Reindeer Health Aide Manual

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INTRODUCTION

The first edition of the Reindeer Health Aide Manual was printed in 1981. It represented a written summary of information presented at a number of Reindeer Health Aide Workshops sponsored by the University of Alaska and the Alaska Reindeer Herders' Association. These workshops were designed to provide herders with basic reindeer health information so they could recognize diseased animals, collect samples, and treat various ailments of reindeer in cooperation with and under the supervision of agency personnel and veterinarians. Over the past several years there has been an increasing interest in ownership of reindeer by individuals both within and outside the state of Alaska. These individuals routinely request information on the care of their reindeer. New drugs and vaccines have been developed since this manual was last published. These products are now described and discussed in the text. Products no longer in use have been deleted. Additionally, basic blood test parameters are listed to aid owners working with veterinarians who have not had experience in the treatment of reindeer diseases. It is not the purpose of this manual to describe each subject in great detail or in technical terms. Some items may seem overly simplified, but most people using this manual are not biologists, and every effort has been made to address their needs.

Anatomy of Reindeer

The Skeleton

The skeleton of an animal is a hard, bony framework which provides internal support and form to the body. It also supplies points of attachment for the muscles which enables an animal to make strong physical movement. Generally, the types of bones making up the skeleton are the same in all animals. Figure 1 identifies the major bones of the reindeer skeleton. These will be discussed in the following paragraphs.

Skull: The skull is formed by the fusion of many smaller bones. It provides a protective case for the brain and contains the bones of the nasal cavity, or turbinates. The upper jaw, or maxilla, is formed by the front lower surface of the skull. The lower jaw, or mandible, moves on a hinge to open and close the mouth. The reindeer's teeth are embedded in the bone of the upper and lower jaw. On the crown of the skull are the two short permanent stems, or pedicles, from which the antlers grow every year.

Vertebrae: The vertebrae are bones which fit together in a column that makes up the neck and backbone. Running through a canal in the vertebrae is the spinal cord which transmits messages between the brain and body. The vertebrae, then, serves to protect the spinal cord from injury. The cervical vertebrae are in the neck, the thoracic vertebrae in the chest area, and the lumbar vertebrae in the lower back area. They fuse in the pelvic region and continue back to become the smaller tail bones.

Ribs: The ribs form a cage of bones that encase and protect the lungs and heart; they also give form to the chest and play a role in breathing.

Limbs: The front limb attaches by a large muscle mass connecting the shoulder blade, or the scapula, to the body. The humerus is similar to a man's upper arm, and the radius to man's forearm. The reindeer's "hand" bones are elongated and fused into a third long limb bone, the metacarpus. In the hind limb, the femur corresponds to a man's thigh bone, and the tibia is similar to man's calf bone. As with the 'hand" bones, the "foot" bones have elongated and fused, creating the metatarsus. The reindeer's hooves consist of two digits (fingers) plus two dewclaws representing a total of four digits.

The Organs

The internal organs of a reindeer are illustrated in Figure 2. The esophagus is the tube which carries food from the mouth to the stomach. The ruminant stomach has four chambers. The largest is the rumen, a large sac in the abdomen, which lies mostly on the left side of the body. The other three chambers are the reticulum, omasum, and the abomasum. From the stomach, food passes into the coiled intestine at the rear of the animal. The intestine leads to outside the body, and feces pass out by this route.

The trachea or windpipe is the tube below the esophagus and can be identified by the rings of cartilage holding the tube open. Air passes through the trachea from the nostrils and mouth to the lungs. The lungs have several lobes and fill much of the chest area. The heart lies within the lungs at the bottom of the chest. The diaphragm is the strong wall of muscle separating the chest from the abdomen.

The liver is the large mass of tissue lying behind the diaphragm. The smaller, reddish-grey organ on top of the rumen is the spleen. The kidneys are paired and lie in the upper abdomen next to the back towards the rear.

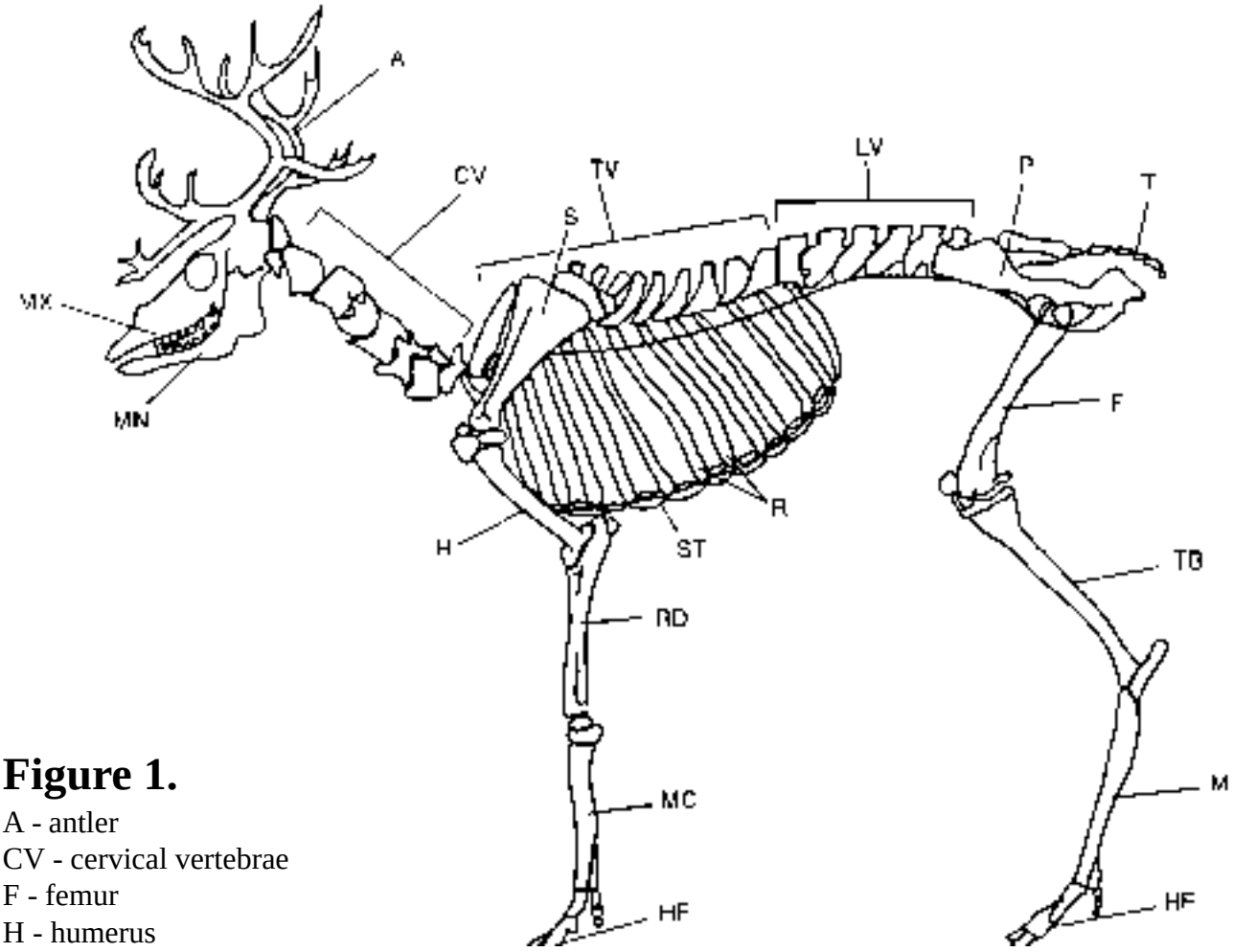


Figure 1.

A - antler
CV - cervical vertebrae
F - femur
H - humerus
HF - hoof
LV - lumbar vertebrae
MC - metacarpus
MN - mandible
MT - metatarsus
MX - maxilla
P - pelvis
R - ribs
RD - radius
S - scapula
ST - sternum
T - tail
TB - tibia
TV - thoracic vertebrae

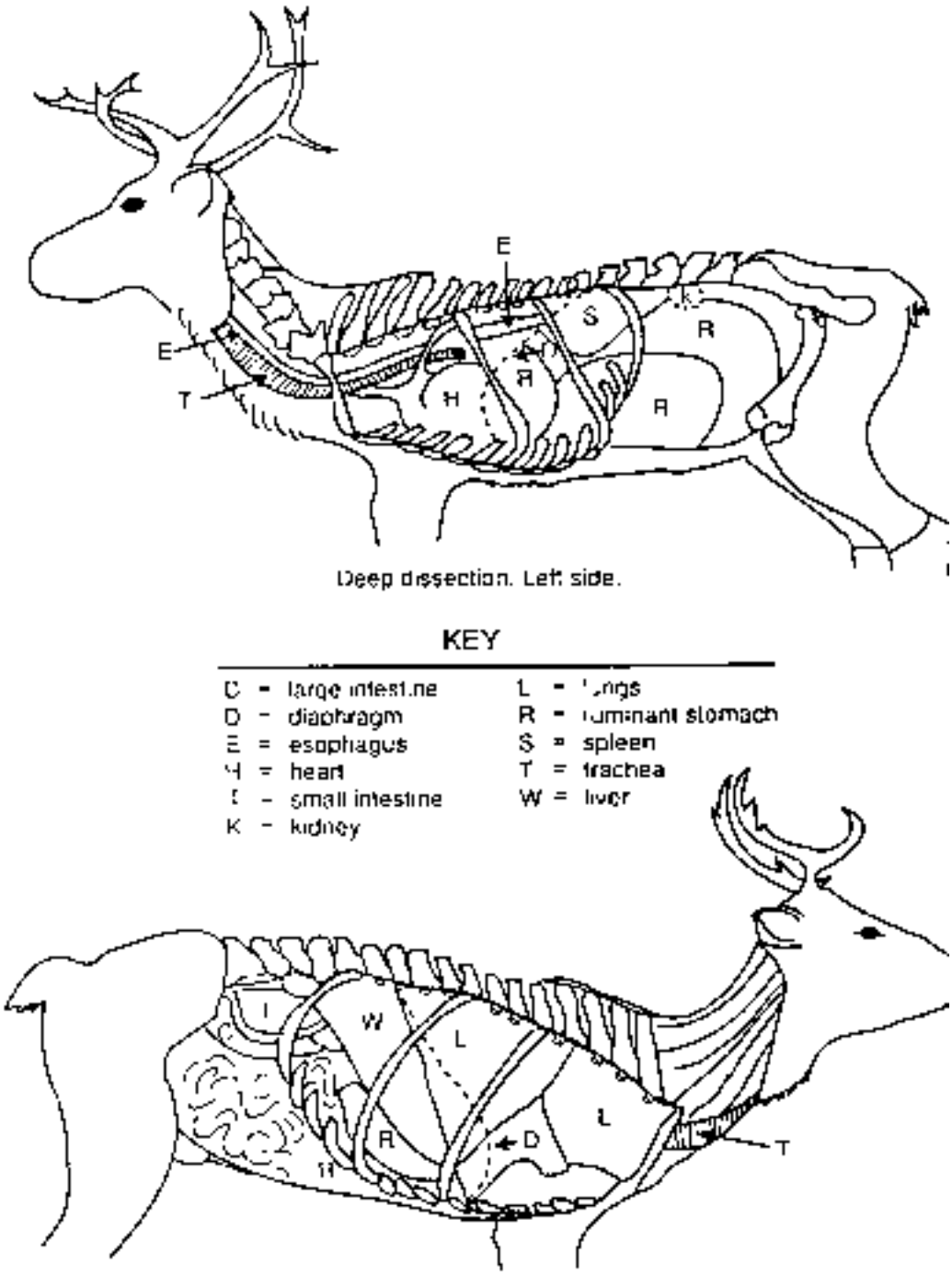


Figure 2. Internal organs of the reindeer

Physiology of Reindeer

Physiology describes how cells, organs, or even whole systems such as the digestive tract function to keep an animal alive. Physiology, then, deals with how an animal takes in food and digests it, how it breathes in oxygen and gets rid of unwanted gases, transports nutrition and oxygen to its body parts, and how it grows and reproduces. In discussing physiology, it is convenient to look at digestion, respiration, circulation, and reproduction separately, but it is important to realize that each of these systems in the deer's body depends on and influences the others.

Circulation

Circulation is the flow of blood through the body. Blood supplies nutrition and oxygen to body parts and carries away carbon dioxide, a waste product exhaled by the lungs. Blood consists of red and white blood cells and clotting cells in a suspension of clear plasma. The red blood cells transport oxygen and carbon dioxide: white cells are important in fighting infection. Clotting cells gather at a cut or wound to stop bleeding. The plasma is the portion that contains the antibodies. The heart serves as a pump that keeps the circulation flowing (see Figure 1). Blood from the body parts flow to the heart through vessels called veins. This blood is low in oxygen. It enters the heart at the right atrium and passes to the right ventricle, which pumps it through the pulmonary artery to the lungs.

In the lungs, oxygen is picked up from inhaled air, and carbon dioxide is exhaled. The blood then returns to the left atrium of the heart with its new supply of oxygen and is pumped from the left ventricle back to the body parts through the aorta.

The spleen aids in circulation by making and storing new red blood cells. It can contract and send new red blood cells to the circulatory system when oxygen is in low supply; this may occur, for instance, when an animal exercises or becomes very excited.

Respiration

Respiration is the process of inhaling air into the lungs in order to extract oxygen for the body's use. Carbon dioxide, a waste product of many body functions, is given off with the exhaled breath. Figure 2 shows the structure of the lungs with their many air passages. Air is inhaled through the nostrils and mouth into the back of the throat and down the trachea, or windpipe. The windpipe remains open and stiff because rings of cartilage run the length of its walls. This differs from the esophagus which is soft and collapses after swallowing. In the chest the windpipe branches into a series of air passages. The branching occurs again and again until the air passages are so thin that they become microscopic. At this level, carbon dioxide leaves the blood in which it has been transported and oxygen flows in.

The diaphragm aids in respiration. It contracts and squeezes the chest forcing air out of the lungs. When the diaphragm relaxes, the chest expands and air flows in. During normal activity a deer breathes through its nostrils. The air passage within the reindeer's nostrils is a scroll-like pattern, formed by special bones called turbinates. Inhaled air must pass through this spiral route and in doing so, cold dry air is moistened and warmed by the animal's nasal tissues before reaching the lungs. When this air is exhaled, it again passes through the turbinates and some of that heat and moisture is returned to the tissues instead of leaving the body. In this way, heat and moisture are retained within the body.

When a reindeer runs hard, it breathes through its mouth to gain an increase in the flow of oxygen and to cool itself. In this case, the turbinate bones are bypassed and cold dry air goes directly to the lungs. The advantage of moisture retention is lost and if the animal is excessively run, stress in combination with drying of the mucous membranes of the respiratory system can lead to lung illnesses such as pneumonia.

Digestion and Nutrition

Remember that the reindeer's stomach consists of four chambers, each with a special function in digesting food. Figure 3 shows the path food takes when it reaches the stomach area. Food passes back and forth between the reticulum and rumen after being swallowed. The rumen is the large fermentation sac containing bacteria and other one celled organisms. The rumen is unique to grazing animals whose diet consists of plants and grasses. Such plants are made of a tough material called cellulose, which is indigestible to animals with a one-chambered stomach, like humans. The bacteria within the rumen have the ability to break down the cellulose in plants to a form usable by the reindeer's body. Without the bacteria in its rumen, the reindeer could not survive on plants and lichen. The reticulum chamber has an inner lining which is folded into an intricate honeycomb pattern, which strains finer food particles from coarse undigested particles.

Any food which is still coarse and indigestible leaves the rumen and reticulum and is brought back to the mouth and rechewed. After it is swallowed again and further digested in the rumen and reticulum, it next goes to the omasum. The omasum has many folds of tissue inside that are pressed together like leaves. Here food is ground further, and water from the food is absorbed by the body. Food particles then pass to the abomasum, which is a true stomach like ours. Digestive juices act on the food here and the particles pass on to the intestine.

The nutritive portion of the food particles is absorbed by the intestinal wall. The liver receives the nutritive particles and converts them into products that will be used as fuel by the rest of the body. This fuel is used for movement, maintaining body heat, reproduction, and antler and body growth. The liver also removes poisonous substances from the intestine, and stores and filters the blood. The leftover, unusable portion of the food particles is packaged into pellets, or fecal droppings, in the lower part of the intestine, and passed outside the body.

Seasonal migration of the reindeer is due, in part, to nutritional needs. In the summer, the animals migrate to areas where lush, young, green plant shoots are emerging. This new growth is the most desirable to the deer because it provides energy and is very nutritious.

In the summer, the reindeer's diet consists primarily of green vegetation such as shrubs, sedges, grasses, and herbs. As green vegetation ages and dies in late summer, the reindeer turns to lichen, which, by wintertime, forms a great part of its winter diet. Lichen is high in quick energy but lacks many important nutrients and is also low in salts. The reindeer, however, seems to be well-adjusted to this type of winter diet.

Published lists exist which outline the plants that reindeer are observed to feed on, or that have been found in rumen sample contents. These lists can help in evaluating how nutritious a particular rangeland will be to the reindeer herd.

Water is essential to the life of all animals. A reindeer can do without feed for a longer period than it can go without water. Lack of water may become a serious problem to the herd when the animals are driven hard, kept moving for a long time period, or contained in corrals with no water source available. Generally, a good rule of thumb is that the animals should not go longer than 12 hours without water.

Urogenital System

This system is a combination of that part of the body which produces urine (uro-) and the portion dealing with reproduction (-genital). These two systems are often considered together because they are so close anatomically.

Urine is a concentrated fluid that carries waste products from the body. It is formed in the kidneys which filter the wastes from circulating blood. From the kidneys, urine flows down a duct called the ureter. The bladder receives and stores this urine. From here it is voided to the outside through the urethra. Both males and females have basically the same type of urinary system. Figures

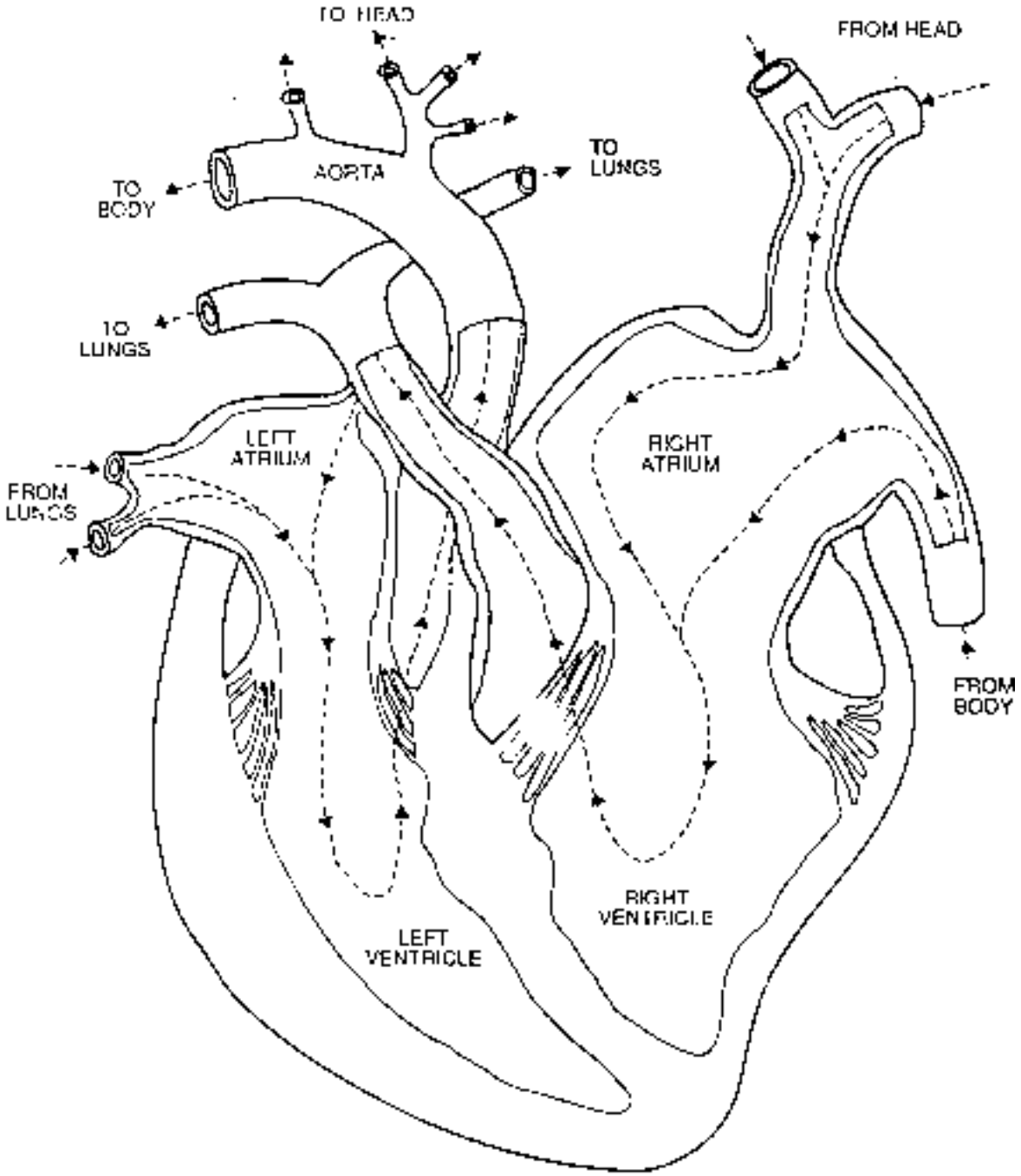


Figure 1. Structure of the heart. Arrows show direction of blood flow.

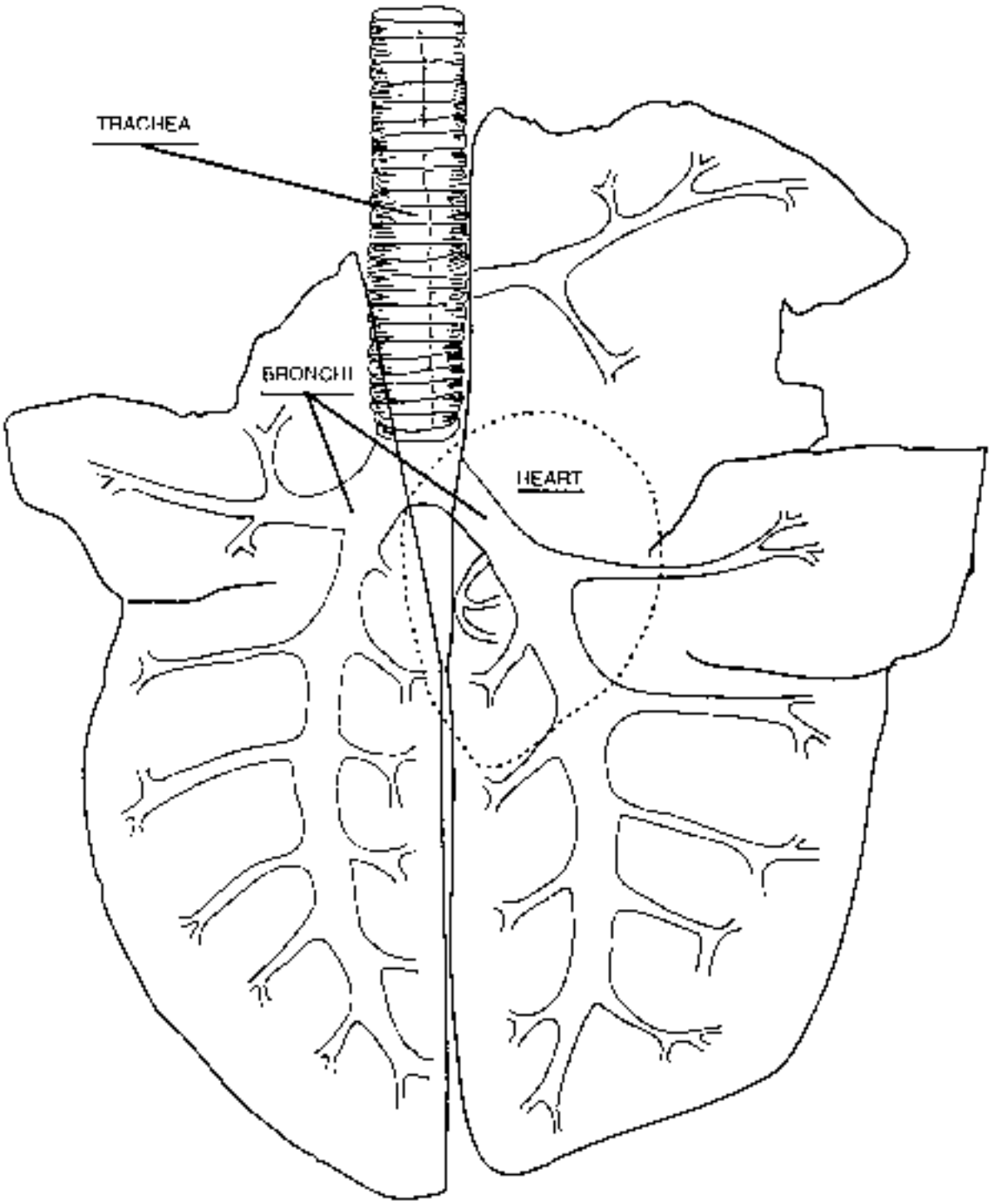


Figure 2. Structure of the lungs.

