
  - head tremors;
  - esophagus impacted with food, gizzard stained green;
  - green or bile-stained feces;
  - paralysis of lower legs;
  - blindness;
  - impaired locomotion and balance;
  - the head of some geese may appear swollen;
  - drooping wings;
  - lack of fat in the abdominal cavity;
  - metallic lead fragments may be present in the stomach. The absence of such fragments in lead-poisoned birds indicates that complete erosion and subsequent absorption of the fragments may have occurred, that the fragments were eliminated in the feces, or, in the case of raptorial birds, voided in a regurgitate (pellet).

Meat Edible?

- Game-bird hunters are aware that lead shot pellets are commonplace in tissues of shot birds and deliberately avoid the pellets when the bird is consumed.
- Most of the lead present in lead-poisoned bird is in organs such as liver and kidneys rather than in muscle. Although there is no appreciable risk to human health from eating organs from a lead-poisoned bird, it is not advisable to do so.
- Dogs are at the same risk of exposure to metallic lead in hunter-killed game meat.

Risk Reduction

- As of 1999, Canadian law prohibits the use of lead shot for hunting migratory birds such as ducks, geese (Anatidae), thick-billed murres (*Uria lomvia*), cranes (Gruidae), rails (Rallidae), gallinules (Rallidae) and coots (*Fulica americana*), and common snipe (*Gallinago gallinago*). Restrictions have also been made on the use of lead fishing sinkers and jigs. For further information regarding the environmental effects of lead on wildlife in Canada, click here.
- The ban on using lead shot for hunting migratory birds should decrease the annual losses; however, metallic lead remains in the environment for years, thus allowing lead deposited prior to the government bans to be available to feeding birds.
- More recently, in the Fraser Valley of British Columbia and Northern Washington, trumpeter swans (*Cygnus buccinator*) have died from lead poisoning in large numbers. Intensive studies by the Canadian Wildlife Service and counterparts from Washington are now underway to address this problem. For more information, click here (PDF file).

Samples for Diagnosis

- After death, lead levels in the liver and kidneys are typically used to determine the extent of exposure.
- Whole birds should be submitted for analysis; however, the entire liver or kidney can be submitted alone. Liver or kidney samples should be wrapped in tin foil and submitted frozen.

Further Reading

- Michigan Department of Natural Resources – Lead Poisoning
- The Wildlife Society: Lead and Wildlife (PDF file)
- Tufts University – Lead Poisoning
- USGS National Wildlife Health Center – Lead Poisoning
- Locke L.N., Thomas N.J. 1996. Lead poisoning of waterfowl and raptors. Pp. 108-117 in A. Fairbrother, L.N. Locke, G.L. Hoff (eds.), *Non-infectious Diseases of Wildlife*. Iowa State University Press. Ames, Iowa. 219 pp.
- Friend M. 2001. Lead. Pp. 317-344 in *Field Manual of Wildlife Diseases: General Field Procedures and Diseases of Birds*. M. Friend, J.C. Franson (Tech. eds.), E.A. Ciganovich (ed.). Biological Resources Division Information and Technology Report 1999-001. U.S. Department of the Interior and U.S. Geological Survey. Washington, DC. (Chapter in PDF format)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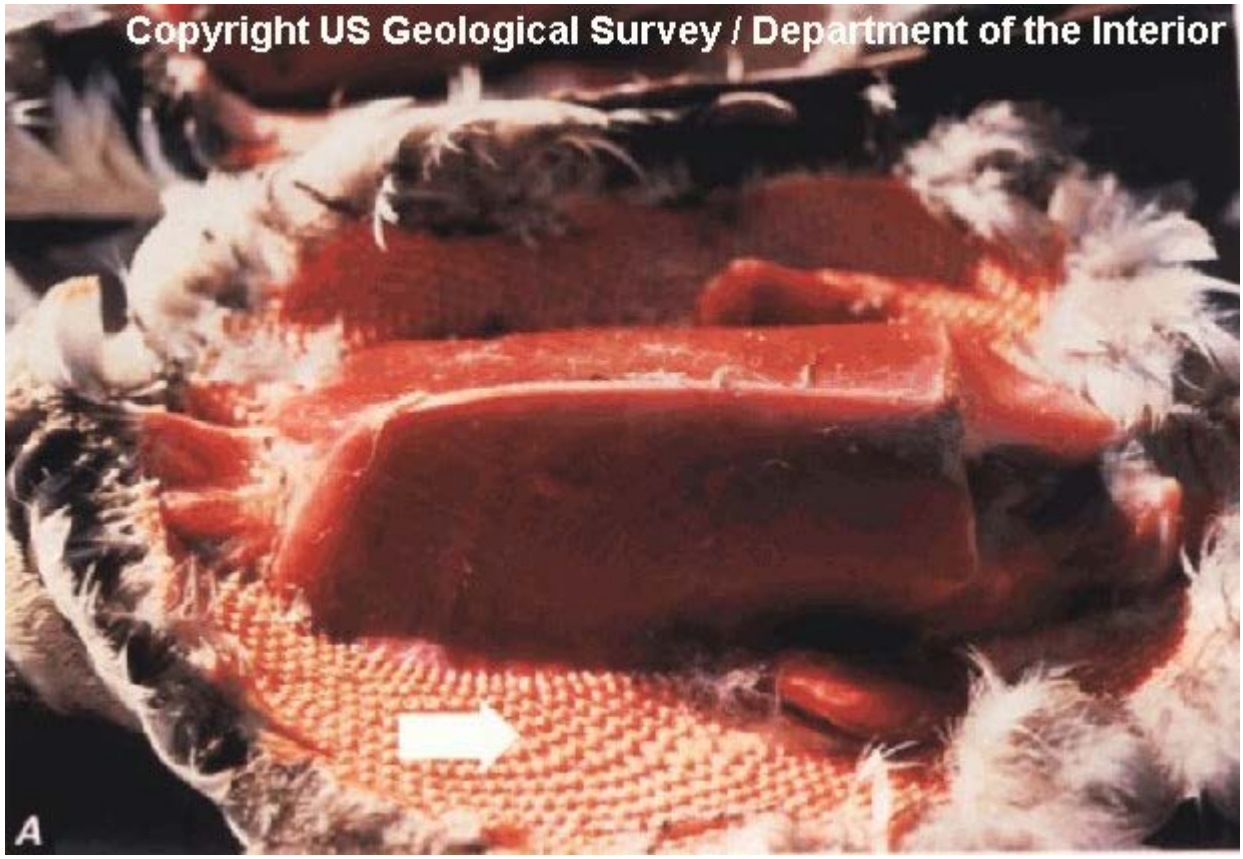
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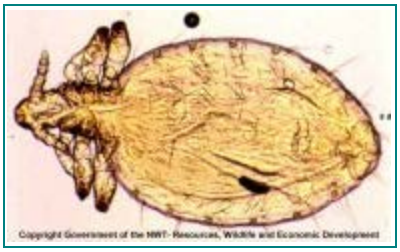
Lice

Causative Agent

- Lice are small, flattened, wingless insects that are external parasites of mammals and birds.
- Lice are of two general types:
  - those that chew on fur, feathers and skin debris;
  - those that suck on blood.

Images

Click on images to enlarge.



Photomicrograph of a chewing louse.

Lice within the fur of an Arctic fox.

Mule deer from Washington state showing hair loss due to infestation with exotic lice.

Distribution

Geographic:

- Found throughout the world.
- **Recently, cases have been reported of deer (Cervidae) in the western United States and British Columbia experiencing mild to severe hair loss due to infestations with exotic louse species brought to North America on non-native introduced or exotic species of deer.**

Seasonality:

- Lice populations undergo seasonal fluctuations that vary according to the biology of the louse and affected host.
- Found at higher numbers on affected animals in winter and early spring, and are generally absent or extremely rare in summer and autumn.

Hosts, Transmission and Life Cycle

Hosts:

- Birds and mammals.
- Chewing lice are more often found on birds.
- Sucking lice are exclusively found on mammals.

Transmission and Life Cycle:

- Lice vary from 0.3 to 10 mm long; chewing lice have a head that is broader than the rest of the body while the head of sucking lice is narrower than the rest of the body.
- The entire life cycle of lice occurs on the host.

- Lice lay eggs directly onto fur or feathers.
- Transfer of lice between hosts occurs from physical contact.
- Lice are very well adapted to a particular host species and even to specific areas on a host's body; lice will not survive on other host species.
- Lice may serve as vectors for other wildlife diseases such as Lyme disease, brucellosis, hemobartonella, ringworm, salmonellosis and certain tapeworms.
- A generation of lice usually lasts 45 days.

Signs and Symptoms

- Small infestations of lice are commonplace on animals, and do not often cause harm to the host.
- Large numbers of lice may be found on older or young animals, animals in poor condition, those suffering from a concurrent illness, or those that are inefficient at grooming.
- Lice leave the host 1-2 days following death of the host.
- Animals may become immune to the effects of lice infestation resulting in reduced survival of eggs, fewer eggs being produced, and a reduction in feeding on host tissues.
- Lice may cause the following in animals:
    - anemia;
    - itching;
    - inflammation of the skin;
    - skin sensitivity;
    - allergic reactions;
    - intense grooming;
    - fur mats;
    - loss of hair;
    - secondary infections at the location of bites;
    - reduced survival in winter due to hair loss.
- Death may result from heavy infestations in young animals or those in poor condition from other disease conditions.

Meat Edible?

- Meat quality is not affected by lice infestation.

Human Health Concerns and Risk Reduction

- Rubber gloves and protective clothing should be worn when handling wildlife with skin conditions.
- Although lice from animals cannot be transferred to humans, lice may initially crawl onto humans when infected animals are handled. This may cause a minor irritation, but the lice do not remain for long.

Samples for Diagnosis

- Collection of a whole louse placed in 70% ethanol is sufficient for identification.

Similar Diseases

- Ticks and mites are also external parasites but are very different in appearance.

Further Reading

Alaska Department of Fish and Game – Lice
- Idaho Fish and Game – Exotic Lice
- Washington Department of Fish and Wildlife – Exotic Lice
- LiceDurden L.A. 2001. Lice (Phthiraptera). Pp. 3-17 in W.M. Samuel, M.J. Pybus, A.A. Kocan (eds.), *Parasitic Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.
- Elkin B., Zamke R.L. 2001. *Common Wildlife Diseases and Parasites in Alaska*. Alaska Department of Fish and Game. Anchorage, AK.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Washington Department of Fish and Wildlife

Liver Flukes

Causative Agent

- Parasitic disease of ruminants caused by infection with a flatworm, particularly the giant liver fluke, *Fascioloides magna*.

Images

Click on images to enlarge.

***Tissue damage in the liver of a moose infected with* Fascioloides magna.**

Two adult* F. magna *removed from a capsule (host-derived tissue) in the liver of a white-tailed deer.

Distribution

Geographic:

- In North America, *F. magna* can be found in the southeastern United States, the Great Lakes basin, Labrador and northern Quebec, the Pacific Northwest including Vancouver Island, the Rocky Mountains of BC/AB and isolated pockets in central Saskatchewan.
- *F. magna* infections are most common around wetlands where large numbers of susceptible definitive hosts congregate for extensive periods with a suitable population of snails.

Seasonality:

- Infections generally occur in late summer and fall. Seasonal changes in moisture and temperature will affect the abundance and activity of snails, which are the intermediate host.

Hosts and Life Cycle

Hosts:

- definitive hosts such as moose (*Alces alces*), elk (*Cervus canadensis*), white-tailed deer (*Odocoileus virginianus*), mule deer (*O. hemionus*), and caribou (*Rangifer tarandus*), harbor the adult flukes.
- intermediate host are aquatic snails that carry the larval stages of the life cycle.

Life Cycle:

- Adult worms occupy the liver of infected definitive hosts.
- Eggs are swept into the bile collecting system within the liver, enter the small intestine and leave the host along with the feces, where they hatch if they are in contact with aerated water.

A free-swimming life stage emerges from the egg, which then penetrates the tissues of a suitable snail host (intermediate host) where multiplication of the parasite occurs.
- A more developed life-stage emerges from the snail and encysts on aquatic vegetation where it can remain for prolonged periods. Contaminated vegetation is then fed upon by a suitable herbivorous definitive host.
- Ingested larval flukes penetrate the intestinal wall and migrate within the abdominal cavity towards the liver, where they slowly develop into adults.
- Flukes are generally found in groups of 2 or more within the liver.
- Adult flukes are generally observed more often in older animals.
- If larval flukes are ingested by *dead-end* hosts such as moose or domestic cattle, they are unable to complete their development because they are walled off in scar tissue or encapsulated by tissues of the host.
- Flukes are also not able to complete development if ingested by an *aberrant* host such as domestic sheep and goats. These hosts may die from extensive tissue damage that occurs during migration of the fluke in the liver.

Signs and Symptoms

- Adult flukes are purple-gray in color, flat, elongated and oval in shape, and look like leeches (although, leeches are not closely related to flukes). When found while cutting open or slicing liver, they resemble a blood clot and are surrounded by a thick black-grey discharge. The flukes vary in size from 15-30 mm wide by 30-100 mm long by 2-5 mm thick.
- Livers of infected animals may be enlarged.
- In definitive hosts, flukes are found within thin-walled capsules containing 2 or more adult flukes. Changes in liver structure may occur in response to tracts and damage caused by migrating flukes. Liver damage is usually minor in definitive hosts but increases with age and number of flukes present.
- In aberrant hosts, flukes are not contained in a capsule and liver damage in the form of hemorrhage and necrotic tissue is extensive.
- In dead-end hosts, flukes are contained in thick-walled capsules with areas of black pigmentation (digested blood) visible throughout the liver.
- Animals infected with adult flukes may be healthy or be in poor condition, appearing drowsy, depressed, with poor appetite.
- Distended abdomens have been observed in infected elk.

Meat Edible?

- Except for infected liver tissue, the meat from infected animals is suitable for human consumption.

Human Health Concerns and Risk Reduction

- Humans are not at risk.
- Transfer of the fluke to domestic sheep and cattle herds can lead to economic losses due to mortality of animals and condemnation of infected livers. Despite the endemic status of the giant liver fluke in areas of BC, there does not appear to be a significant problem in the livestock industry.

Samples for Diagnosis

- Infection can be verified through examination of the liver for adult flukes or on the basis of finding eggs in fecal material.

Further Reading

Alberta Environment and Sustainable Resource Development – Liver Flukes (PDF file)
- Michigan Department of Natural Resources – Liver Flukes
- Pybus M.J. 2001. Liver flukes. Pp. 121-149 in W.M. Samuel, M.J. Pybus, A.A. Kocan (eds.), *Parasitic Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.

					
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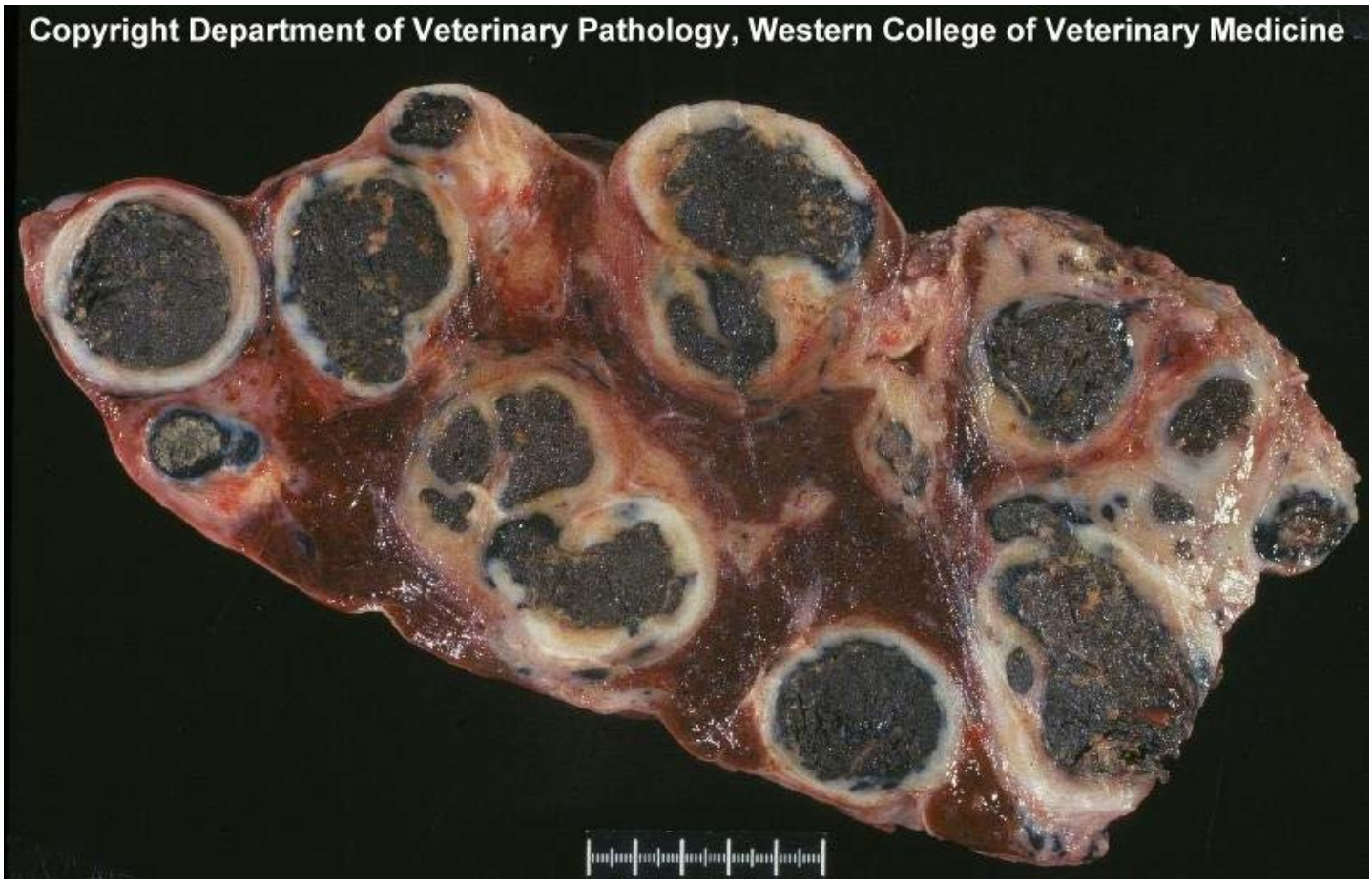


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Lumpy Jaw

Causative Agent

- Lumpy jaw is the result of an infection of the jawbone with the bacteria, *Actinomyces bovis*.
- *A. bovis* is normally found in the mouths of healthy animals.
- Bacteria may enter small wounds in the mouth, caused by tooth eruption or by coarse feed.

Images

Click on image to enlarge.

Swelling of the jaw bone subsequent to bacterial infection causes the formation of conspicuous "lumps".

Distribution

Geographic and Seasonality:

- Can occur throughout the year and throughout BC.

Hosts, Transmission and Life Cycle

- Occasionally found in wild ungulates such as white-tailed deer (*Odocoileus virginianus*), mule deer (*O. hemionus*), moose (*Alces alces*), caribou (*Rangifer tarandus*) and mountain sheep (*Ovis canadensis*).
- This disease does not normally spread from animal to animal, but draining wounds can spread bacteria on common feed sources.

Signs and Symptoms

- Once bacterial infection is established, bacterial by-products break down existing bone and promote the growth of new bone; consequently, affected areas of the jaw expand forming lumps or thickened areas of bone, honeycombed with tiny abscesses.
- Tissues within the mouth may become swollen and there can be spread to nearby areas of the mouth.
- Difficulty chewing.
- Tooth loss and impaction of feed usually occurs in affected areas.
- Other than lesions in the mouth, animals may appear healthy but are often thin since jaw lesions may interfere with the ability to eat.

Meat Edible?

- Affected areas of the jaw should not be consumed; otherwise, the rest of the carcass is suitable for human consumption.

Human Health Concerns and Risk Reduction

- Although lumpy jaw cannot be contracted from animals, care should be taken not to cut into the swellings of the jaw as pus can spread and contaminate other parts of the carcass.

Samples for Diagnosis

- Lower jaw and surrounding tissue.

Further Reading

- Alaska Department of Fish and Game – Lumpy Jaw
- Wobeser G. 2001. Actinomyces and Arcanobacterium infections. Pp. 487-488 in E.S. Williams, I.K. Barker (eds.), *Infectious Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.
- Elkin B., Zamke R.L. 2001. *Common Wildlife Diseases and Parasites in Alaska*. Alaska Department of Fish and Game. Anchorage, AK.






