REINDEER HEALTH AIDE MANUAL

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Reindeer Health Aide Manual

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<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
<td></td>
</tr>
<tr>
<td>ANATOMY</td>
<td></td>
</tr>
<tr>
<td>The skeleton</td>
<td>1</td>
</tr>
<tr>
<td>The skull</td>
<td>1</td>
</tr>
<tr>
<td>The vertebrae</td>
<td>1</td>
</tr>
<tr>
<td>The ribs</td>
<td>2</td>
</tr>
<tr>
<td>The limbs</td>
<td>2</td>
</tr>
<tr>
<td>The organs</td>
<td>4</td>
</tr>
<tr>
<td>PHYSIOLOGY</td>
<td></td>
</tr>
<tr>
<td>Circulation</td>
<td>8</td>
</tr>
<tr>
<td>Respiration</td>
<td>10</td>
</tr>
<tr>
<td>Digestion &amp; Nutrition</td>
<td>13</td>
</tr>
<tr>
<td>Urogenital System</td>
<td>17</td>
</tr>
<tr>
<td>Antler Growth</td>
<td>21</td>
</tr>
<tr>
<td>Body Heat Control</td>
<td>23</td>
</tr>
<tr>
<td>Determination of Age by Tooth Wear</td>
<td>25</td>
</tr>
<tr>
<td>DISEASES OF REINDEER</td>
<td></td>
</tr>
<tr>
<td>Bacteria and Viruses</td>
<td>27</td>
</tr>
<tr>
<td>Immunity to Disease</td>
<td>29</td>
</tr>
<tr>
<td>Brucellosis</td>
<td>34</td>
</tr>
<tr>
<td>Rabies</td>
<td>44</td>
</tr>
<tr>
<td>Miscellaneous Reindeer Diseases</td>
<td>46</td>
</tr>
<tr>
<td>Respiratory Diseases</td>
<td>46</td>
</tr>
<tr>
<td>Foot Rot</td>
<td>48</td>
</tr>
<tr>
<td>Mandibular Lesions</td>
<td>48</td>
</tr>
<tr>
<td>Setaria</td>
<td>49</td>
</tr>
<tr>
<td>Fibropapillomas</td>
<td>49</td>
</tr>
<tr>
<td>Keratitis (Pink-Eye)</td>
<td>50</td>
</tr>
<tr>
<td>Abortion</td>
<td>50</td>
</tr>
<tr>
<td>Broken Antlers</td>
<td>50</td>
</tr>
<tr>
<td>PARASITOLOGY</td>
<td></td>
</tr>
<tr>
<td>Parasites</td>
<td>53</td>
</tr>
<tr>
<td>Warble Flies</td>
<td>54</td>
</tr>
<tr>
<td>Nasal Bots</td>
<td>59</td>
</tr>
<tr>
<td>Internal Parasites</td>
<td>61</td>
</tr>
<tr>
<td>COMMON MEDICAL TREATMENTS FOR REINDEER</td>
<td></td>
</tr>
<tr>
<td>First Aid</td>
<td>71</td>
</tr>
<tr>
<td>Castration</td>
<td>75</td>
</tr>
<tr>
<td>Aid in Fawning</td>
<td>77</td>
</tr>
</tbody>
</table>
NECROPSY PROCEDURES AND TECHNIQUES
Specimen Preparation 83
Tissue Collection 86
Causative Agents 87

APPENDICES
Appendix I—Reindeer Health Aide Kit 93
Appendix II—Tissue Collection 95
Appendix III—Serum Collection 97
Appendix IV—Whole Blood Collection for Complete Blood Count 99
Appendix V—Care and Use of Syringes 101
Appendix VI—Label for Warbex 105
Appendix VII—Specimen Submission for Rabies Assay 107
Appendix VIII—Feeding Orphan Fawns 111
Appendix IX—Nutrition 115
Appendix X—Glossary 145

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# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Section</th>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANATOMY</strong></td>
<td>Figure 1. Skeleton of the reindeer</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Figure 2. Internal organs of the reindeer</td>
<td>5</td>
</tr>
<tr>
<td><strong>PHYSIOLOGY</strong></td>
<td>Figure 1. Structure of the heart</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Figure 2. Structure of the lungs</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Figure 3. Ruminant stomach of the reindeer</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Figure 4. Female urogenital system in reindeer</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Figure 5. Male urogenital system in reindeer</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Figure 6. Age determination of reindeer by tooth wear</td>
<td>26</td>
</tr>
<tr>
<td><strong>DISEASE RESPONSE</strong></td>
<td>Figure 1. Natural disease response</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Figure 2. Vaccination</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Figure 3. Overwhelming infection</td>
<td>33</td>
</tr>
<tr>
<td><strong>PARASITES OF REINDEER</strong></td>
<td>Figure 1. Warble flies</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Figure 2. Nasal bots</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Figure 1. Roundworms</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>Figure 2. Lungworms</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>Figure 3. Tapeworms</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>Figure 4. Wild carnivore-wild ruminant tapeworms</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>Figure 5. <em>Echinococcus</em></td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>Figure 6. <em>Sarcocystis</em></td>
<td>69</td>
</tr>
<tr>
<td><strong>AID IN FAWNING</strong></td>
<td>Figure 1. Normal presentation of fawn at birth</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>Figure 2. Some abnormal presentations of the fawn</td>
<td>81</td>
</tr>
<tr>
<td><strong>NECROPSY</strong></td>
<td>Figure 1. Skinning the upper half of the body</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>Figure 2. Disarticulating the left hip joint</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Figure 3. View of chest and abdomen fully exposed</td>
<td>91</td>
</tr>
<tr>
<td><strong>CARE AND USE OF THE SYRINGE</strong></td>
<td>Figure 1. Assembly of multiple dose syringe unit</td>
<td>104</td>
</tr>
</tbody>
</table>
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Reindeer Health Aide Manual

ANATOMY

PHYSIOLOGY

DISEASES

PARASITOLOGY

TREATMENT

NECROPSY

APPENDICES
INTRODUCTION

The need for reindeer Health Aides was realized during the 1980 Reindeer Herder's Workshop held at Candle, Alaska. At that time it was apparent that with increased technical knowledge becoming available it would be necessary to train people working directly with herders and "on location" to observe, necropsy and treat various ailments of reindeer.