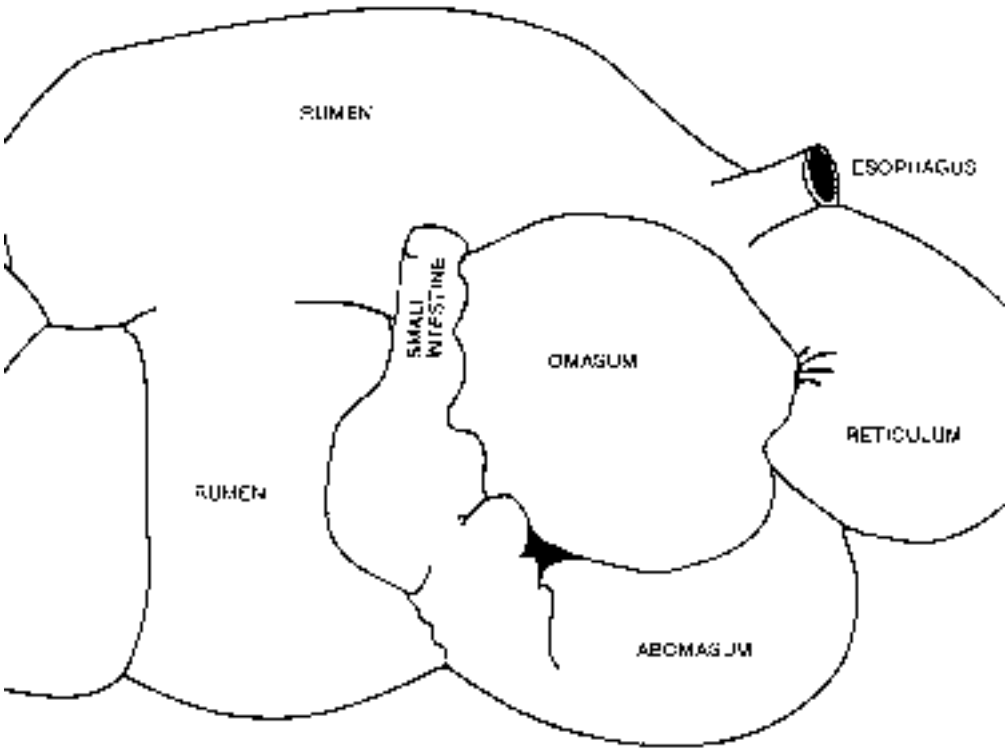


Figure 3. Ruminant stomach of the reindeer.

4 and 5 show the makeup of the male and female urogenital tracts.

The two ovaries produce eggs which travel to the uterus through the oviducts. When fertilized by the male reindeer's sperm, the egg will develop into a fawn within the female uterus. In addition to producing eggs, the ovaries make important hormones which regulate the female reproductive cycle and control the progress and maintenance of pregnancy.

The uterus in reindeer consists of two branches called horns. The two horns join into one unit near the cervix. From the cervix the reproductive tract opens to the outside of the body through the vagina. The testicles of the male correspond to the female ovaries. Sperm is produced in the testicles. During breeding, sperm travels down the vas deferens duct, leaves through the penis, and unites with the egg in the female which results in fertilization. Testicles also produce hormones that play a role in the male breeding cycle.

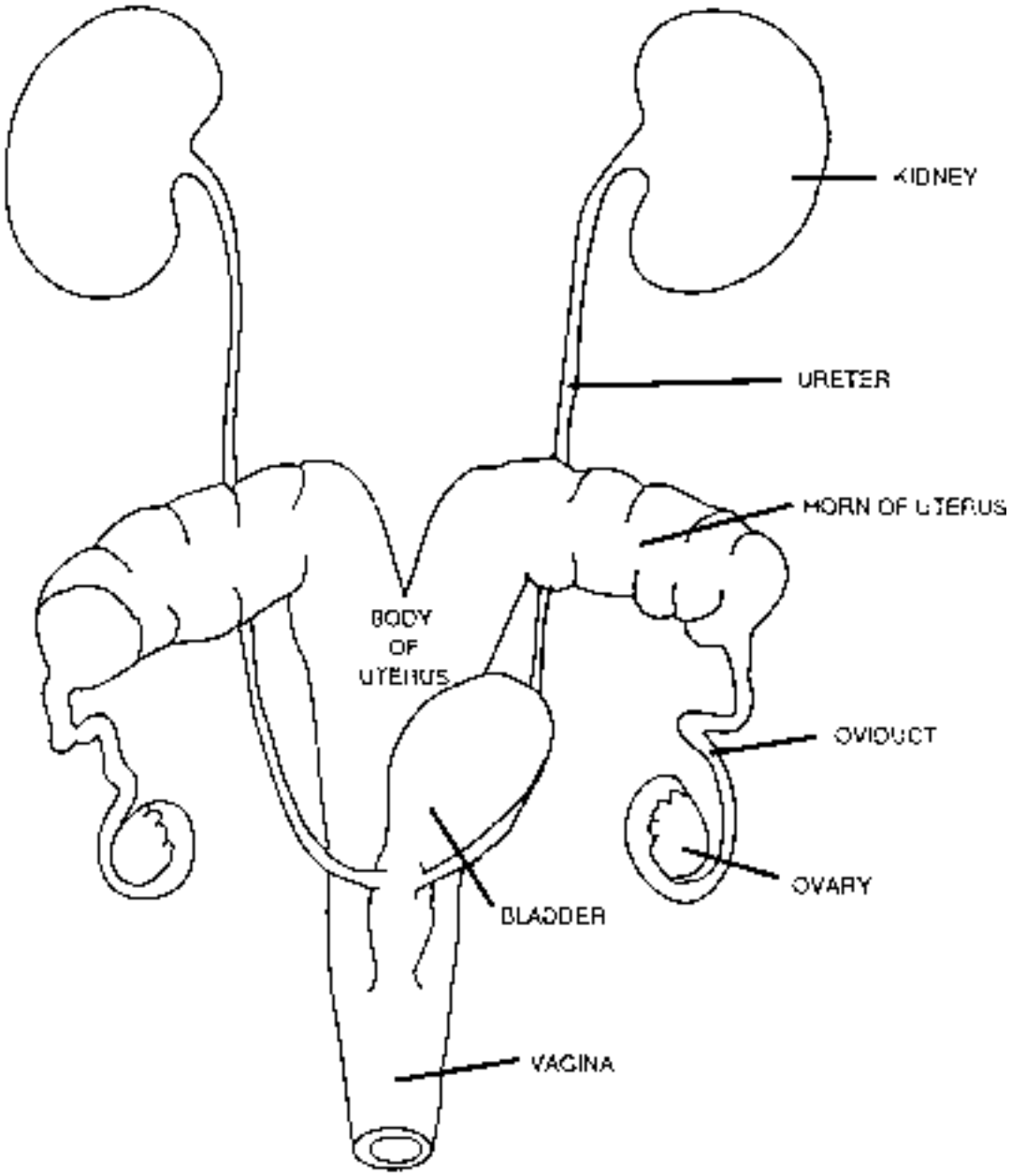


Figure 4. Female urogenital system in reindeer.

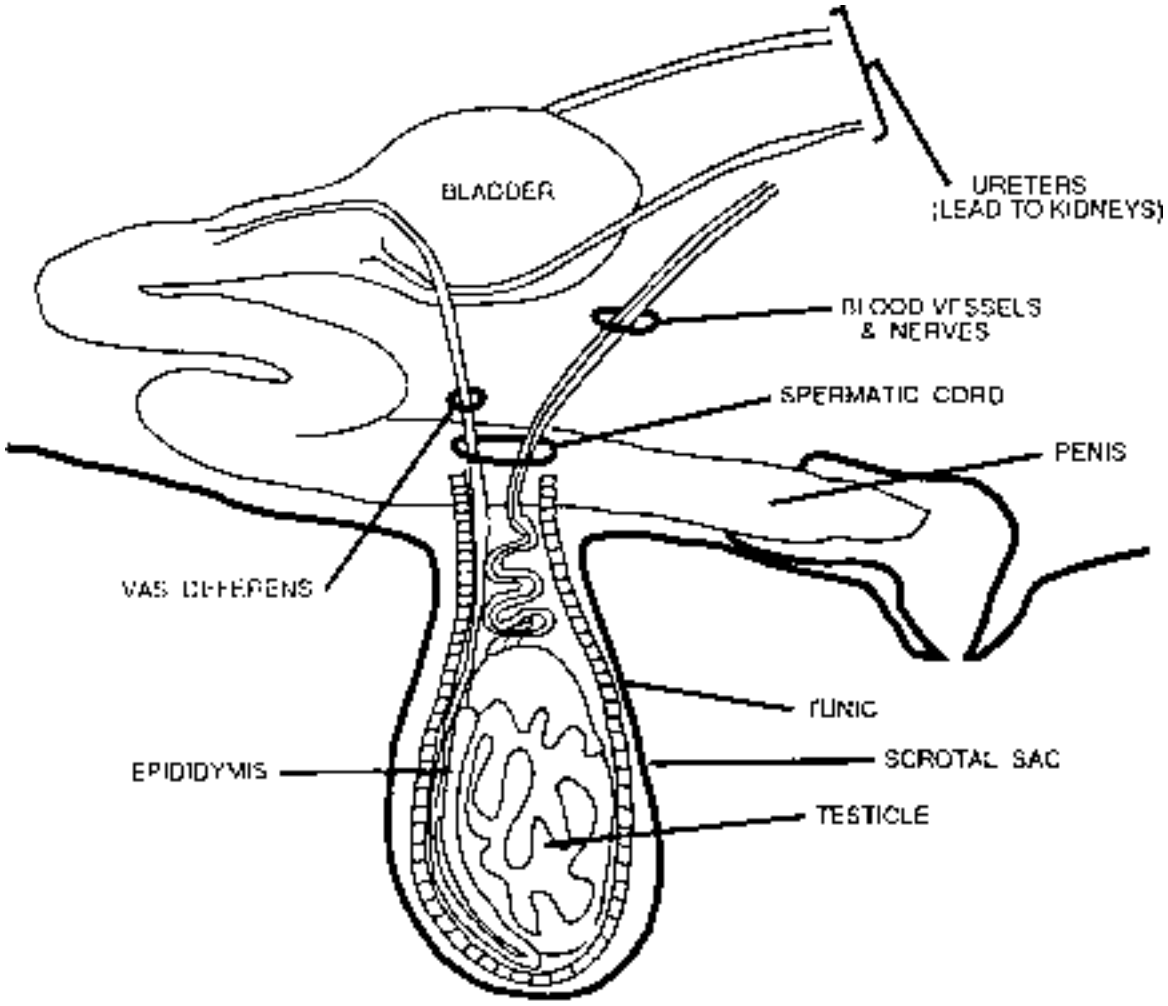


Figure 5. Male urogenital system in reindeer.

Antler Growth

Unlike other members of the deer family, both sexes of reindeer grow antlers. Generally, the bulls' antler cycle is a few weeks ahead of the females of the same herd. Both males and females shed their antlers yearly. The following account describes a typical yearly antler cycle.

Bulls start the growth of a new set of antlers in early spring, just before and during the fawning period. The females' antlers begin growing soon after giving birth. The outside of the growing antlers is covered with soft, furred skin, or velvet, which carries nerves and blood vessels to the new tissue. Blood is also supplied through the stem of the antler itself. By mid-June bulls' antlers are good-sized and are beginning to calcify. This is the usual time for cutting the male antlers. Females' antlers are cut two to three weeks later because of their slower development.

As antlers continue to grow through the summer, they harden to bone and the blood supply is gradually stopped. By the breeding season, bulls' antlers are full-sized, bony, and hard. The velvet has dried and has been rubbed off. Some females may still have their velvet at this time.

When bulls lose their antlers in November-December, the females, who still have their racks, become more dominant. In February and March, those females who are barren (not pregnant) drop their antlers. Pregnant cows drop their racks shortly after giving birth in late spring.

Fawns begin antler growth in their first summer. They retain this set through the winter and drop them the following spring.

Body Heat Control

It is of interest to look at the special features of reindeer which enable them to withstand the cold arctic winter.

Reindeer hair is unique because it is hollow, like a straw. Air is trapped inside the separate hairs, and this serves as good insulation. Air is also trapped close to the body by the long, thick winter hair coat, and in this way the body is further insulated. Hollow hair allows reindeer to float when swimming.

Why are the reindeer's legs not well-protected with a thick hair coat in winter? It has been found that the reindeer has the ability to cool down its limbs; in other words, when the weather is very cold (about -30^0F) the deer doesn't spend much heat and energy keeping its lower legs warm. Instead, the temperature in the lower legs is allowed to go down to about 33^0F just above freezing, while the chest and abdomen are still kept at the normal body temperature of 101.5^0F. Leg temperature is lowered by the tightening, or constriction, of the blood vessels feeding the legs. In this way, very little warm blood can flow down into the legs. Most of the reindeer's muscles are up high in the body where they will stay warm and functional. The lower legs and hooves are primarily tendons and ligaments. These can continue to function at low temperatures, and cool leg temperatures don't affect the reindeer's ability to move.

When the outside temperature warms above 0^0F, the blood vessels in the deer's legs open, and warm blood flows into the legs. This allows the legs to heat back to normal body temperature. This ability to cool down or warm up the lower legs allows the reindeer to conserve heat within the body. In the long run, this means less fuel, and therefore, less food is needed by the body to keep warm.

How does a reindeer cool itself? People cool of through perspiring; sweat evaporates and cools the body. Reindeer have very few sweat glands, so perspiration is not important to them. Instead, they pant like a dog and heat is given off from the moist, hot air that they exhale.

Excess heat can also be lost by the legs and antlers where there is less hair cover. Blood vessels carry more blood close to the surface of the skin to allow heat to escape. The nasal turbinates, discussed in the respiration section of this manual, are also important body temperature regulators.

Determination of Age by Tooth Wear

Reindeer have two sets of teeth. The fawn is born with milk teeth, which fall out and are re-

placed by a permanent set by the time the reindeer has reached two years of age.

In the front of the mandible are the incisor teeth, which are used to nip and tear at plants while feeding. In the rear of the mouth are the large molars. Molars are important in grinding and crushing food to make it more digestible.

The age of a reindeer can be estimated by looking at the incisor teeth on the lower jaw. A fawn still has the tiny milk teeth. A yearling has grown a permanent set which is new and unworn. As the deer grows older, the front teeth will wear down to a flat surface. The middle two incisors are the first to show wear. With age the incisors on both sides progressively wear down. A very old reindeer m•v have only tiny nubs remaining, and feeding will be impaired. Figure 6 illustrates the wearing process on the teeth of a reindeer.

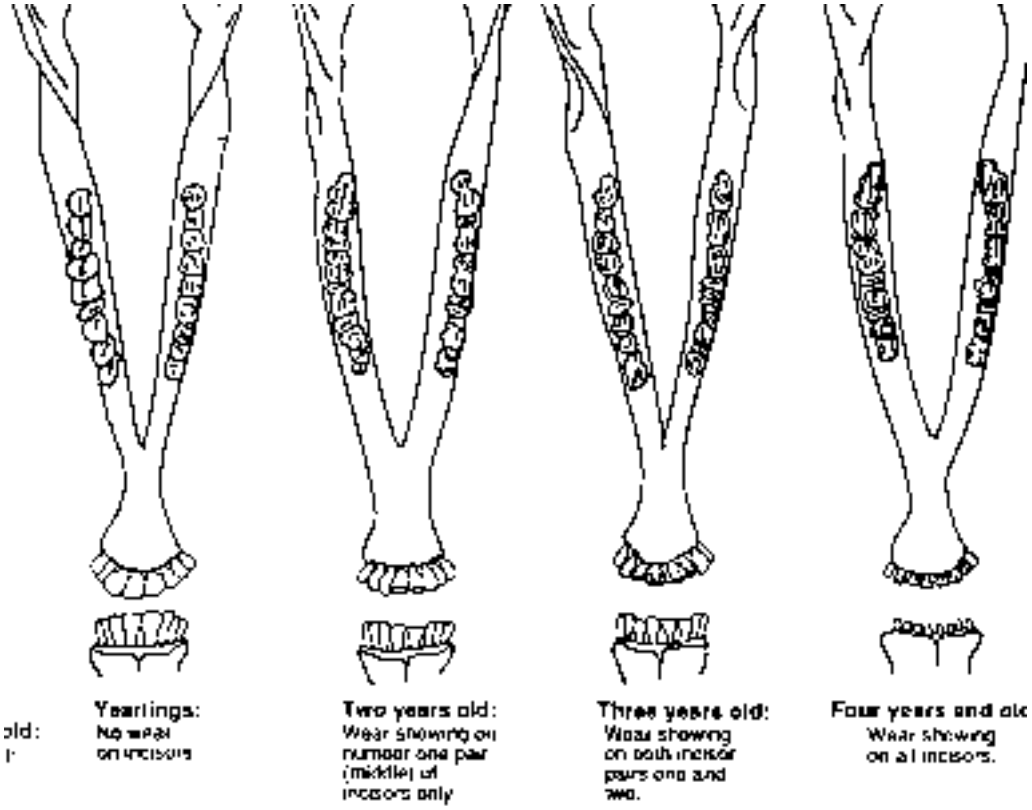


Figure 6. Age determination of reindeer by tooth wear

Bacteria and Viruses

Think of the smallest thing you've ever seen: the tip of a needle, a snowflake, or a piece of dust. Bacteria are 1.000 times smaller than anything you can see. Although they are so small, they are alive. Bacteria can be found almost anywhere. They live in water, air, on surfaces and inside living plants and animals. They can be helpful or harmful.

Helpful bacteria include those used to produce foods such as cheese and yogurt, sauerkraut, corned beef, and vinegar. Bacteria are important in decomposition of dead plants and animals, garbage, and sewage. Inside animals, bacteria can help with digestion. Bacteria are found in reindeer and cattle rumens and play an important part in digestive processes.

Some bacteria, however, are harmful. Bacteria can cause bad breath, food spoilage, food poisoning, and many diseases. Brucellosis, for example, is a disease found in reindeer and cattle which is caused by bacteria.

It is important to identify disease–causing bacteria. If the bacterial agent can be identified, the correct cure can be given to the diseased animal. Even if it is too late or impractical to cure diseased animals, if the bacteria is identified, other animals can be protected with vaccine, medications, or precautions.

How are bacteria identified? They can be stained and seen under a microscope. Bacteria come in three basic shapes: round (cocci), rodshaped (bacilli), and spiral. Some bacteria turn different colors with a certain staining method. Bacteria can be divided into general categories by use of a microscope, but there are hundreds of types of bacteria. They must be further identified by use of what is called media. Media is simply food for bacteria. It contains different vitamins, proteins, and sugars. Some bacteria form acid or produce gas when grown on certain media and will cause it to change colors. Some will only grow on specific types of media. Bacteria can be identified by their characteristics of growth on different media after they have been categorized by their shapes and staining under the microscope.

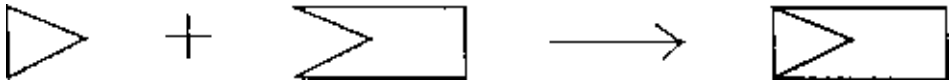
Viruses can be 10,000 times smaller than bacteria. They cannot be seen with ordinary microscopes. Although they seem to be spread nearly everywhere, unlike bacteria they cannot live by themselves. They must be inside another living cell to grow and reproduce. In doing so, they often kill the host cell. Viruses can be found in animal cells, plant cells, or even in bacteria. For these reasons, viruses are much harder to grow and identify in the laboratory. It is much easier to detect antibodies to particular viruses by doing blood tests. If an animal has some antibodies to a virus, it means it has been exposed to that virus sometime earlier. If it has many antibodies to that virus, it is probably infected with it at the time.

Virus diseases are much harder to treat than bacterial diseases because antibiotics are not effective against viruses.

Immunity to Disease

The skin is the first line of defense in keeping harmful organisms such as bacteria and viruses out of the body. However, these organisms can enter the body through a break in the skin, such as a cut, by being swallowed, or by passing through the membranes of the eyes, nose, or mouth.

Once inside the body, organisms are met by the body's army of antibodies. Antibodies are very small, microscopic molecules found in the clear plasma portion of blood. They are formed by the body in response to a foreign invader and are specific for that one type of organism. Bacteria and viruses all have a slightly different shape, and antibodies are produced to combine with a particular–shaped organism causing the problem. The antibodies react with the bacteria in a lock and key fashion:



When the antibody is stimulated by the organism, it begins dividing to make more antibodies. It takes about a week or 10 days to make enough antibodies to be effective; consequently the organism can often cause disease symptoms before enough antibodies are produced to inactivate the organism. However, once these antibodies are produced, they remain in the body and are ready for immediate action the next time the organism enters the body. This is why, for example, a person only gets mumps once. Enough antibodies are produced during the first exposure to prevent disease when the person is exposed the second time (see Figure 1 on Natural Disease Response).

This principle is used to vaccinate animals against a disease. Disease organisms can often be changed enough in the laboratory that they are able to stimulate antibody production but can't cause disease. A vaccine contains the organisms that will stimulate the body to make antibodies. The body produces antibodies to a vaccine just as it does in a natural disease response, and when the animal is later exposed to the real disease organisms, a full army of antibodies is ready to fight. Thus vaccination prevents disease. Because it still takes the body at least a week or 10 days to make protective antibodies, a vaccine must be given well before natural disease exposure. A vaccination will do the animal no good once it is already sick (see Figure 2 on Vaccination).

Antibiotics or certain drugs may be given to treat a sick animal. Sometimes the animal's natural defense mechanisms are not effective against the disease process, and antibiotics help by killing the disease organisms (see Figure 3 on Antibiotics and Treatment).

Brucellosis

Brucellosis is a bacterial disease that also goes by the name of Bang's disease in cattle, contagious abortion, and undulant fever (in humans). Different species of the bacteria affect different species of animals: *Brucella abortus* (cattle), *B. suis* (swine), *B. melitensis* (goats), *B. ovis* (sheep), *B. canis* (dogs), and *B. neotomae* (desert wood rats). Man can be infected by each type.

A variety of wild animals can become infected with brucellosis. These include elk, bison, caribou, reindeer, wolves, fox, and bears. In Alaska the disease is of primary concern in reindeer and caribou which are infected by their own type of Brucella, *Brucella suis* type 4. It has been suggested it should be better called *B. rangifer*.

History

The disease organism was first isolated from humans dead of "gastric fever" in 1887 by David Bruce, whose name is the basis for the term brucellosis. In 1897 Frederick Bang isolated and identified *Brucella abortus* from aborted bovine fetuses. As time passed, more was learned about the organism, and it was found in a wide range of hosts. Important sources of infection for humans were found to be milk, aborted fetuses, or slaughtered cattle carcasses. Symptoms in humans include malaise, fever, weakness, aches, sweats, digestive and nervous upsets, liver and bone marrow inflammations.