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Lyme Disease

General Information

- Lyme Disease is classified as a vector-borne, zoonotic illness – it is spread by ticks (the vector, or agent of transmission). The organism which causes Lyme disease is a spiral-shaped bacterium called *Borrelia burgdorfei* and it has been found in two species of ticks collected from many areas of BC including Vancouver Island, the Lower Mainland, the Sunshine Coast, the Fraser Valley and the Kootenays.
- The tick that spreads Lyme Disease in BC is the blood-feeding western black-legged tick (*Ixodes pacificus*), which are about the size of a sesame seed.
- While most tick bites do not result in disease, some do.
- In BC, less than 1 percent of ticks tested carry the bacteria that causes Lyme Disease, and there is only a very small chance of the bacteria being transmitted to a human that has been bitten. ***However, the disease can be serious, so it is worth taking steps to avoid being bitten.***
- Ticks prefer habitat that includes wooded regions and areas with tall grass; this habitat preference also coincides with the preferred habitat of their primary host, black-tailed deer (*Odocoileus hemionus*).
- Ticks attach to people or animals as they pass by, burrow part way into the skin, bite, draw blood, then drop off.
- Ticks are easiest to spot when they are feeding on a host. During the blood meal, only the mouth parts of ticks are inserted beneath the skin of the host, while the posterior body remains exterior to the host's body. Once fully engorged with blood, ticks detach and move onto vegetation.
- **As of 2013, there have been over 60 confirmed cases of Lyme Disease in British Columbia.**

Images

Click on image to enlarge.

Western black-legged ticks (*Ixodes pacificus*) is responsible for the spread of Lyme Disease along the Pacific coast, mostly in southern British Columbia. (Source: Public Health Image Library (PHIL). James Gathany; William Nicholshon. Available online: http://phil.cdc.gov.)

Symptoms and Treatment

Symptoms:

- **If you have the following symptoms within days or weeks after being bitten by a tick, consult your family physician or other healthcare professional. Tell your doctor when and where you were bitten by a tick.**
- Symptoms include a skin rash that looks like a "bull's eye" and may be quite large (5 cm or

2 inches) in diameter may develop. It often spreads out from where the tick bite was.

- **Also, general symptoms of:**
  - fever;
  - headache;
  - muscle and joint pains;
  - fatigue or weakness of the muscles of the face;
- **In some cases paralysis may occur. The paralysis usually starts in the feet and legs and gradually works its way up to the upper body, arms and head. This paralysis can develop from within a few hours to several days.**

Treatment:

- Most cases of Lyme Disease can be treated successfully with a course of antibiotics, especially if caught early. Untreated, Lyme Disease can affect the joints, the heart and the nervous system and is much more difficult to treat.

Avoiding Ticks

- To protect yourself against tick and insect bites:
  - walk on cleared trails wherever possible in areas of tall grass or woods;
  - wear light-colored clothing, tuck your top into your pants and tuck your pant legs into your boots or socks;
  - put insect repellent containing DEET on all exposed skin. Reapply as frequently as directed on the container;
  - check clothing and scalp (covered or not) when leaving an area where ticks may live;
  - check in folds of skin. Use good lighting and have someone help you check hard-to-see areas. When a tick is located, remove it immediately. Check the whole body! Don't stop when you find one tick, as there may be more;
  - regularly check household pets for ticks.

What To Do If You Find a Tick on Your Skin or Scalp

1. Use tweezers or forceps to gently get a hold of the tick as close to the skin as possible. Don't touch the tick with your hands.
2. Without squeezing the tick, steadily lift it straight off the skin. Avoid jerking it out. Try to make sure that all of the tick is removed.
3. Once the tick has been removed, clean the bite area with soap and water then disinfect the wound with antiseptic cream. Wash hands with soap and water.
4. If possible, save the tick in a container with a tight fitting top. If the tick is alive, dampen a small cotton ball with water and put it into the container to keep the tick alive. (A live tick is necessary for culturing the bacteria that causes Lyme Disease.) Label the container with the date, name and address of person bitten or what type of animal the tick was from, what part of the body was bitten, and what part of the province the tick probably came from. Also include the name and address of your family physician.
5. Ask your doctor for further advice.

For laboratory testing, this container should be mailed as soon as possible to: BCCDC Laboratory Services, Parasitology Section, 655 West 12th Ave., Vancouver V5Z 4R4 BC Canada

Further Reading

- Alberta Environment and Sustainable Resource Development – Lyme Disease (PDF file)
- BC Ministry of Health – Healthlink BC – Lyme Disease
- BC Centre for Disease Control – Lyme Disease

- BC Ministry of Agriculture - Ticks and Humans in British Columbia – Ticks in BC
- Michigan Department of Natural Resources – Lyme Disease

					
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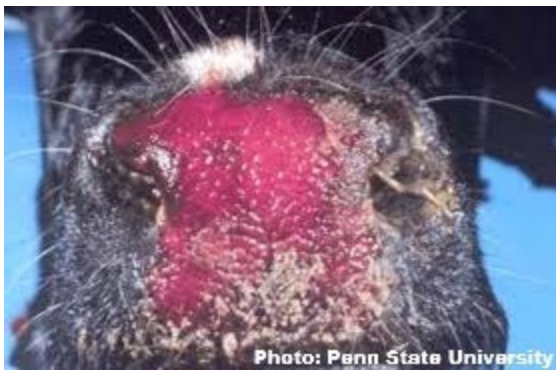
Malignant Catarrhal Fever

Causative Agent

- Malignant catarrhal fever (MCF) is an infectious, viral disease of many ruminants, including bison (*Bison bison*). It occurs worldwide and is generally sporadic, although herd outbreaks have been reported.
- In North America, MCF is caused by ovine herpes virus-2, which infects sheep with no ill effects and spreads to susceptible species like bison.

Images

Click on images to enlarge.



Domestic cattle showing signs of MCF.

Distribution

Geographic:

- MCF has been documented worldwide in both wild and domestic ruminants.
- MCF has not been detected in wild ruminants in BC.

Seasonality:

- MCF can occur any time throughout the year.

Hosts and Transmission

- MCF has been documented in wild ruminants globally.
- In Saskatchewan, MCF has been found to have been transferred from sheep to free-ranging moose (*Alces alces*).
- Transmission of MCF had been shown to occur from animal to animal within the same species as well as from mother to young during pregnancy or birth.

Signs and Symptoms

- Gross pathological changes are generally widespread and may involve most organ systems. The severity of this disease does vary, and signs include:
  - severe inflammation of the oral and nasal mucosa;
  - bleeding and inflammation of stomach and small intestine (hemorrhagic gastroenteritis);

- fever;
- diarrhea;
- redness of oral and nasal mucosa with accompanying discharges;
- encrustation of the muzzle and nasal area, causing obstruction of the nostrils and shortness of breath, open-mouthed breathing, and drooling;
- skin lesions occasionally are seen, and horn as well as hooves wall may be loosened or sloughed;
- clouding or ulceration of the eyes.

Meat Edible?

- Not suitable for human consumption.

Human Health Concerns and Risk Reduction

- The CFIA has recognized Bovine Malignant Catarrhal Fever as an annually notifiable disease, which in general are diseases that are present in Canada, but are not classified as reportable or immediately notifiable.
- There is no zoonotic potential for this disease.

Samples for Diagnosis

- A set of affected tissues should be collected in a 10% solution of formalin for microscopic examination.
- Blood samples also can be submitted to diagnose this disease.

Further Reading

- Alberta Rural and Agriculture Development – Malignant Catarrhal Fever in Bison and Sheep
- European Association of Zoos and Aquaria – Malignant Catarrhal Fever (PDF file)
- Texas A & M University – Malignant Catarrhal Fever


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Photo: Texas A & M University

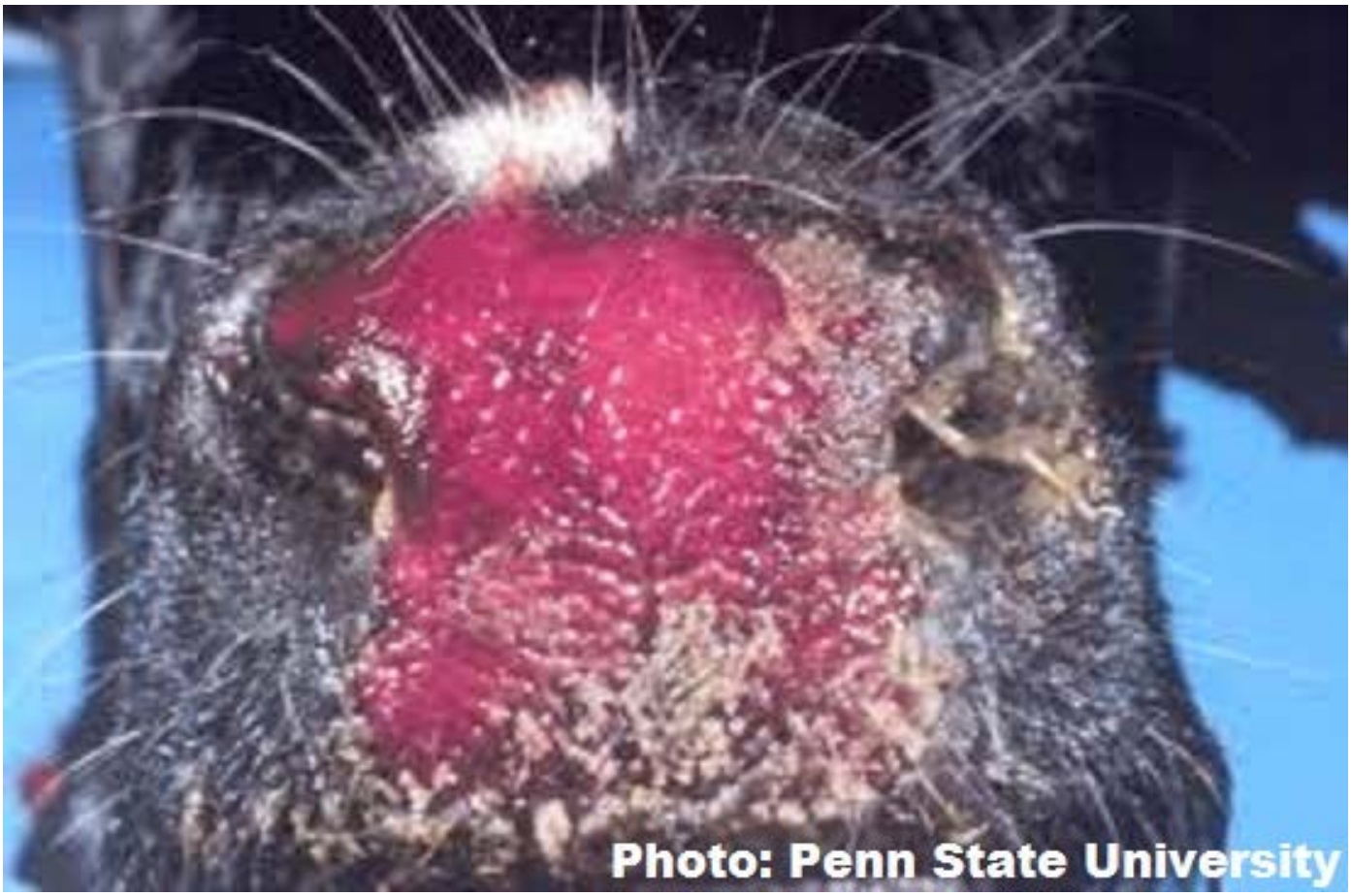
Photo: Penn State University

Malnutrition and Starvation

Risk Factors

- Malnutrition is the condition that occurs when a diet provides nutrients in sub-optimal amounts.
- Malnutrition occurs prior to starvation, which is simply the long-term deprival of food and its adverse effects.

Images

Click on images to enlarge.

A moose in poor nutritional condition.

Sections of leg bones from caribou showing depletion of fat stores from left to right.

Distribution

Geographic:

- Can occur in areas of food shortage brought upon by drought, heavy snow-pack, etc.

Seasonality:

- Occurs most often during the winter when food sources are scarce or with coexisting disease conditions.

Mechanisms of Action

- Malnutrition leading to starvation occurs because of poor quantity or quality of food (e.g., drought), the inability of an animal to reach the source of food due to environmental factors (e.g., deep or hard-crusted snow), or physical ailments that prevent the animal from foraging or eating effectively (e.g., physical injury, poor teeth).
- Malnutrition and starvation may occur in any wildlife species, and occur more often among the very young, aged, weak or sick animals.

Signs and Symptoms

- Animals are weak with very little body fat.
- Signs of malnutrition and starvation in mammals include:
  - bones of the shoulders, ribs, back-bone and hips protrude;
  - sunken eyes;
  - tucked up abdomens;
  - when butchering, a lack of fat under the skin, around the heart, kidneys and other organs and within the bone marrow;

- bone marrow of malnourished and starving mammals resembles a reddish jelly or liquid in contrast to the marrow from healthy animals which usually is solid, white and waxy;
- muscles and organs may be shrunken or decreased in size;
- little food or food of poor quality may be found in the alimentary tract.

Meat Edible?

- Meat from starving or malnourished animals is suitable for human consumption, but may be of poor quality.

Samples for Diagnosis

- Appearance at post-mortem can be used for a tentative diagnosis, and confirmed by breaking open any long bone (e.g., femur) that normally contains marrow to examine extent of marrow depletion.

Similar Diseases

- There is often a pre-existing condition that make animals more susceptible to malnutrition and starvation. A full post-mortem examination may be required to identify chronic diseases that result in malnutrition or starvation.

Further Reading

- Alaska Department of Fish and Game – Starvation / Malnutrition
- Michigan Department of Natural Resources – Starvation / Malnutrition
- Elkin B., Zamke R.L. 2001. *Common Wildlife Diseases and Parasites in Alaska*. Alaska Department of Fish and Game. Anchorage, AK

					
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Photo: Patrick Lafreniere

Alaska Department of Fish and Game

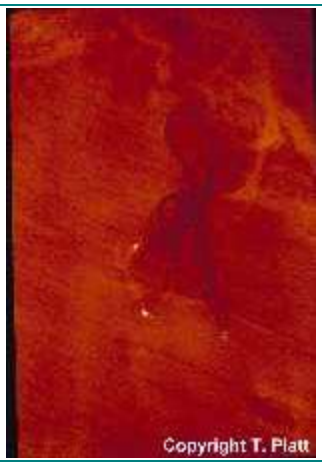
Muscle Worms

Causative Agent

- Muscle worms are nematodes that parasitize muscle and lung tissue of some cervids.
- Two species are known to cause disease in BC:
  - *Parelaphostrongylus andersoni*
    - muscle worm of caribou (*Rangifer tarandus*) and occasionally white-tailed deer (*Odocoileus virginianus*).
    - Adult worms, which are delicate and thread-like, are found in association with blood vessels and connective tissue of the loin and thigh muscles.
    - Adult worms are often found in the meat of backstraps, back muscles close to the vertebrae.
    - Adult worms are 19 - 35 mm in length and approximately 0.1 mm in width.
    - The dark, threadlike intestine of adult worms is noticeable against muscle tissue.
  - *P. odocoilei*
    - muscle worm of primarily of mule and black-tailed deer (*O. hemionus*); occasionally, mountain goat (*Oreamnos americanus*), mountain sheep (*Ovis canadensis*) and caribou are infected.
    - Adult worms are delicate, thread-like, and white, with a central thin, black intestine. Like *P. andersoni*, they are found in association with blood vessels and connective tissue of the loin and other muscles.
    - Adult worms are about 55 mm in length and approximately 0.2 mm in width.

Images

Click on image to enlarge.



Adult muscle worm, P. odocoilei, in muscle of mule deer from Alberta.

Distribution

Geographic:

- *P. andersoni* has been documented in northern BC, as well as in the southeastern and south-central areas of the province.
- *P. odocoilei* has been documented on Vancouver Island, in the Okanagan Valley, and in coastal mountain goats and some populations of mountain sheep.

Seasonality:

- New infections begin during periods when vegetation is greening up.

- Larvae are passed in the feces at varying intensities throughout the year.

Hosts, Transmission and Life Cycle

P. anderonsi:

- Adult male and female worms are often found paired.
- Females deposit eggs into veins of hosts which are then carried to the lungs where they hatch in small blood vessels.
- Larvae move up the through the lungs and into the trachea where they are coughed up, swallowed, and passed in the feces.
- Larvae must then penetrate the body of a land snail to develop into the infective stage.
- The snail and infective larvae are then inadvertently ingested by caribou and white-tailed deer while feeding.

P. odocoilei:

- Similar to that of *P. andersoni*.

Signs and Symptoms

P. anderonsi:

- Natural infections in caribou and white-tailed deer are generally well tolerated.
- In general, the signs listed below are observed in heavily infected animals; young are more susceptible than older animals.
- Notable signs in caribou include:
    - reluctance to stand;
    - weakness;
    - panting;
    - short steps;
    - arched back.
- Signs in white-tailed deer are more severe and include:
    - hemorrhage on the surface of back and thigh muscles;
    - green abscesses may be observed near eggs in lungs or worms in muscle;
    - small (up to 1 mm in diameter) nodules may be observed in the lung.

P. odocoilei:

- Outward signs of disease are rarely seen with *P. odocoilei*.
- Laboured breathing may be observed in some infected animals.
- Other signs are similar to those described above for white-tailed deer infected with *P. andersoni*.
- Recent research has identified this parasite in mountain sheep and mountain goats. There is some evidence that heavy infections of larvae can damage the lungs of Stone's sheep, but further studies are required to understand any role the parasite plays in the health of these sheep.

Meat Edible?

- Carcasses containing *P. odocoilei* and *P. andersoni* are safe for human and animal consumption since they do not affect the quality of meat.

Samples for Diagnosis

- Submission of adult worms from loin or thigh muscles is necessary to confirm infection.
- Submitting fecal samples may also aid in diagnosis.

Further Reading

- Lankester M.W. 2001. Extrapulmonary lungworms of Cervids. Pp. 228-278 in W.M. Samuel, M.J. Pybus, A.A. Kocan (eds.), *Parasitic Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.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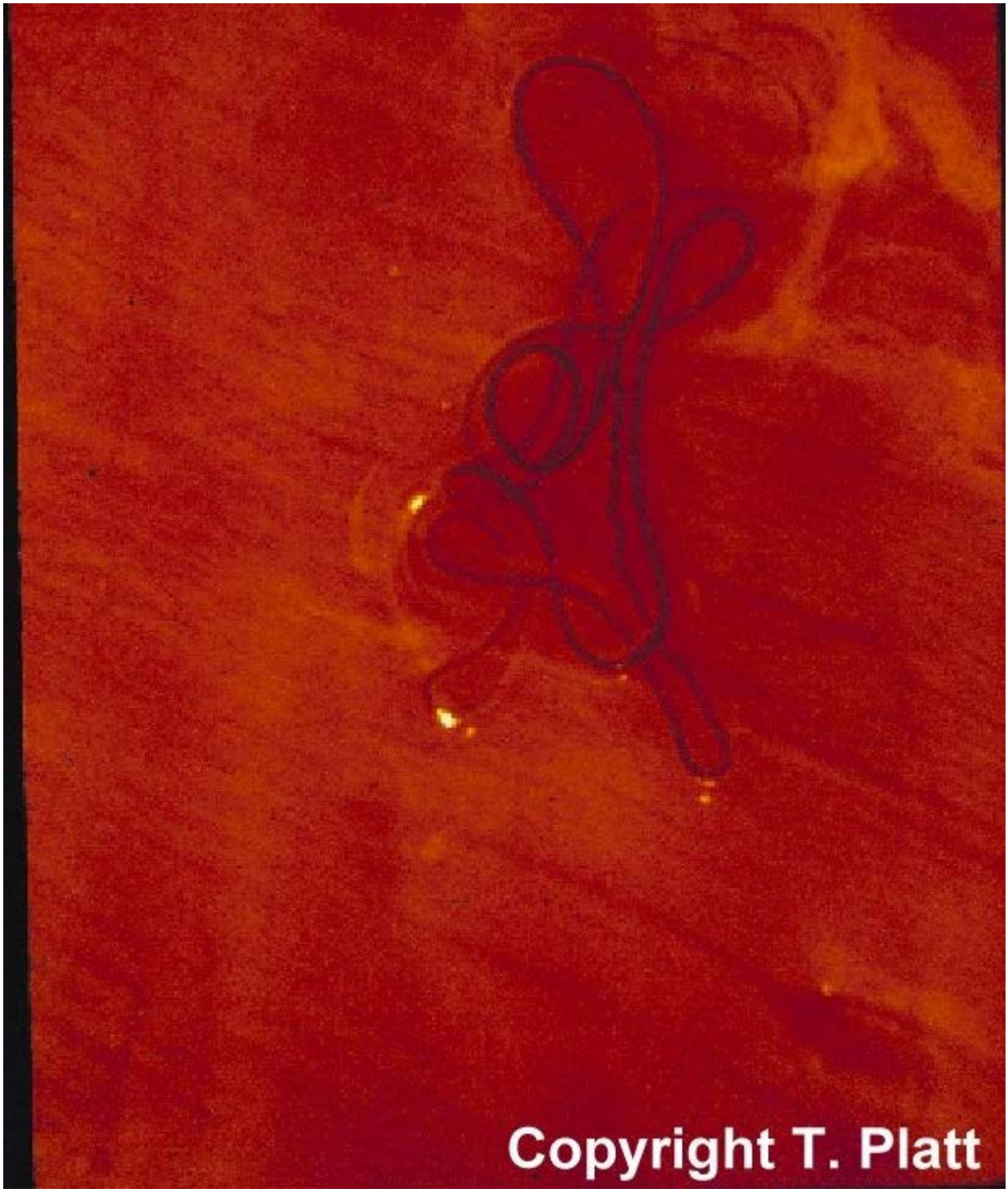
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Nasal Leeches of Waterfowl

Causative Agent

- A leech of the genus *Theromyzon* that feeds directly on blood from the nasal passages, trachea and mucous membranes of the eyes of migratory waterfowl.
- Other species of leeches feed on other exposed surfaces of waterfowl.