The University of Alaska, Cooperative Extension Service put together a proposal for training of local reindeer assistants which was funded by the United States Department of Agriculture. In many cases herd owners sent their assistant to this Health Aide Workshop realizing that they themselves would be busy with the management of the herd and would have little time to do the actual treatments, etc.

With these considerations in mind, the first Reindeer Health Aide Workshop was held at the University of Alaska, Fairbanks on October 6-10, 1980. This manual is based on information taught at that workshop.

The training of a Reindeer Health Aide is a progressive and continuing educational experience. The entry level of the program has been designated Reindeer Health Aide I with future levels of more training to be designated II and III.

The following is a listing of tasks that the three levels of training would allow a Reindeer Health Aide to accomplish:
Reindeer Health Aide I

1. Administer medications under direction of reindeer veterinarian.
2. Castrate reindeer.
4. Obtain blood samples for diagnostic tests.
5. Obtain necropsy samples.
6. Administer limited first aid to reindeer.
7. Care for orphan fawns, general nursing care.

Reindeer Health Aide II

1. Perform all duties of Reindeer Health Aide I.
2. Recognize common diseases of reindeer and treat under reindeer veterinarian's direction.
3. Perform parasite examinations on reindeer.

Reindeer Health Aide III

1. Perform all duties of Reindeer Health Aide I and II.
2. Perform advanced first aid procedures.
3. Perform laboratory tests on reindeer blood and feces.

This manual is an attempt to place the information needed to qualify for the Reindeer Health Aide I level in an understandable form which can be used as a reference source for those having had the course and as a teaching guide for those entering the program at the I level.
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.

The 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.

The 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, serve 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 together in the pelvic region and continue back to become the smaller tail bones.
The 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.

The limbs. The front limb attaches by a large muscle mass connecting 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 metacarpal.

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 each consist of two digits, (fingers) with two dewclaws representing two more digits.
Figure 1. Skeleton of the reindeer.
THE ORGANS

The internal organs of a reindeer are illustrated in Figure 2. The esophagus is the tube running from the mouth to the rumen. When food is swallowed, it travels down this pipe. The ruminant stomach has four chambers. The largest is the rumen, which is a large sac in the abdomen, lying mostly on the left side of the body. From the stomach food passes into the coiled intestine at the rear of the animal. The intestine leads to the outside of 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 up 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 2. Internal organs of the reindeer.
PHYSIOLOGY
PHYSIOLOGY

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 actually depends on and influences the others.
Circulation is the flow of blood through the body. Blood supplies nutrition and oxygen to body parts and carries away carbon dioxide, which is a waste product that is exhaled by the lungs. Blood is made of red and white blood cells and clotting cells in a suspension of clear serum. The red blood cells transport oxygen and carbon dioxide, and the white cells are important in fighting infection. Clotting cells gather at a cut or wound to stop bleeding. The serum 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 flows 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 exhaled. The blood then returns to the heart with its new supply of oxygen and is pumped from the left ventricle back to the body parts through arteries.

The spleen aids in circulation by making new red blood cells and acts as a storage place for red blood cells. It can contract and send new red blood cells to the circulation when oxygen is in low supply; this may occur, for instance, when an animal exercises or becomes very excited.
Figure I. Structure of the heart. Arrows show direction of blood flow.
Respiration is the process of inhaling air into the lungs in order to extract oxygen for the body's use. Carbon dioxide, which is 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 of the rings of cartilage running down 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 are microscopic. At this level, carbon dioxide can leave the blood in which it has been transported, and oxygen flow in.

The diaphragm aids in respiration. It contracts and squeezes down on the chest, forcing air out of the lungs; when the diaphragm relaxes, the chest expands and air can flow in.

During normal activity, a deer breathes through his nostrils. The air passage within the reindeer's nostrils is in a scroll-like pattern, formed by special bones called turbinate bones. Air that is inhaled 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 rather
than leaving the body. In this way, heat and moisture are retained within the body.

When a reindeer runs hard, it must resort to breathing through its mouth in order to get enough oxygen. In this case, the turbinate bones are bypassed and cold dry air goes directly to the lungs. Not only are extra heat and energy wasted in order to reheat the lungs in this situation, but cold air may damage lungs that are already weak. This may lead to pneumonia or other lung illnesses.
Figure 2. Structure of the lungs.
DIGESTION AND NUTRITION

Recall that the reindeer's stomach is actually made of four chambers, each with a special function in digesting food. Figure 3 shows the path that food takes when it reaches the stomach area. Food is passed back and forth between the reticulum and rumen after being swallowed. The rumen is the large fermentation sac containing bacteria and other one-celled creatures. The rumen stomach is unique to grazing animals whose diet consists of plants and grasses. Plants are made of a tough material called cellulose, which is undigestible 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 that is 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 up 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 they pass outside of the body.

Seasonal migration of the reindeer is due, in part, to nutritional needs. In the summer, the animals migrate progressively northward or towards the coast to follow the emergence of lush, young, green new plant shoots. This new growth is the most desirable to the deer because it provides the most energy and is most nutritious at this stage.

In the summer, the reindeer's diet consists mostly 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 winter time, makes up a great portion 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 be helpful in evaluating how nutritious a particular rangeland will be to the reindeer herd. In the Appendix of this manual are two articles published by Dr. Jack Luick concerning reindeer nutrition and feeds.
Water is essential to the life of all animals. A reindeer can do without feed for a longer period of time 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 eight hours without water.
Figure 3. Ruminant stomach of reindeer.
UROGENITAL SYSTEM

This system is a combination of that part of 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 out of 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 this urine and stores it. From here it empties to the outside. Both male and female have basically the same type of urinary system.