For a number of years, *Brucella* has been known to infect reindeer and caribou in the Soviet Union. It is not known whether the disease was introduced into Alaska with the importation of reindeer from Siberia in the late 1800s or if it has been present since prehistoric times. The disease was identified in Alaska in humans with 49 cases being recorded between 1939 and 1953. During that period it was believed that these cases were due to drinking raw milk or contact with cattle or swine. However, later studies suggested that caribou might have been the source of infection in some cases. *Brucella* was isolated in caribou in Alaska in 1963 which established the actual source of most

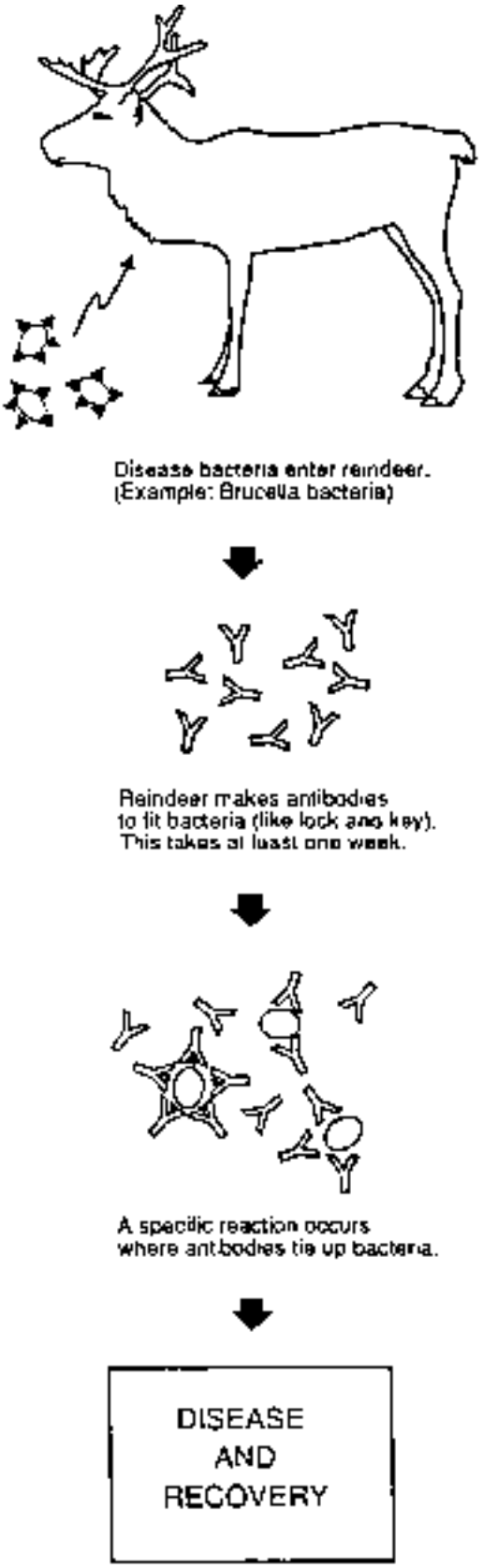
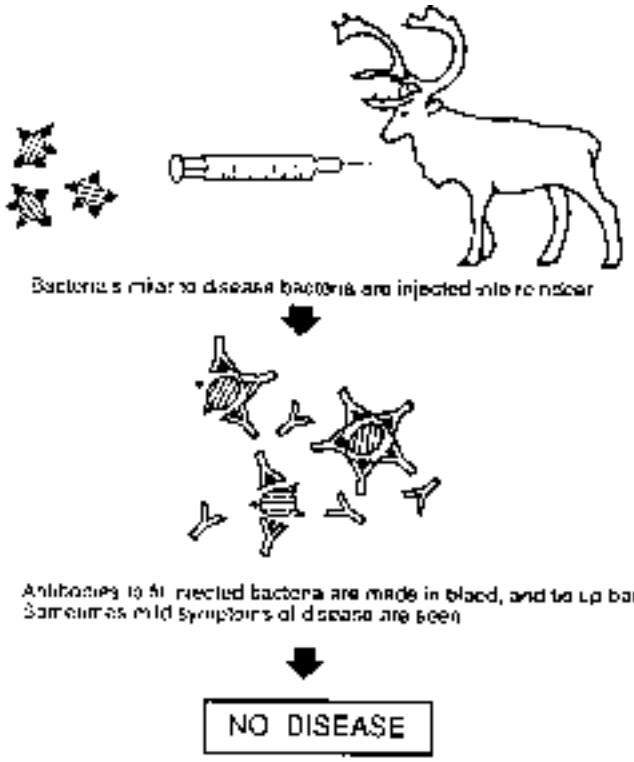


Figure 1. Natural disease response.

A.



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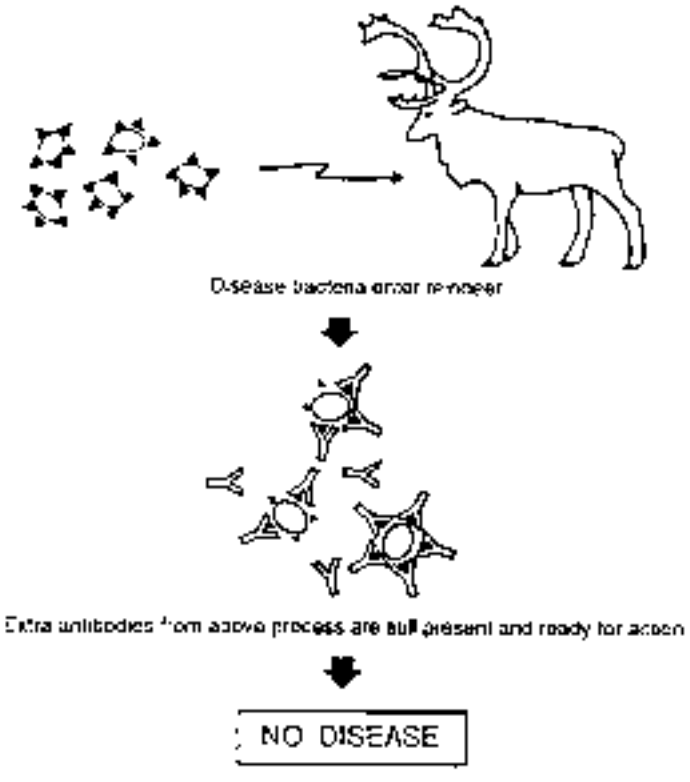


Figure 2. Vaccination

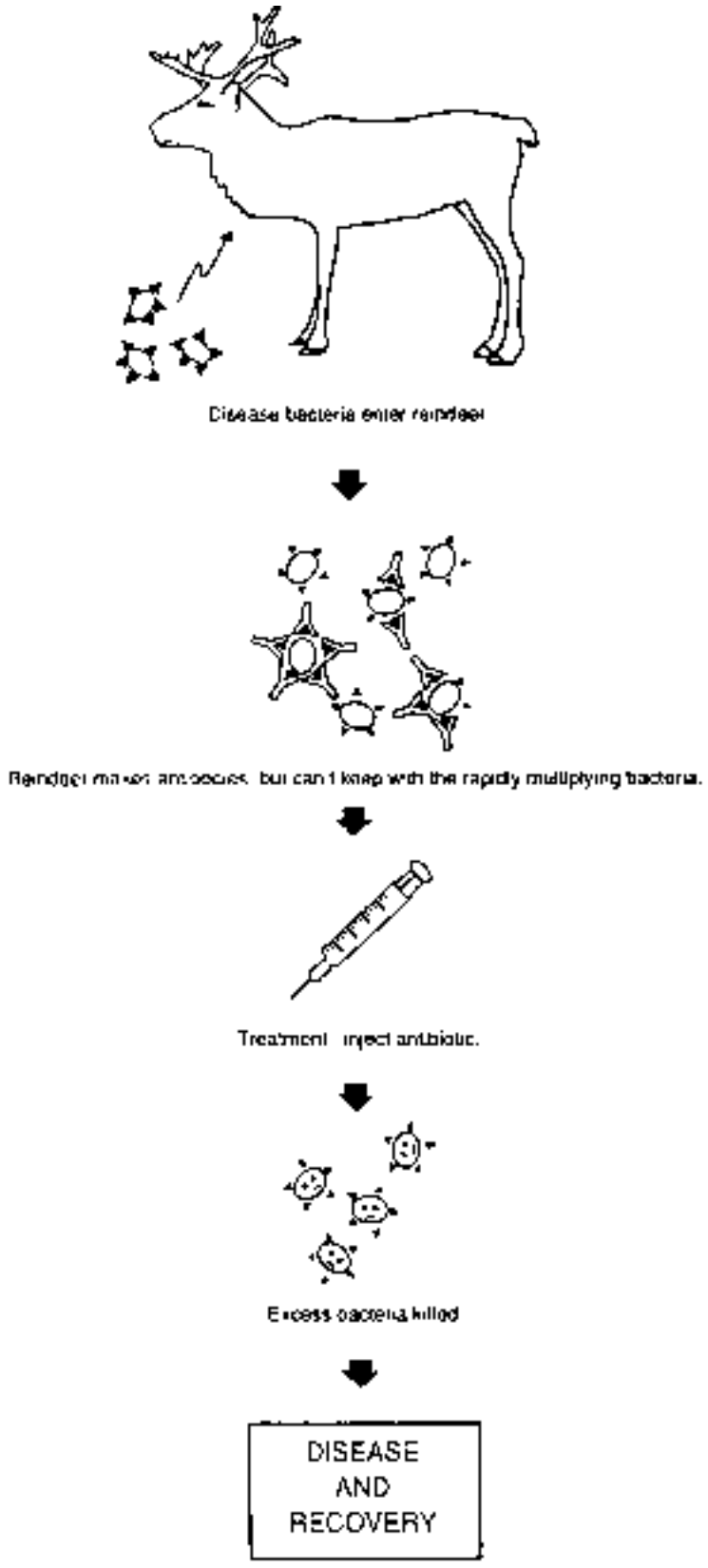


Figure 3. Overwhelming infection.

recent infections. The type of *Brucella* isolated in caribou was found to be the same type infecting several Native patients in rural Alaska. In 1964, about 20% of the residents of Fort Yukon and Arctic Village were positive for brucellosis as determined by the rapid slide test. In a serologic study of seven villages in 1962-1964, 11% of 763 individuals tested had evidence of past *Brucella* infection. It was also reported that eight cases occurred from 1962-1964 in Eskimos having frequent contact with reindeer or caribou in northern Alaska. No cases were found at that time among people living outside that area. Seventeen cases of brucellosis in humans were reported in Alaska between 1966 and 1975. Authors point out there is little doubt that many cases do not come to the attention of medical personnel. Physicians in Alaska bush communities are frequently short-term and many cases of brucellosis may go undiscovered because medical personnel are unaware of the many signs of the disease.

Following the detection of brucellosis in Alaska reindeer and caribou, evidence of the disease was also found in Alaskan grizzly bears, wolves, red foxes, sled dogs, and Arctic ground squirrels that come into contact or feed upon tissues of reindeer and caribou. Serologic blood testing of caribou and reindeer for brucellosis was carried out during the early 1960s and 1970s. The highest percentage of animals having a positive blood test at various times was 30% for the Arctic caribou herd, 6.5% for the Nelchina caribou herd and up to 15% for some of the reindeer herds on the Seward Peninsula. Recently, renewed testing of reindeer on the Seward Peninsula indicates that the disease has spread into herds found on the northern part with incidence of serologically positive animals reaching 30%. Signs of brucellosis are commonly seen in these infected reindeer herds when the animals are closely observed.

Brucellosis is also recognized as a health problem in elk and bison herds in North America. The disease is now under study in these populations by several different research teams.

Transmission and Pathogenesis

Brucella bacteria grow well in the male and female reproductive organs, and the major impact on herd health occurs because of abortion and sterility. Brucellosis causes abortion, retained placentas and impaired health in female reindeer and caribou. Infection in males is seen in the testicles and related reproductive tissue In both males and females there can be swelling of the joints with associated lameness. It is believed that the primary spread of the disease is by contact with infective uterine discharges following abortion. Abortion in reindeer appears to occur one to two months before normal fawning time in early May. Fawns may also be born alive but weak and die within a few days. Other fawns born to infected females can survive but remain infected as carriers of the disease. In domestic cattle. Females commonly abort when first infected. They may or may not abort the next year, and after that they produce live calves. This same pattern appears to be true for reindeer, but joint disease, abscesses, and other chronic signs of the disease appear as the infection progresses. The exact course of the disease and its impact on reindeer and caribou herds in Alaska has yet to be determined. The role of male animals in passing on the disease through mating is not fully understood.

It should be stressed that the major impact of brucellosis on a reindeer herd is reduced reproduction. Lame animals are commonly seen in a herd of infected reindeer. Infected individuals will most often have enlarged knee or hoof joints and will only use the affected limb when being chased. These animals will be particularly lame when they first move after resting. Careful examination of males will reveal enlarged testicles, some as large as 12 to 20 cm in diameter. Others may only have a swollen epididymis (found attached to the testicle) which can only be detected by feeling the swelling or seeing it at necropsy. Such visible signs of the disease in reindeer or caribou herds represent only a small part of the overall effect of the disease.

Abscesses containing an odorless, thick, light-green pus are found in *Brucella*–infected reindeer and caribou. These are most commonly located in the milk–producing tissue but can be found in the reproductive organs, liver, kidney, abdominal cavity, or as lumps under the skin.

Diagnosis

Diagnosis of brucellosis in wildlife can be made by serologic testing or by actual isolation of the bacteria (*B. suis* type 4 in Alaska) in the laboratory. In reindeer, it has been found that the commonly used field tests (rapid card test and standard plate test) will not identify all chronically infected carrier animals. These tests do, however, accurately identify acutely infected animals.

The actual isolation of the bacteria in the laboratory proves that a *Brucella* infection is present, but this procedure depends on supplying the laboratory with suitable tissues for culture. Tissues (obvious abscesses or swellings, lymph nodes, organs) must be submitted within a few hours of sterile collection or can be frozen immediately and submitted later. Isolation of the organism is dependent on the proper collection of infected tissues. *Brucella*–infected tissues may not show outward signs of disease. Handling diseased animals should be done with extreme care using aseptic procedures to reduce the possibility of human infection.

Significance and Control

The importance of brucellosis in reindeer appears to be substantial. It should be stressed that brucellosis in reindeer is a disease that directly causes relatively few deaths in adults but does infect many animals chronically. It does cause death of unborn young and greater loss through predation and weather–related mortality because of the associated lameness. Therefore, the occasional observer of a herd will not be struck with the effect of the disease because he will not see animals laying about dead nor many obviously ill. The actual impact will be seen in herd reproduction which is difficult to measure in wild populations. Other factors such as climate, nutrition, predators, etc. affect population numbers, but it is hard to determine how each factor affects groups of animals that are only occasionally observed. In domestic animals that are herded closely or confined to pens, the owner will easily notice a retained placenta, dead calf, or a barren cow.

The predators of reindeer are known to be naturally infected with the *Brucella* organism. In the laboratory, transmission of brucellosis from fox to reindeer has been demonstrated. Grizzly bears harbor the disease for a prolonged period after being experimentally infected. The effects of brucellosis on the predators themselves does not appear to be of major consequence.

Brucellosis has rarely been reported in moose even in areas which overlap with reindeer or caribou range. Moose are highly susceptible to *Brucella*, and it has been postulated that infected moose may die in a short period of time and thus, are removed from any population being sampled. Further research is needed before any conclusion can be reached.

Brucellosis is a zoonotic disease, that is, a disease that can spread from animals to man. Some Alaskans who handle reindeer or caribou tissues are infected each year. The number of infections is not great. The degree of illness varies among individuals. Some humans with serologic evidence of brucellosis report few or no symptoms. Others are severely ill and require hospitalization. If brucellosis is recognized early, it can be treated successfully with antibiotics. The chronic cases are more difficult to cure. *Brucella* organisms rarely infect muscle tissue so most meat from infected animals is safe to eat. Reproductive organs, internal organs, Iymph nodes, and bone marrow should be handled with care, preferably with protective gloves. Thorough cooking kills the organism but freezing does not. Extreme care should be exercised in handling any fetal membranes or aborted tissues.

Two methods of brucellosis control are now being developed for reindeer. First, with the aid of

an accurate blood test, infected animals could be detected and removed from the herd. This removal would have to be linked to the economics of herding because many animals would be involved. However, it is difficult, if not infeasible to round up all the reindeer at one time for testing, and the possibility would exist of reinfection of "clean" herds by non-tested reindeer or by infected migratory caribou or predators. A vaccination program is the preferred method of controlling the disease. If most a herd is vaccinated, then the amount of infective organisms is greatly reduced. There is a significant reduction in the incidence of the disease and the observation of clinical signs.

The current product used to control brucellosis in Alaska reindeer is call a *killed homologous vaccine in adjuvant*. This product provides protection for up to at least four years. Currently it is recommended that all reindeer in a herd be vaccinated after reaching the age of six months. In practice this means that all non–vaccinated reindeer should be vaccinated when corralled during the normal winter handlings for separation, marking, and warble treatment.

Vaccination stimulates the animal's immune system to produce antibodies to the brucellosis organism as discussed in the Immunity to Diseases section. These antibodies present a problem when reindeer are blood tested after being vaccinated to determine if they are carriers of the disease. Current testing methods cannot determine the difference between a reindeer that has been vaccinated and one that has contracted the disease naturally. Research is currently under way to develop a modified vaccine and new testing methods that would be able to distinguish between naturally infected and vaccinated reindeer. This differentiation becomes particularly important when reindeer are shipped from an infected herd to other locations. Non-vaccinated, blood test negative animals, or known vaccinated animals are the safest to ship to other locations.

The current brucellosis vaccine is produced in Alaska and is approved for use in the state with the permission of the state veterinarian. Administration of the vaccine is not difficult, but care must be taken to ensure that it is properly cared for (refrigerator temperature, not allowed to freeze, clean syringes and needles, etc.), and that it is given subcutaneously (under the skin) in the side of the neck. It is not uncommon for a lump to form at the site of the injection. This lump can enlarge to the size of a lemon and fill with a non-infective pus–like material. This material is the reindeer body's reaction to the foreign matter and is not harmful. If it is found at slaughter time, it should be cut away as a sack and discarded. These lumps do not affect the wholesomeness of the carcass and do not represent any threat to the reindeer or the people slaughtering the animals.

As more Alaskan reindeer are vaccinated, the prevalence of brucellosis will decrease resulting in a healthier herd. Increased profits will accrue resulting from increased herd productivity.

Rabies

Rabies is a very serious disease caused by a virus. The virus is carried in the saliva. Rabies is spread through a bite by the infected animal. The virus can also be carried in saliva that gets into a cut or wound in the skin. The disease affects all animals, including man, and if left untreated, results in death. Although rabies is not commonly found in reindeer, it is an important condition to be aware of. The disease is always present in a few red and arctic fox throughout Alaska, and the possibility for infection of reindeer or humans by local foxes or dogs does exist.

The disease virus does its damage by reproducing many times within the animal and migrating along nerve fibers to the brain. Because it acts upon brain tissue, rabies usually causes an animal to act strangely and will often affect its ability to walk, swallow, or bark. A rabid wild animal may lose its fear of humans (it will act tame and unafraid), and will be seen in places that it would normally avoid. The disease may cause an animal to become vicious and unpredictable, attacking anything that moves. In other cases, a rabid animal might avoid light and noise and simply seek out a quiet dark corner to lie down.

A typical sign of a rabid animal is heavy drooling at the mouth; this occurs because it has lost the ability to swallow.

In Alaska, rabies is most commonly found in foxes, and the number of affected animals in an area seems to follow a cycle. When fox populations rise, the number of infected foxes also rises. Outbreaks of the disease occur most often in fall and winter. Rabies seems to occur less frequently in wolves, bear, caribou and moose.

In the past, rabies in reindeer has coincided with a high prevalence of the disease in foxes. The number of foxes typically increases and peaks every few years. The great increase in foxes with rabies which attack and bite reindeer results in infection and death in herds. It has been estimated that about 100 reindeer have died on the Seward Peninsula during an outbreak. No deaths have been reported in years of low rabies prevalence in foxes. The disease is self-limiting in reindeer as they apparently do not spread the infection among themselves. Rabies vaccination of reindeer is normally not recommended because of the low prevalence of the disease. No rabies vaccine currently available is approved for use in reindeer. Vaccines are available for use in most domestic animals.

A reindeer with rabies typically has some degree of impairment of locomotion such as staggering, posterior paralysis, or the appearance of being blind. They can be aggressive to humans or other reindeer, attacking them with their head or front feet. Some will have saliva hanging from their mouths. Infected reindeer should be killed. It is best not to shoot the animal in the head as the brain may be needed by a diagnostic laboratory. Observations of reindeer with rabies symptoms should be reported to public health officials and appropriate agencies. Precautions, such as wearing rubber gloves should be taken if it is requested that the animal's head be shipped to a laboratory for diagnosis.

Although foxes are most commonly infected, they do transmit the disease to dogs. It is through dogs that most human infections have occurred. If rabies is suspected in a certain area, it is wise to wear gloves when skinning a fox and to avoid getting the fox's saliva on the hands.

If a person has been bitten by a wild animal suspected of having rabies, the animal should be killed immediately and the head sent to the nearest rabies unit (see Appendix VI). The laboratory will test the brain matter to see if the animal truly had rabies. If so, the person must start rabies treatments immediately. A doctor, nurse, or veterinarian should be notified immediately if someone is bitten by an animal that could have rabies. In some cases, the treatments must be started immediately without waiting for the laboratory results. This will depend on where on the body the bite is located and how badly the person was bitten. It normally takes anywhere from two to eight weeks for the signs of the disease to show. Once symptoms appear, it is too late to start treatments.

An important way to reduce the number of rabies infections in the state is to vaccinate dogs against the disease. By protecting dogs from rabies, you indirectly protect the people in your area.

Respiratory Diseases

Many factors can lead to diseases of the respiratory tract. If the reindeer is weakened by stress, exhaustion, cold, wet weather, poor nutrition, lungworms, or other disease, the body's immune system may also be weakened. Organisms normally present in the reindeer's environment become harmful when the normal defense mechanisms are lowered.

Pneumonia is one of the most common results of a weakened condition. Lungs in a reindeer with bacteria–caused pneumonia may be off-color with a white or green pus. Lungs may be "sticky," i.e., stuck to the wall of the chest cavity. A dark color due to an abnormal accumulation of blood may be seen. Badly diseased lungs may look like liver. A reindeer with respiratory disease may be observed to be slow, weak, and may travel with its head held low. It may have a thin, watery or a thick, mucous discharge from the nose. If the lungs are damaged, they simply can't transfer enough oxygen

to the blood for survival.

Recently, serologic (blood test) evidence has shown some reindeer have antibodies to a group of bovine respiratory viruses. This indicates that the reindeer have been exposed to these viruses at some time. This group of viruses includes BVD (bovine viral diarrhea), IBR (infectious bovine rhinotracheitis) and PI_3 (para-influenza-3). Although the signs and symptoms in reindeer are not yet certain, these viruses cause many effects in domestic cattle including respiratory tract infections, diarrhea, reproductive tract infections, abortion, eye infections and brain infections. Signs in cattle are usually associated with stress. Antibiotics may be used to treat certain respiratory tract infections. Diseases of the respiratory tract can probably best be prevented by reducing or eliminating stress. Certain vaccines have been used in cattle, but their effectiveness in reindeer has not been determined.

Foot Rot

Two diseases cause most of the lameness seen in reindeer. One is brucellosis, discussed in a separate section, and the other is foot rot.

Foot rot probably starts when the hoof is damaged. Bacteria can then enter the foot through the break in the hoof. It is believed the bacteria (*Fusobacterium necrophorum*) which causes foot rot in cattle is the same one that causes foot rot in reindeer.