Images

Click on images to enlarge.

Nasal leeches are often visible as they infest external nasal passages.

Nasal leeches also infest the nasal sinuses.

Distribution

Geographic:

- Common on birds north of the 30th parallel and in western North America.

Seasonality:

- Peak infestations occur during the spring and summer months when leeches are actively seeking potential hosts and reproducing.
- Winter slows the metabolic rate and activity of leeches.

Hosts

- Many aquatic birds are affected; commonly dabbling ducks (e.g., mallard, teal, wigeon, northern shoveler, etc.) and swans.

Signs and Symptoms

- Leeches are 10-45 mm long when fully engorged, and are dark yellow to olive in color.
- Free-living leeches are green with patterns of spots on the top surface.
- Birds with leeches protruding from the nostrils or attached to the mucous membranes of the eyes are easily recognized at a distance with binoculars.
- Leeches may become so engorged with blood that they resemble sacks of blood.
- Infected birds may vigorously shake their heads, scratching at their bills with their feet, or sneeze in an attempt to dislodge leeches.
- Leeches lodged in the nostrils and respiratory tract can cause labored breathing and gaping (breathing with an open bill) similar to that seen in birds affected by *Aspergillus* infection.
- Feeding leeches can lead to extensive damage and inflammation of the lining of the nasal

cavity.

- Severe infestations of the eye can result in temporary blindness.
- Leeches protruding from the nostrils or attached to the eyes can be removed with forceps.

Meat Edible?

- Meat is edible but, if considerable blood-loss has occurred from leech infestation, the quality of meat may be decreased.

Human Health Concerns and Risk Reduction

- *Theromyzon* leeches feed exclusively on birds and are not considered a threat to humans.

Samples for Diagnosis

- Nasal leeches often cannot be observed externally, so submitting the entire carcass is warranted.
- Nasal leeches will depart from a dead bird or may move to other areas of the bird, making them difficult to see. Leeches found on the carcass should be submitted as well for identification.
- Leeches can be shipped live in pond water and maintained for several months in a refrigerator.

Similar Diseases

- Similar breathing difficulty is observed in birds with aspergillosis

Further Reading

- Tuggle B.N. 2001. Nasal leeches. Pp. 245-248 in *Field Manual of Wildlife Diseases: General Field Procedures and Diseases of Birds*. M. Friend, J.C. Franson (Tech. eds.), E.A. Ciganovich (ed.). Biological Resources Division Information and Technology Report 1999-001. U.S. Department of the Interior and U.S. Geological Survey. Washington, DC. (Chapter in PDF Format)

					
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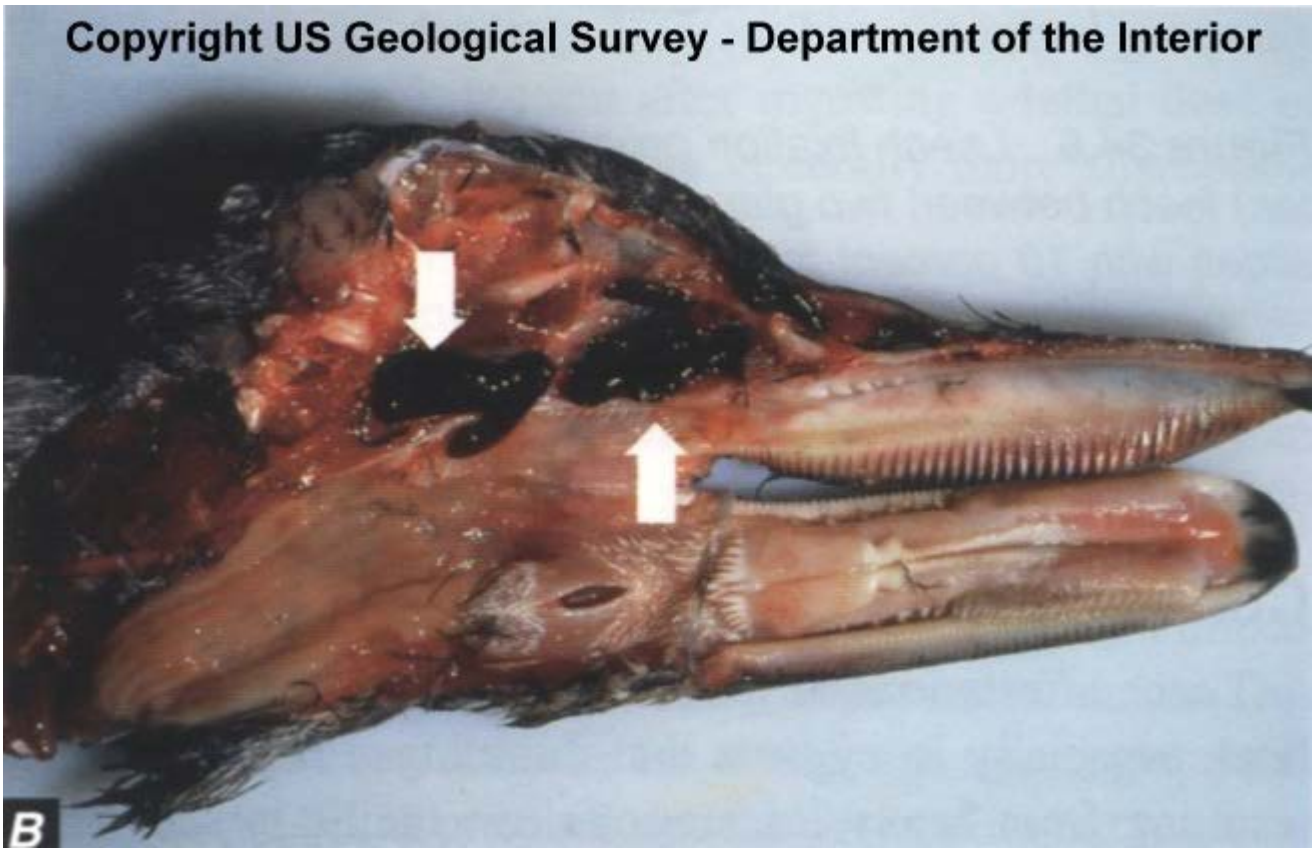
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B

Papillomavirus

Causative Agent

- Lumps, known as papillomas or warts, present on the skin and mucous membranes are benign (non-cancerous) tumors most often caused by the papillomavirus group of viruses.

Images

Click on image to enlarge.

Large, wart-like lesions are fairly common on deer and moose.

Distribution

Geographic:

- Worldwide.

Seasonality:

- Throughout the year.

Hosts, Transmission and Life Cycle

Hosts:

- Papillomas have been described in at least 50 mammalian species.
- Most commonly observed in moose (*Alces alces*) in BC, although white-tailed (*Odocoileus virginianus*), black-tailed and mule deer (*O. hemionus*) are also reported to be affected occasionally.

Transmission:

- Occurs through direct contact with warts or lesions of an infected animal that contain virus particles.
- Transmission may also result when infective lesions are abraded by vegetation that is subsequently in contact with uninfected hosts.
- Bites of blood-feeding invertebrates (ticks, mites, mosquitoes, etc.) may also transfer the virus.
- Transmission usually occurs among members of the same species or closely related species. Reports have described areas where several animals are affected over successive years.

Life Cycle:

- Once infected, lesions may persist for weeks to months.
- 75-80% of lesions eventually regress, leaving the host immune to future infections.
- The disease is often self-limiting and lumps usually will disappear; therefore, treatment and control in wild populations is not necessary.

Signs and Symptoms

- Lesions on the skin and mucous membranes.
- Lesions can be quite variable in number (few to numerous), size (very small [1-2 mm] to huge [8-10 cm]), coloration (light to dark) and texture (smooth to cauliflower-like in appearance).
- Animals are generally in good body condition but may become weak and debilitated if the number and size of tumors becomes unusually large or when tumors compromise vision or the ability to eat.
- Lesions may resemble those of poxvirus infection in birds.

Meat Edible?

- Meat from infected animals is suitable for human consumption since warts do not affect the quality of the meat.
- Trim off tissues containing warts prior to consumption for both humans and domestic pets.

Human Health Concerns and Risk Reduction

- Although unsightly, papillomas are of no consequence to human health, as humans cannot acquire warts from non-primate wild mammals.

Samples for Diagnosis

- Gross and/or microscopic diagnosis is relatively straightforward.
- After trimming excess tissue from wart, samples can be placed in a household freezer (-20º C) prior to submission to a suitable laboratory.

Further Reading

- Alaska Department of Fish and Game – Papilloma
- Alberta Environment and Sustainable Resource Development – Papilloma (PDF file)
- Elkin B., Zamke R.L. 2001. *Common Wildlife Diseases and Parasites in Alaska*. Alaska Department of Fish and Game. Anchorage, AK.
- Sundberg J.P., Van Ranst M., Jenson A.B. 2001. Papillomavirus infections. Pp. 223-231 in E.S. Williams, I.K. Barker (eds.), *Infectious Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.






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Parvovirus

Causative Agent

- Parvovirus is an infectious viral disease that affects some wild and domestic carnivores.
- Worldwide, several variants of the virus have been identified, each associated with a single wild animal host species that acts as a reservoir of infection for a particular geographic area.

Images

Click on image to enlarge.

Inflammation of the inner walls of the intestine are commonplace in parvovirus infections as observed in this coyote.

Distribution

Geographic:

- Worldwide.

Seasonality:

- Throughout the year; but most often in late spring and early summer when there is an abundance of susceptible animals (i.e., young of the year).

Hosts, Transmission and Life Cycle

Hosts:

- In BC, the potential hosts of parvovirus include susceptible wild and domestic animals: dogs, cats, coyotes (*Canis latrans*), wolves (*Canis lupus*), raccoons (*Procyon lotor*), mustelids, foxes (Canidae), and bears (Ursidae).

Transmission and Life Cycle:

- Transmission generally occurs through ingestion of viral particles passed in the feces of an infected animal rather than through direct contact with another animal.
- Parvovirus is hardy, stable when frozen, and capable of surviving for at least several months under dark, cool, and moist conditions.
- Birds, rats, flies and inanimate objects (fomites) have been implicated in mechanical transmission of parvovirus.
- Life cycle in animals greater than 4 weeks in age:
    - upon entering the body, the virus begins replication in lymphoid tissue;
    - virus spreads throughout the body via blood vessels and infected lymph cells;
    - in particular, parvovirus targets rapidly dividing cells in the body, such as those in the intestinal walls;
    - damage occurs through the killing of cells of the intestinal wall, which do not

immediately regenerate. As a result, tissue fluids and blood are lost into the intestine. Diarrhea follows, often containing blood and mucous;
    - with the loss of fluids, dehydration occurs and the potential uptake of toxins normally voided in the feces increases;
    - provided animals survive this initial phase of the disease, complete recovery is possible as cell populations regenerate.
- Life cycle in animals less than 4 weeks in age:
    - infection of the gut is not observed in young animals;
    - infection of the developing brain or heart has been observed in kittens and puppies, respectively.
- Immunity may be passed from mother to offspring in dogs.
- If an infected animal recovers after exposure to the virus, natural immunity usually persists.
- Parvovirus is not thought to have any population level effects in wildlife, except in small populations that are isolated from sources of immigration, such as on islands.

Signs and Symptoms

- Four to five days after exposure, infected animals may be anemic from loss of blood, dehydrated, depressed, tired and lacking an appetite. This is followed by fever, vomiting and diarrhea.
- Parvoviral diarrhea is watery, pasty or porridge-like, foul-smelling, and often contains blood and mucous.
- Animals that resume eating within 3-4 days after infection usually survive. Most animals that die from the infection do so within 4-5 days. Infected animals can shed the virus for up to 2 weeks.

Meat Edible?

- Carnivore meat is usually not consumed; however, if an animal is suspected of being infected with parvovirus, care should be taken in removing the intestines, as infectious particles may still be present and may contaminate the local environment.
- Areas contaminated with feces containing parvovirus should be cleaned with bleach.

Human Health Concerns and Risk Reduction

- There is no evidence to suggest that humans are vulnerable to parvovirus infection.

Samples for Diagnosis

- Parvovirus is usually detected in the feces.
- Diagnosis of parvovirus infection can be made during post-mortem examination of the gastrointestinal tract.

Further Reading

- BC Wildlife Health Fact Sheet - Canine Parvovirus in BC - (PDF file)
- Barker I.K., Parrish C.R. 2001. Parvovirus infections. Pp. 131-146 in E.S. Williams, I.K. Barker (eds.), *Infectious Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.






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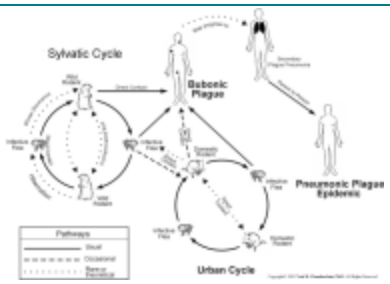
Plague

Causative Agent

- Bacterial disease caused by infection with *Yersinia pestis*, causing an acute infection and high mortality rates in mammals.
- Plague is a flea-transmitted disease affecting and perpetuated by rodents.
- This same bacteria caused three human epidemics in recorded history; today, wildlife act as reservoirs for the bacteria throughout the world in semi-arid areas on every continent except Australia and Antarctica.

Images

Click on image to enlarge.



Plague cycles can occur both in wild (sylvatic) and urban areas.

Distribution

Geographic:

- In BC, mortality from *Y. pestis* was reported near Kamloops in the 1980s in bushy-tailed woodrats (*Neotoma cinerea*) and serological exposure to the bacterium was reported in the Okanagan Valley in mink (*Mustela vison*), weasel (Mustelidae), marten (*Martes*), lynx (*Lynx canadensis*), and bobcat (*Lynx rufus*).
- Click here for a graphic depicting global distribution of plague in humans and animals (US CDC).

Seasonality:

- Unknown.

Hosts, Transmission and Life Cycle

Hosts:

- *Y. pestis* bacteria are maintained in a complex cycle involving rodents and fleas.
- Infected fleas tend to remain in burrows for prolonged periods. Hence, burrowing rodents, their predators and animals that share similar habitats as burrowing rodents will often have high rates of infection when compared to other species.
- Spill-over from rodents to other species often results in outbreaks or epizootics.
- Rabbits, carnivores, primates and birds are generally not involved in cycles, although they may occasionally aid in spreading infectious fleas or prey.

Transmission:

- Transmission of bacteria usually occurs via a flea bite; blood-borne bacteria from the infected animal, remaining in the gastrointestinal tract of the flea, is transferred when the flea begins its blood meal from its next uninfected host.
- Less commonly, a predator/scavenger can become infected upon ingestion of tissues of an infected animal. Sharp objects, such as bones, may puncture tissues of the mouth and throat, thereby enabling entry of the bacteria.
- Rarely, infection occurs through inhalation of aerosolized bacteria.

Life Cycle:

- See above diagram.
- Plague cycles can occur in both wild (sylvatic) and urban areas.

Signs and Symptoms

- Observation of clinically affected wild mammals is unlikely. The discovery of dead animals is more common.
- Lesions vary according to the mode of transmission and susceptibility of the host.
- Accordingly, symptoms of animals that have contracted plague will vary from:
    - swollen lymph nodes and abscess formation near site of inoculation (flea bites, oral punctures);
    - muscle soreness;
    - loss of appetite;
    - fever;
    - depression;
    - necrosis of lymphoid tissue;
    - edema in the lungs;
    - death may occur rapidly before the appearance of clinical symptoms.
- A history of rapid, large declines of colonial rodents is suggestive of plague, but confirmation requires submission of samples to an appropriate diagnostic laboratory.
- Three types of plague are possible in susceptible non-rodent mammal species:
    - Bubonic:
        - initially characterized by swelling (from the Latin *bubo* = swelling) of tissues around the flea bite;
        - replication of the bacteria occurs and, in this type of plague, is restricted to the lymph nodes that drain the site of the flea bite, often producing hemorrhage and localized necrosis of affected lymph nodes.
    - Septicemic:
        - defined by bacteria in the blood without the presence of buboes. Results from ingestion of infected prey or through the bites from infected animals;
        - lesions are typically first observed in the liver and spleen;
        - coagulation of blood within vessels, escape of blood from vessels into surrounding tissues, hemorrhage, and blood clotting may cause a dark, reddish-black discoloration of tissues visible under the skin - leading to the name *black death*;
        - bacteria in blood may spread to lungs leading to the pneumonic form of disease.
    - Pneumonic:
        - inhalation of aerosolized droplets (mist) containing bacteria;
        - often fatal.

Meat Edible?

- Human infection has been reported from contact with recently dead animals (e.g., when animals are dressed skinned).
- If you suspect an animal has been infected with plague **DO NOT CONSUME ANY MEAT** and

contact the nearest Health Authority.

Human Health Concerns and Risk Reduction

- Plague is a potentially deadly zoonotic disease and precautions should be taken when an animal suspected of having plague is encountered.
- Symptoms in humans include:
  - acute onset of fever;
  - swollen/painful lymph nodes;
  - general malaise.
- In humans, septicemia and pneumonic plague are the most serious. These are characterized by fever, prostration, coughing, respiratory distress; shock, hemorrhage and death may follow.
- Viable *Y. pestis* bacteria have also been isolated from soft tissues of carcasses after approximately 1 week and bone marrow of infected animals after longer periods.
- Transfer of bacteria to humans has also been reported from bites/scratches/abscesses of infected domestic pets.
- Wild rodents are the natural reservoir; lagomorphs and carnivores may also be a source of infection to humans.
- Since vaccination of free-ranging wildlife is not possible, large-scale attempts to control plague both in humans and endangered wildlife populations are directed mainly at eliminating flea populations; however, removal of non-target insect species with associated ramifications to ecosystems have made this control method problematic.
- Removal of food sources and rodent habitats in areas occupied by humans will help to reduce rodent infestation and, subsequently, flea populations.
- Treatment of pets for fleas should also help to reduce transmission to humans and other wildlife.
- No control measures have ever been required in British Columbia, as the level of plague appears to be low.

Samples for Diagnosis

- Appropriate personal protection should be used: eye protection, gloves, gowns, high-density surgical masks or respirators.
- Plague suspects should be dusted with carbamate or pyrethrin insecticides to kill fleas.
- Using appropriate personal protection, collect a representative sample of fleas (mature, immature, male, female) from fresh, affected mammals.
- **DO NOT ATTEMPT TO COLLECT TISSUE SAMPLES.**
- Animals surviving infection with *Y. pestis* develop serum antibodies that can be used for diagnosis of exposure.
- Detection of antibodies in the blood of carnivores has been used to monitor plague activity in areas where plague is normally found.

Similar Diseases

- Acute bacterial infections, such as tularemia, can mimic signs associated with infection with *Y. pestis.*
- Both infections cause an acute, feverish disease in certain species and can be followed by pneumonia or sudden death.
- Also found in colonial rodents, tularemia does not appear to induce the high mortality typical of plague.
- Infection with *Pasteurella* bacteria may cause individual mortality in rodents and occasional localized die-offs.
- White spots or spotty necrosis of the liver and spleen, observed in *Y. pestis* infection, can appear similar to infections by other species of *Yersinia* or may result from migration tracts of parasites.
- Poisonings from rodenticides may also cause acute population declines in colonial rodents.