Figures 4 and 5 show the make-up of the male and female reproductive tracts and the accompanying urinary tract.

The female reproductive tract opens to the outside of the body through the vagina, the lower portion of the birth canal. The vagina leads to the uterus, or womb, where the baby fawn develops. The uterus in reindeer branches into two horns; at the end of each horn is an ovary. The ovary produces eggs, which travel to the uterus through the oviduct. When fertilized by a male reindeer's sperm, the egg will develop into a reindeer fawn within the female uterus. Besides producing eggs, the ovaries make important hormones which regulate the female heat cycle and control the progress and maintenance of pregnancy.

The testicles of the male correspond to the female ovaries. In the testicles, sperm is produced; during breeding sperm join with the female
egg to fertilize it. Testicles also produce hormones that play a role in the male breeding cycle. Sperm travels down the vas deferens duct and leaves through the penis.
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 the males and females shed their antlers yearly. The following account outlines a typical yearly antler cycle.

Bulls start the growth of a new set of antlers in early spring, after the fawning period. The female's antlers begin growing soon after this. 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 begin to calcify. This is the usual time for cutting the male antlers, whereas cutting the females' should be done two to three weeks later because of their later start in growth.

Bulls growing a large rack will have an especially heavy blood supply to the antlers; for this reason, when the antlers are cut, rubber bands should be applied to stop bleeding.

As uncut antlers continue to grow through the summer, they harden to bone and blood supply is gradually cut off. By the breeding season, bulls' antlers are full-sized, bony, and hard. The velvet has dried up and been rubbed off. Some of the females may still have their velvet at this point.
The bulls lose their antlers in November-December, and 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 give birth in late spring and drop their racks at this time.

Newly born fawns begin antler growth in their first summer, and this set will be retained through the winter to be dropped in the following spring.
BODY HEAT CONTROL

It is of interest to look at the special features of reindeer that make them able to withstand the cold arctic winter.

Reindeer hair is unique because it is hollow, like a straw. Air is trapped inside the hair itself 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 kept well insulated. Hollow hair allows reindeer to float well when swimming.

Why are the reindeer's legs not well protected with a thick hair coat in winter? It has been found experimentally that the reindeer has the ability to cool down its limbs; in other words, when the weather is very cold (about -30°F) the deer doesn't spend a lot of heat and energy keeping its lower legs warm. Instead, the temperature in the lower legs is allowed to go down to about 33°F, just above freezing, while the chest and abdomen are still kept at the normal body temperature of 101.5°F. 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; down in the lower legs and hooves are mostly tendons and ligaments. These can continue to function at low temperatures, and cool leg temperatures don't affect the reindeer's ability to move.

Nasal turbinates discussed in the "Respiration" section of this manual, are also important in regulating body heat. When the outside
temperature warms up above 0°F, the blood vessels in the deer's legs open up, and warm blood flows down into the legs. This allows the legs to heat back up to normal body temperature. This ability to cool down or warm up the lower legs is a means by which the reindeer conserves heat within the body, and in the long run, means that less fuel, and therefore food, is needed by the body to keep warm.

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

Excess heat can also be given off in the legs where there is less hair cover. Blood vessels will carry more blood close to the surface of the skin to allow heat to escape to the air.
DETERMINATION OF AGE BY TOOTH WEAR

Reindeer have two sets of teeth. The fawn is born with milk teeth, which fall out and are replaced 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 in the 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, and with age the incisors on both sides progressively wear down also. A very old reindeer may 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
DISEASES
BACTERIA AND VIRUSES

Think of the smallest thing you've ever seen such as the tip of a needle, a snowflake, or a piece of dust. Bacteria are 1,000 times smaller than anything you can see. Even though they are so small, they are alive. Bacteria can be found almost anywhere and live, for instance, 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 the 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 a very important part in their digestion processes.

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

It is important to identify disease-causing bacteria. First of all, if the bacterial agent can be identified, the correct cure can then be given to the diseased animal. If it is too late or impractical to cure specific animals, when the bacteria is identified, other animals can be protected with the correct vaccine or the correct precautions.

How are bacteria identified? They can be stained and seen under a microscope. Bacteria come in three basic shapes: round (cocci),
rod-shaped (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 around 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 this other 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 only some antibodies to a virus, it means it has been exposed to that virus sometime in the past. 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.
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 serum 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 that 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 antibody. It takes about a week or 10 days to make enough antibodies to be effective, thus 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 a person only gets mumps, for example, 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 principal 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 are not able to 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 cannot keep up with the disease process, and antibiotics help by killing the disease organisms (see Figure 3 on Antibiotics and Treatment).
Disease bacteria enter reindeer.
(Example: Brucella bacteria)

Reindeer makes antibodies to fit bacteria (like lock and key). This takes at least one week.

A specific reaction occurs where antibodies tie up bacteria.

Figure 1. Natural disease response.
Figure 2. Vaccination.

A.

Bacteria similar to disease bacteria are injected into reindeer.

Antibodies to fit injected bacteria are made in blood, and tie up bacteria. Sometimes mild symptoms of disease are seen.

NO DISEASE

B. Later:

Disease bacteria enter reindeer.

Extra antibodies from above process are still present and ready for action.

NO DISEASE
Disease bacteria enter reindeer.

Reindeer makes antibodies, but can't keep up with the rapidly multiplying bacteria.

Treatment: inject antibiotic. Excess bacteria killed.

Figure 3. Overwhelming infection.
BRUCELLOSIS

INTRODUCTION

Brucellosis is a bacterial disease that also goes by the name of Bang's disease, 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 kind of Brucella, Brucella suis type 4. It has been suggested it should be better called B. rangiferi.