As the infection progresses, the foot and hoof may become large and deformed. An open, draining sore in the foot is usually seen in foot rot but not in brucellosis.

Foot rot can be treated with some success with penicillin injections or sulfa-containing pills. Certain chemical foot baths can also be used.

Certain other nonspecific events such as an inflammation or injury in the hoof or mineral deficiencies can also cause large, abnormal hooves. Sometimes reindeer will quit using an injured foot or leg, and the lack of use will allow the hoof to grow longer than normal.

Mandibular Lesions

An abnormal swelling or deformity in the lower jaw (mandible) is called a mandibular lesion. It is an infection of the bone. It begins from damage around the root of the tooth along the gum line. The same type of syndrome in people is called periodontal disease. Damaged teeth may fall out. The incidence of mandibular lesions seems to increase with age; more mandibular lesions are seen in older deer than younger. There is no specific treatment for this disease.

Setaria

Setaria is a parasite but is discussed here because it affects the reindeer more like a disease than a parasite. The adult worm lives free in the abdominal cavity outside the intestines. It is a white worm visible to the naked eye. *Setaria* causes a gray, cloudy surface on the liver.

Immature *Setaria* live as microscopic larvae in the bloodstream. Biting flies pick up these microscopic larvae (called microfilariae) in the blood and carry them to another animal when they bite it.

Moose can also be infected with *Setaria*. *Setaria* appears to be more prevalent in reindeer in interior Alaska probably because it is transmitted to reindeer from moose in the area.

Fibropapillomas

Fibropapillomas are warts caused by a virus and may be seen on the side, head, or elsewhere on reindeer. Although they can grow as large as a man’s fist, they are attached to the reindeer by a thin stalk. They are not harmful, but they can become quite annoying. These warts can be cut off at the stalk or base. An antiseptic or antibiotic powder should be applied afterwards to prevent infection.

Keratitis (white–eye)

Keratitis is an infection of the eye. It is usually seen in the summer and is associated with dusty conditions and flies. The affected eye may appear cloudy or white with redness in the white of the eye and around the border. Pus may be seen around the eyelids. It can lead to blindness.

Fortunately, keratitis can be treated with a combination of penicillin and cortisone.

Reindeer with keratitis and blindness in both eyes probably die. Consequently, keratitis is usually only seen in one eye.

Abortion

Abortion, or premature birth of a dead fawn, can be caused by any one of several things. Brucellosis is the most common cause in reindeer. Other diseases, malnutrition, and stress can also cause abortion.

Broken Antlers

Broken antlers should be cut off if possible. Reindeer ‘go crazy’ with a broken antler flopping around. They may starve to death from being so distracted. It is *especially* important in fawns as the skull is usually also broken. Continued movement of that antler moves the broken skull cap around and damages the sensitive brain tissue underneath. Fawns will probably die of brain damage if untreated.

Broken antlers on adults may be cut at the break or at the base. On fawns they should be cut off as close to the head as possible without breaking the skin.

An antiseptic or fly repellent should be sprayed to help prevent infection. Rubber bands may be applied to the base to control bleeding if necessary on adults.

Parasitology of Reindeer

Parasites

A parasite lives in or on another animal and gets its nourishment and shelter from that animal, called a host. Parasites living inside the animal are called internal parasites and resemble worms. They are small, but most can be seen with the naked eye. Internal parasites may be found in the intestines, stomach, and lungs. Some, *Setaria* for example, may be found free within the abdominal cavity. Parasites living outside an animal are called external parasites and include lice, mites, and ticks.

Warbles

The warble is a major pest infecting Alaskan reindeer. The larval stage of the warble is a parasite that lives underneath the skin. It impairs the health of the reindeer. General management of the herds is affected by the widespread presence of the adult fly.

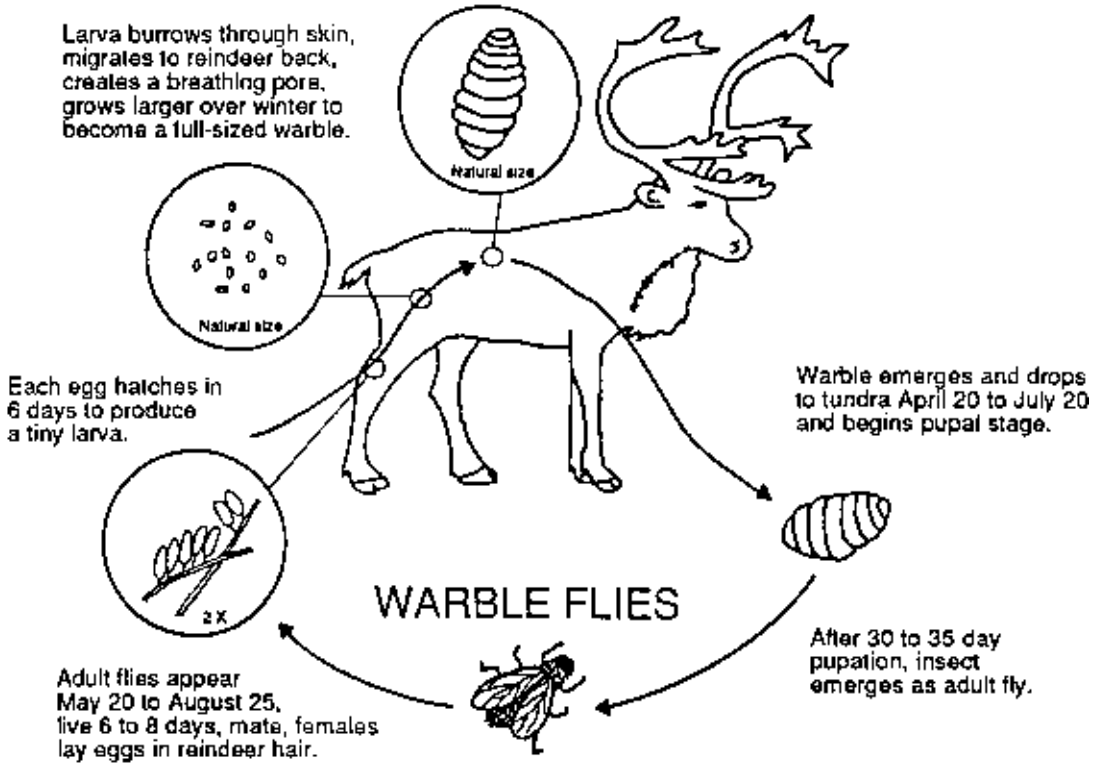
Figure 1 illustrates the life cycle of the warble fly. Adult flies can be found on the tundra from late May to late August. The flies do not feed during this time, and are not parasitic to reindeer as adults. Thee flies mate. After mating, females spend their time laying eggs. The eggs are laid onto the base of the shaft of reindeer hair, near the warmth of the reindeer's body. Eggs are most commonly laid on the deer's legs, rump, and back. Adults continue laying eggs through the summer. They die when temperatures drop in early fall. The eggs take about six days to hatch into tiny, wormlike larvae. The larvae are the true parasites of reindeer. They burrow into the skin and travel underneath the skin to the deer's back. When the larva comes to rest, it becomes walled off in a sac of tissue called a cyst. Here the larvae feed on the reindeer's blood and body fluids. In late September to October, the larvae chew a breathing hole in the skin where they are resting. Through the winter they grow into thick grubs about an inch long. In late spring, these grubs emerge from their holes in the reindeer's skin and drop to the tundra. Once on the ground, they transform into adult flies, and the cycle begins again.

During summer, adult flies are a worrisome nuisance to the reindeer who frantically try to avoid the buzzing flies that are trying to lay their eggs. The flies are most active on warm, sunny days. At these times, the reindeer may spend much less time feeding as they run or trot to keep away from the flies. For this reason, the warble flies can prevent the reindeer from fattening up during the summer. From the herder's viewpoint, the deer are much harder to control and keep together because of their nervous reaction to warble flies.

Infected reindeer have been found to have as many as 200 to 2000 larvae living under the skin. This can greatly weaken the deer and may especially harm young fawns who need all their nourishment to feed their growing bodies. Presence of the larvae can increase the risk of bacterial infection or cause harmful bodily reactions in which the body tries to kill the large number of invading larvae. The generally weakened condition of infected reindeer may make them more vulnerable to bad weather conditions, predators, or diseases.

The large number of larvae breathing holes and the scar tissue resulting from cysts greatly reduces reindeer's hide quality. This can have major economic importance on the value of the herd as the hides are worth less to the buyers. There are several reasons, then, to protect reindeer from warble parasites.

Treatment of reindeer infected with warbles involves the use of the drug Ivermectin which kills the larvae but does not harm the reindeer. Ivermectin is used in most other domestic animals to



Effects:
1. Slow growth, decreased weight gain
2. Secondary infections along back.
3. Death in severe cases.
4. Increased susceptibility to disease, climatic stress, and predators.
5. Erratic behavior to avoid adult fly (difficult herding).
6. Lowered value of scarred hides.

Control:
1. Single yearly injection of drug (Ivermectin) eliminated 98% or more of warbles.
2. Treatment must be done from September to the end of January to reach larvae.

Figure 1. Warble flies.

control both internal and external parasites. Tests were performed by the University of Alaska in cooperation with the United States Department of Agriculture to determine Ivermectin's safety, effectiveness, and body tissue residues. Results of these tests were submitted to the US Food and Drug Administration (FDA) and approval was granted to use Ivermectin in reindeer. These studies demonstrated that the drug could be given up to at least 10 times the normal dosage with no adverse effects. The drug was shown to be more than 98% effective in killing warble fly larvae when administered sometime between October and the first of February.

Ivermectin is not considered toxic to humans, but as with all drugs given to meat producing animals, the FDA sets a limit on the number of days after treatment during which treated animals are not to be slaughtered. This limit is called the withdrawal period. For reindeer it is 56 days. This withdrawal period allows the reindeer to eliminate the drug from its tissues before the meat is eaten. If a herder wishes to slaughter some animals within 56 days after a marking and treatment handling, he should not inject the reindeer scheduled for slaughter. This will not affect the overall control of warbles in a herd as the larvae in the slaughtered animals will die.

Ivermectin is given by injection subcutaneously (under the skin) in the side of the neck. There is no reaction to the injection (no lumps, etc.). As mentioned earlier, reindeer should be treated between October and the first of February. This timing is important to kill the warble larvae while it is still small and living in the body of the reindeer. None of the adult warble flies live past the end of the summer (after a heavy frost), so it is possible to kill almost all the warbles in a herd if all the animals are treated. Fawns and adults should be treated at a dosage rate of 1 ml per 110 pounds of body weight.

Another reason not to treat reindeer past the first of February is to avoid handling pregnant females. Handling stress can induce abortions in females in the last third of pregnancy.

Treatment with Ivermectin is an easy, economical way to control warbles and other parasites in reindeer. A good treatment program can do much to increase the general health of a herd, improve the quality of hides, and make herding and management an easier process.

Nasal Bots

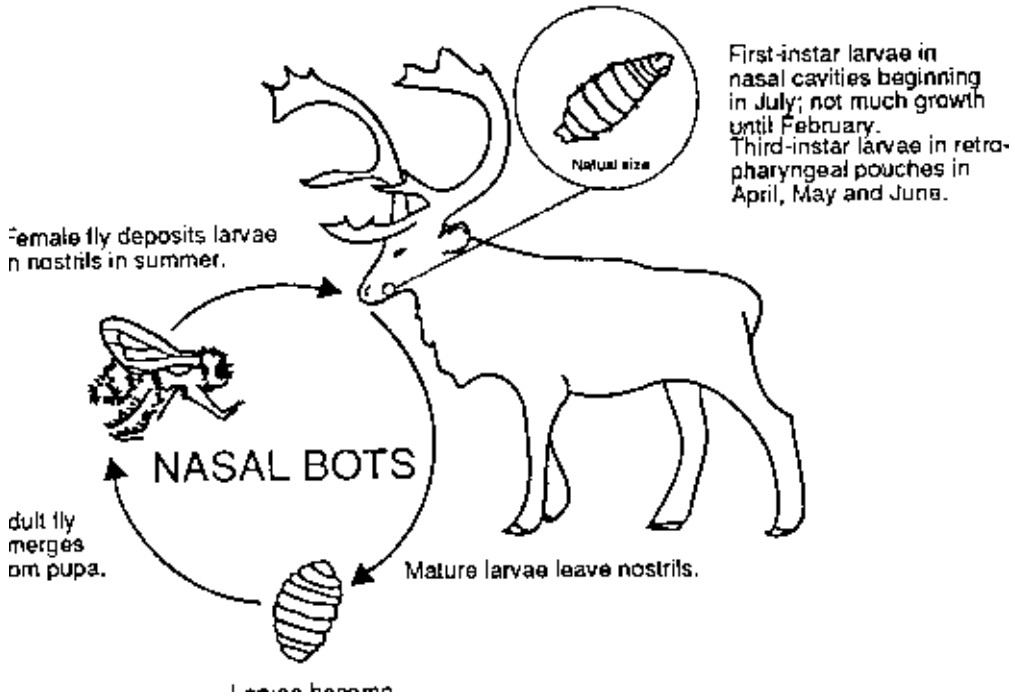
Nasal bots are similar to warbles in that it is not the adult that is the true parasite of the reindeer, but its immature form or larvae (Figure 2). In the summer, the adult fly deposits larvae close to the nostril openings. This in itself causes strange, irregular, or erratic behavior in the reindeer as they try to avoid the adult pest.

The first stage larvae travel to the nasal cavities where they live most of the winter. As they begin to grow in the spring, they move to what are called the retropharyngeal pouches or sacs at the upper end of the nasal cavity. This causes considerable irritation, and reindeer can be heard snorting and sneezing in their attempt to get rid of the larvae.

By the time the nasal bot larvae make their way out of the nostrils or are sneezed out, they are about the size of the warbles seen in the back. Once on the ground, the larvae develop into pupae and become adult flies continuing the cycle.

Both the adult fly and the larvae are severe pests for the reindeer. Large numbers of larvae in the nasal pouches can cause suffocation. Sometimes larvae find their way to the lungs where they start a pneumonia process.

Fortunately, the same drug that is used to kill the warble fly larvae also kills the nasal bot larvae. Control of this pest has progressed with the control of warbles (see Figure 1).



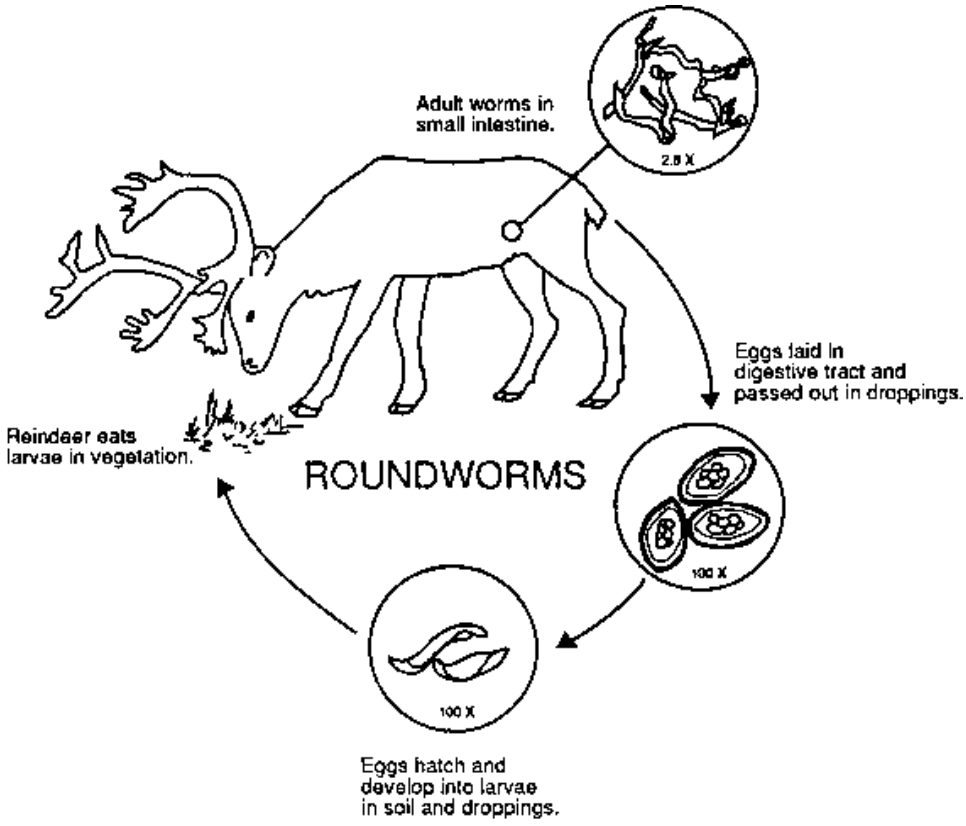
Effects :

1. Erratic behavior to avoid adult fly.
2. Nasal irritation, sneezing as mature larvae leave nostrils.
3. Heavy infection may cause suffocation.
4. Larvae sometimes migrate to lungs.

Control:

Ivermectin (same drug for warble control) will aid in the control.

Figure 2. Nasal bots.



Effects:

Stomach worms are bloodsuckers; Cause anemia, poor growth, diarrhea.

Intestinal worms cause poor growth and diarrhea; may be followed by constipation.

Diagnosis:

Microscopic, in feces.

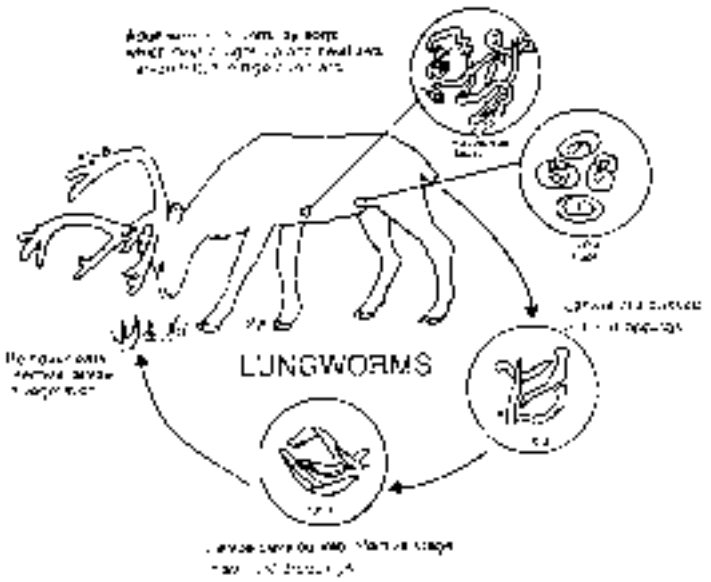
Figure 3. Roundworms.

Internal Parasites

Adult roundworms living in the stomach and intestines lay eggs which pass out of the body with the manure and fall to the ground. These microscopic eggs hatch and are eaten by other animals as they graze. The immature worms develop into adults in the stomach or intestines, and the cycle begins again (Figure 3).

Adult lungworms live in the lungs. After the eggs are laid, they are coughed up and swallowed. Eggs hatch in the intestines, and immature lungworms (larvae) are passed in the manure. When these larvae are eaten by a grazing animal, they go first to the intestines, then migrate to their home in the lungs where they live as adults (Figure 4).

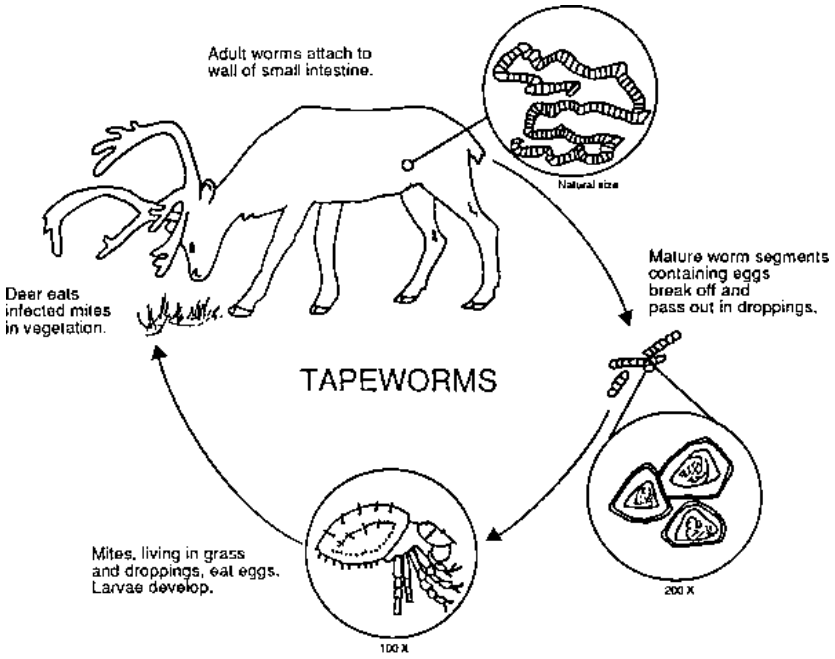
Tapeworms may live in the intestines of reindeer. They are white, flat, and quite long, resembling a miniature tape measure. They attach to the wall of the intestines with hooks or suckers in their head. The adults are made of many sections called segments which contain the eggs. Periodically, some segments break off and are passed with the manure. On the ground, these eggs must be eaten by a mite to develop. If the mite is eaten by a reindeer as it grazes, the immature tapeworm is carried to the intestines where it will grow and live as an adult (Figure 5).



Effects:

Diagnosis:

Figure 4 Lungworms.



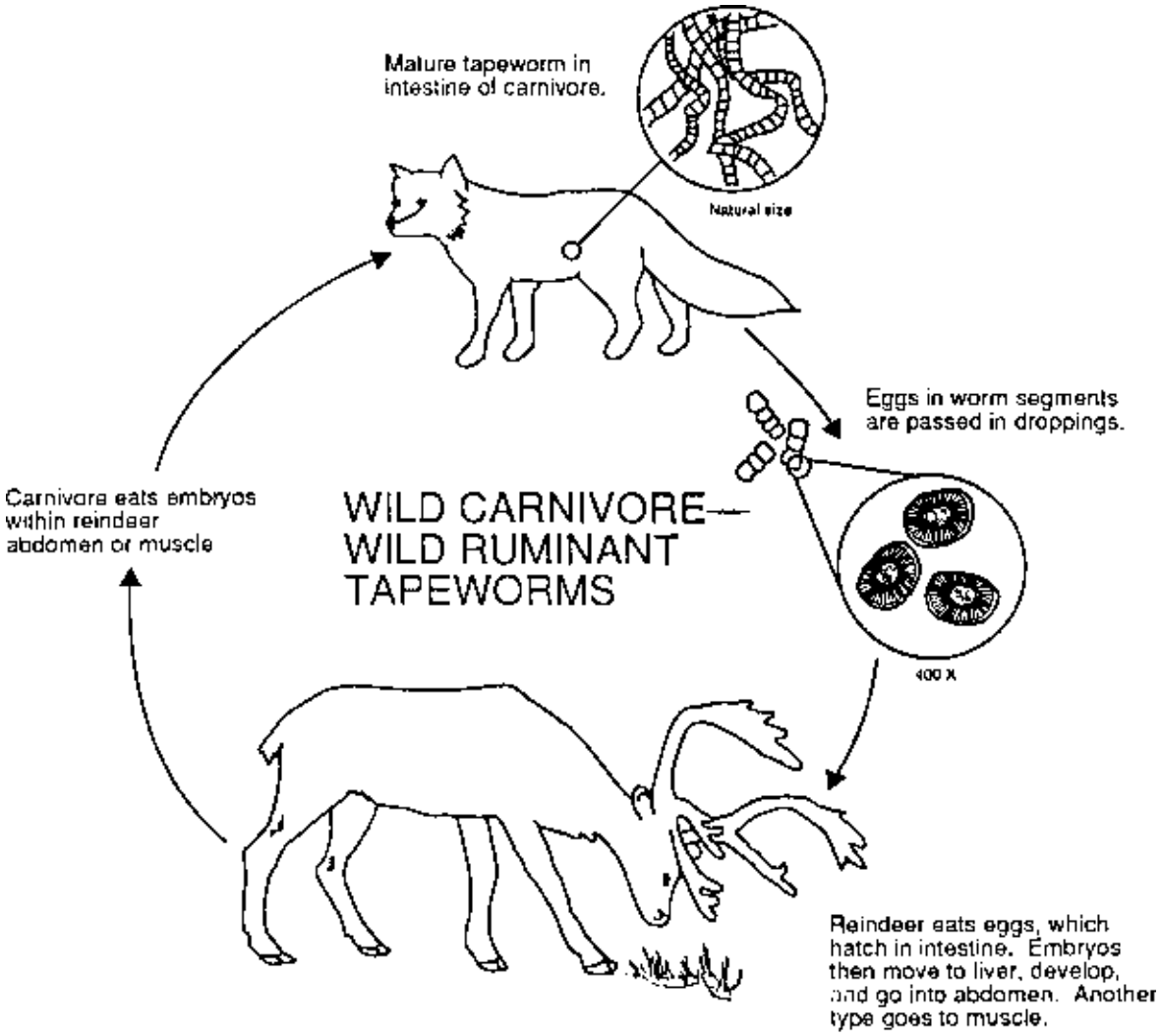
Effects:

May be debilitating.