Further Reading

- BC Centre for Disease Control – Plague
- USGS National Wildlife Health Centre – Plague (PDF file)
- Gasper P.W., Watson R.P. 2001. Plague and Yersiniosis. Pp. 313-329 in E.S. Williams, I.K. Barker (eds.), *Infectious Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.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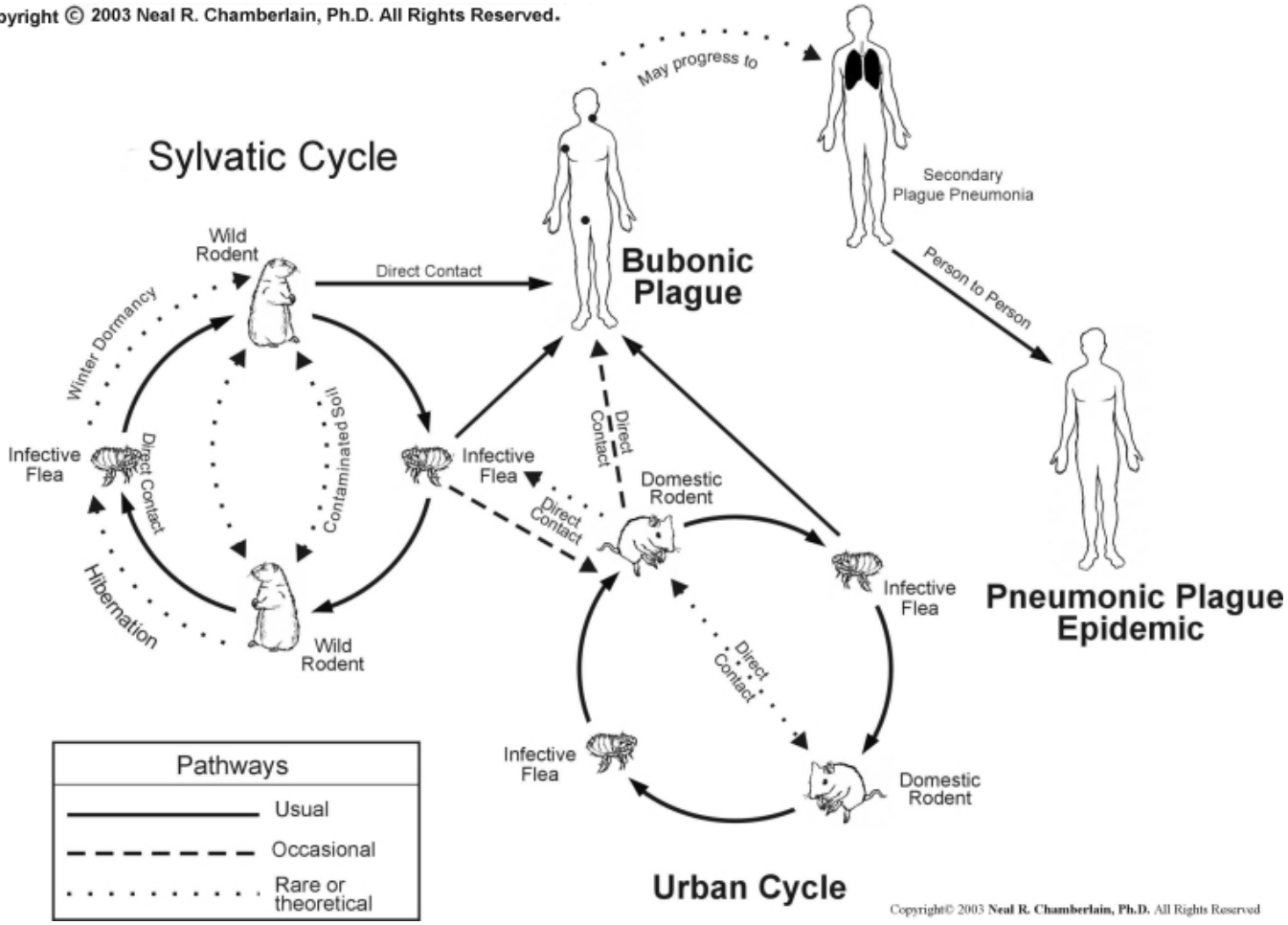

Psoroptic Mange in California Bighorn Sheep

Causative Agent

- *Psoroptes ovis* is a non-burrowing ectoparasitic mite belonging to the family Psorptidae (Order: Acarina)
- It is the cause of psoroptic mange, also referred to as “sheep scab”, psoroptic scabies or *Psoroptes* infestation, a highly contagious and devastating condition that can affect domestic and wild sheep.
- Psoroptic mange has been the cause of significant economic loss in domestic sheep farms due to reduced condition and damage to the fleece in infested animals, and, accordingly, has been listed as an annually notifiable disease by the Canadian Food Inspection Agency (CFIA) under the Health of Animals Act.

Images

Click on image to enlarge.

Ram affected with psoroptic mange from Olalla, British Columbia.

Distribution

Geographic:

- **Psoroptic mange is a newly recognized health issue of wild sheep in the Similkameen Valley of southern BC.**
- Despite occurring worldwide, *Psoroptes* mites are considered uncommon in domestic sheep and cattle as they are easily controlled with injectable pharmaceuticals.
- Because it is so easily controlled, psoroptic mange was eradicated from Canadian domestic sheep in 1924.
- While it is still present to varying degrees in some populations of bighorn sheep in the US, it has never before been reported in Canada prior to February 2011.

Seasonality:

- Mite populations are generally lower in the spring and summer, with increases in the fall/winter.

Hosts, Transmission and Life Cycle

Hosts:

- In BC, California Bighorn Sheep (*Ovis canadensis*).

Transmission:

- Transmission is typically through direct contact with infested individuals, making psoroptic mange a herd disease; it only takes a single gravid female mite to establish an infestation on an individual and, hence, the entire herd.
- Fomites, such as contaminated fence posts, feeders, or chutes, are sources of infection in domestic animals, and similar contaminated objects in nature may play a role in transmission and maintenance of the mite among and within bighorn sheep populations.

Life Cycle:

- *Psoroptes ovis* is an obligate ectoparasite - its entire life cycle occurs on a single host.
- As mites abrade the skin and incite a potent inflammatory response, the subsequent exudate and crust that forms provides a perfect environment for mites to thrive and reproduce in.
- A single female mite can deposit anywhere between 35-100 eggs in her adult lifetime, which is approximately 30-60 days.
- Once hatched, mites proceed through one larval stage and two nymphal stages before finally molting into their adult form.
- This entire lifecycle, from egg to egg, takes approximately two weeks, but may vary with environmental conditions.

Signs and Symptoms

- In some locations and in some animals, a severe disease occurs where animals develop heavy crusts in and around their ears and over their bodies, lose hair and body condition, and subsequently may die.
- The disease is considered an animal welfare issue due to the intense pain and irritation caused by the mites.
- Signs in individual sheep may include:
    - yellowish, scaly crusts are usually seen on the ears/shoulders/neck in mild cases or early stages of the disease, and may spread with time to other regions of the body;
    - the animal is very itchy and will damage its skin by scratching, rubbing and biting, often causing secondary bacterial infections;
    - decreased appetite, weight loss, anemia and emaciation can occur in animals with severe skin lesions;
    - it is unknown why some animals develop severe disease, but it may be a result of poor immune systems or the presence of other health issues;
    - adult sheep can regrow hair and recover with time, but may continue to carry mites in their ears. Such “carrier” animals may or may not show signs associated with the mites, such as ear rubbing or head shaking.

Meat Edible?

- Meat is edible, but heavy infestations can result in secondary bacterial infections that preclude consumption of the meat.

Human Health Concerns and Risk Reduction

- Captive or domestic animals are quarantined and treated with specific doses of injectable drugs; however, all animals must be treated, in some cases more than once, to eliminate the mites. If not, the untreated sheep will re-infest the herd.
- Attempts to eliminate the mites from wild sheep populations have not been successful to date.
- Psoroptes mites can spread to other herds of bighorns and potentially to other wild and domestic ungulates that are in close contact.
- Mites are not contagious to humans.

Samples for Diagnosis

- Photographs of affected animals and samples collected in alcohol from live or dead animals with confirmation by a laboratory experienced with mite identification is necessary for proof of *Psoroptes* infestation.

Similar Diseases

- Other skin diseases reported in bighorn sheep include mange caused by other mites (such as sarcoptic mange), lice or tick infestations, toxicities, viral diseases or even trauma.
- Unlike ticks, mites cannot be seen with the naked eye.

Further Reading

- BC Wildlife Health Fact Sheet – Psoroptic Mange in Bighorn Sheep (PDF file)
- Scott S., Schwantje H., Bollinger T.K. 2013. Psoroptic mange in California bighorn sheep in southern British Columbia: a preliminary review of occurrence, risk and management options. (PDF file)

					
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Rabies

Causative Agent

- Rabies is a viral disease that leads to inflammation of the brain (encephalitis). The virus is a member of the family Rhabdoviridae.
- Worldwide, several variants of the virus have been identified, each associated with a single wild animal host species that acts as a reservoir of infection for a particular geographic area.

Images

Click on image to enlarge.

Carnivores infected with rabies, such as this skunk, often show evidence of having attacked a porcupine.

Distribution

Geographic:

- Currently, rabies from insectivorous bats is the only known variant of the virus present in British Columbia.
- Bats confirmed to have rabies have been found throughout BC; therefore, all bats should be considered as potential sources of rabies. This is particularly true if bats are observed behaving abnormally, such as being found during the day or on the ground.

Seasonality:

- The potential for exposure to rabies from bats exists primarily during the spring and summer months when bats are most active.

Hosts, Transmission and Life Cycle

Hosts:

- Although all warm-blooded vertebrates are susceptible, only mammals are important in the spread of rabies.
- In BC, bats are the only reservoir of rabies. Records of bats submitted for rabies testing suggest that relatively few are infected, even among those submitted because they are behaving abnormally. Bats are a valuable component of the natural ecosystem and many species are at risk in BC. For further information on bats and how to live safely with them, see this BC Ministry of Environment web page.
- Other potential hosts in BC include domestic dogs and cats, foxes, raccoons, skunks, wolves (*Canis lupus*) and coyotes.
- **Spill over** of rabies to terrestrial mammals from bats has occurred in BC, but rabies has never been maintained in wild populations of terrestrial mammals.
- In BC, rabies acquired through bites from animals other than bats is unknown; however, strange behavior in pets and other animals can suggest that they may have rabies. Avoid contact with any wild or unfamiliar animal.

- In other parts of Canada, rabies is found in a variety of wild animals, such as bats (Vespertilionidae), raccoons (*Procyon lotor*), skunks (Mephitidae), foxes (Canidae) and coyotes (*Canis latrans*).

Transmission:

- Transmission principally occurs through bites of infected carnivores and bats.
- Rabies can also be acquired if licked by an infected animal OR if saliva from an infected animal comes into contact with the mucous membranes of the eyes, nose, lips, or through wounds in the skin.
- The rabies virus does not persist in the external environment; the virus is rapidly inactivated through exposure to most detergents, chemicals, ultraviolet radiation, strong acids and bases, and direct sunlight.

Life Cycle:

- Rabies viruses move from the site of entry, such as through a wound, and are transported along nerve fibres towards the spinal cord and, ultimately, the brain, where the virus undergoes replication.
- Abnormal behavior results from the effects of viral infection in nerve tissues.
- From the brain, rabies virus is further spread to other organs via the nervous system.
- The salivary glands, located in the tissues of the mouth and cheeks, receive high concentrations of virus, making saliva an effective medium for virus transfer when the infected animal bites another animal.

Signs and Symptoms

- Rabies should be suspected in any wild animal exhibiting any behavior considered abnormal, including:
  - loss of fear or unusual friendliness;
  - excitation or aggression;
  - depression;
  - incoordination;
  - paralysis;
  - convulsions or seizures;
  - abnormal vocalizations;
  - appearance of nocturnal creatures during the day;
  - signs of choking or inability to drink or swallow food;
  - drooling of saliva or frothing at the mouth;
  - in carnivores, evidence of having attacked porcupines.
- Bats, unlike many mammals with rabies, may get sick and die before being observed or showing symptoms typically found in other mammals.

Meat Edible?

- **DO NOT** consume meat from an animal with rabies or suspected to have rabies.
- **DO NOT** feed meat from an animal with rabies or suspected to have rabies to pets.

Human Health Concerns and Risk Reduction

- **Rabies is a potentially life-threatening disease for humans; signs of infection may not be detectable for weeks or months - left untreated, rabies is always fatal.**
- Symptoms in humans are similar to those in wildlife:
  - depression;
  - headache;

    - vertigo;
    - stiff neck;
    - inability to drink (hydrophobia);
    - spasms and paralysis;
    - left untreated, death results from swelling of the brain or pneumonia.
- **Two human deaths have been attributed to bat rabies in BC. One was a 22-year old college student bitten by a bat while visiting Alberta in 1985, while more recently, a 52-year old man died of rabies in January 2003.**
- Prevention of rabies depends on 4 basic activities:
    - vaccination of domestic animals that live in close proximity to people and which may be exposed to wildlife reservoirs of rabies;
    - avoid contact with potentially infected animals. Always consult a health authority if a bat is found in the house. Never approach any wild animal whether it appears to be acting normally or not. Never feed wild animals;
    - if there is a high risk of occupational exposure to bats, a rabies vaccination should be considered;
    - any person that is bitten, scratched, etc. by an animal and suspects they have been exposed to rabies should wash wounds immediately with soap and water, disinfect the wounds with 50-70% alcohol, and contact the nearest health authority and inform them of the potential exposure to rabies.
- DO NOT go near any animal suspected of having rabies.
- Report any animal suspected of having rabies to the local Ministry of Forests, Lands and Natural Resource Operations office or the RCMP.
- Do not attempt to collect tissues yourself; if possible, submit the entire carcass for testing. Specimens can be frozen.
- For small animals such as bats and foxes, double-bag the entire animal in strong garbage bags and place in a leak-proof container.
- For larger specimens, contact the nearest Ministry of Forests, Lands and Natural Resource Operations office or Ministry of Health office for instructions on where to submit the specimen.
- Further public health information on rabies can be found at the BC Ministry of Health.
- Rabies is a reportable disease in Canada, and under the Health of Animals Act, all cases must be reported to the Canadian Food Inspection Agency (CFIA).

Samples for Diagnosis

- Intact brain tissue is the key diagnostic tool in confirming rabies infection. If an animal suspected of having rabies must be destroyed, it is important that it NOT be killed by gunshot to the head - other forms of euthanasia must be considered.

Further Reading

- Alberta Environment and Sustainable Resource Development – Rabies (PDF file)
- Alaska Department of Fish and Game – Rabies
- BC Centre for Disease Control – Rabies
- BC Wildlife Health Fact Sheet – Rabies (PDF file)
- Canadian Centre for Occupational Health and Safety – Rabies
- US Centers for Disease Control – Bats and Rabies
- Canadian Cooperative Wildlife Heath Centre. 1995. *Health Risks to Wildlife Personnel: Hazards from Disease-Causing Agents*. Canadian Cooperative Wildlife Heath Centre, Western College of Veterinary Medicine, University of Saskatchewan. Saskatoon, SK
- Elkin B., R.L. Zamke. 2001. *Common Wildlife Diseases and Parasites in Alaska*. Alaska Department of Fish and Game. Anchorage, AK.
- Rupprecht C.E., Strohr K., Meredith C. 2001. Rabies. Pp. 3-37 in E.S. Williams, I.K. Barker (eds.), *Infectious Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.


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Ringworm

Causative Agent

- A potentially zoonotic disease of the skin, hair or nails caused by one of several species of fungi (dermatophytes). Some of these fungi are adapted to soils (e.g., *Microsporum gypseum*), others to animals and humans (e.g., *M. canis*, *Trichophyton verrucosum*). Both can potentially cause disease in animals and humans.
- Despite the name, worms have nothing to do with this disease.

Images

Click on image to enlarge.

Characteristic ringworm lesions are often round, devoid of hair and red in color, as demonstrated in this mule deer.

Distribution

Geographic:

- Worldwide.

Seasonality:

- Fungal spores can remain viable for extended periods in the environment.

Hosts, Transmission and Life Cycle

Hosts:

- Humans and wild mammals: in BC, ringworm has been reported in black-tailed and mule deer (*Odocoileus hemionus*), and small carnivores.
- Young mammals and those suffering from other diseases or with reduced immunological competence may be prone to severe ringworm infection.
- Some species of fungus are well adapted to specific species hosts and these hosts may not have symptoms. Such species can act as reservoirs of infection.

Transmission and Life Cycle:

- Transmission occurs through direct contact with fungal material on carrier animals or contact with fungal spores from objects (fomites), such as feed, bedding, etc., especially on abraded skin.
- Ringworm infection is usually self-limiting, with lesions taking a few weeks to several months to regress, depending on the fungal species, degree of host adaptation and response of the

individual host. Secondary bacterial infections of the skin can be extensive and debilitating.

Signs and Symptoms

- Ringworm skin lesions typically begin as distinct, round areas of hair loss, which may then progress to skin reddening, thickening and loss of pigmentation.
- Breakage of the hair shaft and subsequent hair loss is accomplished by fungal elements entering the shaft of the hair itself, rendering it brittle.

Meat Edible?

- Infected areas of the skin should not be consumed.

Human Health Concerns and Risk Reduction

- Ringworm infection in humans is similar to that in wildlife but infections may be more severe.
- Skin lesions are often red, expansive, and can vary from dry and scaly to moist and seeping fluid. Lesions may also have a central healed zone surrounded by expanded ring of infection, hence the name ringworm.
- Rubber gloves should be worn when handling wildlife with skin conditions. The area in which the infected animal was handled should also be disinfected with household bleach in a 1:10 dilution.
- Topical application of antifungal agents, sometimes for extended periods, is the usual mode of treatment.

Samples for Diagnosis

- Presence of fungal infection can be confirmed in the laboratory with skin samples, skin scrapings, or hair samples.

Similar Diseases

- Viral diseases such as pox, bacterial diseases causing inflammation of the hair follicle, and parasitic infections, such as sarcoptic mange, may present similar clinical signs.

Further Reading

- Alberta Environment and Sustainable Resource Development – Ringworm (PDF file)
- BC Ministry of Environment - Diseases You Can Get From Wildlife – Ringworm (PDF file)
- HealthlinkBC – Ringworm and Human Health
- Burek K. 2001. Mycotic diseases. Pp. 514-531 in E.S. Williams, I.K. Barker (eds.), *Infectious Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.
- Canadian Cooperative Wildlife Heath Centre. 1995. Ringworm. Pp. 35-37. *Health Risks to Wildlife Personnel: Hazards from Disease-causing Agents*. Canadian Cooperative Wildlife Heath Centre, Western College of Veterinary Medicine, University of Saskatchewan. Saskatoon, SK.


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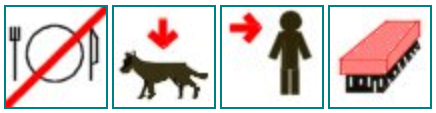
Salmonellosis



Causative Agent

- A disease caused by infection with *Salmonella* spp. bacteria.
- Relatively small numbers of bacteria are sufficient to cause disease.

Images

Click on images to enlarge.

Lesions of salmonellosis may appear in large flat areas of the esophagus, as demonstrated in this evening grosbeak.

Lesions of salmonellosis in the esophagus may also appear as large nodules resembling "cheese", as observed in this house sparrow.

Distribution

Geographic:

- Worldwide.

Seasonality:

- Generally, throughout the year.
- In passerine birds, salmonellosis outbreaks are more common at bird feeders during the late winter and early spring, and also during hot periods in the summer when birds are stressed and must congregate for food and water.
- In colonial nesting waterbirds, such as gulls, terns and cormorants, outbreaks of salmonellosis are more common early in the summer when young-of-the-year are present.

Hosts, Transmission and Life Cycle

Hosts:

- Humans, wild and domestic mammals, birds, reptiles and insects.
- Most frequently isolated from birds.
- Among birds, salmonellosis outbreaks are most frequently reported in association with passerine birds at feeders and colonial nesting waterbirds.

Transmission and Life Cycle:

- **Mammals:**
  - Infections are acquired from eating feed contaminated with feces that contain bacteria shed by carrier animals.
  - Animals can be either healthy, long-term carriers of the bacteria and show no clinical signs, or susceptible to the disease.
  - *Salmonella* bacteria primarily invade the wall of the intestines, causing inflammation

and damage.
    - Infection can spread in the body through the bloodstream to other organs, such as the liver, spleen, lung, joints, placenta or fetus, and the membranes surrounding the brain.
    - Toxic substances produced by bacteria can be released and affect the rest of the body.
    - Infected animals may shed *Salmonella* bacteria in their feces for weeks or months.
    - *Salmonella* bacteria are tolerant of a wide-range of temperatures and survive for months in soil and water.
- **Birds:**
    - Like mammals, infected birds may shed *Salmonella* bacteria in their feces for weeks or months.
    - Crowding, stress, contamination of feed with feces, prolonged stays, and the presence of carriers of *Salmonella* bacteria promote the regular occurrence of salmonellosis at bird feeders.