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 of the organism and it was found in the wide range of hosts mentioned earlier. 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.
Brucella has been known to infect reindeer and caribou in the Soviet Union for a number of years.\textsuperscript{3,5} 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 from caribou in Alaska in 1963 which established the actual source of most recent infections.\textsuperscript{6} It is not known whether the disease was introduced into Alaska with the importation of reindeer from Siberia in the late 1800's or if it has been present since prehistoric times. The kind of Brucella isolated from caribou was found to be the same type infecting several Native patients in rural Alaska.\textsuperscript{8} In 1964, approximately 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 7 villages in 1962-1964, 11\% of 763 individuals tested had evidence of past Brucella infection.\textsuperscript{1} It was also reported that 8 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 that there is little doubt that many cases do not come to the attention of medical personnel. Physicians in Alaskan bush communities are frequently short-term and many cases of brucellosis may go undiscovered because medical personnel are not aware of the many signs of the disease.
Following the detection of brucellosis in Alaskan 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.\textsuperscript{10,11} Serologic testing of caribou and reindeer for brucellosis was carried out during the early 1960's and 1970's.\textsuperscript{9} The highest percentage of animals having a positive blood test at various times was 30% for the Arctic caribou herd, 6.5% for the Melchina 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 located on the northern portion with incidence of serologically positive animals reaching 20%. 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 currently under study in these populations by several different research teams.\textsuperscript{13,14}

**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. In males, infection is seen in the testicles and related reproductive tissue. In both males and females there can be swelling of the joints with associated lameness.\textsuperscript{16} 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 initially infected. They may or may not abort the next year and thereafter they produce live calves. This same pattern appears to be true for reindeer, but joint disease, abscesses and other chronic symptoms 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. Visible signs of the disease in reindeer or caribou herds represent only a small portion of the overall effect of the disease. When a herd containing infected reindeer or caribou is observed, one can commonly see lame animals. 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.
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 accurately identify acutely infected animals. Research is underway at the University of Alaska to determine which type of serologic test will identify chronically infected animals, and at this time the complement fixation test is the most promising. Unfortunately, this is a complicated procedure and can not be used in the field.

The actual isolation of the bacteria in the laboratory indicates that a Brucella infection is definitely present, but this procedure depends on providing 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 at a later time. 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. In December 1979, the Reindeer Herder's Association named the control of brucellosis and warble fly infestation as its highest research priorities.

It should be emphasized that brucellosis in reindeer and caribou is a disease that causes relatively few deaths in adults as a direct result, but does infect many animals chronically. Of course, 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 impact 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. all 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 more importantly, a cow that is barren.

It is not known if the predators of reindeer and caribou serve as end hosts for the disease or if they are capable of spreading the disease back to uninfected reindeer or caribou. Also unknown are the effects of the disease on the predator itself or its reproductive success. Grizzly bears harbor the disease for a prolonged period after being experimentally infected (personal observation).
Brucellosis has rarely been reported in moose even in areas of 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 that handle reindeer or caribou tissues are infected each year. The number of infections is not great and the degree of illness varies between 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, lymph 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 control are currently being developed for reindeer. First, with the aid of an accurate blood test, infected animals could be detected and subsequently 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. Therefore the possibility would
exist of reinfection of "clean" herds by non-tested reindeer or by infected migratory caribou or predators. Therefore, development of a suitable vaccine which would protect the animals from infection and thus prevent abortion is a major long-term goal. Such a vaccine would not only increase herd productivity, but would also reduce the main source of transmission. Costs associated with the destruction of infected animals would be greatly reduced. Information gained from reindeer control programs may eventually lead to attempts to control brucellosis in other wildlife species.

Newly developed drug delivery methods such as the Ballistic Implant System could make vaccination or treatment of some free ranging species possible. This system is based on an air powered rifle that delivers a biodegradable implant pellet, containing a vaccine or drug plus a dye marker ball that stains and identifies animals as they are treated.
References


Rabies is a very serious disease caused by a virus, which is a type of microscopic organism even smaller than bacteria. The disease affects all animals, including man, and if left untreated, will end in death. Although rabies is not a common disease found in reindeer, it is an important condition for reindeer health aides to be aware of. The disease is always present in a small number of red and arctic fox throughout Alaska, and the possibility for infection of reindeer or humans by local fox 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 may 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.

The disease is most commonly found in fox, and the number of affected animals in an area seems to follow a cycle. When fox populations rise, the number of infected fox also rises. Outbreaks of the disease occur most often in fall and winter. Rabies seems to be rare in wolves, bear, caribou and moose, but has been known to occur.
Although fox are most commonly infected, they do transmit the disease to dogs. It is through dogs that most human infections have occurred. The disease is passed on through the bite of the sick animal because the virus is carried in the saliva. Rabies can also be passed on if the saliva gets into a cut or wound on the skin. If rabies is suspected in a certain area, it is wise to wear gloves when skinning out a fox and to avoid getting the fox's saliva on the hands. Rabies should be considered if a reindeer becomes sick or dies with aggressive or other strange symptoms.

If a person has been bitten by a wild animal that is suspected of having rabies, that animal should be killed at once and the head sent to the nearest rabies unit as outlined in the appendix. The laboratory will test the brain matter to see if the animal truly had rabies. If so, the person must start rabies treatments at once. 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 2 to 8 weeks for the signs of the disease to show. Once symptoms actually 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. The rabies vaccine can be obtained from a veterinarian. By protecting dogs from rabies, you indirectly protect the people in that 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 a pneumonia caused by bacteria 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 indicating 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 PI3 (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 such as penicillin may be used to treat certain respiratory tract infections. For specific dosages, Dr. Dieterich, Fairbanks, 479-7166, should be contacted as each case needs to be treated differently.

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 on such things as rocks. Bacteria can then enter the foot through the break in the hoof. It is believed the bacteria that 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 out 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 gumline. 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, i.e. more mandibular lesions are seen in older deer than younger deer.

There is no specific treatment for this disease.