Diagnosis:

Microscopic: Eggs in feces.
Necropsy: Adults in intestine.

Figure 5. Tapeworms.



Effects:

Dogs: Diarrhea in heavy infections.

Reindeer: Liver damage; more serious in young animals.

Diagnosis:

Dogs: Eggs in feces; adult in intestine at necropsy.

Reindeer: Embryos (“bladder worm”) in abdominal cavity (or muscle) at necropsy.

Treatment:

Dogs: Drugs to kill adults in intestine (domestic dogs).

Prevention:

Dogs: Don’t feed reindeer viscera or meat with cysts to dogs.

Figure 6. Wild carnivore—wild ruminant tapeworms.

Other species of tapeworms live as adults in meat-eating animals (carnivores) such as foxes or dogs. Segments containing eggs are passed with the manure as in reindeer. If the reindeer eats these segments as it grazes, the eggs hatch in the reindeer and develop only into immature, tapeworms within a small water-filled sack called a cyst or bladder. These small, white cysts may be found free within the abdominal cavity or in the muscles. If these bladders are eaten by a dog, they will develop into adult tapeworms in the dog's intestine (Figure 6).

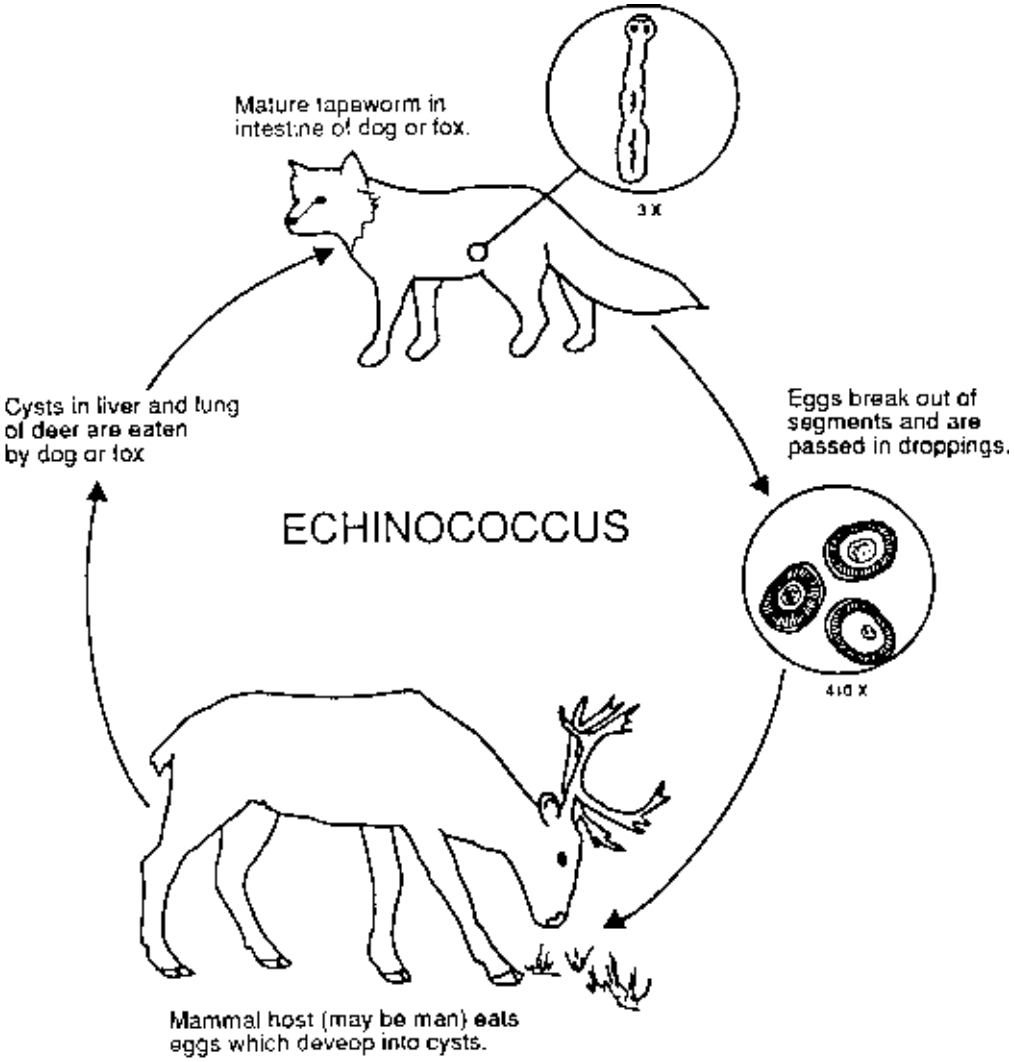
One particular tapeworm of dogs and foxes, *Echinococcus*, is especially dangerous for man and sometimes reindeer. The eggs are passed out in the manure of the fox or dog. If a person handles the manure, then touches his mouth later, or if a reindeer eats the eggs off the ground, the eggs hatch and develop into immature tapeworms in cysts. These cysts, called hydatid cysts, are usually found in the lungs or liver. These cysts can be quite harmful to man and, if in large enough numbers, to reindeer (Figure 7).

Another parasite of reindeer, *Sarcocystis*, is found in reindeer as an immature microscopic cyst in the muscle. If a dog or fox eats the raw meat, the cysts develop into the mature, but still microscopic, adult in the intestine of the dog (Figure 8).

It is not to the parasites' advantage to take enough nutrients from the host to kill it for then it would be out of a home. Most parasites establish a fairly good balance with the host. However, it is harmful to the reindeer to have to be feeding so many mouths. Parasites take nutrients the reindeer could be using for itself.

With an understanding of the life cycles of parasites, certain control measures become apparent. Reindeer-feeding in the same area for a long time are more likely to eat more parasite eggs off the ground. Consequently it is best to change grazing areas periodically. Internal organs or muscle of reindeer containing the tapeworm cysts should not be fed to dogs. Dog or fox manure should not be handled unless protective gloves are worn.

External parasites do not pose a problem for Alaskan reindeer. However, warbles pose such a serious problem, they are covered in another section.



Effects:

Effects:

Dogs: Non-apparent effects.

Reindeer, moose, etc.: Depends on number of cysts; may not be too serious.

Man: Always serious.

Diagnosis:

Dogs: Segments in feces or worms in intestine at necropsy.

Reindeer, moose, etc.: Cysts in liver or lung at necropsy.

Treatment:

Dogs: Give drugs to kill adults in intestine.

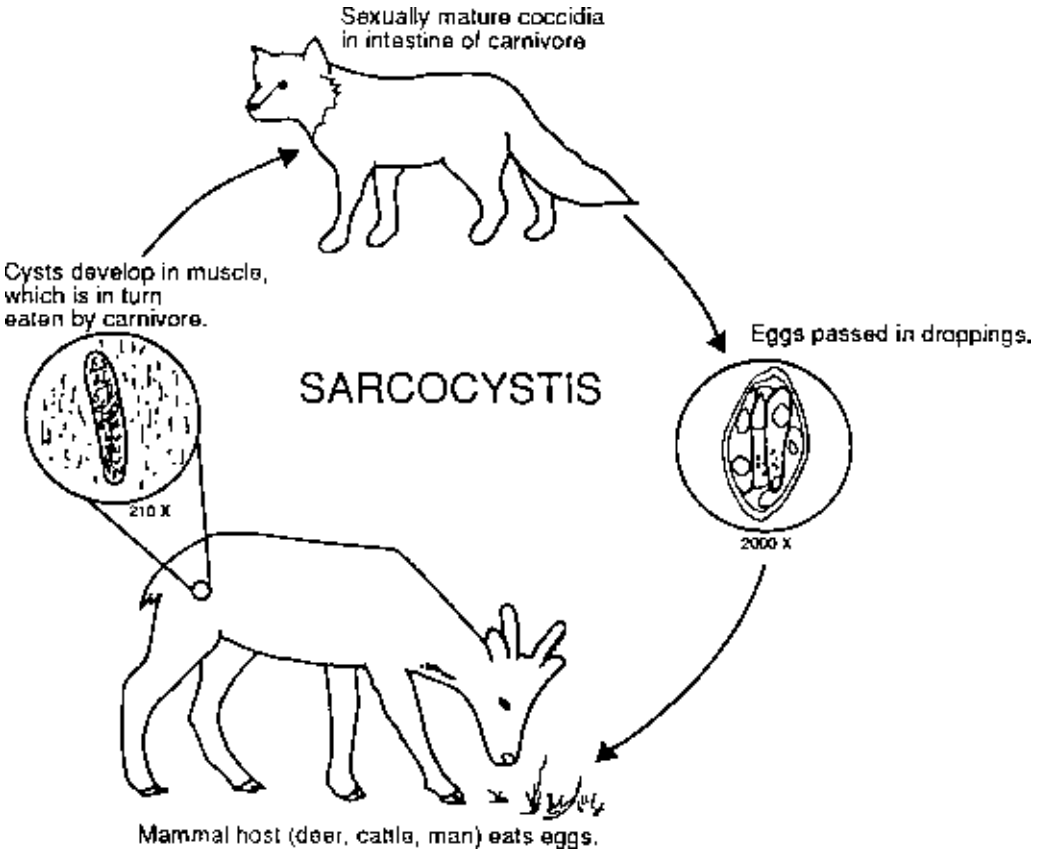
Man: Surgery.

Prevention:

Dogs: Don’t feed reindeer viscera to dogs.

Man: Wear gloves when handling dog droppings.

Figure 7. *Echinococcus*



Effects:

Dogs: Diarrhea?

Reindeer: None apparent.

Cattle: Anemia, weight loss.

Mule deer: May be fatal

Diagnosis:

Carnivore: Eggs in feces.

Cattle, deer: Cysts in muscle tissue.

Reindeer: Microscopic cysts in muscle tissue.

Treatment:

Dogs: Drugs to kill mature coccidia in intestine.

Prevention:

Dogs: Don't feed raw reindeer meat.

Man: Cook meat before eating (effects in man are not clear; probably usually not serious except in pregnant women).

Figure 8. *Sarcocystis*

Treatment for Reindeer

First Aid

1. Advice for particular problems can be obtained by calling the Applied Reindeer Research Program in Fairbanks at (907) 474-7166.

2. For wounds, first clean the area as well as possible. Remove any dirt or hair in the wound. To prevent infection, apply a topical antibiotic powder such as Furacin®. Gentian Violet® is another drug that can be used on surface wounds.

In the summer a wound spray with fly repellent is useful in preventing infection by flies. This should be used to spray around the scrotal area after castration and on the base of a cut-off broken antler on a fawn (shield the fawn's eyes with your hand as you spray). If there is bleeding, apply direct pressure on the wound as you would on yourself.

3. Hooves that are too long may be trimmed with cutters.

4. Ivermectin is available for parasite control.

5. Keratitis (White-eye) is treated by injecting a mixture of two parts of penicillin plus one part vetalog into the white of the eye just under the first layer. One-half to one ml. of the drug combination is carefully deposited under the conjunctiva (white part of eye) by just penetrating this thin layer and making a small blip of drug. Assistance will be needed to hold the reindeer's head still to avoid injuring the eye with the injection needle and to keep the eyelid open.

6. Pay attention to how your reindeer are acting. For instance, sick animals don't shed their coat as fast as well ones. Many animals slow in shedding out in a herd may indicate a herd health problem.

7. Many antibiotics are available and can be used on your own reindeer under the orders or supervision of a veterinarian. Many drugs are available only through a veterinarian.

Castration

Castration takes away the bull's desire to breed and reduces male traits such as aggressiveness and dominant behavior. Besides making males easier to handle as work animals, it is used on bulls meant for slaughter later in the year. Once castrated, the male will feed and put on weight through the fall instead of losing weight during the rut. Also, meat from a castrated male is thought by some to be of less gamey flavor and more tender than meat from a bull.

Castration methods fall under two categories—open and closed. Open castration is done by cutting the scrotal sac and removing the testes. It is a fast procedure, and if done properly will not harm the bull's health. Once the testes are removed, the male's sexual drive should be eliminated. The following steps outline the typical way for an open castration:

1. Take the loose, excess skin of the scrotal sac and slice out a semicircle of skin with a sharp knife.

2. Pop out the first testis, and slide your hand down along the spermatic cord pushing connective tissue ahead and away from the testis. This exposes a 4 to 6 inch length of spermatic cord running from the testis to the body.

3. Fray and cut the spermatic cord close to the body opening in a back and forth motion to minimize bleeding. Repeat 2) and 3) with the other testis.

4. Spray the scrotal opening with a repellent/disinfectant in warm weather.

Closed castration is done by crushing the spermatic cord without having to cut the scrotum open. There are several types of plier–like tools available on the market to do this job. When the vessels, nerves, and vas deferens are crushed, passage of material to the testes is blocked. Eventually

the testes will wither and die. This method is effective when done accurately, but room for error exists. If the tool is placed or used incorrectly, castration may be incomplete or totally ineffective.

Aid In Fawning

Although most reindeer will give birth normally without aid from people, it is possible to encounter a cow having difficulty while fawning. There are several conditions that create problems while fawning, the most common of which is called abnormal presentation. This refers to the fawn's position, or presentation, as it enters the birth canal to be born. An abnormal presentation is one in which the fawn is turned or twisted so that it gets caught in the relatively small opening of the birth canal, making birth dangerously slow or impossible.

With knowledge of how the fawn should be positioned in order to emerge easily, a person can straighten it so that a normal birth can take place. This is a process that can be done without special tools or complex medical know–how. If carefully done, it is often successful and may prevent the death of the cow and also save the fawn,

In a normal birth the fawn is positioned, or presented, so that the front hooves and head are aimed down the birth canal. In this position, the fawn faces the rear of the cow (see Figure l). It is not uncommon for the fawn to be facing the opposite way, that is, with the hind legs emerging first and the head pointing in the same direction as the cow's head (posterior presentation). This, too, can lead to a normal birth.

When beginning labor, the cow will experience hard muscular contractions and will appear to be straining. Usually the fawn will emerge anywhere from a few minutes to a half hour after the cow begins straining heavily. When the fawn is born, the cow licks off the membranes and mucus surrounding its body and tears the umbilical cord if it is still attached. The cow's constant licking dries the calf and stimulates its circulation. A healthy fawn will rise on its shaky legs within the next hour to begin suckling milk.

A cow having trouble giving birth will be in labor for an unusually long time. There are two signs that will indicate that a cow is having difficulties:

1. If part of the fawn is visible at the entrance to the vagina for longer than a half hour without being born.

2. If the cow is straining hard with no results for an hour. If a cow is in this situation, steps can be taken to straighten the fawn out into the normal position.

1. Approach the cow quietly and slowly. It is very important not to spook her because after giving birth she may abandon the fawn if she has been badly frightened. Although it is possible to raise the fawn by hand, the fawn's natural mother is its best chance for survival.

2. If possible, wear gloves, or at least wash hands well before and after this process. This is to protect not only the cow, but you. Remember that brucellosis can cause late abortion, and the cow you are treating may be infected.

3. Gradually work your hand into the vagina to reach the fawn, avoiding injury to the birth passage. Determine the position of the fawn and feel for the head. Figure 2 illustrates some typical abnormal positions of the fawn. It may be necessary to twist the head back to a forward position, straighten a leg or unhook it from the pelvic girdle. If there are twins in the womb, the situation may be more confusing. One fawn should be pushed back slightly to allow the other to emerge. The problem here is sorting out which legs belong to which fawn. If the fawn is facing backwards (posterior presentation), try to position it so that the rear legs are heading down the birth canal.

4. Once the fawn's position has been straightened, leave the cow and watch from a distance. If she still has the strength she will give a normal birth, and all will be well. If the fawn is still not born,

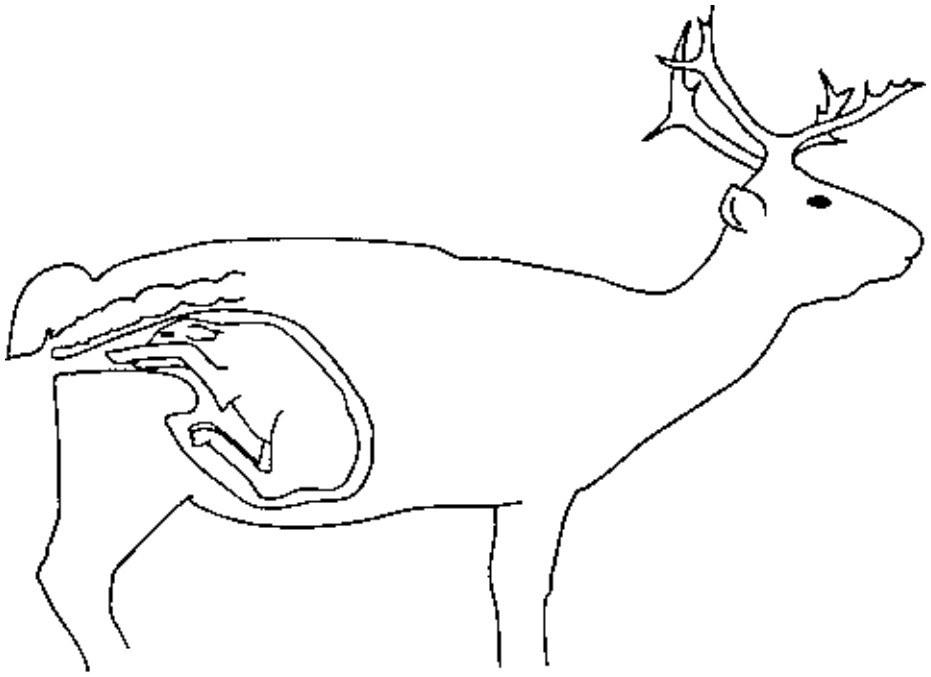


Figure 1. Normal presentation of fawn at birth.

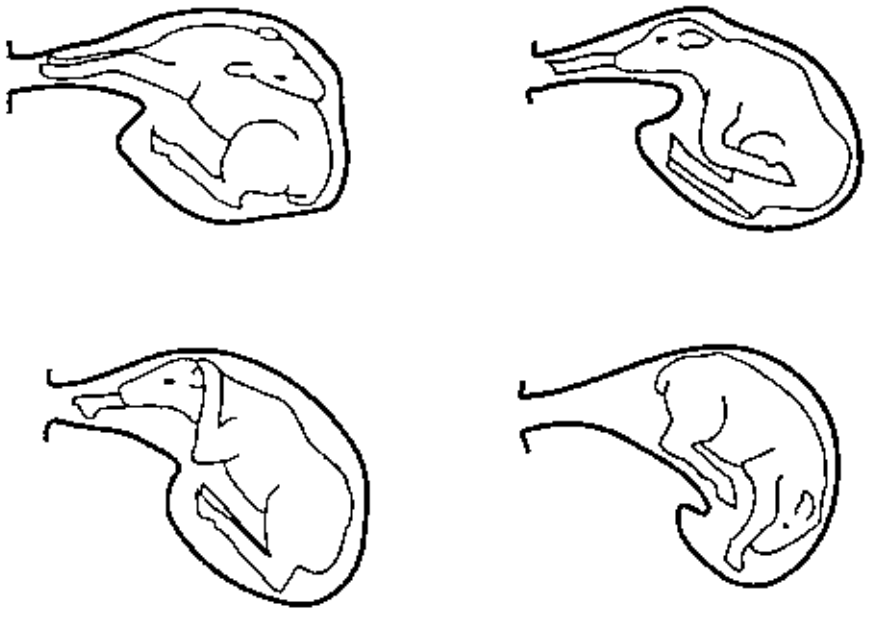


Figure 2. Some abnormal presentations of the fawn.

return and grasp the fawn by the forelegs (or hind legs). With a gentle , smooth motion, pull in unison with the cow's contractions to help the fawn out. Pulling should be the last resort, because if done too hard or at the wrong time, it can do much damage to both the cow and fawn.

After the fawn is born, the cow should take over its care automatically. The cow will be more likely to reject the fawn if she is frightened by your presence, or if the fawn has been handled too much by humans. The cow and fawn should be left alone after birth. The fawn should not be handled unless the cow is too weak to take over. In extreme cases it may be necessary to clean and dry the fawn, clear its nose and nostrils to breathe, and tie off the umbilical cord close to the fawn. Cut the umbilical cord between the knot and the mother. Make the cut two to three inches from the knot. Dip the fawn end of the stump in iodine to prevent infection. If a fawn has been abandoned, follow feeding directions in the nursing care section of this manual.

Necropsy of Reindeer

Necropsy Procedures and Techniques

Protection of humans against infection should always be the primary concern of everyone involved in the sampling process. The essence of this is to "think clean". Wear adequate protective clothing and follow clean techniques during the necropsy. Minimization of contamination results in better samples and reduced environmental contamination while decreasing the chance of infection for personnel.

Documentation (recording the facts) is an essential aspect of the sampling process. Complete, accurate, legible field notes specifying the circumstances of the animal's death—species, age, sex, location, environmental characteristics, clinical signs, and other pertinent observations are necessary for generating reports that accompany tissue samples to the laboratory. Photographs of parasites or lesions are extremely useful for determining diagnoses and indicating disease causing potential (pathogenicity). A label showing the specimen number and some reference of scale (such as a coin or knife) should appear in the photo. Exposure numbers with brief descriptions should be recorded in the field notes if many exposures are taken.

Specimen Preparation

The procedure listed is for land (terrestrial) mammal (reindeer, bears, foxes, etc.) samples under ideal conditions. Usually, conditions are somewhat less than ideal and one must salvage whatever possible from a decomposing carcass under inclement weather conditions. Two people can conduct a more efficient necropsy than one. This allows one person ("dirty") to remove tissues and one person ("clean") to take photographs, record notes, label and hold sample bags. For large animals, a third person is useful to help separate leg joints, move organs, and help prevent contamination of the people or parts of the carcass.

1. Collect a blood sample. This applies only to living animals or ones that can be sampled within minutes after death. The best sources are the jugular vein, femoral artery (in the leg), or the heart. Avoid taking blood from open wounds as it will contain unwanted material. Blood should not be allowed to freeze or be exposed to excessive heat or agitation as this causes the red blood cells to break open. A suitable anticoagulant, such as EDTA, should be added to whole blood samples to be used for measuring cell counts, packed cell volume, glucose determinations (enzyme inhibitor also needed) or other measurements. Blood put in a clean, dry tube or plastic bag will clot after standing about 12 hours at room temperature. Blood serum, which separates after the blood clots, can be carefully removed with a syringe or eye dropper and put into a sterile vial for antibody detection. Serum may be stored frozen, although repeated freezing and thawing should be avoided.

Figure 1. Skinning the upper half of the body.

If the animal is found dead, serum can often be collected from the heart clot. The whole clot, or the yellow “chicken fat” part, if separation has occurred, is placed in a plastic bag, allowed to stand for 12 hours, and then free serum is collected.