Signs and Symptoms

- **Mammals:**
    - The extent and severity of lesions will depend on the species, age and health status of the host, as well as the type of *Salmonella*.
    - Generally, the intestines appear bloody and inflamed.
    - Other signs caused by *Salmonella* infection include: enlargement of the spleen and lymph nodes, accumulation of fluid and blood in organs such as the lungs, and damage to the liver.
- **Birds:**
    - As with mammals, the extent and severity of lesions will depend on the species, age and health status of the host as well as the type of *Salmonella*.
    - Young birds are more severely affected than older birds.
    - Infected birds may suddenly die or gradually show signs of disease.
    - Sick birds are depressed and may huddle together with ruffled feathers and show unsteadiness, shivering, loss of appetite, increased or decreased thirst, rapid loss of weight, accelerated breathing, watery yellow, green or blood-tinged feces, and closing of the eyes with swollen and pasted eyelids shortly before death.
    - Infected birds may show signs of an affected nervous system: blindness, incoordination, staggering, tremors, and convulsions.
    - Feathers around the vent (cloaca) may become matted with feces.
    - The liver and spleen are often enlarged, and the intestinal tract may show inflammation and hemorrhage.
    - The inner surface of the crop may thicken into a yellow, cheese-like membrane.

Meat Edible?

- The meat of wildlife believed to be suffering from salmonellosis **should NOT be consumed NOR fed to domestic dogs or cats**. Many domestic cats are reported to become ill after consuming infected birds during salmonellosis outbreaks in songbirds.

Human Health Concerns and Risk Reduction

- The probability of humans contracting *Salmonella* bacteria directly from wildlife is low; however, if pet cats are affected, the risk to their owners increases.
- Contamination of the environment from sewage, manure or effluent from abattoirs contributes to the occurrence of salmonellosis in wildlife.
- Efforts to disinfect bird feeders regularly (e.g., weekly) in all parts of a neighborhood with 1 part bleach to 10 parts water and change wet feed, plus the removal of spilled feed, should reduce the recurrence of salmonellosis outbreaks at feeders.

If a *Salmonella* die-off has occurred at a feeder, feed should be removed for 1 month to prevent further concentration of birds at the site.

- *Salmonella* bacteria are well-documented disease-causing agents in humans, causing food poisoning, which is characterized by acute intestinal pain and diarrhea.
- Extra care with personal hygiene is warranted by those who maintain bird feeders, and by bird banders, wildlife rehabilitators and biologists who handle birds or materials soiled by bird feces, even when the disease is not apparent.

Samples for Diagnosis

- Bacteria may be cultured and identified from fecal samples from live animals, or after death tissues from the spleen, liver, small intestine, large intestine, and lymph nodes of the body cavity may be taken.
- In birds, the entire gastrointestinal system, at the minimum, should be submitted for testing.
- In birds, the presence of yellow, cheese-like material in the crop is suggestive of *Salmonella* infection and should be submitted to an appropriate diagnostic lab.

Similar Diseases

- Localized die-offs in birds due to *Salmonella* poisoning may mimic the effects of certain pesticides; apart from laboratory testing, an accurate history of the die-off may help to discern if pesticides had played a role in the die-offs.

Further Reading

- Michigan Department of Natural Resources – Salmonellosis
- NY State Department of Environmental Conservation – Salmonellosis
- Mörner T. 2001. Salmonellosis. Pp. 505-507 in E.S. Williams, I.K. Barker (eds.), *Infectious Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.
- Friend, M. 1999. Salmonellosis. Pp. 99-109 in *Field Manual of Wildlife Diseases: General Field Procedures and Diseases of Birds*. M. Friend, J.C. Franson (Tech. eds.), E. A. Ciganovich (ed.). Biological Resources Division Information and Technology Report 1999-001. U.S. Department of the Interior and U.S. Geological Survey. Washington, DC. (Chapter in PDF Format)



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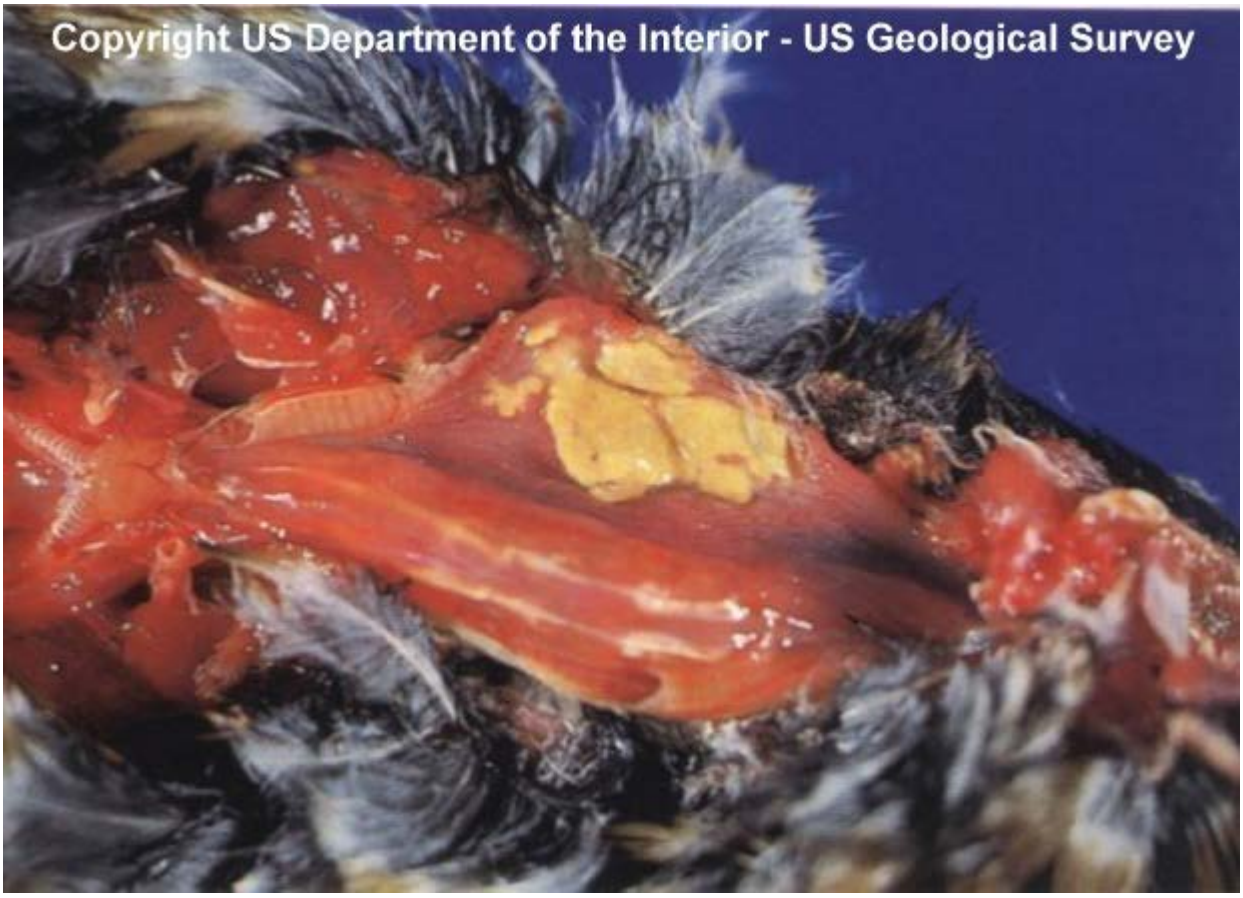
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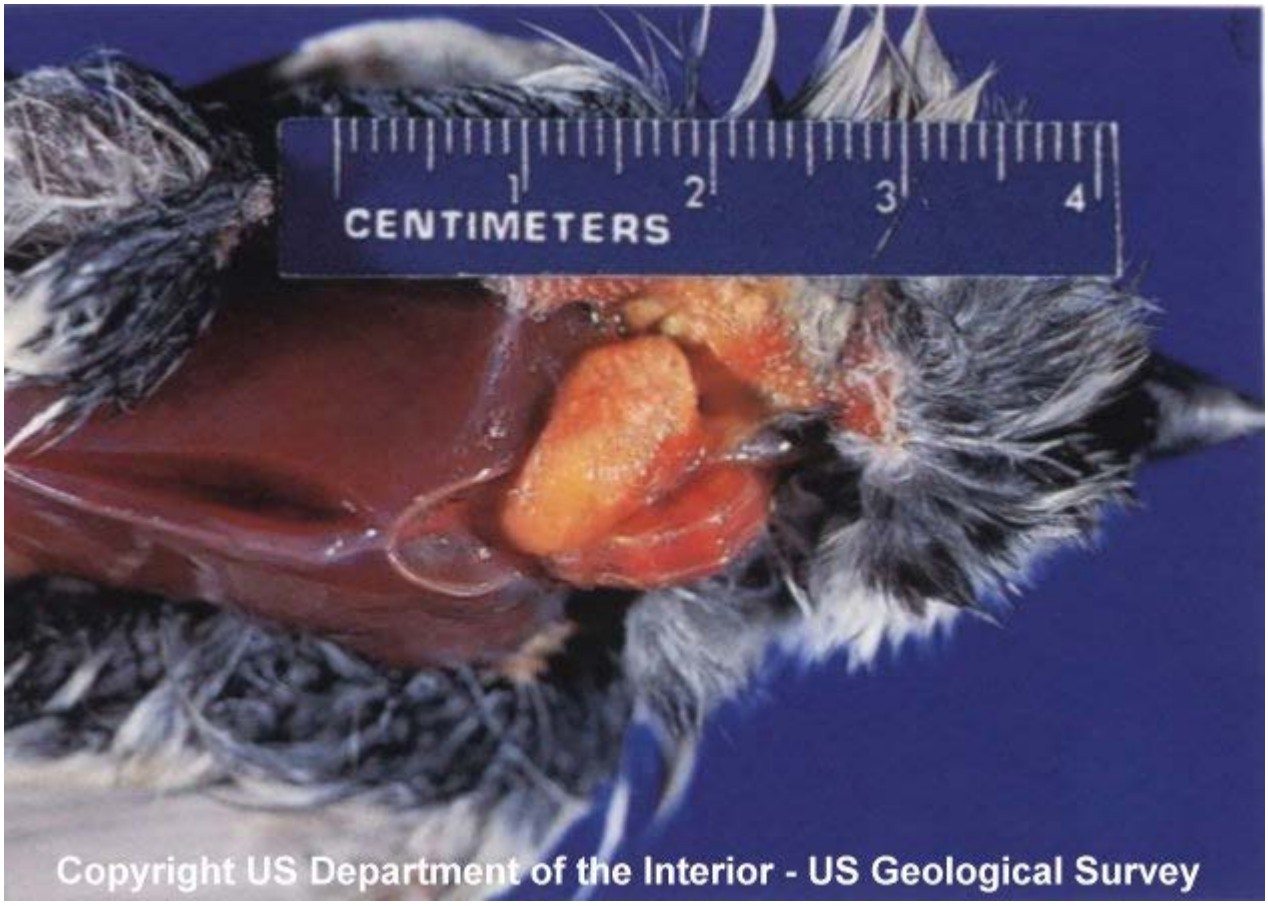
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Sarcocystosis (Rice Breast Disease)

Causative Agent

- Sarcocystosis is a nonfatal infection, primarily of birds, caused by a protozoan parasite, *Sarcocystis rileyi*.
- This parasite is most commonly reported in waterfowl, where it is also known as “rice breast disease”.

Images

Click on image to enlarge.

Cysts of* Sarcocystis *resemble rice grains running parallel to muscle fibres, as demonstrated in the breast muscle of a mallard duck.

Distribution

Geographic:

- The geographic range of this disease mirrors the range of the species of waterfowl in which it has been reported.

Seasonality:

- Infected birds can be found year-round, but the disease is most commonly reported during the waterfowl hunting season.

Hosts, Transmission and Life Cycle

Hosts:

- Most commonly observed in dabbling ducks: mallard (*Anas platyrhynchos*), northern pintail (*A. acuta*), northern shoveler (*A. clypeata*), teal (*A. crecca*, *A. discors*), gadwall (*A. strepera*), and American black duck (*A. rubripes*).
- Most often observed in adult birds.
- A large number of species of *Sarcocystis* also occur in domestic and wild mammals. In most mammals the disease is only found microscopically; however, livestock and even humans have been affected with severe infections.

Transmission and Life Cycle:

- The life cycle of *Sarcocystis* requires two hosts: an intermediate host (waterfowl) for the asexual component and a definitive host (mammalian carnivore) for the sexual stage.
- Birds ingest water contaminated with the feces of carnivores that contain the eggs of *Sarcocystis*. Eggs may persist in the environment for extended periods of time.
- The parasite develops in the intestines of the bird, and then enters the bloodstream, where it further infects cells of the blood vessels.
- The parasite is then carried by the blood to voluntary muscles where the characteristic,

elongated cysts are produced. The time it takes from ingestion of eggs to the formation of cysts is several months.
- When a carnivore ingests infected muscle tissue from a bird, the life-cycle is completed. The parasite reaches maturity in the intestines of the carnivore and repeats the cycle by producing eggs.

Signs and Symptoms

- Cream-colored cylindrical cysts (several mm long), resembling rice grains, that run in parallel streaks within muscles characterize this disease when the infection is visible to the naked eye.
- Cysts are mostly commonly found within breast muscle of birds, but can also be seen in heart muscle and muscles of the limbs.
- Calcium may be deposited around cysts which, when cut with a knife, may feel gritty.
- Severe infections can result in loss of muscle tissue and result in lameness, weakness and even paralysis; debilitation could increase susceptibility to predation and other causes of mortality.

Meat Edible?

- Sarcocystosis presents little health hazard to humans as the parasite is destroyed by cooking.

Human Health Concerns and Risk Reduction

- The primary importance to humans of *Sarcocystis* in waterfowl is the loss of infected birds for food as the unaesthetic appearance of parasitized muscle may prompt hunters to discard the carcass.
- However, at this time, some scientists feel that so much is unknown about infections of *Sarcocystis* that it is recommended that infected meat from ducks and rabbits not be used for human consumption or fed to cats and dogs.

Samples for Diagnosis

- The visible presence of cysts within muscle tissue is often sufficient to diagnose this disease.
- Whole birds should be submitted; however, frozen samples of muscle tissue or muscle tissue preserved in a 10% formalin solution may be submitted for diagnosis.

Further Reading

- Alberta Environment and Sustainable Resource Development – *Sarcocystis*(PDF file)
- Alaska Department of Fish and Game – *Sarcocystis*
- Michigan Department of Natural Resources – *Sarcocystis*
- Tuggle, B. J. and M. Friend. 1999. Sarcocystis. Pp. 219-222 in *Field Manual of Wildlife Diseases: General Field Procedures and Diseases of Birds*. M. Friend, J.C. Franson (Tech. ds.), E.A. Ciganovich (ed.). Biological Resources Division Information and Technology Report 1999-001. U.S. Department of the Interior and U.S. Geological Survey. Washington, DC. (Chapter in PDF format)


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A

Sarcoptic Mange

Causative Agent

- Caused by the mite, *Sarcoptes scabiei*, a skin parasite of mammals.

Images

Click on images to enlarge.

The mage mite,* Sarcoptes scabiei*.

Extensive loss of hair may occur in severe cases of sarcoptic mange. Mange is commonly found on wild canids such as this grey wolf.

Red fox with severe sarcoptic mange.

Distribution

Geographic:

- Found throughout the world.

Seasonality:

- Observed throughout the year, but most commonly observed during winter months when hair loss can be life-threatening.

Hosts, Transmission and Life Cycle

Hosts:

- Infections occur in humans (called "scabies"), wild and domestic dogs and cats, bears and mustelids.
- Sarcoptic mange is commonly found on red fox (*Vulpes vulpes*), wolves (*Canis lupus*), and coyotes (*C. latrans*) in North America. It has been reported to occur in all three of these species in British Columbia.
- Mange in wild species predominantly affects younger animals.

Transmission and Life Cycle:

- Mange is highly contagious, usually resulting from direct transfer of mites at any stage of their development.
- Indirect transfer of mites may also occur from infected inanimate objects (mechanical transmission).
- Populations of *S. scabiei* are usually highly specific as to their host species; human-adapted

populations spread more rapidly among humans, dog-adapted types spread more rapidly among dogs, etc.

- The life cycle of *S. scabiei* is completed within burrows in the epidermis of the host.
- Adult mites mate in small pockets near the surface of the skin.
- After mating, female mites burrow through the skin by chewing and feeding on live cells or fluid from damaged tissue. Eggs are laid throughout the tunnel.
- Hatched larvae pass through a nymphal stage and continue migration through the epidermis, becoming adults within 2 weeks of hatching.
- Mites can remain infective without a host for extended periods; an important factor in the maintenance of the disease.

Signs and Symptoms

Animals:

- Mange infestations are characterized by oily skin, crusting, hair loss, and scab formation.
- Infections typically begin on elbows and towards the tips of the ears, and can eventually involve large areas of the body.
- Lesions result from physical damage to the skin, irritation caused by parasite excretions, and the immune response of the host.
- Lesions may be covered by thick fur, but hair is often lost in characteristic patterns.
- Affected skin is itchy and self-trauma may often be evident.
- Poor body condition and listlessness may be observed in severely infected animals; for example, mangy wild canids (e.g., coyotes) may be easily approached.
- Severely affected carnivores may scavenge with increased frequency.
- Severely affected carnivores may ultimately die from complications with mange infection or exposure to the elements that results from hair loss in winter.

Humans:

- Lesions usually occur at sites where contact was made with infected animals (e.g., hands and arms) and are usually short in duration. As in animals, skin becomes red, inflamed and intensely itchy.
- Human infections from animal sources are short-lived and self-limiting.

Meat Edible?

- There is no risk to humans since the meat from canids or other potential carnivore hosts is not normally consumed.

Human Health Concerns and Risk Reduction

- Rubber gloves and protective clothing should be worn when handling wildlife with skin conditions.
- Applications of pesticides (acaricides) can be used to treat infected animals and people; however, repeated applications are necessary.

Samples for Diagnosis

- Identification of the mite from deep skin scrapings or skin biopsy of the affected area.

Similar Diseases

- Unlike ticks, mites causing sarcoptic mange cannot be seen with the naked eye.

Further Reading

- Alberta Environment and Sustainable Resource Development - Sarcoptic Mange (PDF file)
- BC Ministry of Environment - Wildlife Health Fact Sheet: Mange in British Columbia (PDF file)
- OIE - Sarcoptic Mange in Wildlife (PDF file)
- US Centers for Disease Control and Prevention - Scabies
- Canadian Cooperative Wildlife Heath Centre. 1995. Sarcoptic mange. Pp. 39-40. *Health Risks to Wildlife Personnel: Hazards from Disease-causing Agents*. Canadian Cooperative Wildlife Heath Centre, Western College of Veterinary Medicine, University of Saskatchewan. Saskatoon, SK
- Bornstein S., Mörner T., Samuel W.M. 2001. *Sarcoptes scabiei* and sarcoptic mange. Pp. 107-119 in W.M. Samuel, M.J. Pybus, A.A. Kocan (eds.), *Parasitic Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.


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Glossary


Contact Information


M. Dryden, Kansas State University


Karen Donahue. Tufts Universitv

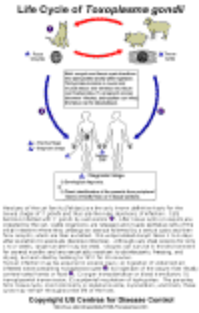
Toxoplasmosis

Causative Agent

- Toxoplasmosis is a disease caused by the protozoan parasite, *Toxoplasma gondii*.

Images

Click on image to enlarge.



***Life cycle of* Toxoplasma gondii.**

Distribution

Geographic:

- Common throughout the world.

Seasonality:

- Unknown.

Hosts, Transmission and Life Cycle

Hosts:

- Domestic or wild cats are the definitive host, with feral cats being the main reservoir for this parasite. Cougars (*Felis concolor*) in British Columbia have been reported to harbor this parasite.
- Other wildlife in BC and North America known to act as intermediate hosts and to have suffered clinical effects of toxoplasmosis include:
    - moose (*Alces alces*), pronghorn antelope (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), and white-tailed deer (*O. virginianus*);
    - black bear (*Ursus americanus*), red fox (*Vulpes vulpes*), skunk (*Mephitidae*), opossum (*Didelphis virginiana*), mink (*Mustela vison*), and other small mammals.
- Toxoplasmosis is also a potentially serious zoonotic disease. A waterborne epidemic occurred in 1995 in Victoria, BC and affected a number of humans.