SETARIA

Setaria is actually a parasite but is discussed here because it affects the reindeer more like a disease than a parasite. The adult worm lives outside the intestines, free in the abdominal cavity. 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 by biting 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 (Pink-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, streptomycin and cortisone. Methods for this injection will be taught in a later course.

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

ABORTION

Abortion, or premature birth of a dead baby, can be caused by a number of factors. 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 at all possible. Reindeer "go crazy" with a broken antler flapping around. They may starve to death from being so distracted. It is especially important in fawns as the skull is usually broken also. Continued movement of that antler moves the broken skull cap around and damages the sensitive brain tissue underneath. Fawns will probably die from brain damage if untreated.
Broken antlers on adults may be cut off 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 on to help prevent infection. Rubber bands may be applied to the base to control bleeding if necessary.
PARASITOLOGY
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. Parasites living on the outside of an animal are called external parasites and include lice, mites and ticks.

Internal parasites may be found in the intestines, stomach and lungs. Some, such as Setaria, may be found free within the abdominal cavity.
WARBLE FLIES

The warble fly is a major pest infecting reindeer in Alaska. The larval stage of the warble is a parasite that lives underneath the skin. It impairs the health of the reindeer, and the general management of the herds is affected by the widespread presence of this 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. Rather, the flies mate, and the females then 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 legs, rump, and back of the deer. The adults continue laying eggs through the summer, and die as temperatures drop in early fall.

After being laid, 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, and 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 who are attempting 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 actually prevent the reindeer from fattening up well during the summer. From the herder's viewpoint, the deer are much harder to control and keep together due to their nervous reaction to the warble flies.

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

The large number of breathing holes from the larvae and the scar tissue due to the cysts greatly reduce the quality of the reindeer's hide. 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 involves the use of a chemical which is poisonous to the larvae. The chemical is also poisonous to reindeer and other animals, but the size of dose used is small enough that it kills the larvae but doesn't harm the reindeer. A normal dose will not hurt a pregnant cow or her fawn and will, in fact, make her healthier during her pregnancy. It is very important not to give a deer more than its normal dosage,
however, since an overdose could make a deer sick or cause death in extreme cases.

Several methods of treatment have been tested in Alaska. Cattle are also infected by warble flies, and they are successfully treated with a solution of warble medicine that is poured right along the animal's back. The medicine soaks through the cattle's skin and kills the larvae. This has been tried on reindeer, but because of their thick hair, the medicine does not reach the skin in enough volume to kill many of the warbles. It was also found that the reindeer shook the solution off as soon as it was applied and little stayed on the animals.

Another method tested involved forcing the reindeer to swallow a pill containing the warble medicine. The reindeer, however, were able to spit the pill out, and this idea was rejected.

This has led to the method of injecting reindeer with a dose of medicine called famphur, which is now in use in Finland and Russia. The injections can be given fairly quickly without slowing down a normal handling process. The U.S. Food and Drug Administration has now given conditional, experimental approval of the use of this drug, under the brand name of Warbex, with one restriction. An animal injected with Warbex can not be slaughtered and used for food for one year after treatment until final approval is given. A six week waiting period appears to be necessary.

In 1976, the famphur drug was injected into 300 reindeer at a herd roundup in Kotzebue. About one half of these animals were recaptured in the spring of 1977 and checked for warbles. Seventy-six percent of the
treated reindeer were entirely free of warble larvae, and thirty-three percent had only one to five larvae. Only two animals out of the 155 that were checked had 25 larvae. At the same time, untreated reindeer were also checked for warbles for comparison. All of the 93 untreated reindeer had warble larvae, and two-thirds of the animals had over 100 larvae apiece. It was clear that the treated animals had less warble larvae.

Treatment with Warbex, then, is best done in the fall between October and January. This kills the larvae before they have had the chance to chew holes in the reindeer's hide. Those animals that will be slaughtered that fall should not be treated. If more reindeer will be needed for slaughter later in the same year, these should not be treated either. These untreated animals can be marked with special ear tags so that they can be found and slaughtered at a later date.

The herd may have to be treated every year in areas where several herds are located on nearby ranges. In this situation, the flies will be able to travel from herd to herd and cause new infections each year. Isolated herds may only have to be treated once every few years; since the drug kills the larvae, there should be far fewer adult flies the following summer to reinfect the herd. As treatment programs are put into action, more will be learned about how frequently treatment will be necessary.

A warble treatment program could do much to increase the overall health of the herd, improve the quality of the hides, and make herding and management an easier process.
Larvae burrows through skin, migrates to reindeer back, creates a breathing pore, grows larger over winter to become a full-sized warble.

WARBLE FLIES

Each egg hatches in 6 days to produce a tiny larva. Warble emerges and drops to tundra April 20 to July 20, and begins pupal stage.

After 30 to 35 day pupation, insect emerges as adult fly.

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 (Warbex) eliminates 95% or more of warbles
2. Treatment must be done from September to January to reach larvae
3. Ballistic Implant System may make treatment easier

Figure 1
NASAL BOTS

Nasal bots are similar to warbles in that it is not the adult that is the true parasite of the reindeer, but rather its immature form or larvae (Figure 2). The adult fly lays her eggs close to the openings of the nostrils in the summer. This in itself causes strange, irregular or erratic behavior in the reindeer as it tries to avoid the adult pest.

The eggs hatch soon after being laid, and the first stage larvae live in the nasal cavities 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 a great deal of 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 finally into adult flies to continue 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. Hopefully, control of this pest will progress with the control of the warble (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:
Warbex (same drug for warble control) will aid in the control
INTERNAL PARASITES

Adult roundworms living in the stomach and intestines lay eggs which pass out with the manure on the ground. These microscopic eggs hatch and are eaten by another animal as it grazes. The immature worms develop into adults in the stomach or intestines, and the cycle begins again (Figure 1).