2. Visually inspect the carcass for external parasites, hair loss, traumatic injuries, discharges from the nose, mouth, or anus and other abnormalities. Photographs and external parasites should be taken at this time.

3. Position the animal right side down (to expose the spleen when opened) and remove its skin from the left (upper) side. The testes or mammary glands should not be exposed or damaged during skinning. Take care when skinning around Iymph nodes under the skin if these are needed. Remove the nodes and the testes or mammary glands after the skinning is finished. Disinfect instruments before handling tissues to be sampled. Tissues should not contact the sides of sample containers when placed inside.

4. Raise the left foreleg and cut beneath the shoulder blade (scapula) until the leg and shoulder can be laid back (see Figure 1). Separate (disarticulate) the joint of the left rear leg at the pelvis by cutting the muscles through the joint (Figure 2). If time is critical, the carcass can be temporarily left as cooling will proceed. Sampling should resume as soon as possible to prevent tissue deterioration, especially in high air temperatures.

5. Open the belly (abdomen) to the breast bone (sternum) taking care not to cut the intestines or rumen. Split the sternum with a knife or saw. Be careful not to puncture the chest (thoracic) organs. Free the diaphragm from its upper attachment to the ribs. Cut the muscles between every second or

Figure 2. Disarticulating the left hip joint.

third rib and break them back at their points of connection with the vertebrae. Split the front part of the pelvis (pubis) to expose the pelvic organs if desired. The specimen is now ready for removing tissue samples (Figure 3).

Tissue Collection

Before disturbing the internal organs (viscera), record an estimate of the time of death, gross internal abnormalities and any visible internal parasites (e.g. *Setaria*). Aseptically collect samples of the major visceral organs (heart, lung, liver, spleen, and kidney) approximately one inch in size and place in containers labeled with specimen number and tissue type. Start with clean, disinfected instruments. If possible, disinfect instruments between each different tissue collected. Do not get hair or dirt on any sample. (Note: whirl packs make very good containers as they are unbreakable, relatively fluid tight, and require a minimum amount of space.) Collect internal Iymph nodes if wanted. Remove the reproductive organs and place in a separate container. These tissues should be frozen for later culturing.

Samples of the major visceral organs, skeletal muscle, diaphragm and tongue can now be collected for microscopic (histologic) examination. These tissues can be placed in a single container with a suitable fixative (e.g. 10% buffered formalin). Tissues for histology should not be mutilated since the ultimate analysis is based on the structure and organization of cells.

Examine the carcass for endoparasites after collecting tissue samples. Warble (*Hypoderma tarandi*) and bot fly (*Cephenomyia trompe*) larvae can readily be found from early spring through

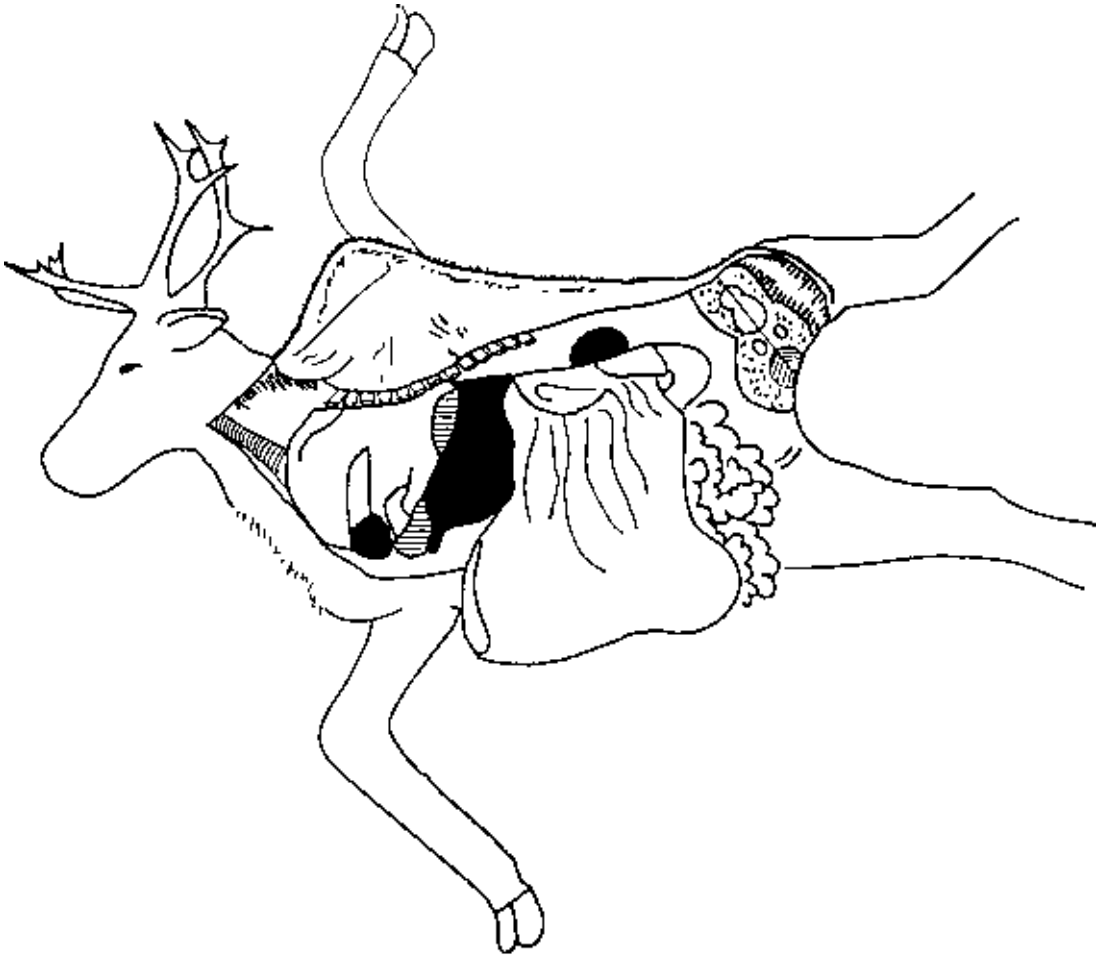


Figure 3. View of chest and abdomen fully exposed.

midsummer beneath the skin and in pharyngeal pouches respectively. Other reindeer parasites, such as lung worms (*Dictyocaulus viuiparus*), will occur less often and will require a more diligent search. Any tissue suspected of being parasitized should be collected.

Causative Agents

Bacterial, mycotic (mold), and viral diseases may be indicated by:

1. large epizootics which involve many individuals of a population;
2. bloody mucous discharges from the mouth, nose, or anus;
3. reddened and congested lungs, kidneys, and intestines;
4. an enlarged, dark colored spleen;
5. an enlarged, off-colored liver; and
6. presence of pus.

Preserve both frozen and formalin-fixed tissue samples and blood serum if bacterial, mycotic, or viral causes are suspected.

Ectoparasites (e.g. fleas, ticks, and lice) are usually visible with the naked eye. Host reactions to endoparasites may result in cysts that obscure the parasitic organisms. Collect these cysts in their entirety by removing the effected block of host tissue. Endoparasites are often specific as to host species and anatomical region of attack. Therefore, it is important to note both aspects of the condition as well as the number of parasites present.

Non-infectious diseases, i.e. toxicities and nutritional or mineral deficiencies, are often indistinct. Localized sick or dead animals may indicate a non-infectious etiology. Hair bundles approximately 3/4 of an inch in diameter should be collected along with whole blood. Collect soil and water samples, in addition to tissue samples, and place them in inert containers (i.e. glass or plastic vials). These samples must be analyzed as quickly as possible as many toxins rapidly break down in moist conditions. Containers holding water should not contain any air space after being covered. Soil samples should extend a minimum of four inches deep. Plants for mineral assays or toxin analyses are collected in their entirety, quickly pressed, and dried. Stomach samples from ruminants can be placed in porous cloth and excess water squeezed out before placing in 10% formalin. Stomach samples from monogastric (one stomach) animals can be placed directly in 10% formalin, if small enough, or portions of their contents removed and preserved.

APPENDIX I

Tissue Collection

Two sets of samples are to be obtained:

1. The first set is for culture to check for bacteria (including *Brucella*).
2. The second set is for formalin preservation.

Wearing gloves and using clean instruments, expose the internal organs of the deer. Be careful not to contaminate any structures.

Use clean forceps and scalpel to collect one inch cubes of tissue from the major organs in this order: heart, lung, spleen, kidney, liver, reproductive organs, muscle from tongue, and muscle from rear leg. Put these samples in a large whirlpack bag and roll the bag closed. This bag may be frozen.

In a separate bag, put a second similar set of tissues measuring about 1/4 inch by 1 inch. Add enough formalin to this bag to cover the tissues. Roll the bag closed. Do not freeze this bag.

Contact:
Applied Reindeer Research Project
Agricultural and Forestry Experiment Station
University of Alaska Fairbanks
Fairbanks, Alaska 99775–0100
Tel: (907)–474–7166

APPENDIX II

Serum Collection

Serum is the clear portion of blood that separates from the clot. Within the serum are the antibodies against specific diseases. Tests conducted on serum for antibodies are called serologic tests. Some common serologic tests for brucellosis that will be run in the laboratory are the standard plate test (SPT), rapid card test (BBA), rivanol (Riv) and complement fixation test (CFT).

	FOR COLLECTION	FOR STORAGE
Equipment needed:	Gloves	Clean syringe & needle
	Syringe (35 cc) & Needle	Small plastic vials
	Whirlpack bag (small size)	
	Vacutainer® tube (red top)	

Procedure:

1. Collection
   a. If the animal is still alive, collect blood from the jugular vein. Inject blood carefully into one or two Vacutainer® (red top) tubes.
   b. If the animal is dead, try to collect from the jugular vein or heart. Inject blood care fully into one or two Vacutainer® tubes.
   c. If the blood has already clotted, open the heart, Remove the yellowish colored portion of clot from the heart and place in a whirlpack bag.
   d. If none of the above are possible, collect blood from the body cavity and place in a whirlpack bag.

2. Record location, date, sex, approximate age (adult or fawn?), and other important information. Label the tubes.

3. Storage
   a. Let set at room temperature overnight. Keep blood sample upright. Don't shake and don't freeze the blood.

4. Collection of serum
   a. After the clear serum has separated from the clot, use a syringe and needle or an eye dropper to remove the serum from the clotted sample. Put the serum in a clean, small plastic bottle (vial) or another Vacutainer® tube. The serum should be frozen. It will keep for many months in the freezer, but will only keep a few days in the refrigerator.

   b. As soon as possible, contact:

      Applied Reindeer Research Program
      Agricultural and Forestry Experiment Station
      University of Alaska Fairbanks
      Fairbanks, Alaska 99775-0100
      Tel: (907)-474-7166.

APPENDIX III

Whole Blood Collection For Complete Blood Count (CBC)

This is only to be done if:
1. The blood can be taken immediately to a laboratory for testing.
2. The animal is to be treated.

Equipment needed:
Gloves
Syringe (12 cc or 6 cc) and needle
Vacutainer® (purple top) (EDTA tube)

Procedure:
1. Collect blood from the jugular vein.
2. Inject blood very slowly and gently into the purple stopper Vacutainer® tube. Gently turn tube upside down and right side up several times. Label the tube. Record time collected and important information.
3. Keep the tube cool and take to a laboratory for testing immediately. (The blood will only keep for one day.) Do not freeze.

APPENDIX IV
Care and Use of Syringes

Disposable Syringe

This is useful when delivering a single dose of medicine. It is also valuable when it is crucial that the syringe be sterile.

Keep the sterile syringe in its plastic container until needed. After using the syringe, throw the needle away. The syringe itself can be cleaned by plunging warm water through the barrel four or five times. Next, it should be disinfected with alcohol. The barrel can then be reused with a new sterile needle.

Choose a needle size appropriate for the task. For example, a larger needle (16 ga.) is needed when injecting thick medicine, or when drawing blood from a large animal. A smaller needle (18 ga. or 20 ga.) is used for more delicate processes, such as a smaller animal or thinner medicine.

Syringe barrels also are provided in several sizes. The long graduations on the barrel are in units of cubic centimeters (cc), which is the same as milliliters (ml). Fractions of the cubic centimeter are measured with the shorter graduated lines.

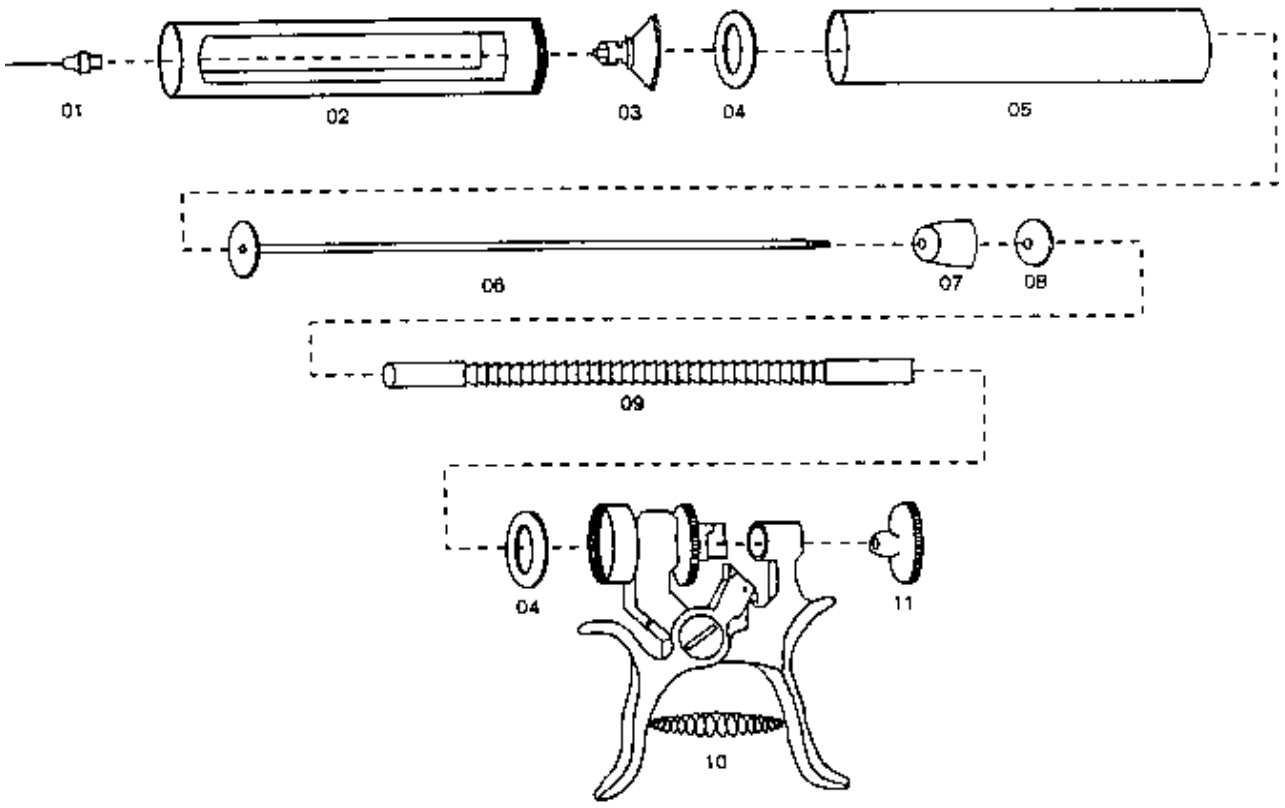
Automatic Syringe

This is useful when many doses of one type of medicine will be delivered to many animals. Although normally not as sterile as disposable syringes, it can be kept adequately clean. It is practical in large handling situations.

Before using, thoroughly wash all parts with warm water and dry. While using the syringe, keep a jar filled with alcohol to resterilize needles. Each time the barrel is refilled with medicine, put a clean sterile needle onto the syringe. If the syringe becomes contaminated with blood or dirt, the medicine should be evacuated in a safe place, and the syringe and needle thoroughly washed before refilling.

The syringe can be taken apart and reassembled according to Figure 1. The plunger or washers may need replacing if they become dry or cracked. New glass barrels should be kept in stock in case one is broken.

When using the multiple dose syringe, it is important to remain aware of the size of dose each animal needs. The graduated dial on the hand grip allows you to adjust the dosage. Each number represents a cubic centimeter, as in the disposable syringe. Even when the same dose is administered each time, make it a habit to check the dial every two or three shots to make sure that it hasn’t slipped from the proper dosage.



Key

0l	Needle
02	Metal barrel frame
03	Forward end tablet
04	Barrel washer
05	Glass barrel
06	Inner piston rod
07	Rubber plunger
08	Plunger upper disc
09	Graduated ratchet sleeve
10	Hand grip
11	Plunger adjustment knob

Figure 1. Assembly of multiple dose syringe unit.

Care and Use of Automatic (Pistol Grip) Syringes

Cleaning

1. Completely dissemble all parts. Wash in hot soapy water. Be sure to flush the inside portion of the outer plunger shaft. Rinse well. Air dry.
2. Re-assemble when dry. Tension on the barrel washer should be loose so it moves freely. Tighten the large and small screws on the pistol-grip handle.
3. Flush dirty needles with soapy water, rinse well. Check needles for sharpness. If barbed, gently rub over sharpening stone. (If badly bent, discard). Rinse again, air dry.

Use

1. Fill two needle cans with 70% ethanol. Use one for dirty needles and one for clean needles. Place clean sharp needles in the clean needle alcohol can.
2. Use clean 12 gauge needle from alcohol can on syringe for filling with brucellosis adjuvant (or other thick) vaccine. A 16 gauge needle can be used to fill syringe with thinner solutions such as Ivermectin.
3. Adjust tension on barrel washer by turning the knob at the end of the plunger shaft so it is just tight enough to draw vaccine from the bottle, but not so loose it allows vaccine to flow around the washer. Maintain pressure to fill syringe.
4. When syringe is full (or bottle is empty), remove 12 gauge needle from syringe and place it in the dirty needle alcohol can.
5. Take a 16 gauge needle from the clean needle alcohol can and place on end of syringe. This needle can be used for all the animals vaccinated with that syringe of vaccine providing the needle stays clean and sharp. If there is any doubt, replace it with a clean needle from the alcohol can.
6. Set the dosage to be administered by aligning the number on the dial with the arrow. Each squeeze administers the number of cc’s indicated on the dial. If it is hard to squeeze the handle, loosen the tension slightly on the barrel plunger washer. Be careful not to allow vaccine to run around the washer.
7. When the syringe is empty, remove the used needle and place it in the dirty needle alcohol can. Remove a 12 gauge filling needle from the clean needle alcohol can and repeat the syringe-filling process.
8. Regularly check that the two screws on the handle are tight.
9. To clean needles in dirty needle alcohol can, flush alcohol up and down through needles can using a 12 cc. syringe. When needles are clean, transfer them to the clean needle alcohol can.
10. If any blood appears inside the glass barrel, stop using that syringe until it has been washed.
11. Vaccine or drug left in the syringe should be discarded after 24 hours .

Injections

Ivermectin and brucellosis vaccine are two products commonly injected into reindeer. Both are given subcutaneously (under the skin) in the loose skin on the sides of the neck. The site of the injection is midway between the head and the shoulder about one half the way up the neck. This site is termed mid-cervical. Using a short (1/2 inch) 16 gauge needle, it is easy to make a short jab at an angle into the skin in such a manner that the medication or vaccine is deposited into the proper area. Opposite sides of the animal should be used if an animal is being treated with two products at the same time. Injection equipment should be exchanged and cleaned if the hair is dirty, or there is any obvious contamination of the syringe or needle.

Other medication, such as antibiotics, may have to be given in the muscle or in a vein. Any of these products should be administered only after consultation with a veterinarian. Remember that reindeer are used for human food and strict guidelines must be followed to ensure there are no drug residues and that the meat is wholesome.

APPENDIX V

Label and Use of Ivermectin

Used for the treatment of parasites in reindeer
IVOMECB (Ivermectin) 1% sterile solution
Inject subcutaneously at a dosage rate of 200 mcg per kilogram of body weight
(1 ml per 110 pounds body weight)
WARNING: Do not treat reindeer within eight weeks (56 days) of slaughter

APPENDIX VI

Specimen Submission For Rabies Assay

Alaska Department of Health and Social Services
Division of Public Health
Section of Laboratories
Virology-Rabies Unit

Rabies laboratory services are provided through the Virology-Rabies Unit established in Fairbanks. To assure accurate and reliable reports, the directions listed below must be followed.

1. Specimens will be accepted from physicians, veterinarians, public health officials, health or sanitation aides, wildlife agents, authorized medical or physician assistants, or individuals designated by the Division of Public Health.
2. Rabies laboratory examinations will be limited to warm–blooded animals of any type in which there is a clear history of human or possible human exposure, or animals deemed necessary by health or wildlife authorities.
3. Special Instructions:
   Virology-Rabies Unit must be notified prior to submission of rabies specimens. Call Fairbanks (907) 474–7017 or I907) 474–7018, or on weekends (907) 456–5974.
4. Minimum Information:
   The following information, or a completed Rabies Investigation Report (Form 06-1272) must accompany each specimen. This information is essential for the evaluation of each case and expediting the transmission of results to the responsible physician.
   a. Name and address of person(s) bitten and/or exposed.
   b. Date of exposure.
   c. Location of bite(s).
   d. Severity of bite(s).
   e. Date of first aid treatment and name of physician.
   f. In the case of a dog or cat, was the animal vaccinated?
   g. Provoked or unprovoked attack?
   h. Name, address and phone number of person sending the specimen.
   i. Name, address, and phone number of person to receive the laboratory report.
5. Conditions of Shipment:
   a. No Iiving animal(s) will be accepted for rabies diagnostic studies.
   b. When killing the animal, do not shoot in the head or mutilate the head in any way.
   c. Wear gloves when handling the animal, and send the head and part of the neck of large animals, such as dogs, foxes, wolves, Iynx, etc. Sever the head at the neck and leave sufficient tissue attached to the region of the head to ensure inclusion of the salivary glands. No other part of the animal should be submitted.
   d. Small animals such as mice, voles, and bats may be sent intact if recently expired, and ONLY after consultation with the Chief of the Virology Unit or the State Medical Epidemiologist.
   e. Specimens for rabies examination must be fresh. Decomposed specimens will be evaluated, and if unsuitable for assay, will be promptly incinerated, and no rabies assay will be attempted.
6. Packing:
   a. Wear gloves when handling the animal.
   b. Wrap the head in absorbent material, and place into two heavy, water-tight plastic bags.

Tie-off the bags to prevent leakage.

c. Place the packaged head in a leak-proof container, and pack the bag next to a water-tight can of frozen water or freeze packs. An alternative is to use a second set of heavy plastic bags and fill these with ice cubes and seal the top tightly. Remote areas may use river ice, but this type of ice has rough edges and will cut the bag. This can be avoided by wrapping the ice in newspaper and then packing with absorbent material to prevent movement of the ice in the carton.

d. Remove the gloves and either burn the gloves or enclose them with the head for disposal. Then wash hands thoroughly with soap.

e. Check the carton or container for security and include the Rabies Investigation Report. Please include contact telephone numbers.

7. Labeling:

a. All rabies specimens must bear the special Rabies Biohazard Label or the following statements:

MEDICAL MATERIALS
PACKAGING CONFORMS WITH STANDARDS IN 49 CFR173.386 (2) CFR72.25 (c), and NIH GUIDE OF FEBRUARY 10, 1975.

DIAGNOSTIC SPECIMEN
THIS CARTON CONTAINS THE HEAD OF AN ANIMAL. PLEASE REFRIGERATE ON ARRIVAL AND CONTACT THE VIROLOGY-RABIES UNIT AT 474-7017 or 474-7018, ON WEEKENDS 456-5974. IF NO Answer, CALL 452-0467 AND LEAVE A MESSAGE.

b. Address all shipments to:

Virology-Rabies Unit
Alaska Division of Public Health
Arctic Health Research Building, Room 233
UAF, Fairbanks, Alaska 99706-0230

8. Shipping:

a. Specimens may be brought directly to the Virology-Rabies Unit.

b. Ship specimens by air freight or air special package service. If mail service must be used, send via airmail-special delivery, or express mail, if available.

c. All shipments must be prepaid unless prior arrangements have been worked out with the Virology-Rabies Unit.

d. Contact the SVL and advise the method of routing and the airway bill number, etc.