Transmission and Life Cycle:

- **Refer to above life cycle diagram**
- Cats ingest cysts of *T. gondii* that are contained in the tissues of intermediate hosts. Cysts then disintegrate within the stomach and small intestine.
- After multiplication and reproduction within the walls of the intestines, egg-like oocysts are passed in the feces. Oocysts can survive in the environment for several months and are

extremely resistant to disinfectants, freezing, and drying.

- Within a few days in the external environment oocysts become infective and are ingested incidental to feeding or drinking in areas contaminated with cat feces.
- Cysts form in the tissues of intermediate hosts, primarily in muscle and nervous tissue and, to a lesser extent, in lungs, liver and kidney. Cysts may persist for years.
- The cycle continues when a cat consumes meat contaminated with cysts.
- Humans may enter this cycle either by consuming meat contaminated with cysts or through ingestion of food or water contaminated by cat feces.

Signs and Symptoms

- Outward signs are rarely observed in cats or intermediate hosts.
- In humans symptoms may include:
  - fever;
  - fatigue;
  - muscle pains and sore throat;
  - in more severe cases, inflammation of the brain and eyes, birth defects and even death can occur in patients with suppressed immune systems.

Meat Edible?

- Meat is edible if cooked thoroughly to at least 67ºC.
- When skinning infected animals, care should be taken, as viable parasites may be present even if the infected animals show no outward signs of disease.

Human Health Concerns and Risk Reduction

Health Concerns:

- **Toxoplasmosis is of considerable risk to pregnant women, as *T. gondii* can be readily transmitted from the mother through the placenta to the developing fetus.**
- Complications in the developing fetus may lead to diminished vision, mental deficiencies, convulsions and hydrocephalus (enlargement of the skull caused by fluid accumulation).
- Some of these complications may not appear until later in life.

Risk Reduction:

- Hands, utensils and cutting surfaces should be washed with soap and water after handling meat.
- Thoroughly cook meat (see above).
- Pregnant women should avoid contact with cat litter boxes, soil, raw meat and aborted animals.
- Cats should be fed dry, canned or cooked food, not allowed to hunt out of doors, and not allowed to scavenge from household garbage.
- When gardening, gloves should be worn and vegetables thoroughly washed prior to consumption.

Samples for Diagnosis

- Microscopic and immunologic examination of secretions, excretions, body fluids and other tissues collected either at necropsy or through biopsy of live tissue will help to determine the presence of *T. gondii*.
- Whole carcasses should be submitted for necropsy.

Further Reading

- BC Centre for Disease Control – Toxoplasmosis
- Public Health Agency of Canada – Toxoplasmosis
- US Centers for Disease Control and Prevention – Toxoplasmosis (human implications)
- Dubey J.P., Odening K. 2001. Toxoplasmosis and related infections. Pp. 479-519 in W.M. Samuel, M.J. Pybus, A.A. Kocan (eds.), *Parasitic Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.



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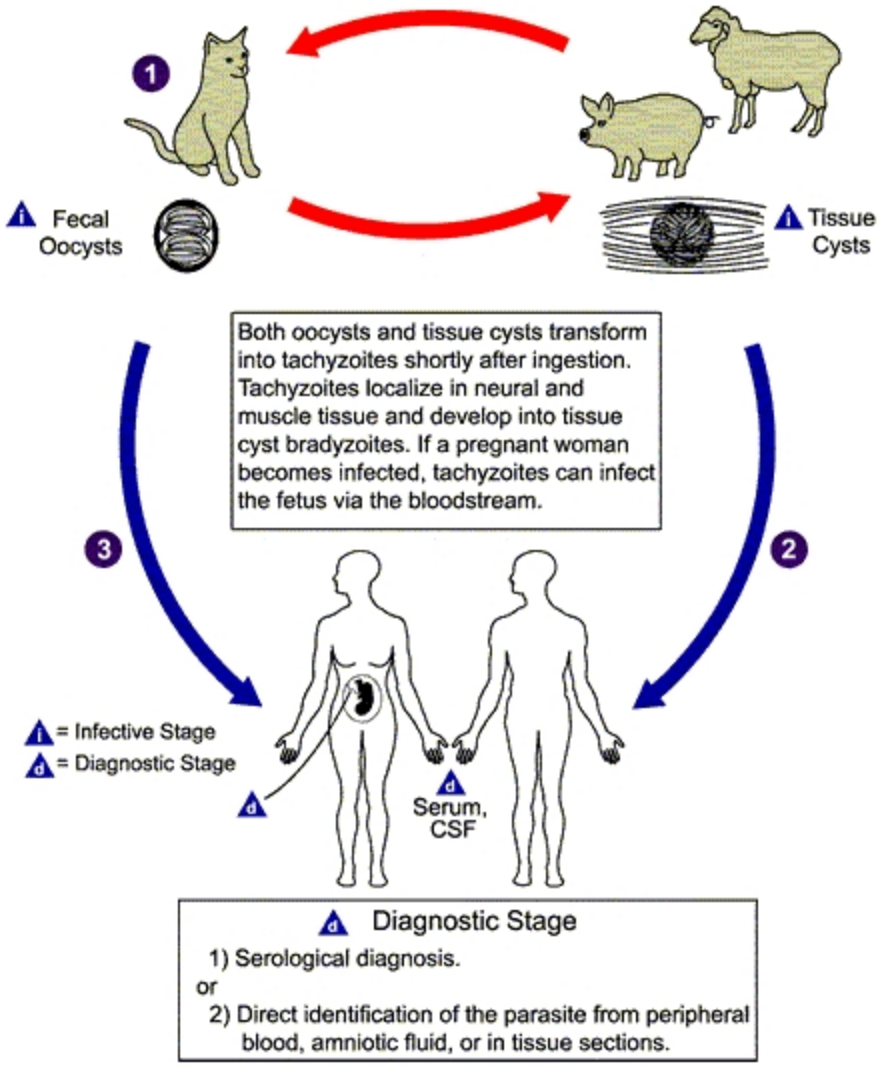

Members of the cat family (Felidae) are the only known definitive hosts for the sexual stages of *T. gondii* and thus are the main reservoirs of infection. Cats become infected with *T. gondii* by carnivorism 1. After tissue cysts or oocysts are ingested by the cat, viable organisms are released and invade epithelial cells of the small intestine where they undergo an asexual followed by a sexual cycle and then form oocysts, which are then excreted. The unsporulated oocyst takes 1 to 5 days after excretion to sporulate (become infective). Although cats shed oocysts for only 1 to 2 weeks, large numbers may be shed. Oocysts can survive in the environment for several months and are remarkably resistant to disinfectants, freezing, and drying, but are killed by heating to 70°C for 10 minutes. Human infection may be acquired in several ways: A) ingestion of undercooked infected meat containing *Toxoplasma* cysts 2; B) ingestion of the oocyst from fecally contaminated hands or food 3; C) organ transplantation or blood transfusion; D) transplacental transmission; E) accidental inoculation of tachyzoites. The parasites form tissue cysts, most commonly in skeletal muscle, myocardium, and brain; these cysts may remain throughout the life of the host.

http://www.dpd.cdc.gov/dpdx/HTML/Toxoplasmosis.htm

Trauma

Risk Factor

- Injuries or death resulting from a violent force that results in compression, stretching, twisting or penetration of tissues.
- Most common injuries or mortalities are from collisions with vehicles, trains, aircraft, power lines or transmission towers.
- Other traumatic injuries and deaths also include wounds received through trapping or shooting, fighting with members of the same species, or wounds resulting from predators.

Images

Click on images to enlarge.

Deer and other mammals are often struck by vehicles and may succumb to their injuries.

Breast musculature is often completely removed on depredated birds.

Distribution

Geographic:

- The potential for traumatic injuries and traumatic deaths can occur anywhere.

Seasonality:

- Throughout the year

Mechanism of Action

- The extent and severity of traumatic wounds will depend on the area of the body involved, the tissues damaged, as well as the strength of the physical blow.
- Secondary bacterial infections may occur at wound sites.
- Internal injuries may be severe or fatal, particularly if they result in organ rupture.

Signs and Symptoms

- Collisions with vehicles are often fatal, although some animals can survive.
- Victims of vehicle collisions are often found on or near roadways. Injuries may not be apparent as wounds may not be visible.
- Shooting wounds may be fatal, although fragments of ammunition may become lodged in bone or, rarely, in tissue and become essentially inert.
- Within-species fighting injuries are rarely fatal or serious. Gore wounds may occur in species

with horns or antlers, while bite wounds on the neck and throat may be observed in wild dogs. Secondary infections or organ or body cavity penetrations/ruptures may cause illness or death days or weeks after the original injury.

- Injuries resulting from predator attacks may be found on the hind legs, neck, head and flanks. Hemorrhage underneath the skin at the site of the wound is common and may extend beyond the range of the wound itself.
- Any animal with a pre-existing injury may be more susceptible to a predator.
- Predators may receive wounds from large game defending themselves, e.g., head wounds or broken bones resulting from antler or kicking blows.
- Birds that have collided with power lines are often found beneath either power lines or transmission towers. See also electrocution.

Meat Edible?

- Unless another condition is present, meat from animals succumbing to traumatic injury is safe for human consumption.
- Any traumatic injury will, however, likely reduce the quality of meat.

Samples for Diagnosis

- A full post-mortem will identify the cause of death of most traumatic mortalities. Portions of affected tissue can also be submitted.

Similar Diseases

- A bird that is found dead beside or near power poles or power lines cannot immediately be assumed to have succumbed to traumatic collisions with power lines, as electrocution may also have occurred.

Further Reading

- Alaska Department of Fish and Game – Trauma
- Cooper J.E. 1996. Physical injury. Pp. 157-172 in A. Fairbrother, L.N. Locke, G.L. Hoff (eds.), *Non-infectious Diseases of Wildlife*. Iowa State University Press. Ames, Iowa. 219 pp.
- Elkin B., Zamke R.L. 2001. *Common Wildlife Diseases and Parasites in Alaska*. Alaska Department of Fish and Game. Anchorage, AK.






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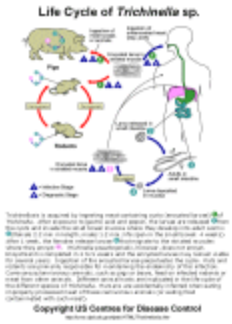
Trichinellosis

Causative Agent

- Parasitic and zoonotic disease of carnivorous mammals and birds caused by infection with the roundworm, *Trichinella spiralis*.

Images

Click on images to enlarge.



***Life cycle of* Trichinella.**

Bear muscle showing the encysted larvae at 200x magnification.

Distribution

Geographic:

- Worldwide, except for Australia and Antarctica.

Seasonality:

- Throughout the year.

Hosts, Transmission and Life Cycle

Hosts:

- Primarily a disease of carnivores with scavenging or cannibalistic tendencies.
- Several wildlife species in North America are known to be affected, including bears (Ursidae), wild dogs and cats, pigs (Suidae), seals (Phocidae, Otariidae), walruses (*Odobenus rosmarus*), rodents and mustelids.
- Humans can become infected by *T. spiralis* by consuming undercooked, infected meat.

Generalized Life Cycle:

- **Refer to the above generalized life cycle diagram of *Trichinella* sp.**
- Transmission between hosts occurs when infected meat is consumed.
- Cysts containing larvae are digested; larvae form cysts in the inner surface of the small intestine where they mature into adults and mate.
- New larvae move via the bloodstream to muscle where they remain as the infective stage until eaten by a susceptible carnivore or scavenger.
- Cysts may remain in muscle for 6-12 months and can survive after the death of the host, and so infect scavengers.

Signs and Symptoms

- Like other adult roundworms, *T. spiralis* are unsegmented, cylindrical and tapered at both ends, and can measure between 1.2 - 2.2 cm in length.
- In wildlife, disease can occur at two stages of infection: in the muscle and in the intestines
    - muscle: muscle pain, edema, fever; large burdens of cysts may lead to death;
    - intestines: adult worms may cause hemorrhage.
- In humans, symptoms such as edema around the eyes, muscle pain, fever, diarrhea, itchiness in the skin, and lesions of the skin have been described.
- More serious cases in humans have caused inflammation of the brain, heart failure, and breathing difficulties as a result of an infected diaphragm.

Meat Edible?

- **Humans may contract *T. spiralis* from eating improperly cooked meat of an infected animal.**
- **Meat from an infected animal should not be fed to dogs or cats.**

Human Health Concerns and Risk Reduction

- *Trichinella* is a potential zoonotic parasite.
- Infection can be spread to humans through consumption of improperly cooked meat, especially from bears and seals.
- To minimize the chances of infection, meat must be cooked to 77ºC throughout to kill all larvae that may be present. Microwave ovens do not uniformly cook meat and, as a result, may not kill the parasite.
- Freezing meat is NOT a reliable way of killing *Trichinella* roundworms.
- Several safe and effective prescription drugs are available to treat trichinellosis. Treatment should begin as soon as possible and the decision to treat is based upon symptoms, exposure to raw or undercooked meat, and laboratory test results.
- Trichinellosis is a reportable disease in Canada, and under the Health of Animals Act, all cases must be reported to the Canadian Food Inspection Agency (CFIA).

Samples for Diagnosis

- Muscle tissue containing larval cysts should be submitted for diagnosis.
- Cysts may be difficult to see with the naked eye; however, active muscles such as the tongue, diaphragm and muscles of the jaw usually contain the highest concentrations of infective larvae.

Further Reading

- Alberta Environment and Sustainable Resource Development – Trichinellosis (PDF file)
- Alaska Department of Fish and Game – Trichinellosis
- Appleyard G.D., Gajadhar A.A. 2000. A review of Trichinellosis in people and wildlife in Canada. *Canadian Journal of Public Health* 91: 293-297. (PDF file)
- Canadian Food Inspection Agency – Trichinellosis (human health)
- US Centers for Disease Control and Prevention – Trichinellosis (human health)
- Canadian Cooperative Wildlife Heath Centre. 1995. Trichinosis. Pp. 41-42. *Health Risks to Wildlife Personnel: Hazards from Disease-causing Agents*. Canadian Cooperative Wildlife Heath Centre, Western College of Veterinary Medicine, University of Saskatchewan. Saskatoon, SK.
- Dick T.A., Pozio E. 2001. *Trichinella* spp. and Trichinellosis. Pp. 380-396 in W.M. Samuel, M.J. Pybus, A.A. Kocan (eds.), *Parasitic Diseases of Wild Mammals*. 3rd Ed. Iowa State

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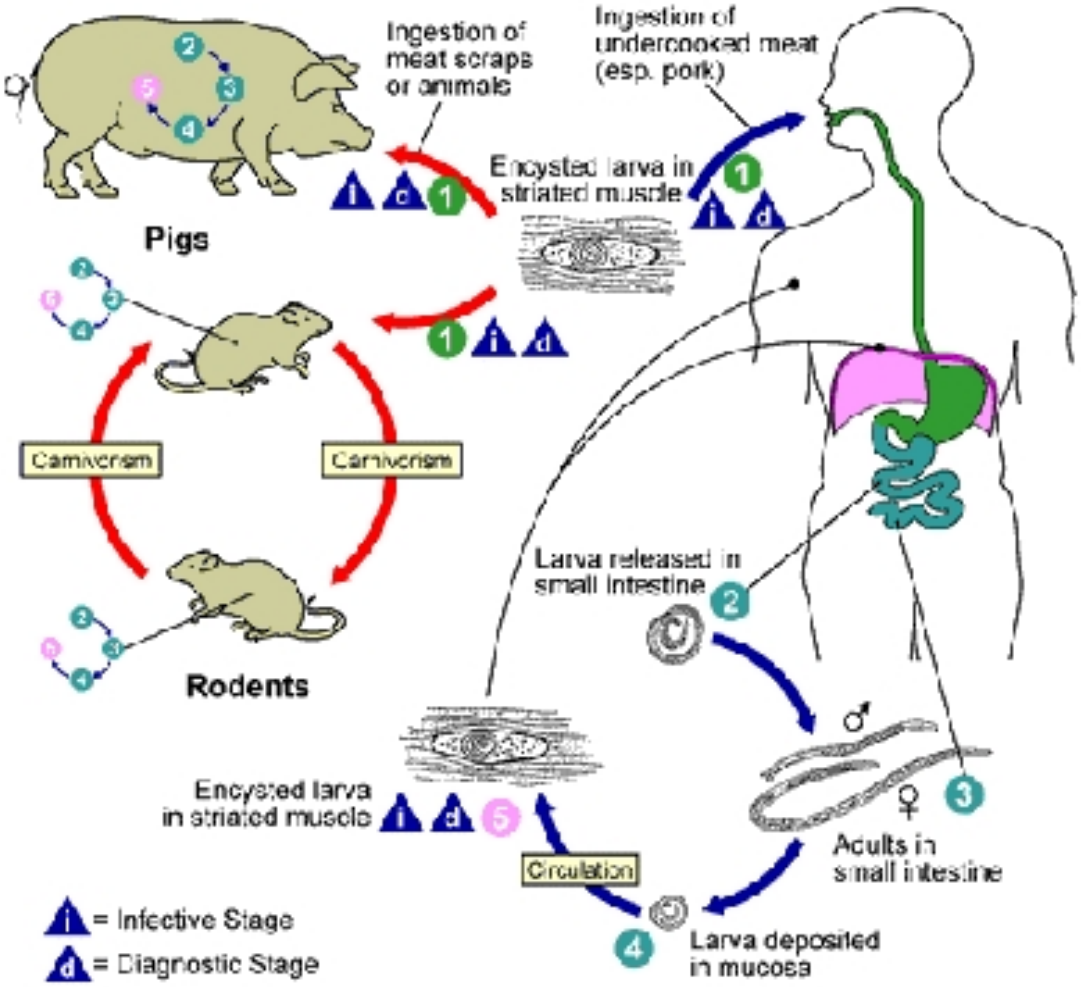


Trichinellosis is acquired by ingesting meat containing cysts (encysted larvae) 1 of *Trichinella*. After exposure to gastric acid and pepsin, the larvae are released 2 from the cysts and invade the small bowel mucosa where they develop into adult worms 3 (female 2.2 mm in length, males 1.2 mm; life span in the small bowel: 4 weeks). After 1 week, the females release larvae 4 that migrate to the striated muscles where they encyst 5. *Trichinella pseudospiralis*, however, does not encyst. Encystment is completed in 4 to 5 weeks and the encysted larvae may remain viable for several years. Ingestion of the encysted larvae perpetuates the cycle. Rats and rodents are primarily responsible for maintaining the endemicity of this infection. Carnivorous/omnivorous animals, such as pigs or bears, feed on infected rodents or meat from other animals. Different animal hosts are implicated in the life cycle of the different species of *Trichinella*. Humans are accidentally infected when eating improperly processed meat of these carnivorous animals (or eating food contaminated with such meat).

http://www.dpd.cdc.gov/dpdx/HTML/Trichinellosis.htm


US Centres for Disease Control

Tuberculosis (Tb)

Causative Agent

Mammals:

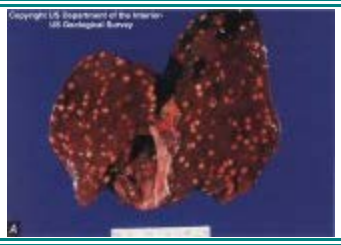
- Bacterial disease caused by infection with *Mycobacterium bovis*, previously found in domestic cattle, but also known to occur in specific wildlife populations. In BC, the species of most concern is wood bison.

Birds:

- Bacterial disease caused by infection with *Mycobacterium avium*.

Images

Click on images to enlarge.



Firm nodules within the liver associated with avian tuberculosis.

Tuberculosis nodules lying against ribs within the chest cavity of a wood bison

Distribution

Mammals:

- **Geographic**
  - At present, BC is free of *Mycobacterium bovis*.
  - There is a potential for Tb infection in wild wood bison (*Bison bison athabascae*) populations in northeastern BC if infected bison disperse from Wood Buffalo National Park.
- **Seasonality**
  - Infections with *M. bovis* are chronic.

Birds:

- **Geographic**
  - Seasonal trends of tuberculosis in wild birds have not been documented; infections may occur throughout the year owing to the chronic nature of this disease.
- **Seasonality**
  - In free-ranging wild birds, avian tuberculosis is found most often in species that live in close association with domestic stock (house sparrows [*Passer domesticus*] and Eurasian starlings [*Sturnus vulgaris*]) and in scavengers (crows and gulls), and likely exists in small numbers of free-ranging wild birds wherever there are major bird concentrations.
  - A study in BC found tuberculosis in 0.6 percent of more than 600 wild birds.