Adult lungworms live in the lungs. After they lay eggs, they are coughed up and swallowed. Eggs hatch in the intestines, and immature lungworms (larvae) are passed out with 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 2).

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. Every once in a while, 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 3).

Other species of tapeworms live as adults in meat-eating animals (carnivores) such as foxes or dogs. Segments containing eggs are passed out 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, baby 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 4).

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 5).

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 6).

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 detrimental 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 period of time are more likely to eat more parasite eggs off the
ground. Thus it would be 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 without gloves.

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

Certain drugs are available to kill internal parasites. One of these, Levamisol, was injected into several thousand reindeer on the Seward Peninsula in the summer of 1980.
Eggs hatch and develop into larvae in soil and droppings.

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
EFFECTS:
Coughing and debilitation;
May be complicating factor in pneumonia

DIAGNOSIS:
Microscopic: larvae in feces
Necropsy: adults in lungs

Figure 2
EFFECTS:
May be debilitating

DIAGNOSIS:
Microscopic: eggs in feces
Necropsy: adults in intestine
Dogs: Diarrhea in heavy infections
Reindeer: Liver damage; more serious in young animals

DIAGNOSIS:

Dogs: Eggs in feces; adults 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 4
EFFECTS:
Dog: Non-apparent effects
Reindeer, moose, etc.: Depends on number of cysts; may not be too serious
Man: Always serious

DIAGNOSIS:
Dog: 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 5
Sexually mature coccidia in intestine of carnivore

Cysts develop in muscle, which is in turn eaten by carnivore

Eggs passed in droppings

SARCOCYSTIS

Mammal host (deer, cattle, man) eats eggs

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)

Figure 6
TREATMENT
FIRST AID

1. Probably the best advice for particular problems can be obtained by calling Dr. Dieterich, Fairbanks, 479-7166. Dr. Leedy in Nome is another good source for help.

2. For wounds, first clean the area as well as possible. Remove any dirt or hair in the wound. Secondly, 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. More advanced first aid for wounds will be covered in later courses.

3. Several antibiotics are available to treat infections. All of these should be used on the advice or under the directions of a veterinarian.

a) Penicillin - Streptomycin is a widely used, relatively cheap, injectable antibiotic. Its effects are of short duration, thus several injections must be given.
b) Benzathine penicillin is a long-acting form of antibiotic. Its effects will last 5-7 days.

c) Eye ointments that may be put right in the eye are useful for many eye infections. However, antibiotics for pink-eye must be injected into the eye. Treatment is very successful, but the techniques will be covered in a later course.

d) Antibiotic pills are available for certain infections. Contact your reindeer veterinarian for advice.

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

5. Some drugs are available for parasite control:

   a) Warbex is an injectable drug that kills warbles and nasal bots. It must be used in the fall, between October and January, during the time the larvae are still small in the reindeer.

   b) Levamisole (Ripercol) is an injectable drug for treating reindeer for internal parasites.

   c) "Rabon" ear tags contain a white, fly-repellent powder. As the deer shakes its head this powder is spread around on its body. The powder is gradually released for 2 or 3 months.
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.

Drugs commonly used for reindeer are summarized on the following sheet.
Drugs Commonly Used for Reindeer
Under the Supervision of a Reindeer Veterinarian

Drugs for Infection

- Procaine penicillin and Streptomycin - short acting
- Benzathine penicillin - long acting
- Several other types available for use in specialized cases

Drugs for Topical Use

- Gentian Violet - skin
- Furacin - deep wounds
- Eye ointment
- Wound spray with fly repellent
- Many other types available

Drugs for Parasite Control

- Warbex for warbles and nasal bots - injectable
- Levamisole (Rispercol) for intestinal parasites - injectable
- Rabon ear tags for biting insects

Drugs for Tranquillization and Pain

- Local anesthetic - lidocaine
- Tranquilizer - acetylpromazine
- Immobilizer - xylazine (Rompun)
- Immobilizer - M-99

Vaccines

Vaccines for reindeer are under development at this time or untested. Many vaccines used for cattle may be effective in reindeer.

- Brucellosis - under development.
- Shipping fever - tested, appear moderately effective.
- Respiratory viruses - untested.
- Other vaccines such as those for leptospirosis may be helpful if new diseases are discovered.
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 rather than 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 fairly 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 procedure 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, slit the tunic covering and slide it down the spermatic cord. Cut this membrane off close to the cord.

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) Sprinkle an antibiotic powder such as Furacin into the scrotal opening during cold weather or spray 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 much room for error exists. If the tool is placed or used incorrectly, castration may be incomplete or totally ineffective. For this reason this method is not recommended for reindeer.
AID IN FAWNING

Although most reindeer will give birth normally without aid from people, there may be a few occasions when a reindeer health aide will 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 reindeer health aide 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 done carefully, it is often successful, and may prevent the death of the cow and hopefully 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 1). It is not too 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 bites the umbilical cord if it is still attached. The cow's constant licking dries the calf off 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 calf 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 provided in the reindeer health aide kit, 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, return and grasp the fawn by the forelegs (or hindlegs). 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, and the fawn not handled at all unless the cow is too weak to take over. In extreme cases it may be necessary for the aide to clean and dry the fawn, clear its nose and nostrils to breathe, tie off the umbilical cord close to the fawn, cut off the umbilical cord past where it is tied, and 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.
Figure 1. Normal presentation of reindeer fawn at birth.

Figure 2. Some abnormal presentations of the fawn.
NECROPSY
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 probability 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, i.e. species age, sex, location, environmental characteristics, clinical symptoms and other pertinent observations, are necessary for generating "path. 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 (i.e. centimeter markings along one edge or simply 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) mammals, i.e. reindeer, bears, fox, etc., samples under ideal conditions. Usually, conditions are somewhat less than ideal and aides must salvage what they can
from a decomposing carcass under inclement weather conditions. Two people are ideally needed to conduct an efficient necropsy. This allows 1 person ("dirty") to actually remove tissues and 1 person ("clean") to take photographs, record notes, label and hold sample bags. For large animals, a third person may be desired to help separate joints of the legs, move organs and help in any way that will prevent contamination of the people or other parts of the carcass.