9. Reports:

a. A preliminary fluorescent microscopic report will be called all on positive animal heads, and human exposure cases within 24–48 hours after specimen receipt and confirmation. Copies of the report will be mailed to the submitters.

b. An interim report will be forwarded at completion of the fluorescent microscopic (FA) examination. When the mouse inoculation test (MI) is performed, this final report will be forwarded subsequent to completion of a 28-day observation period.

10. For further information on rabies antiserum and vaccine for human use: Contact the Alaska Division of Public Health Regional Health Officer or Laboratory serving your area.

Medical Epidemiologist
Section of Communicable Disease Control
3601 C St., Suite 540
P.O. 8ox 240249
Anchorage. Alaska 99524-0249
Phone: (907)-5614406

State Virology Laboratory
Alaska Division of Public Health
232 Arctic Health Building
901 Koyukuk
P.O. Box 60230
Fairbanks, Alaska 99706-0230
Phone:(907)474-7017,0r(907)474-7018

APPENDIX VII

Raising Orphan Reindeer Fawns

Orphan reindeer fawns are often observed at summer handlings. Sometimes an abandoned fawn is found on the range. These fawns can be saved and raised for pets or for sale as live animals. There is an increasing demand for live reindeer to be shipped to locations outside Alaska. Tame reindeer adapted to a commercial diet can be a potential source of income for the herder as well as a rewarding project for the family. The following information is intended for reindeer herders in Alaska who do not have ready access to modern veterinary facilities or care. Raising a reindeer fawn on a bottle is one of the easiest ways to obtain a gentle deer. If started on a bottle within the first few days of life, a reindeer will quickly form a bond with humans. The older they are when started, the less likely they are to form a bond. However, there are other advantages to feeding older fawns: they don't have to be fed as often, and they can be fed solid foods. No matter what the age, feeding a reindeer fawn is very rewarding and potentially profitable. The following is intended to be a guideline for feeding a fawn. One thing to remember is that no two animals are exactly identical any more than two human babies are exactly alike. Each must be treated as an individual.

For newly born fawns or fawns up to two months of age:

1. In our experience and that of others raising reindeer fawns as well as other species of wild fawns or calves, commercial formulas such as Land O'Lakes Lamb Replacer can be used as a milk substitute for nursing fawns. Alaska feed stores might be able to special order a replacer formula for you if they do not have it in stock.
2. A temporary substitute formula of*: one quart of whole milk or reconstituted whole powdered milk for example Milkman mixed with one can of evaporated milk* can be used until the commercial replacer is available. The substitute formula, however, should be used only as a temporary substitute. It is not satisfactory for prolonged use. Regular human baby vitamins can be added to the formula at the same dosage as specified for human babies. Warm the formula to body temperature before feeding. Refrigerate any leftover formula or replacer between feedings.
3. Use either a regular baby bottle and nipple or a lamb nipple on a bottle to feed the fawn. The hole in the nipple can be made a little larger by heating the sharp end of a large safety pin in a flame. Then stick the hot point through the hole in the nipple. Don't cut big slits in the nipple to make a huge hole. Just as human babies like to suck their thumbs, fawns also like to suck. If the hole in the nipple is too big, fawns will suck too fast and finish too soon to satisfy their sucking reflex. It is better that they take longer to finish and feel more satisfied. They can also choke if they suck too fast. This can lead to pneumonia.
4. Hold the nipple end of the bottle between the thumb and first two fingers with the nipple pointed towards the palm of the hand. Cup the fawn's chin in the palm of your hand. The bottle and fawn's chin are now in the palm of your hand so your hand and the bottle can move with the movements of the fawn to help keep the fawn from swallowing air. The last two fingers can be used to help direct the nipple into the fawn's mouth.
5. Start off feeding small amounts of formula or replacer.

For example:

Age (weeks)	Ounces	Times/Day
0-1	2-3	5-7
1-2	3-4	5-6
2-4	4-5	4-5
4-6	6-8	3-4
6-8	8-10	3
8-12	8	3

Another guideline is that a baby animal usually requires 1/10 of its body weight per day of total milk replacement if that is all it is eating. If a fawn weighs 10 pounds, which equals 160 ounces (16 ounces per pound times 10), that fawn should have a total of 16 ounces (1/10 of 160 ounces) of formula or replacer per day. That 16 ounces could be divided as four ounces four times a day. A 15 pound fawn should have a total of 24 ounces per day, and a 20 pound fawn should have a total of 32 ounces per day. By the time it is eight weeks old, the quantity of milk replacement fed should be decreasing as the quantity of grain and greens increases.

6. Make each increase gradually. Do not jump from one level to the next all at once.
7. DO NOT OVERFEED. Fawns will always act like they want more. Overfeeding is the most common cause of diarrhea. A fawn's manure is normally soft but it should not be watery. Prolonged diarrhea can cause death. Fawns can actually eat themselves to death.

If diarrhea does occur:

a. Reduce on the amount of formula at each feeding until diarrhea is under control. You can use less powdered milk with the usual volume of water until the manure is normal again. Then gradually increase the milk powder back to the proper amount according to the recipe.

b. If diarrhea continues, give a baby's dose of human medicine for diarrhea such as Kaopectate or Pepto-Bismol. Use the dosage directed by the instruction on the bottle.

OR

c. Add a little baby rice cereal (Gerbers' for example) to the formula.

NOTE: Diarrhea is usually watery and yellowish from eating too much milk or from a disease. It is usually green from eating too many greens.

9. After eating, at least two times a day until the fawn is well trained (generally one to two weeks old), gently rub its rear end with warm water on a washcloth to stimulate the fawn to pass manure. Female reindeer lick their fawn's rear end to do the same thing.
1O. If your fawn is older than three weeks when you start, it may not be willing to drink from a bottle. If it doesn't, offer the milk replacement in a pan or bucket.
11. After the fawn is about five days old, offer it some grain immediately after it finishes the milk replacement. To get the fawn started, dip your fingers in some milk replacement, then in the grain so some grain sticks to your finger. Put your finger into the fawn's mouth. It will usually suck your finger getting the grain at the same time. Do this until it gets used to the taste and texture of the grain and eats grain by itself. Don't force it. Some fawns take to grain right away. Others just aren't interested for a while.

During the first few weeks of life, use a commercially available feed prepared for young calves. Purina's Nursing Chow and Calf Manna are two examples of the many brands on the market that can be successfully used at this stage of the fawn's life.

When a fawn is about six weeks old, mix your starter feed 1:1 with pelletted feed mixture suitable for reindeer. The University of Alaska Fairbanks has had years of experience and success feeding reindeer a mixture which contains:

Crude Protein 16% (minimum)
Crude Fiber 8% (minimum)
Crude Fat 3% (minimum)

This feed is a mixture of rolled corn and/or barley; ground oats, barley and/or corn; cottonseed and/or soybean meal; wheat millrun; wheat middlings; beet pulp pellets; salt and molasses. Commercial feeds such as Wod-Lyn Feeds or a feed specifically formulated for reindeer from Alaska Mill and Feed meet these requirements. Check with your local feed supplier for a ration that meets these nutritional requirements.

Fawns will usually not eat more than about one cup of grain twice a day until they are older

than four weeks. From four to six weeks of age, they will eat about one and one half cups of grain twice a day. From six to eight weeks, they will eat about two cups of grain once a day.

12. When the fawn is about one week old, provide some willows for it to eat. Start with a few leaves at a time and gradually work up to a small branch. If you are feeding too many greens, the fawn will develop a green colored diarrhea. Cut back on the quantity of greens until the manure is normal again. If you are keeping the fawn in an outside pen, fawns usually have no trouble grazing on natural feed.
13. Keep a pan of clean drinking water available at all times.
14. Provide some dirt for it to lick if you are keeping it inside.
15. Keep the fawn in a clean, sanitary, dog-proof area. Provide shelter from the sun and the rain.

Summary

Age weeks	Quantity milk replmt	Frequency times per day	Greens	Grain
0-1	2-3	5-7		
1-2	3-4	4-5	Offer willow leaves	Offer commercial calf feed
2-4	4-5	4-5	Willows natural feed	1/2-1 cup twice a day calf feed
4-6	6-8	4	Willows natural feed	1-1 1/2 cups twice a day calf feed
6-8	8-10	3	Willows natural feed	2 cups twice a day calf feed with equal parts of adult feed
8	8	3	willows natural feed	1 part calf feed to 2 parts adult feed twice a day
8-12	8	3	Wiilows natural feed	1 part calf feed to 3 parts adult feed twice a day

Appendix VIII

Nutrition

Free grazing reindeer consume a wide variety of plants that are selected on a seasonal basis. Many of these arctic plants are of an exotic nature and unusual chemical composition. A publication by Dr. Jack Luick summarized information on the diet of freely grazing reindeer. This publication is reproduced as part of this appendix on reindeer nutrition. As Dr. Luick states, it seems hardly surprising that in some reindeer relocation attempts, more than 60 percent of the reindeer have died within a few weeks of departure from tundra ranges. Although other factors such as handling stresses, hypothermia, regurgitation and inhalation of rumen contents, injury, disease, and overdose of immobilizing agents have compromised relocation attempts, diet is all-important in pen farming reindeer. For more information on the relocation of reindeer, refer to Circular 70, *Air Transport of Alaskan Reindeer* by Dr. Bob Dieterich. This circular can be obtained from the Agricultural and Forestry Experiment Station, University of Alaska, Fairbanks, Alaska, 99775-0080.

Good husbandry practices are equally important when feeding pen farmed reindeer. The whole process of adaptation to confinement and a new diet can prove very stressful to reindeer if it is not done correctly. After arriving at a new location where they are to be pen farmed, reindeer should be unloaded as quietly as possible and taken to a dog-proofed fenced field and released. It is best if this field has some natural hiding areas such as trees, so the animals can stay out of sight if they wish. Adaptation to a new diet is one of the most important factors to ensure survival. Natural grasses, fine stemmed grass hay, and commercial grain mixtures are used. The commercial feed Quality Texture (Purina Mills, St. Louis, Missouri) has been successfully used in many relocations of reindeer. This grain mixture is first mixed with high quality fine stemmed hay and placed on the ground. Later, after the reindeer learn to accept the grain mixture, it is fed in”V” shaped feeding troughs placed on posts about two feet above the ground. These troughs prevent the animals from wasting feed by pawing and aid parasite control by keeping feces away from food sources. The grain mixture has been used as the primary feed source for several generations of reindeer for at least 15 years. One manager reported good results with fine stemmed grass or hammer milled brome hay fed at 20 percent of the diet mixed with Quality Texture. Many other successful feeding programs have been used in zoos and private herds. It has been our experience that a diet containing a large amount of alfalfa hay has led to the development of laminitis (foundering) in some reindeer.

Usually 90 to 95 percent of relocated reindeer will successfully adapt to captivity and a commercial diet. The remaining 5 to 10 percent will show signs of weight loss after two to three weeks. It appears that the time of greatest weakness in most newly transported reindeer occurs after their natural body reserves are depleted at three to four weeks post transport. Unless it is absolutely necessary, newly transported reindeer should not be approached or handled during this critical adjustment period.

After the initial conditioning period is completed, the reindeer should be treated for parasites with ivermectin at the standard rate of one ml per 110 pounds body weight and vaccinated with a killed bacterin-toxoid containing *Clostridium chauvaei-septicum-novyiperfringens* Type C and D.

DIETS FOR FREELY GRAZING Reindeer *

J. R. Luick

Reindeer† are indigenous to arctic tundra and taiga range lands where they subsist (and indeed thrive) under widely ranging nutritional circumstances and survive ostensibly unremitting environmental stresses. During the six- to eight-month winter grazing period, reindeer subsist chiefly on lichens, which are algal/fungal symbionts of poor nutritional quality. Additional stresses include predation by arctic carnivores, violent climatic conditions, scarcity of food, and the necessity of locating and excavating food from beneath deep and frequently encrusted snow.

Summer gazing conditions impose an entirely different set of nutritional and environmental stresses and with the exception of the considerably improved nutritional quality of available food, appear to be no less severe than winter grazing conditions. Female reindeer calve during April and May when food is often scarce, and their body condition is extremely poor. The metabolic demands for producing an adequate supply of highly nutritious milk, as well as energy demands for almost continual movement of the herd in search of food impose additional stresses during late spring. Predators are always present, and harassment by mosquitos, black flies, and parasitic warble and nostril flies provide a significant deterrent to the attainment of the peak body condition necessary for winter survival.

Thus, the annual movement patterns of reindeer and, hence, the plant foods they consume are dictated seemingly by a number of environmental and climatic factors. Comprehensive discussions of these factors and consideration of the adaptive significance of the observed migration patterns have been published recently by Kelsall[1], Skogland[2], and White et a1.[3] In brief, it seems that motivation for herd movement is dictated mainly by the necessity of following the phenotypic progression and primary production of various plant species. This seasonal usage of phytosociological plant communities in Norway and Siberia is well described by Skogland[2], and Glinka[4], respectively (Table l).

Table 2 lists a number of vegetative types and plant species that are consumed selectively by reindeer during migration. Interestingly, these plants are found in most of the reindeer grazing ranges of the circumpolar nations. [1,6-8] Perhaps the considerable differences found in the chemical composition of various food plants (Tables 3 through 5), the dry matter digestibility of individual plants and mixed forages (Table 6), and especially the seasonal changes that occur in the nutritive value of these plants as they progress through the various stages of maturity are of greater interest (Table 7).[5,9]

*Data reported in this chapter that originated in the author's laboratory resulted from research activities supported by U.S. Atomic Energy Commission Contract AT(04-3)-310; Energy Research Development Administration Contract E(45-1)-2229; and the Office of Polar Programs and the International Biological Program of the National Science Foundation (NSF Grant Number GV-29342). By acceptance of this article, the publisher and/or recipient acknowledges the U.S. Government's right to retain a nonexclusive, royalty-free Iicense in and to any copyright covering this paper.

†Unless otherwise noted, the term "reindeer" as used in this chapter refers to both semidomesticated (i.e., herded) and wild reindeer (in North America, "caribou"), classified taxonomically as *Rangifer tarandus.*

TABLE 1

Range Use by Reindeer in Southern Norway[2]

Plant community	Annual Use (%)	Period of high intensity use
Lichen heaths	60.0	December—April (95%)
Grassy meadows	14.5	Early spring, late fall (50%)
Salices and herb snow beds	22.5	Early, late summer (95%)
Bogs	3.0	Midsummer (45%)

TABLE 2

Food Plants Commonly Selected By Reindeer And Caribou[a]

Arboreal lichens
Alectoria jubota
A. oregana
Evernia mesomorpha
Parmelia physodes
P. saxalilis
Ramalina farinacea
Usnea hirta
U. plicata

Fruticose lichens
Cetraria islandica
C. nivalis
Cladonia alpestris
C. amaurocraea
C. arbuscula
C. gracilis
C. mitis
C. multiformis
C. rangiferina
C. uncialis
Peltigera spp.
Slereocaulon spp.
Thamnolia vermicularis

Rock lichens
Umbilicaria hyperborea

Herbs and forbs
Arlemisia arctica
A. richardsonii
Equisitum spp.
Hedysanrm spp.
Heraculum lanatum
Luplnus spp.
Oxytropis spp.
Pedicularis spp.
Perasitesfrigidus
Polygonium bistorta
Saxifraga oppositifolia

Shrubs
Betula glandulosa
B. nana
Dryas integrifolia
D. octapetala
Salix arctica
S. glauca
S. lanata
S. ovalifolila
S. pulchra
S. rotundifolia
S. scirpoidia

Grasses
Arctophila fulva
Calamagrostic spp.
Deschampsia spp.
Dupontia fischeri
Festuca spp.
Hierochloe spp.
Poa spp.

Sedges
Carex aquatilis
Eriophorum angustifolium

Woody perennials
Arctostaphylos alpina
A. rubra
Empetrum nigrum
Ledum decumbens
L. groenlandicum
Rhododendron lapponicum
Vaccinium oxycoccus
V. uliginosum
V. vitis-idaea

[a] Relative contribution to daily food intake varies seasonally with availability and state of maturity of the various plant species.

TABLE 3

Chemical Analyses

of Some Preferred Reindeer and Caribou Food Plants [1,5,9,31]

Item	n[a]	Crude protein	Crude fat	Crude fiber	ash	N-free extract	gcal /100g	Ref.
Fungi	2	34.76	4.76	20.80	8.12	31.55		1
Musci spp.	2	4.81	3.39	28.26	6.88	56.64		1
Arboreal lichen								
Alectoria jubata	1	4.81	2.55	39.70				31
A. sarmmtosa	1	3.50	10.94	3.40				31
Fruticose lichen								
Cefrarip cucullata	3	3.77	3.82	11.23	2.14	80.02		1
	2	2.30	2.30	5.30	1.20	89.00	468	5
C. islandica	5	4.60	3.38	7.85	1.51	82.66		1
	3	2.60	1.10	6.20	1.20	89.30	446	5
C. nivalis	4	2.47	3.95	5.11	2.15	88.34		1
Cladonia alpestris	3	2.75	1.52	44.49	1.87	49.12		1
	2	2.67	2.79	32.30	0.76			31
C. crispata	1	3.50	1.10	40.80	1.30	53.30	431	5
C. gracilis	2	2.60	0.80	30.70	1.10	64.90	451	5
C. mitis	1	2.54	1.67	28.00	2.18	65.62		1
C. rangifera	5	2.21	1.58	42.30	1.49	51.39		1
	1	2.03	1.11	38.30	0.83			31
	3	2.80	0.60	28.30	1.40	66.90	449	5
C. sylvatica	2	1.86	1.16	43.97	2.21	50.80		1
	3	2.30	0.90	23.60	1.10	72.10	435	5
C. uncialis	1	2.30	1.60	19.80	0.90	75.40	437	5
Peltigera sp.	1	19.77	1.29	25.33	9.14	44.47		1
Stereocaulon spp.	4	8.02	1.78	24.57	2.55	63.07		1
Sedges and grasses								
Arctagrostls 1atifolia	1	22.00	2.60	24.9	6.70	43.80		9
Carex aquatilis	3	10.55	3.21	35.44	5.95	44.84		1
	2	10.40	2.90	25.70	3.50	57.60	457	9
C. bigelowii	3	11.30	1.50	28.50	4.30	54.50	475	5
C. nesophila	1	25.10	2.80	22.30	5.10	44.70		9
C.spp.	7	19.40	2.90	30.00	6.10	50.90	468	9
Eriophorun angustifolium	2	14.10	170	21.IO	4.40	58.80	489	5
E. chamissonis	1	15.10	2.50	15.60	4.00	62.80	472	9
Herbs and forbs								
Artemisia arctica	2	20.00	2.20	9.30	10.20	54.30	451	9
Epilobium angustifolium	4	13.37	3.09	27.08	6.60	49.80		1
Equisetum spp.	6	11.36	3.31	18.81	13.55	52.97		1
Heraculum lanatum	2	38.70	2.90	8.70	16.00	338.00	461	9
Ligusticum hultenii	3	25.00	2.80	9.90	7.90	57.00	478	9
Potentilla palustris	1	18.80	3.10	17.50	5.10	55.5	463	5
Ranunculus occidentalis	2	20.90	3.70	12.50	6.60	61.5	466	0
Shrubs								
Betula glandulosa								
& B. nana	15	15.59	7.16	16.21	3.32	57.70		1
B. nana	3	15.80	2.70	19.60	2.80	58.00	546	5
Dryas octapetala	2	13.20	5.20	19.30	3.30	54.50		9
Salix sp.	1	21.90	1.60		4.30			9
S. spp.	15	20.99	3.10	16.66	6.53	52.74		1
S. pulchra	2	23.80	1.90	10.10	4.40	60.00	497	5
Woody perennials								
Arctostaphylos alpina	1	8.55	2.54	9.45	5.37	74.09		1
mpetrum nigrum	4	4.60	9.98	23.11	3.33	58.97		1
	1	5.4	10.2	23.8	1.8	58.8	573	5
Ledum decumbens	3	6.52	6.52	27.30	2.17	57.49		1
	1	7.4	6.2	25.9	1.8	58.7	555	5
Vaccinium uliglnosum	2	6.75	3.14	31.39	3.07	55.64		
	3	14.2	2.4	21.1	2.6	59.6	511	5
V. vitis-idaea	2	5.76	3. 13	20.20	2.66	68.24		1
	1	6.2	3.6	26.9	2.3	61.0	518	5

[a]n =Number of analyses used to compute mean values.

TABLE 4

Elemental Analysis Of Lichens Commonly Selected By Reindeer And Caribou [32]

Element	Mked lichens[a]	*Cladonia alpestris*	*Cladonia rangiferina*	*Cetraria* spp.	*Stereocclulon* spp.
SI	7100	1000	70	300	1000
Na	122	54	63	240	67
K	560	733	693	1510	1625
Ca	790	514	783	1080	450
Mg	390	300	100	500	200
Mn	100	100	150	100	400
P	200	200	100	300	200
Fe	840	300	150	200	200
Zn	18	10	3	50	10
Cu	4.8	2	3	4	2
S	50	100	10	50	200
Pb	1	0.6	3	1	0.6
Co	0.06	0.4	O.1	O.1	0.2
Hg		Trace	Trace	Trace	Trace
Cs	0.2	0.2	0.1	0.3	0.2
Sr	6	6	6	4	4
Al	300	300	300	300	300

Cladonia alpestris (60%); *C. rangiferina* (20%); *C. arbuscula* (10%); *Cetrarla islandica* (5%); miscellaneous species, including *Cladonia gracilis, Cetraria cuculata, C. laevigata*, and *Stereocaulon alpinum* (5%).

TABLE 5

Detergent Fiber Analysis Of Plant Material Consumed By Reindeer And Caribou[14]

Values are Expressed as g/lOOg Dry Matter

Sample	Cell contents	Cell wall contents: Hemi cellulose	Cellulose	Lignin
		Shrubs		
Dryas integrifolia				
leaves/stem base	64.6	2.3	14.0	19.1
inflorescences	53.8	-2.0	21.1	27.1
Salix arctica	81.5	2.1	11.9	4.5
S. lanata	79.4	2.7	13.2	4.7
S. ovalifolia	68.8	3.9	18.6	8.7
S. pulchra	72.9	9.8	11.4	6.0
		Sedges		
Carox aquatilis	41.8	36.5	18.6	3.2
Eriophorum angustifolium				
Live leaves/l0% dead	31.5	43.8	19.1	5.1
Inflorescences + stem	42.5	36.0	16.3	4.7
		Grasses		
Arctophila fulva	32.3	38.8	27.3	1.7
Dupontia fisheri				
Live leaves/lO% inflorescences	54.9	25.4	15.8	3.9
Inflorescences + stem	37.9	31.1	25.5	5.5
		Herbs		
Artemisia richardsonii sp.	57.7	13.1	24.2	5.0
Pedicularis sp.	74.1	5.1	14.3	6.5
Saxifraga oppositifolia	73.1	-8.5	20.5	15.4
		Lichens		
Cetraria cucullata	68.4	27.8	-0.6	4.3
Cladonia alpestris (Coal Creek)	17.0	78.3	1.7	2.9
C. alestris (Nome)	16.7	81.0	-1.3	3.6

TABLE 6

Dry Matter Digestibility[a] of Individual And Mixed Specimens of Plants Selectively Grazed By Reindeer And Carlbou [3, 14]

		In vitro digestibility technique			
		Source of Inoculum			
Plant	Sample	Caribou	Reindeer[b]	Mean	Reindeer[b]
		Shrubs			
Dryas integrifolia	Leaves/stem base	33	33	33	
	Heads		21		
D. octopetala	Leaves and stems (a]pine)				12±2
Salix arctica	Leaves/buds	71	52±2	62	
S. lonata	Live Ieaves		34±7		
S. ovalifolia	Leaves/buds	35	46±6	41	
S. pulchra	Leaves/buds		54	54	24±0.3
S. reticulata	Leaves/buds		38		
		Sedge and cotton grass			
Carex aquatilis	Live leaves	56	68±4	62	39±2
Eriopforum angustifolium	Live leaves	48	59±3	55	32±3
	Inflorescences + stem		56±3		
E. vaginatum	Mature leaves				28±5
Grasses					
Arctophila fulva	Live leaves	56	72	64	
Dupontia fishri	Live Ieaves		79±2		
	Inflorescences	67	70	68	
		Herbs			
Artemisia richardsoiana	Leaves	62	66±3	64	
Braya spp.	Whole plant		68		
Oxytropis sp.	Live leaves		70		
Parrva nudicalus	Whole plant		67		
Pedicularis sp.	Inflorescence + leaves		64±6		
Saxifraga oppositifolia	Inflorescence + leaves		33±1		
		Lichens			
Alectoria nigricans					45
Cetraria cucullata		74±3	48±1	68	77±9
C. islandica					48±9
Cladonia alpestris		27±14	16±7	21	16±3
C. arbuscula					10
C. rangiferina					40
C. uncialis					44
Lobaria linita					45
Peltigera aphthosa					44
Stereocaulon alpinum					18
Thamnolia vermiculoris					59
		Mosses			
Hylocomium sp[endens	Entire gametophyte				19±6
Sphagnum magellanicum	Entire gametophyte				6
Other	Entlre gametophyte				13
		Esophageal egesta			
Dryas heath	Reindeer No. 12		49±3.3		
Dupontia brook bank	Reindeer No. 31		50±0.6		
Eriophorum meadow	Reindeer No. 10		62±O.2		
Eriophorum meadow	Reindeer No. 12		49±1.4		
Combined	reindeer				45±1.0
	Caribou C2	37±2.2			
	Caribou C3	43±1.6			

[a]Percent ±SE.