Hosts, Transmission and Life Cycle

Mammals:

- **Hosts**
  - Bovine Tb is not a naturally occurring disease in wild animals and is believed to have been introduced into wildlife populations through contact with domestic animals.
  - In Canada, Tb has been confirmed both in farmed and free-ranging cervids in some areas, in free ranging wood bison in Wood Buffalo National Park and in some of the surrounding bison populations. For more information on Tb in wild mammals from the Canadian Food Inspection Agency, click here.
  - Carnivores may become infected with bovine Tb by eating infected carcasses.
- **Life Cycle**
  - Survival of *Mycobacterium bovis* outside mammalian hosts is variable depending on ambient environmental conditions (cold, damp condition increases survival; bright, dry conditions decreases survival of the bacteria).
  - Grazing patterns of different species of wildlife may influence prevalence of Tb with wild populations. Communally feeding animals (e.g., elk [*Cervus canadensis*]) tend to have higher rates of infection than those who tend to feed alone or in smaller groups (e.g., mule deer [*Odocoileus hemionus*]). This pattern could affect wildlife populations should Tb ever become established in wood bison or other wild ungulate populations in BC.
- **Transmission**
  - Sick animals shed bacteria through breathing, coughing, or sneezing, and new hosts are infected when they inhale or ingest bacteria.
    - Inhalation: infection establishes itself in the lungs and spreads to the nearest lymph nodes.
    - Ingestion: infection establishes itself in pharynx or small intestine and spreads to the nearest lymph nodes.
  - Bacteria are generally destroyed by white blood cells that the body uses to fight infection; however, some evade destruction and increase in number. These large clusters are often visible to the naked eye. They resemble abscesses and are called “tubercles”.
  - Following infection, an immune response is mounted by the host; a weak response allows bacteria to increase in number producing further tubercles and lead to localized necrosis.
  - Clinical signs depend on which organs are affected.
  - With progression, generalized Tb ensues, leading to weakness, debilitation and ultimately death or predisposition to predation.

Birds:

- **Hosts**
  - All bird species are susceptible to avian Tb.
  - Common in captive birds (poultry, quail, pigeons, raptors, waterfowl).
  - Humans, livestock, and other mammals can become infected with *M. avium*.
- **Life Cycle**
  - In free-ranging wild birds, avian tuberculosis is found most often in species that live in close association with domestic livestock (house sparrows [*Passer domesticus*] and Eurasian starlings [*Sturnus vulgaris*]) and in scavengers (crows and gulls).
- **Transmission**
  - Avian Tb generally is transmitted by direct contact with infected birds, ingestion of contaminated feed and water, or contact with a contaminated environment. Inhalation of the bacteria can cause respiratory tract infections.

Signs and Symptoms

Mammals:

- Some animals may show signs of disease within 6 months of infection while others may

survive for several years without showing signs.

- Severely infected animals may appear normal if lesions are confined to internal lymph nodes or restricted areas of the lung.
- Abscesses often develop and may discharge pus through skin or mucosal surfaces.
- Lesions may mineralize with age and become visible on x-rays.
- General symptoms include weakness, loss of appetite, weight loss, and fluctuating fever.
- Lesions in wood bison have been found in the respiratory tract and associated lymph nodes.
- Tb lesions may be found in any organ or body cavity; early in disease onset, lesions may be difficult to find while in the latter stages, nodules or lumps may be found in lungs and in lymph nodes associated with lungs, head or intestinal tract.
- A Tb-infected animal may have multiple tan or yellow lumps on the inside of the ribcage. Lungs may contain pea-sized tan or yellow lumps or lesions typical of the disease.

Birds:

- Infected birds are often emaciated, weak, and lethargic, and they exhibit wasting of the muscles. Other symptoms depend on which body system is affected and may include diarrhea, lameness, and unthrifty appearance.
- The location of lesions indicates the route of infection: intestinal lesions suggest contaminated feed or water; lesions in the lung suggest inhalation.
- Infected birds often have solid-to-soft or crumbly, yellow to-white or grey nodules that are deeply embedded in infected organs and tissues, < 1 mm to several cm in size. The liver most often contains such nodules, but the spleen, lung, and intestines may also contain similar nodules. Clusters of these nodules may appear as firm, fleshy, grape-like clusters. Abscesses and nodule-like growths have been reported around the eyes, at the wing joints, on the legs, side of the face, and base of the beak. Some infected birds have died without any obvious clinical signs or external lesions.
- Infected birds often have enlarged livers and spleens.

Meat Edible?

For Both Mammals and Birds:

- Tb bacteria are very rarely found in meat (muscle tissue).
- As a precaution, however, all meats, including hunter-harvested deer, should be thoroughly cooked to an internal temperature of 74 ºC (165 ºF) to kill bacteria.
- If the lungs, ribcage or internal organs from wild ungulates look abnormal (multiple tan or yellow lumps), **THE MEAT SHOULD NOT BE EATEN** and the nearest Health Authority contacted (see contact list).
- It is unlikely that a person field-dressing or eating meat of an animal infected with bovine Tb could become infected. Nonetheless, hunters should practice sanitary precautions, including washing after field-dressing an animal.
- Hunters that suspect their kill of being infected **SHOULD NOT EAT THE MEAT** and should contact their provincial or federal agencies (see contact list).
- Dogs and cats should not be allowed to roam freely where they could feed on carcasses or gut piles of infected deer.

Human Health Concerns and Risk Reduction

Bovine Tb:

- Human infection occurs either via the respiratory route or through cuts or abrasions in the skin after being in close contact with infected animals.
- Bovine Tb is one of the most infectious forms of Tb and is reportable under the Health of Animals Act.
- *M. bovis* in the environment can be killed easily by a weak solution of common household bleach (mix 1 part bleach to 9 parts of water) or other commercial disinfectants. They are also quite heat sensitive.

Avian Tb:

- There are many authenticated cases of *M. avium* infection in people, although humans are considered highly resistant to this organism. Avian Tb is generally considered non-contagious and so it is unlikely that an infected person could transmit *M. avium* to an uninfected person. Infection is more likely to occur in persons with pre-existent diseases, especially those involving the lungs, and in persons whose immune systems are impaired by other illnesses.

Samples for Diagnosis

- Post-mortem investigation and microscopic analysis of lesions by a veterinary pathologist is required.
- Definitive diagnosis is accomplished by culturing and identifying the bacteria.
- For birds, if carcasses or tissues cannot be submitted to a laboratory within a short time, tissues may be preserved in 10 % buffered formalin solution. The whole carcass of a bird is preferred; however, if this is not possible, remove the leg at the hip joint, wrap it in clean aluminum foil, place it in a plastic bag, and freeze it for shipment to a qualified disease diagnostic laboratory.
- Bovine tuberculosis is a reportable disease in Canada, and under the Health of Animals Act, all cases must be reported to the Canadian Food Inspection Agency (CFIA).

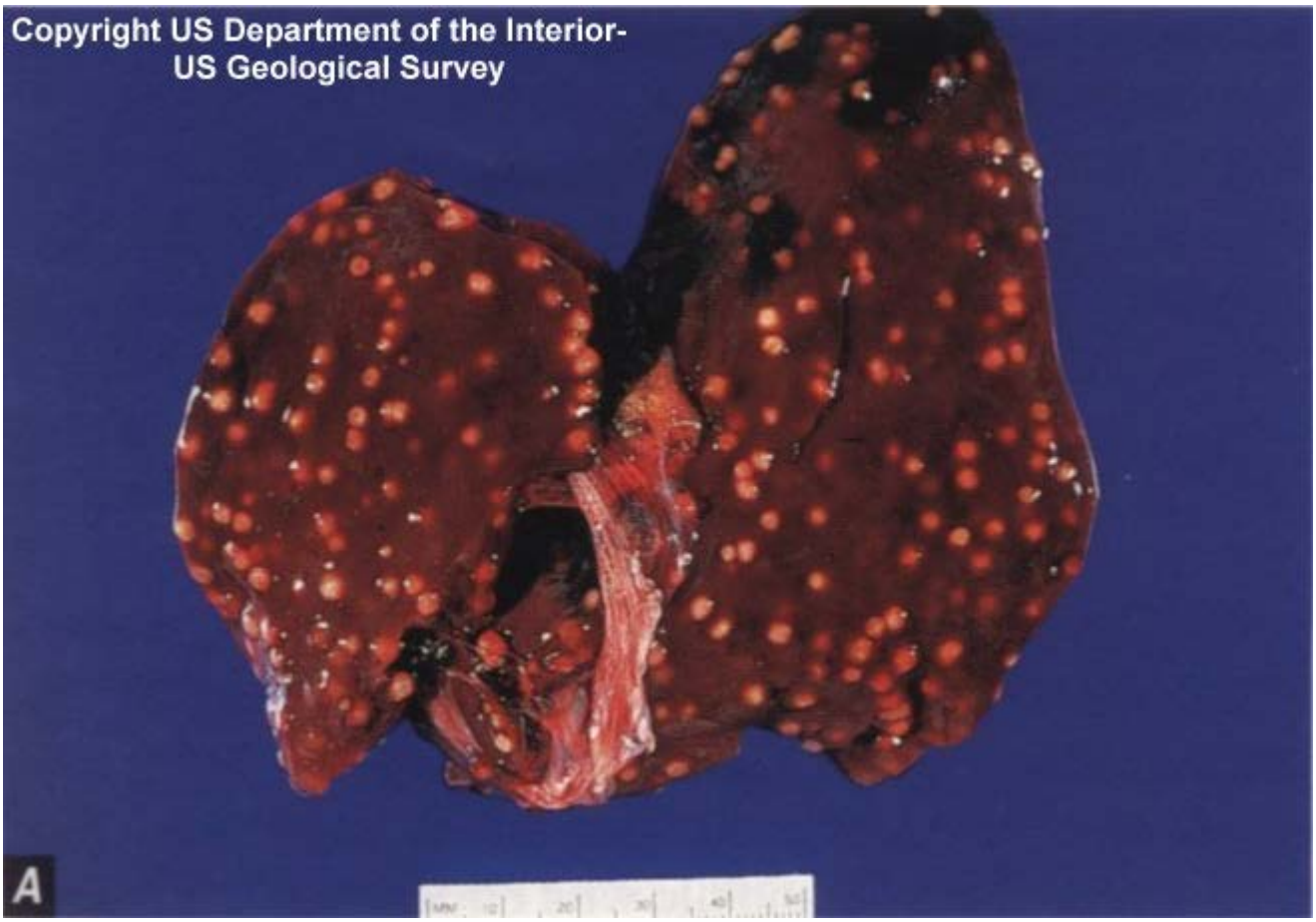
Similar Diseases

Birds:

- The emaciated, weak and lethargic condition of birds resembles lead poisoning.
- Nodular lesions in internal organs are often similar in appearance to those of aspergillosis; laboratory tests are needed to differentiate between the two diseases.
- Abscesses and nodular growths on the skin around the eyes, at the wing joints, on the legs, side of the face, and base of the beak of birds resemble avian pox.

Further Reading

- Canadian Food Inspection Agency – Bovine Tuberculosis
- Clifton-Hadley, R.S., Sauter-Louis C.M., Lugton I.W., Jackson R., Durr P.A., Wilesmith J.W.. 2001. Mycobacterial diseases: *Mycobacterium bovis* infections. Pp. 340-371 in E.S. Williams, I.K. Barker (eds.), *Infectious Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.
- Friend M. 2001. Tuberculosis. Pp. 93-98 in *Field Manual of Wildlife Diseases: General Field Procedures and Diseases of Birds*. M. Friend, J.C. Franson (Tech. eds.), E.A. Ciganovich (ed.). Biological Resources Division Information and Technology Report 1999-001. U.S. Department of the Interior and U.S. Geological Survey. Washington, DC. (Chapter in PDF format)



Tularemia

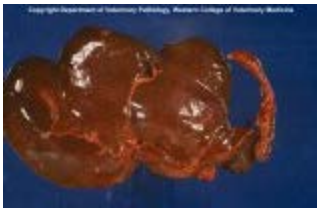


Causative Agent

- A tick-borne, potentially zoonotic, disease primarily of rodents and lagomorphs. Caused by the bacteria, *Francisella tularensis*.
- Two different sub-species of *F. tularensis*:
  - one holarctic (*F. t. palaearctica*);
  - one restricted to North America (*F. t. tularensis*).

Images

Click on images to enlarge.



Small white dots of necrosis on the liver of this beaver are typical of tularemia.

Enlargement of the spleen is typically observed in animals with tularemia.

Distribution

Geographic:

- In North America:
  - *F. t. tularensis* occurs in terrestrial habitats;
  - *F. t. palaearctica* occurs most often in aquatic habitats (wetlands and boreal areas).
- *F. t. tularensis* does not seem to occur in Canada and may be limited to the lower 48 contiguous United States.
- *F. t. palaearctica* infection primarily occurs in Canada.

Seasonality:

- Ticks are only present on hares from May to September (based on Alaska data); as a result, the disease essentially disappears from October through April.
- Human cases may also occur throughout the fall and winter following exposure to lagomorphs during hunting season.

Hosts, Transmission and Life Cycle

Hosts:

- *F. t. tularensis:* rodents and lagomorphs.
- *F. t. palaearctica:* aquatic rodents.
- In North America, tularemia occurs most commonly in cottontail rabbits (*Sylvilagus* spp.), muskrats (*Ondatra zibethicus)*, ground squirrels (Sciuridae), and beavers (*Castor canadensis*).
- It is thought that tularemia is often fatal in the above species, but not so for the snowshoe hare (*Lepus americanus*).

Transmission:

- *F. t. tularensis:* transmission occurs among hosts primarily through ticks, but also by mites, mosquitoes, fleas, lice and biting flies (Tabanidae).
- *F. t. palaearctica:* transmission occurs directly through water, which may remain infectious for weeks to months following contamination.
- For both sub-species, transmission may also occur through contact with feces, urine or body parts of infected animals.

Life Cycle:

- Although often fatal, the bacterium can infect both lagomorphs and rodent hosts without apparent ill-effects. These hosts can then remain infected for extended periods, serving as reservoirs of infection for other animals and biting arthropods.
- Ticks act not only as vectors of transmission, but also as reservoirs of the bacterium, which can live in certain tick species for months.
- *F. t. palaearctica* may also be transferred among voles (*Microtus* spp.) through cannibalism of infected individuals.
- The associations between mammal and arthropods differ from location to location.

Signs and Symptoms

Animals:

- In the most sensitive species, clinical signs are not often observed due to the short duration of infection before death occurs. These animals are usually in good body condition at death.
- In less sensitive species, during the latter stages of the disease, animals may become lethargic or depressed and have elevated body temperature.
- Tularemia is most often recognized during examination at a diagnostic laboratory.
- Tiny, pale spots on the liver, spleen or lung are typical lesions of tularemia.
- Spleen or liver may become enlarged.
- As in humans, an ulcer may form where the bacteria have entered the body.
- Thin, whitish strands of material may be present in the abdominal cavity.
- The lesions described above are not unique to tularemia: see also plague.

Humans:

- Initially, symptoms are: generalized fever-like illness (e.g., fever with chills, headache, vomiting) beginning 1-10 days after infection.
- Confirmation of the disease is usually accomplished using blood tests.
- The course of the disease depends on the route of infection:
    - arthropod bite: an ulcer forms at the bite wound followed by enlargement of the lymph nodes draining the area of the bite wound;
    - inhalation: inhalation of infected material results in pneumonia;
    - ingestion: infected water or meat that is ingested leads to inflammation of the posterior portion of the oral cavity and intestines.
- Disease resulting from *F. t. tularensis* is more serious than that caused by *F. t. palaearctica*.
- Death occurs in 40-60% of untreated cases where pneumonia or inflammation of the inner surface of the intestines occurs, and 7% of all forms of untreated infection with *F. t. tularensis*. In contrast, fatalities occur in 1% of untreated infections with *F. t. palaearctica*.
- Human to human transmission is rare.
- *F. t. palaearctica* is common in trappers.

Meat Edible?

Normal cooking temperatures destroy bacteria in the meat; it is, therefore, safe to eat when thoroughly cooked.

- Human exposure typically results from preparing carcasses.

Human Health Concerns and Risk Reduction

- Human infection in North America prior to 1950 has been closely associated with exposure to cottontail rabbits infected with the *F. t. tularensis* strain.
- After 1950, the major risk factor to humans has switched to muskrats infected with the *F. t. palaearctica* strain.
- Taking certain precautions can reduce the chance of exposure to the tularemia bacteria, such as: basic hygiene, use of insect repellents and protective clothing to avoid arthropod bites, inspection and removal of ticks, use of gloves when handling and dissecting wild animals, particularly rodents and lagomorphs.
- Vaccination against tularemia may be warranted in high-risk areas.
- Dogs and cats can die from tularemia. Since infected animals are easier to catch, pets may become infected after eating the internal organs of the diseased animal. Keeping pets from roaming free should help to reduce the spread of tularemia.
- Tularemia is readily treated with antibiotics if treatment is started early in the course of the disease. Thus, symptoms of general malaise and fever should not be ignored and medical attention sought. Medical personnel should be advised that you may have been exposed to wildlife and so may be at risk with respect to various wildlife diseases including tularemia.

Samples for Diagnosis

- Submission of entire carcass or just the spleen or liver.

Similar Diseases

- Lesions in animals infected with plague, yersiniosis and other bacterial infections may be similar to that of tularemia.

Further Reading

- Alaska Department of Fish and Game – Tularemia
- BC Wildlife Health Fact Sheet – Tularemia (PDF file)
- Pennsylvania Game Commission Wildlife Disease Reference Library – Tularemia
- US Centers for Disease Control – Tularemia
- USGS - National Wildlife Health Center – Tularemia (with links to PDF manual)
- Canadian Cooperative Wildlife Heath Centre. 1995. Tularemia. Pp. 17-19. *Health Risks to Wildlife Personnel: Hazards from Disease-causing Agents*. Canadian Cooperative Wildlife Heath Centre, Western College of Veterinary Medicine, University of Saskatchewan. Saskatoon, SK
- Elkin B., Zamke R.L. 2001. *Common Wildlife Diseases and Parasites in Alaska*. Alaska Department of Fish and Game. Anchorage, AK.
- Mörner T., Addison E. 2001. Tularemia. Pp. 303-312 in E.S. Williams, I.K. Barker (eds.), *Infectious Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.