1. Collect a blood sample. This will apply only when animals are living or 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, i.e. E.D.T.A., 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 eyedropper and put into a sterile vial for antibody detection. Serum may be stored frozen, though repeated freezing and thawing should be avoided.

If the animal is found dead, serum many times can be collected from the heart clot. The whole clot, or the yellow "chicken fat" portion, 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 lymph nodes under the skin (i.e. prescapular, prefemoral and mandibular lymph nodes) if these are desired. Remove these nodes and the testes or mammary glands after the skinning is completed. 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 at this point 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 being 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 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 the presence of visible internal parasites (i.e. *Setaria*). Aseptically collect samples of the major visceral organs (heart, lung, liver, spleen and kidney) approximately 2-3 cm³ 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 lymph nodes if desired. Dissect out the reproductive organs and place in a separate container. These tissues should be frozen for subsequent 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 (i.e. 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 mid-summer beneath the skin and in pharyngeal pouches respectively. Other reindeer parasites, i.e. lungworms (Dictyocaulus viviparus), heartworms (Sarcosporidia spp.) and liver flukes (Fasciola hepatica), will occur less frequently and require a more diligent search. Any tissue suspected of being parasitized should be collected when possible.

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) the presence of pus. Preserve both frozen and formalin-fixed tissue samples and blood serum when possible if bacterial, mycotic or viral causes are suspected.

Ectoparasites (i.e. fleas, ticks and lice) are usually visible with the naked eye. Host reactions to endoparasites may result in cysts that obscure the parasitic organisms per se. Collect these cysts in their entirety by removing the affected block of host tissue. Endoparasites are often specific as to host species and anatomical region of attack. Therefore, it is important to note both of these 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. Hair bundles approximately 2 cm in diameter should be collected along with whole blood. Localized sick or dead animals may indicate a non-infectious etiology. 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 10 cm 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.
Figure 1. Skinning the upper half of the body.
Figure 2. Disarticulating the left hip joint.
Figure 3. Chest and abdomen fully exposed.
APPENDIX I
REINDEER HEALTH AIDE KIT

IN CARTON:

8 vacutainer tubes
1 purple stoppered EDTA tube
2 35 cc syringes
2 16 gauge needles
2 18 gauge needles
ruler
Sharpee indelible ink pen
forceps
scalpel handle and blades

IN POCKET:

extra needles
extra syringes
extra vacutainer tubes
gloves
pencil and pad
strap for bag

OTHER CONTENTS:

bottle of formalin tissue fixative
bottle of Zephran disinfectant (dilute 1/2 teaspoon in 1 quart water for use)
whirlpac bags (large and small)
plastic bags (large and small)
serum vials
handouts on tissue collection, serum collection, and whole blood collection
APPENDIX II

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.

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

2. Use clean Forceps and scalpel to collect 1 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.

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

Mail to:

Dr. R. A. Dieterich
INSTITUTE OF ARCTIC BIOLOGY
UNIVERSITY OF ALASKA
Fairbanks, Alaska 99701
APPENDIX III
SERUM COLLECTION

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

For Collection
Equipment needed:
- Gloves
- Syringe (35 cc) & needle
- Whirlpack bag (small size)
- Vacutainer tube (red)

For Storage
- Clean syringe & needle
- Small plastic vials

Procedure:
1. Collection
   a. If the animal is still alive, collect blood from the jugular vein. Inject blood carefully into one or two vacutainer tubes.
   b. If the animal is dead, try to collect from the jugular vein or heart. Inject blood carefully 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 serum 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 eyedropper to remove the serum from the clotted sample. Put the serum in a clean, small plastic bottle (vial). The serum should be frozen. It will keep for many months in the freezer, but will only keep a few days in the refrigerator.

As soon as possible, mail to:

Dr. R. A. Dieterich
Institute of Arctic Biology
University of Alaska
Fairbanks, Alaska 99701
APPENDIX IV

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 tube with purple stopper (EDTA tube)

Procedure:

1. Collect blood from the jugular vein.
2. Inject blood very slowly and gently into the purple stoppered vacutainer tube. Label the tube. Record time collected and important information.
3. Gently turn tube upside down and right side up several times.
4. Keep the tube cool and take to a laboratory for testing right away. (The blood will only keep for one day.) Do not freeze.
APPENDIX V
CARE AND USE OF SYRINGES

DISPOSABLE SYRINGE

This is useful when delivering a single dose of medicine, or 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 4-5 times, and should next be disinfected with alcohol. The barrel can then be reused with a new sterile needle.

Several needle sizes are provided in the reindeer health aide kit. Choose a needle size appropriate for the need at hand. 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, a smaller animal or thinner medicine.

The 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 off with the shorter graduated lines.

AUTOMATIC SYRINGE

This is useful when many doses of one kind of medicine will be delivered to a large number of animals; although not normally as sterile as disposable syringes, it can be kept adequately clean. It is practical in large handling situations.
Before using, wash all parts well with warm water, and dry. While using the syringe, keep a jar filled with alcohol in which 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 while in use, the medicine should be evacuated in a safe place, and syringe and needle washed well 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 and cracked with age, and new glass barrels should be kept on hand in case one is broken.

When using the multiple dose syringe, it is very important to remain aware of the size of dose each animal requires. 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 time and again, make it a habit to check the dial every 2-3 shots to make sure that it hasn't slipped from the proper dosage.

INJECTIONS

When first inserting the needle into the muscle, pull back on the plunger (aspirate) to see if blood enters the syringe. This will tell you if you've hit a blood vessel. If you have, remove the needle and place the injection in a new spot since certain drugs will be harmful if injected right into the bloodstream (penicillin, for instance). It is not possible to aspirate with the multiple dose syringe. However, the
drugs typically used in this kind of syringe (for example, parasite treatments) will not be directly harmful to the animal in this dosage if allowed to enter the bloodstream.