[b]Rumen inoculum was obtained from tranquilized caribou and reindeer grazing at Prudhoe Bay, Alaska, or reindeer given a mixed diet containing 67 percent (dry weight) lichens, 8 percent *Carex aquatiIis* and 25 percent brome hay. The food was ground in hammermill and thoroughly mixed.

TABLE 7

Seasonal Changes In The Chemical Composition And Caloric Content Of Important Reindeer Forage Plants Near Nome, Alaska

Species	Month	Protein (%; Nx 6.25)	Fat(%) ether extract	Crude fiber (%)	Ash (%)	Nitrogen–free extract	Kcal/lOOg
Betula nana	March	5.3	2.6	29.3	1.3	61.5	560
	June	26.0	2.2	13.2	4.6	54.0	542
	August	16.0	3.5	16.3	2.8	61.4	536
Carex bigelowii[a]	June	16.6	1.3	24.5	4.3	53.3	471
	August	12.9	1.8	3.6	4.0	52.8	479
Cetraria cucullata	June	2.4	1.9	28.5	1.2	90.9	474
	August	2.2	2.6	7.0	1.2	87.0	463
C. islandica	March	2.4	0.8	6.6	1.2	89.0	453
	June	2.6	0.3	3.7	1.1	92.3	426
	August	2.6	1.1	8.4	1.2	86.7	458
Cladonia rangiferina	March	2.7	1.0	30.3	1.1	64.9	451
	June	2.9	0.4	27.7	2.3	66.7	466
	August	2.7	0.4	26.9	0.8	69.2	431
C. gracilis	March	2.8	1.0	29.8	1.1	65.3	471
	August	2.4	0.6	31.6	1.0	64.4	431
C. sylvatica[b]	March	2.5	1.4	21.9	1.1	73.1	426
	June	2.2	0.7	26.8	1.2	69.1	452
	August	2.0	0.6	22.2	0.9	74.3	426
Eriophorum angustifolium	June	16.1	1.3	21.5	5.6	55.5	477
	August	12.1	2.0	20.7	3.1	62.1	501
Salix pulchra	June	25.2	1.6	8.6	4.9	59.7	504
	August	22.4	2.1	11.5	3.8	60.2	490
Vaccinium uliginosum	March	6.0	3.1	35.9	1.3	53.7	543
	June	23.4	2.2	11.0	4.0	59.4	523
	August	13.2	2.0	16.5	2.5	65.8	466

[a]Includes a small portion of *Carex aquatilis*

[b]Includes Cladonia mitis

Spring Diets

In Alaska, spring grazing commences at the time of calving, or shortly thereafter, when snow is disappearing rapidly and green shoots and other vegetative parts of grasses, shrubs, and sedges become available. Reindeer feed extensively on dry heaths and wet grassy meadows, selecting *Dupontia fischeri, Dryas integrifolia,* and especially *Eriophoriun angustifolium*[3]. Wet boggy areas, the habitat of *Carex aquatilis,* are not visited widely during the warm, wind-free, daylight hours, presumably because they harbor hordes of mosquitos and other stinging insects. Lactating reindeer attain peak milk production soon after calving; the milk contains high concentrations of fat and protein but little lactose. The calves commence grazing two to three days following birth;[1,lO,11] consequently, they gain body weight rapidly, whereas the adult females remain in poor body condition.[l2] During early spring, reindeer spend about 50 percent of the day searching for and consuming plants. Eating rates, estimated at 70 to 90 percent of grazing rates, amount to about 10 hours/day during late winter, but increase to nearly 19 hours/day during late spring, when plant foods become more abundant and are of increasing nutritional value. [1,2,5,10]

Midsummer Diets

During midsummer, reindeer gain body weight and improve in condition rapidly while feeding on grasses such as *Carex aquatilis* and *Dupontia fischeri*; sedges, especially *Eriophorum angustifolium*; shrubs, including *Salix* spp.; and glandular birches, B*etula glandulosa* and *B. nana.*[1, 2, 13] Lichens are also eaten selectively, when available in sufficient quantity. According to Kelsall, grasses and sedges make up 28.1 percent of the daily food intake of Canadian reindeer, lichens 31.3 percent, and shrubs 31.2 percent; herbs and forbs are little grazed.[l] White et al. reported similar findings for reindeer at Prudhoe Bay, Alaska, with green vegetation, grasses, and sedges being consumed in a somewhat higher proportion (40 percent) to compensate for the relatively low biomass of lichens.[3] Person[l4] and White et a1.[3] found that the grasses appeared to be the most highly digestible plants, followed in order by herbs and forbs, sedges, and shrubs. Digestibility of lichens was highly variable, whereas the mosses were of little nutritional value. In fact, the mosses, which often comprise more than 50 percent of the vegetative biomass, were never found in significant amounts in rumen contents or egesta collected from esophageal fistula.[14] Thus, in midsummer, when food plants attain peak nutritional content and quality and reindeer spend about 35 percent of the day consuming green vegetation, milk production begins to decline, insect harassment is high, and the reindeer attain the peak body condition necessary for winter survival.[3,5,9,10,15,16]

Late Summer And Fall Diets

The grazing behavior of reindeer during late summer and fall is characterized by a shift in plant selection from grasses and sedges to green leafy parts of woody perennials such as *Arctostaphylos alpina, A. rubra, Vaccinium uliginosum, Ledum decumbens, Empetrum nigrum* and *Rhododendron lapponicum. Dryas integrifolia,* several salices, and various herbs and forbs (especially *Pedicularis* sp.) are eaten in large quantities.[1,3] Mushrooms are so highly prized that the intense search for them often leads to straying and even stampeding of commercial herds of semidomesticated reindeer.[33] Of similar concern to reindeer herders are the effects of tramped dry and brittle lichen heaths during the midsummer to late fall grazing season. Pegau has determined that 35 percent of the edible lichen biomass may be destroyed in this way during close herding of reindeer on the heaths.[17] Fortunately, lichens are so hygroscopic that a brief rain shower or period of high humidity is sufficient to convert the brittle lichen heath to a soggy, sponge–like biomass. Finally, digestibility studies have shown that reindeer make efficient use of the crude fiber in grass and sedge hays.[18,19]

Winter Diets

The singular nutritional characteristic of reindeer that distinguishes them from all other large herbivores and that has enabled them to utilize holoarctic range lands is their preference for and ability to survive on lichens during the long (six– to eight–months) winter grazing period.[13,23] Reindeer seem to have an uncanny ability to locate and excavate lichens, even where these food plants are buried under snow cover of up to 60 cm (two feet) or more.[20] This does not imply that reindeer thrive under these conditions. On the contrary, the very low protein (~2 to 3 percent DM), ash (~2 percent DM), and fat (1.5 percent) content and the high crude fiber (45 percent) of lichens (Table 3) results in a considerable loss of body substance (but not necessarily body weight during prolonged winter grazing.[4,12,21] The data listed in Table 8 are intended to emphasize the great differences in nutritive content that exist between lichens and the common livestock feed, alfalfa hay. The above discussion also should not be construed to imply that reindeer eat only lichens during winter; reindeer also consume variable amounts of frozen grasses, sedges, the leaves of woody plants, and mushrooms which are found in craters that are dug in search of lichens. [4,22,23]

TABLE 8

Nutrient Content of the Preferred Lichen, *Cladoinia Alpestris* Compared To Alfalfa Hay [a,b]

Ingredient	Cladonia alpesaris	Alfalfa hay
Crude protein (%)	2.75	18.2
Crude fat (%)	1.52	2.5
Crude fiber (%)	44.49	28.0
Ash (%)	1.87	10.3
N-free extract (%)	49.12	41.0
Na (mg/kg)	54	190
K (mg/kg)	733	2460
Ca (mg/kg)	514	1350
Mg(mg/kg)	300	340
Mn (mg/kg)	100	46.5
P (mg/kg)	200	300
Fe(mg/kg)	300	50
Zn (mg/kg)	10	35.1
Cu(mg/kg)	2	18.7
Co (mg/kg)	0.4	0.24

[a]Values for proximate analysis and mineral content are taken from Kelsall[1] and Luick,[32] respectively.

[b] Sun–cured, ground alfalfa hay (N.A.S. Ref. No. 1-00-111) as reported in United States–Canadian Table55 of Feed Composition, National Academy of Sciences Publication 1684, Washington. D.C. 1969.

Although competition for grazing on winter lichen ranges is essentially nonexistent, the reindeer's high dependence upon that food source is not without hazard. Massive die-offs have

occurred when early spring rains freeze and form an impenetrable crust of ice on top of the snow.[23] Skogland states that reindeer spend about 62 percent of the day searching for and eating lichens, and various workers have estimated that lichen consumption rates are approximately 2 to 5 kg (four to 11 pounds) per day per animal.[1,2,24,25] The consumption of even these relatively small amounts of frozen foodstuffs and solid water (snow) is of considerable energetic cost to reindeer, since the necessity of raising the temperature of ingesta to deep body temperature has been estimated at approximately five percent of the resting metabolic rate.[13,26]

Lastly, rations have been compounded and tested in Norway and Siberia for use either as supplements to winter lichen diets or as complete rations during emergency feeding conditions.[23,27,28] Formulas for these rations are listed in Table 9.

The Lichen Paradox

Recent findings at the Cantwell Reindeer Research Station, Cantwell, Alaska seem to establish a paradoxical situation insofar as they apply to the winter grazing habits of reindeer. In preliminary studies on the food and water preferences of penned reindeer fed widely differing basal rations, lichens were always selected (and consumed in toto) over nutritionally superior livestock ration (pelletized Purina Cattle Starter No. I) and/or three species of long hay, *Poa pretensis* (Kentucky Nugget Bluegrass), and *Festuca rubra* (mixed Arctared red fescue), and *Calamagrostis canadensis* (Bluejoint reedgass). Snow was preferred over cold, warm, or saline water as a source of water intake.[29]

This strong preference for a nutritionally inadequate and energetically taxing diet, especially when nutritional and climatic stresses are most severe, does not fit easily into the concept of natural selection. However, the recent finding in our laboratory, that the daily water flux of freely grazing reindeer diminishes threefold to fivefold during winter suggests a reasonable explanation for the phenomenon. The survival value of ingesting small amounts of dietary protein and minerals such as lichen and distilled water (snow) may be attributed to the conservation of body water and, therefore, body heat by decreasing the amount of water required to eliminate metabolic nitrogen and body electrolytes.[12] This hypothesis is supported by Cameron’s finding that decreases in water flux of pen–fed reindeer during severe cold are elicited chiefly by the level of dietary protein intake.[26]

Evidence contrary to this hypothesis stems from reports that reindeer crave urine and sea water, gnaw old bones and shed antlers, and kill and eat lemmings and mice, as well as bird’s eggs and nestlings.[30] It is also known that reindeer maintain and even gain body weight during winter when there is an adequate supply of frozen green vegetation to supplement the lichen biomass.[4,21] Similar results have also been noted with reindeer that are fed supplemental and/or complete rations during severe winter weather (Table 9). [23,27,28]

TABLE 9

Diets for Supplementing or Replacing Normal Feeding Regimes of Reindeer During Periods of Severe Undernutrition

Supplemental rations [a,23]	Complete ration A[23]	Complete ration B[27]
Urea (50%)	Cereal grains (41%)	Ground barley (40%)
Dicalcium phosphate (30%)	Ground hay (25%)	Ground oats (17%)
Minerals (20%)	Ground straw (15%)	Wheat bran (15%)
	Molasses beet chips (10%)	Soybean oil (3%)
	Wheat bran (5%)	
	Dicalcium phosphate (1.7%)	
	Iodized Salt (0.3%)	
	vitamins (2%)	
	Mineral mixture (trace)	

[a] This ration is mixed with lichens and fed ad libitum to reindeer as a supplement to typical winter diets.

In rebuttal to the above, it seems unlikely that significant quantities of urine, sea water, old bones, lemmings, bird's eggs, etc. would be available or accessible during deep winter; hence, they should not be considered as supplements to winter lichen diets. Additionally, Cameron and Luick[12] confirmed the earlier findings that reindeer can maintain body weight while grazing mixed vegetation during winter, but discovered further that this was accomplished by replacing a substantial loss of body solids with an almost equivalent amount of body water. Thus, changes in body weight are deceptive and must therefore be interpreted with great caution.

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APPENDIX IX

Normal Blood Values for Reindeer

Hemoglobin (8/dl)	15.1±4
Red Blood Cells (x 10^6)	9.5±1.5
Packed Cell Volume (%)	45.0±5
White Blood Cells (x 10^3)	7.8±2
Neutrophils (%)	45.0±10
Lymphocytes (%)	40.0±10
Monocytes (%)	3.0±2
Eosinophils (%)	5.0±5
Basophils (%)	3.0±2
Plasma Protein (g/dl)	7 5±1
Fibrinogen (mg/dl)	300-500
Glucose (mg/dl)	101±22
Blood Urea Nitrogen (mg/dl)	35.0±6
Uric Acid (mg/dl)	0.36±0.07
Total Bilirubin (mg/dl)	0.31±0.09
Cholesterol (mg/dl)	68.0 ±12
Calicum (mg/dl)	9.8±0.8
Inorganic Phosphate (mg/dl)	6.8±0.9
Sodium (mEq/l)	145±8
Potassium (mEq/l)	5.0±0.8
Magnesium (mg/dl)	2.1±0.*3*

APPENDIX X

Glossary Of Health Related Terms

Abdomen - Area or space in the body between the chest and pelvis; the part of the body behind the diaphragm

Abdominal - Cavity Area or space in the abdomen containing the digestive organs, reproductive organs, kidneys, liver, and spleen

Abomasum - Fourth stomach in a reindeer

Abortion - Premature birth of a dead fetus

Abscess - Pocket of pus

Acute Infection - Infection that lasts a short time

Anatomically - Referring to the structure of the animal

Anatomy - Science of the structure of the animal body

Anemia - Thin blood, a decrease in the red blood cells or hemoglobin in the blood

Antibiotic - Drug given to an animal to fight infection

Antibodies - Produced by the body to fight a specific disease: found in the clear serum portion of the blood

Anticoagulant - A chemical added to blood being collected that keeps it from clotting

Anus - The rear end opening of the digestive tract

Artery - Carries blood away from the heart

Aseptic - Sterile, without contamination

Aspirate - To pull back on the plunger of the syringe (after the needle has been inserted into the animal for an injection) to see if blood can be sucked into the syringe

Atrium - One of the two upper chambers of the heart; blood is received in an atrium and passed to a ventricle

Bacteria - Very small germs; one cell in size; many kinds found in the air, soil, in and on humans and animals; some cause disease, others are necessary for life

Barren - Not pregnant

Bovine - Referring to domestic cattle

Brucellosis - Disease caused by a bacteria named Brucella; causes female reindeer to abort (lose the baby before it is ready to be born); causes males to have swollen testicles; lameness is caused in both sexes in long-term infections; in humans the disease causes fevers, aches and pain

Carbon Dioxide - Gas formed by the tissues and eliminated by the lungs as a waste product

Carnivore - Meat-eating animal

Cartilage - Makes up most of the skeleton before an animal is born and when it is very young; in adults it is found in such places as the ends of the ribs, the joint surfaces of bones and rings of the trachea

Castrate - To remove the testicles of a male

Cervical - Referring to the neck

Chronic - Infection Infection that lasts a long time

Colony - A group of bacteria that can be seen on a culture plate

Congestion - An abnormal accumulation of fluid, usually blood, in the body

Conjunctivitis - Reddening of the white of the eye

Contagious - Can be spread from one animal to another

Contaminant - An unwanted object, usually a bacteria

Cyst - Fluid-filled sac

Debilitate - To make weak, not strong

Diagnosis - Identification of the nature of the disease

Diaphragm - Muscle separating the abdominal cavity from the chest cavity

Disarticulate - Separation of a joint

Discharge - Fluid oozing from an opening

Ectoparasite - Parasite on the outside of an animal such as fleas, ticks, lice, and mites

Endoparasite - Parasite living inside an animal such as lungworms, tapeworms, roundworms, etc.

Epididymis - Structure attached to the testicle in which the sperm are stored

Epizootic - A disease affecting many animals in an area at the same time

Esophagus - Tube carrying food from the mouth to the stomach

Etiology - Study of the events causing a disease

Feces - Manure

Fecal Sample - Sample of manure

Femur - Thigh bone; extends from the pelvis to the tibia

Fetus - Unborn baby inside the mother

Foot Rot - Foot infection caused by a bacteria

Formalin - Chemical used to preserve tissues

Heart - Pumps blood to the lungs to pick up oxygen, then throughout the rest of the body to deliver oxygen and other nutrients

Hemolyze - To break the red blood cells which release hemoglobin

Histologic - Microscopic study of the structure of tissues and their cells

Hormones - Chemicals produced by the body to regulate specific body functions

Humerus - Upper front leg bone; extends from the scapula to the radius

Hydatid Cyst - Fluid-filled sac containing immature *Echinococcus*; usually found in liver or lung

Infection - Invasion and multiplication of germs in the body

Incisor - One of the front four teeth; adapted for cutting

Inflammation - Protective response of the body to injury; characterized by heat, swelling, redness, and pain

Injection - The act of forcing a liquid (usually a drug or medicine) into the body with a syringe and needle

Intestines - Coiled, hose-like portion in the digestive tract between the stomach and anus where water and nutrients from the food are absorbed into the body

Isolation - Removal and growth of a disease-causing agent for identification

Intramuscular - Within a muscle

Kidneys - One on each side of the backbone in the small of the back; filter blood to keep body fluids balanced; selects out unwanted materials and eliminates them from the body in the urine

Larvae - Immature worm or fly

Lesion - Abnormality caused by bacteria, viruses, parasites or chemical or physical injury

Liver - Large red organ located in the top portion of the abdomen; stores and filters blood; receives most of the absorbed foodstuffs from the intestines and changes them into products that can be used in other parts of the body; receives and degrades toxic (poisonous) substances from the intestines; the liver is essential for life

Lumbar - Pertaining to the back between the chest and the pelvis

Lungs - In the chest cavity on each side; puts oxygen in the blood to be used by the rest of the body; in breathing the lungs exchange oxygen which is breathed in for carbon dioxide which is breathed out

Lymph - Node Small round glands that act as filters to clean body fluids

Mammary Gland - Breast; milk-producing gland

Mandible - Lower jaw

Maxilla - Upper jaw

Metacarpus - Lower front leg bone

Metatarsus - Lower rear leg bone

Media - “Food” used to grow bacteria in the laboratory

Micro organism - Living microscopic cell

Microscopic - Something that can only be seen with a microscope

Mycotic - Referring to a mold or fungus

Necropsy - Examination of a dead animal

Necrosis - Cell death

Omasum - Third stomach in a reindeer

Organ - A group of cells organized together in the body to perform a particular function

Ovary - Makes eggs for reproduction: two in normal females

Oviduct - Tube that carries eggs from the ovary to the uterus

Oxygen - A gas that is essential for animal life; it is carried by the blood from the lungs to the rest of the body

Parasite - Worms or insects that live inside the animal (for example, in the lungs or intestines) or outside the animal and take their nourishment from the animal

Pathogenic - Causes disease

Pathogenicity - Ability to cause disease

Path Report - Pathology report; report of the history and examinations performed to determine the cause of death of an animal

Pedicle - Base or stem of the antler

Pelvic Girdle - Union of the two hipbones

Peritonitis - Inflammation (reddening) of the lining around the abdominal cavity and intestines

Petri Dish - Used to grow bacteria in the laboratory

Pink-eye - Infection of the eye

Placenta - Membrane that attaches the fetus to the uterus and through which it receives its nourishment

Pneumonia - Infection of the lungs

Pubis - The part of the hipbone forming the front part of the pelvis

Pus - Accumulation of dead white blood cells and products of tissue
death: usually caused by a bacterial infection

Rabies - Viral disease usually carried by dogs, wolves, foxes, etc. in their saliva; transmitted to humans by a bite or by getting saliva on the body by handling an infected animal; can be prevented in animals by a vaccine; always causes death if not treated

Radius - Upper front leg bone between the humerus and metacarpus

Rectum - Lower part of the large intestine

Reticulum - Second stomach in a reindeer

Retropharyngeal - Pouch Located in the back of the throat, above the windpipe

Rumen - First stomach in a reindeer

Scapula - Shoulder blade

Scrotum - Bag on the outside of the male body that holds the testicles

Serology - Study of the disease reactions of blood serum

Serum - Clear part remaining after blood clots are removed; contains antibodies; the part of the blood that is collected and sent to the laboratory for testing; can be frozen after it is separated from the clot

Spinal Cord - Part of the nervous system carrying messages from the brain to the body

Spleen - Found in the abdominal cavity of the left side of the rumen; flat dark red in color: destroys old red blood cells; makes new red blood cells in young animals: stores blood

Steer - Castrated male

Sternum - Breastbone

Symptom - A non-specific indication of a disease, such as a headache

Testicle (testes-pl.) - Two in normal males: makes sperm which fertilize eggs in the female for reproduction (‘balls”)

Thoracic - Referring to the chest

Tibia - A bone of the upper rear leg between the femur and metatarsus

Tissue - A group of cells that together make a particular structure

Topical - Upon the skin

Trachea - Windpipe: carries air (with oxygen) into the lungs and out of the lungs (with carbon dioxide)

Trauma (traumatic) - Injury caused by physical or chemical means

Treatment - A drug or medicine given to an animal to kill disease-causing germs

Turbinate - Bones in the reindeer nasal cavity

Ulcer - A break or hole

Undulant Fever - Brucellosis in man; symptoms include fever, aches, and pains; can be treated with antibiotics

Ureter - Tube carrying urine•from the kidney to the bladder

Uterus - Organ that receives and holds the fertilized egg to develop into the fetus

Vaccine - A suspension of germs that have been killed or changed so they cannot cause disease but do cause the body to make antibodies that can fight the real disease later; a vaccine prevents disease

Vas Deferens - Tube that carries sperm from the testes to the penis

Veins - Carry blood from the parts of the body to the heart

Ventricle - One of the lower. thick-walled chambers of the heart that pumps blood out to the body

Vertebra - One of the sections of bone of the backbone

Virus - Very small germ, smaller than bacteria; cannot be seen with ordinary microscopes; must live

within another living cell

Viscera - Internal organs of the body

Zoonosis - Disease that can be transmitted from animals to man

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