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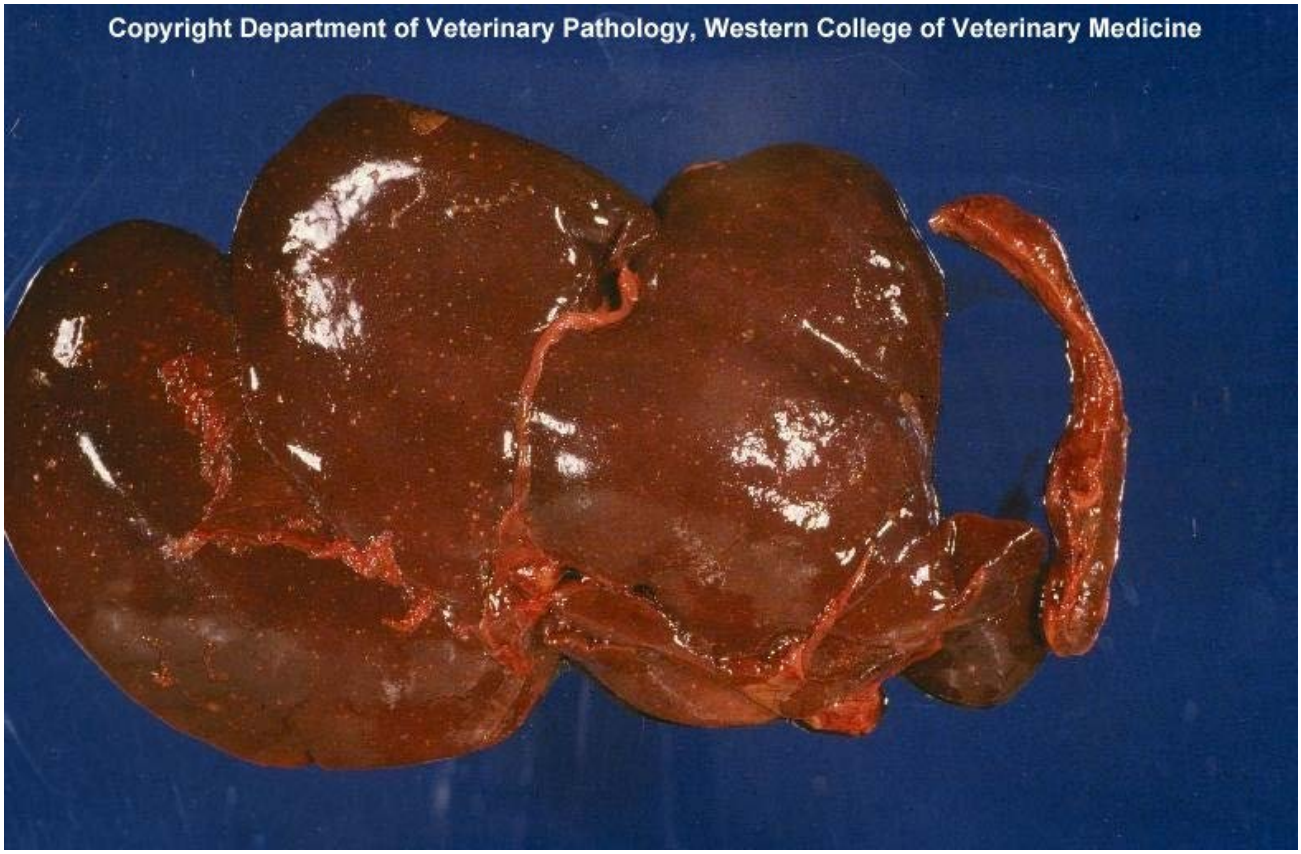
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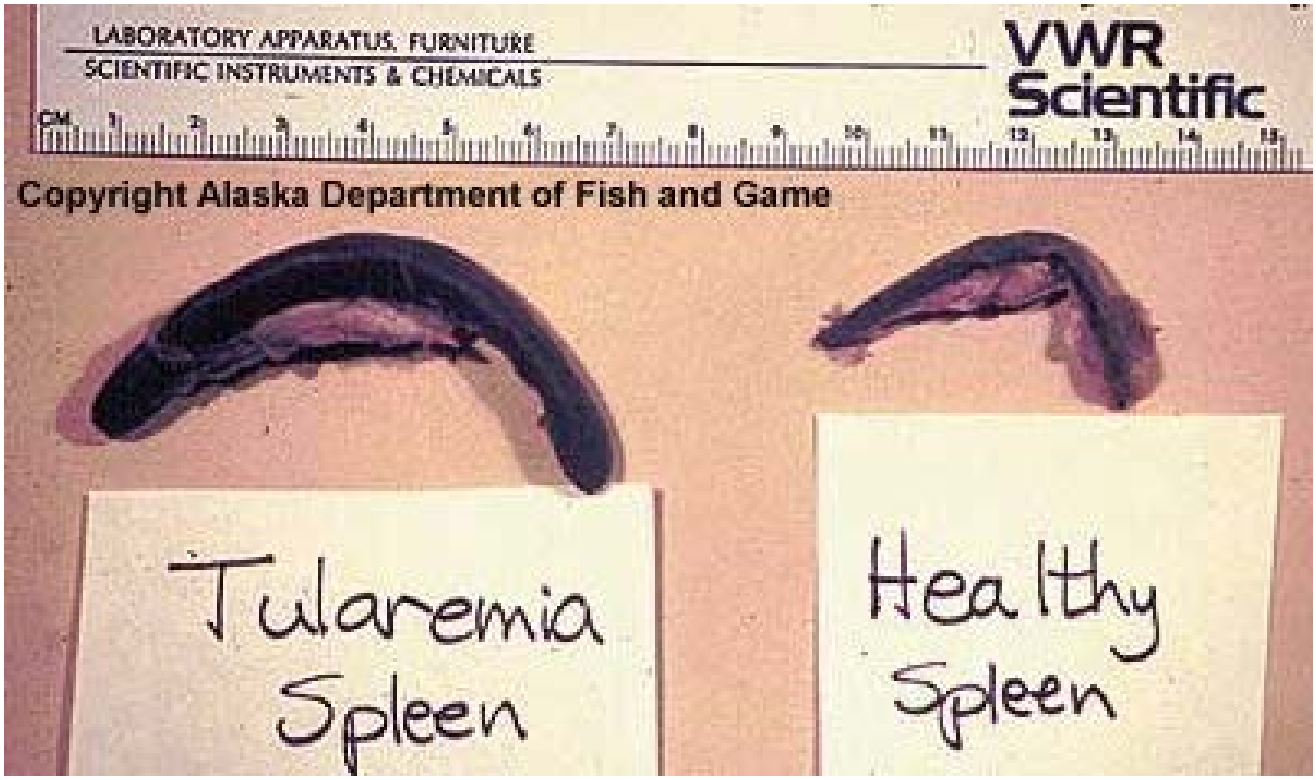
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Tularemia Spleen
Healthy Spleen

West Nile Virus

General Information

- West Nile Virus (WNV) is a member of the family Flaviviridae and is closely related to several mosquito-transmitted flaviviruses that cause human disease on different continents, including St. Louis encephalitis (SLE) virus, a native North American arbovirus. Both WNV and SLE viruses are maintained in a transmission cycle involving birds and mosquitos.
- WNV was first isolated in 1937 in the West Nile district of Uganda, Africa. Outbreaks of WNV have occurred in a number of countries including Egypt, Israel, South Africa, and countries in parts of Asia and Europe. Recent outbreaks, outside of North America, have occurred in France and Israel in 2000, Russia in 1999, and Romania in 1996-97.
- WNV was first detected in the United States in September 1999 during the investigation of an outbreak of encephalitis in humans in New York City.
- WNV is spread to humans by the bite of an infected mosquito. A mosquito becomes infected by feeding on the blood of a bird that carries the virus. Approximately two weeks must elapse after a mosquito has fed on an infected bird before it is capable of transmitting the virus to a human or animal. There is no evidence to suggest that an individual could get WNV from another person. For example, WNV cannot be spread through touching or kissing an infected person, or from exposure to a health care worker who has treated someone infected with WNV.

Surveillance

- The number of bird species in North America that play a role in the transmission of WNV is not known at this time, although the virus has been identified in more than 100 species of birds in the USA between 1999-2001. High mortality rates occur in some bird species, particularly the Corvidae (American crows [*Corvus brachyrhynchos*], blue jays [*Cyanocitta cristata*], gray jays [*Perisoreus canadensis*], magpies [*Pica hudsonia*], and ravens [*Corvus corax*]). The Canadian Cooperative Wildlife Health Centre is currently involved in collecting dead birds for surveillance of West Nile Virus in Canada. See visit their website for further details.
- For general information on WNV, visit Health Canada's website.
- For recent updates on WNV surveillance by province and general information provided by Health Canada, click here.
- **In British Columbia between 2007 and 2014, WNV has been reported in:**
  - **25 people, of which 21 cases are suspected of being contracted outside of the province;**
  - **5 horses, 6 birds (corvids) as well as in mosquitos.**
- **For information on WNV in jurisdictions surrounding BC, see the following:**
  - Alberta
  - Washington
  - Idaho
  - Montana

Further Reading

- Alberta Environment and Sustainable Resource Development – WNV
- BC Centre for Disease Control – WNV
- BC Ministry of Health – WNV
- Public Health Agency of Canada – WNV
- US Centers for Disease Control and Prevention – WNV
- US Geological Survey National Wildlife Health Center – WNV

White-Nose Syndrome

Causative Agent

- White Nose Syndrome, or WNS, is a fungal disease affecting hibernating bats (Vespertilionidae).
- The disease is named for the white fungus, *Pseudogymnoascus* (*Geomyces) destructans*, that infects the skin of the muzzle, ears, and wings of hibernating bats.
- WNS is associated with extensive mortality of bats (millions of animals) in eastern North America.
- First documented in New York state in the winter of 2006-2007, WNS has spread rapidly across the eastern United States and Canada
- The fungus that causes WNS has been detected as far west as Oklahoma.
- Evidence suggests that WNS may be caused by an invasive strain of the fungus, probably from Europe.

Images

Click on image to enlarge.

White fungal growth often appears on the muzzles of hibernating bats.

Distribution

Geographic:

- WNS has not been detected in British Columbia as of December 2014.

Seasonality:

- Mainly observed during the winter months.

Click on map to enlarge.

Distribution of WNS as of December 2013

Hosts, Transmission and Life Cycle

Hosts:

- Bat species known to be affected by WNS:
  - Big brown bat (*Eptesicus fuscus*);
  - Eastern small-footed bat (*Myotis leibii*);
  - Gray bat (*Myotis grisescens*) [endangered];
  - Indiana bat (*Myotis sodalis*) [endangered];
  - Little brown bat (*Myotis lucifugus*);
  - Northern long-eared bat (*Myotis septentrionalis*);
  - Tricolored bat (*Perimyotis subflavus*).

Transmission and Life Cycle:

- It is believed that white-nose syndrome is transmitted primarily from bat to bat.
- WNS may also be transmitted by humans inadvertently carrying the fungus from cave to cave on their clothing and gear.
- The fungus, *Pseudogymnoascus destructans*, associated with WNS, thrives in the cold and humid conditions characteristic of caves and mines used by bats.

Signs and Symptoms

- Bats affected by WNS may exhibit some or all of the following unusual behaviors or characteristics:
  - affected animals will often exhibit a white fungus on the muzzle, wings, ears or tail;
  - bats flying outside during the day in temperatures at or below freezing;
  - bats clustered near entrances of hibernacula;
  - dead or dying bats on the ground or on buildings, trees or other structures.

Meat Edible?

- Meat from bats is generally not consumed.

Human Health Concerns and Risk Reduction

- Thousands of people have visited affected caves and mines since white-nose syndrome was first observed, and there have been no reported human illnesses attributable to WNS.
- To date, there is no known risk to humans from contact with WNS-affected bats.
- Bats should not be handled for concerns over other zoonotic diseases such as rabies, and biologists and researchers should use protective clothing when entering caves or handling bats.
- Taking precautions and not exposing yourself to WNS is urged.

Samples for Diagnosis

- Fresh, intact carcasses.
- Photos of affected animals

Further Reading

- Alberta Environment and Sustainable Resource Development – White-nose Syndrome (PDF file)
- BC Ministry of Environment Fact Sheet – White-nose Syndrome (PDF file)
- US Fish and Wildlife Service Fact Sheet – White-nose Syndrome (PDF file)
- WhiteNoseSyndrome.org – extensive resource site






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Photo by Al Hicks, NY Dept of Environ. Conservation

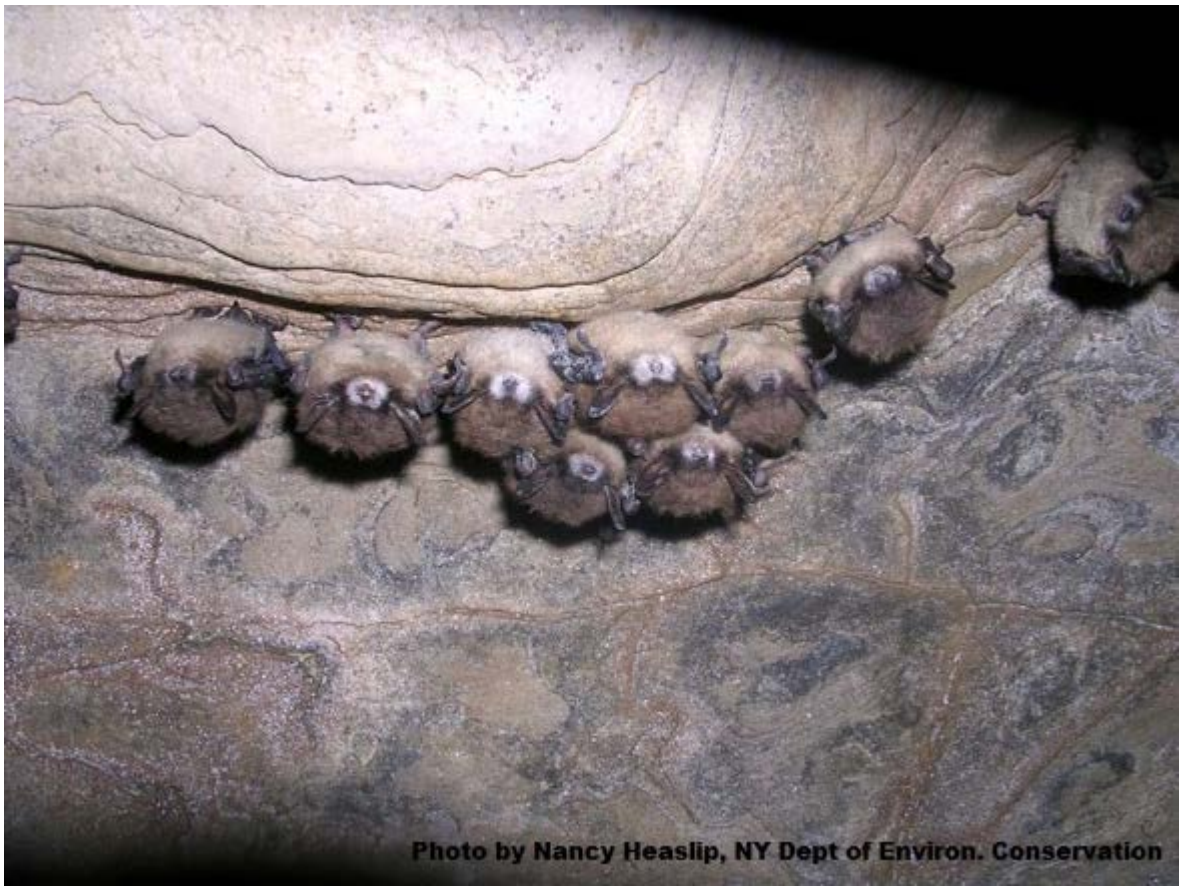
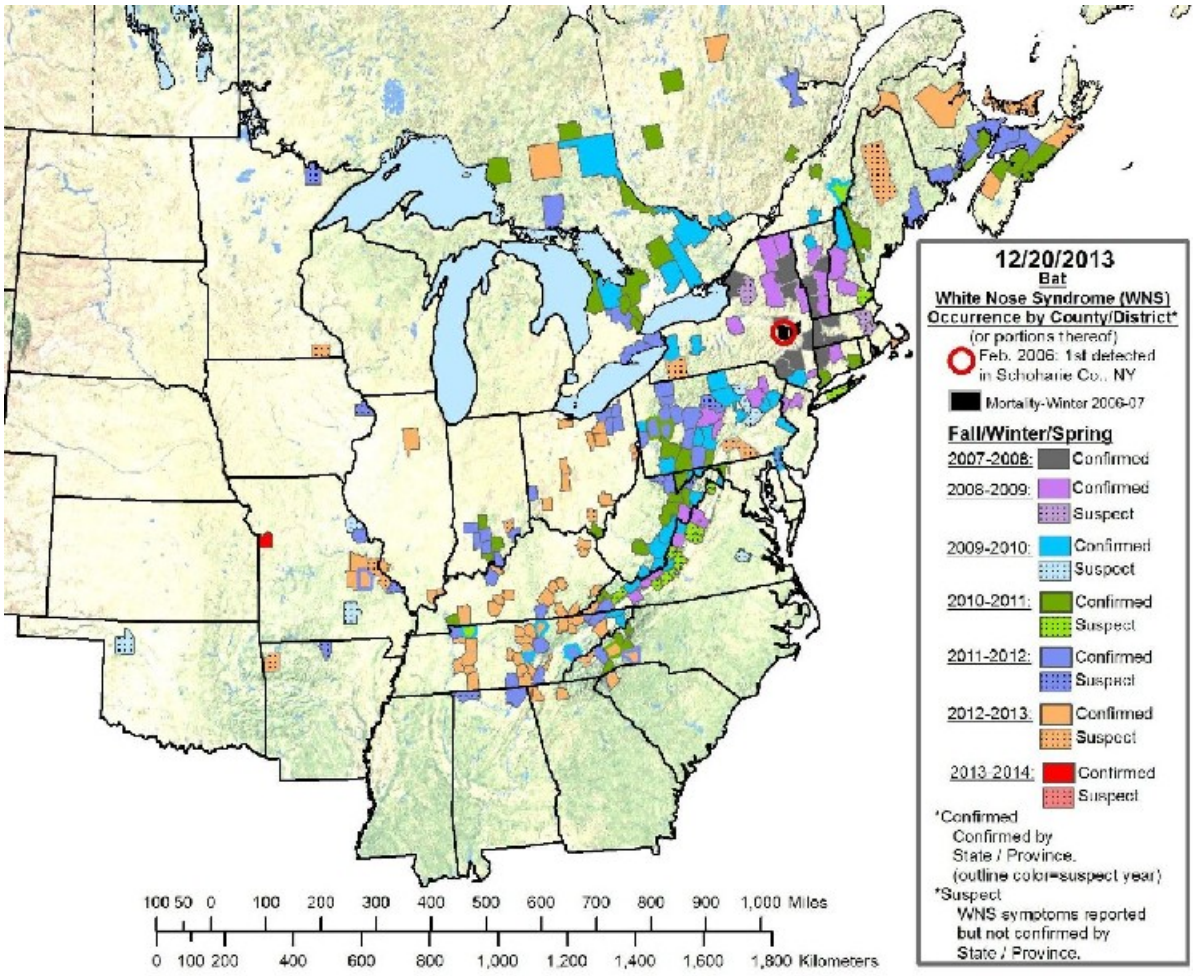


Photo by Nancy Heaslip, NY Dept of Environ. Conservation



Map by: Cal Butchkoski, PA Game Commission

Winter Tick

Causative Agent

- The winter tick, *Dermacentor albipictus*, is a skin parasite of wild ungulates that consumes a blood meal from its host to complete its life cycle.
- While winter ticks have most often been found on moose (*Alces alces*), other wildlife species have been known to be parasitized by and have disease caused by *D. albipictus*, including:
  - moose (*Alces alces*);
  - caribou (*Rangifer tarandus*);
  - elk (*Cervus canadensis*).
- Unlike mites, ticks are visible to the naked eye. Adult winter ticks are large and reddish-brown to grayish-brown in color.

Images

Click on images to enlarge.

Ticks engorged with blood

In early spring, moose may be showing large patches of broken or missing hair where they have tried to rub away ticks. Moose with large patches of broken hair are sometimes referred to as "ghost" moose, as the white base of the hair shaft is all that remains.

Heavy infestation of winter tick on a moose.

Life stages of the winter tick.
Left to right: larva; nymph; adults (with visible legs).
The last two specimens on the right are adult females engorged with blood.

Distribution

Geographic:

- Mostly occurring up to 62ºN latitude in western Canada.
- Greatest abundance in forested, upland or mountain habitats.

Seasonality:

- All stages of this parasite on large mammal hosts occur between fall and spring.

Hosts, Transmission and Life Cycle

Hosts:

- *D. albipictus* requires one host to complete its life cycle.
- Hosts: highest tick densities are found on moose, but also found on elk, deer and mountain sheep.
- Individual moose have been found with > 50,000 ticks.

Transmission and Life Cycle:

- Ticks require blood meals from a host to complete each stage of their life cycle.
- In the host-seeking stage, larvae climb and congregate on tips of vegetation in September and October. Larvae are very resistant to cold and snow.
- Once on the host, a blood meal is taken and larvae molt to nymphs and become adults by March-April.
- Adults that are fully engorged with blood detach in late March through April and lay eggs among leaves or in soil in June. The adults are less resistant to cold and snow at this time.
- Eggs hatch and larvae seek hosts to repeat the cycle.

Signs and Symptoms

- Feeding by *D. albipictus* can result in local inflammation, edema, hemorrhage, irritation, and hair loss from grooming.
- Heavily infested hosts groom extensively and may suffer from extensive hair loss, loss of body fat stores, loss of blood and even death from exposure and starvation. The incessant need to groom can seriously interfere with feeding.
- Moose may rub against trees and other objects in attempts to remove ticks.
- Moose with extensive hair loss look white or grey in appearance and are often called ‘ghost moose’. They are prone to heat loss in winter.
- Other ungulate species are less affected by winter ticks than moose and, although there can be significant hair loss, it is rare to see other species in as poor condition.

Meat Edible?

- Meat is edible but the quality may be reduced if the animal is in poor condition.

Human Health Concerns and Risk Reduction

- *D. albipictus* may parasitize humans but this appears to be rare.
- *D. albipictus* is not known to carry and transmit agents that may cause disease in people.
- Transfer of *D. albipictus* to domestic animals may occur. The response of domestic animals to tick infestation is similar to that of wild mammals.

Samples for Diagnosis

- Remove tick from hide while being careful not to leave mouth parts embedded in the skin.

Further Reading

- Canadian Cooperative Wildlife Health Centre – Winter Tick
- University of Minnesota: Moose in Minnesota – Winter Tick

- Allen S.A. 2001. Ticks. Pp. 72-106 in E.S. Williams, I.K. Barker (eds.), *Infectious Diseases of Wild Mammals*. 3rd Ed. Iowa State University Press. Ames, IA.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