Drugs used to treat for parasites work best if they are absorbed by the body slowly from the muscle tissue. This type of drug can be injected into any large muscle mass on the animal. The thick muscle at the rear of the hindleg is the best spot to aim for. In this area there are few vital structures that can be damaged by the needle. When placing the needle, aim well behind the large femur bone, with its neighboring artery, vein and nerve.
KEY
01 Needle
02 Metal barrel frame
03 Forward end tablet
04 Barrel washer
05 Gloss 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
APPENDIX VI

LABEL FOR WARBEX

Used for treatment of reindeer for Warbles and Nasal Bots

WARBEX 350 mg/ml

Famphur

0,0-dimethyl-0-(p-(dimethylsulfamoyl)-
phenyl) phosphorotioate 350 mg

Diaethylsuccin q.s. ad 1 ml

Inject intramuscularly at a dosage rate of 15 mg/kg
of famphur (2 ml of solution per 100 lbs. body weight)

Caution:
Contains a new animal drug for use only in investigational animals in
clinical trials. Not for use in humans. Edible products of investiga-
tional animals are not to be used for food unless authorization has been
granted by the U.S. Food and Drug Administration or by the U.S. Department
of Agriculture.

Dr. R. A. Dieterich, University of Alaska, Fairbanks
APPENDIX VII

ALASKA DEPARTMENT OF HEALTH AND SOCIAL SERVICES
DIVISION OF PUBLIC HEALTH
SECTION OF LABORATORIES
VIROLOGY-RABIES UNIT

SPECIMEN SUBMISSION FOR RABIES ASSAY

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 479-7017 or 7018, or on weekends 456-5974. If no answer, dial 452-0467, listed for tone (beep) and leave a message. If busy, call 452-1166 and ask for Unit 467.

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 and address of person sending the specimen, and phone number.
   i. Name and address of person to receive the laboratory report, and phone number.

5. Conditions of Shipment:
   a. No LIVING ANIMAL 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, lynx, etc. Sever the head at the neck and leave sufficient tissue attached to the region of the head to insure 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 pack 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, and 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 CFR173.387.42
   CFR72.25(c), and
   NIH GUIDE OF
   FEBRUARY 10, 1975.

   BIOHAZARD: RABIES
   THIS CARTON CONTAINS THE HEAD OF
   AN INFECTED ANIMAL. PLEASE
   REFRIGERATE ON ARRIVAL AND CONTACT
   THE VIROLOGY-RABIES UNIT AT
   479-7017 or 479-7018. ON WEEKENDS
   456-5974. IF NO ANSWER, DIAL
   452-0467, LISTED FOR TONE (BEEP)
   AND LEAVE A MESSAGE. IF BUSY,
   CALL 452-1166 AND ASK FOR UNIT 467.

   b. Address all shipments to:
      Virology-Rabies Unit
      Alaska Division of Public Health
      Arctic Health Research Building, Room 233
      U of A Campus, Fairbanks, Alaska 99701

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 AIR MAIL-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.

9. Reports:

a. A preliminary fluorescent microscopic report will be called on all POSITIVE animal heads, and HUMAN EXPOSURE cases within 24-48 hours after specimen receipt and confirmation, copies of the reports will be mailed to the submitters.

b. The final report will be forwarded at completion of the fluorescent microscopic (FA) work. When the mouse inoculation test is included, the final report will be forwarded after 28 days.

10. 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
Room 313, MacKay Building
338 Denali Street
Anchorage, Alaska 99501
Phone: 272-7534

Northern Regional Health Officer
Medical Dental Arts Building, Suite 223
1919 Lathrop Street, Drawer 34
Fairbanks, Alaska 99701
Phone: 452-1592

Southcentral Regional Health Officer
Room 222, MacKay Building
338 Denali Street
Anchorage, Alaska 99501
Phone: 274-1715

Southeast Regional Health Office
230 S. Franklin St., #102
Juneau, Alaska 99801
Phone: 586-1120

Virology-Rabies Unit
Alaska Division of Public Health
Arctic Health Research Building, Rm 233
U of A Campus
Fairbanks, Alaska 99701
Phone: 479-7017/7018

* * * * *
APPENDIX VIII
FEEDING ORPHAN FAWNS

1. Hold nipple end of bottle between thumb and index (pointer) finger with the nipple pointed towards the palm of the hand.

2. Cup fawn's chin in the palm of the hand.

3. Bottle and fawn's chin are now in the palm of the hand together so hand and bottle can move with the fawn to help keep him from swallowing air.

4. Start off feeding small amounts of milk. For example:

<table>
<thead>
<tr>
<th>Age</th>
<th>Amount</th>
<th>Feedings Per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>first week</td>
<td>2-3 oz</td>
<td>5-7 times a day</td>
</tr>
<tr>
<td>2-4 weeks</td>
<td>4-5 oz</td>
<td>4-5 times a day</td>
</tr>
<tr>
<td>4-6 weeks</td>
<td>6-8 oz</td>
<td>3-4 times a day</td>
</tr>
<tr>
<td>6-8 weeks</td>
<td>8-10 oz</td>
<td>3 times a day</td>
</tr>
<tr>
<td>8 weeks and</td>
<td>8 oz</td>
<td>3 times a day</td>
</tr>
<tr>
<td>up</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. DON'T OVERFEED! Overfeeding is the most common cause of diarrhea in fawns. Prolonged diarrhea can cause death. If diarrhea occurs:
   a. cut down on milk
   b. baby's dose of Kaopectate if diarrhea continues or,
   c. can add a little Gerber's Baby Rice Cereal to milk if diarrhea continues.
   d. Diarrhea is usually yellowish, watery from too much milk or a disease; it is usually green from eating too many greens.
6. Suggested formulas:
   a. Land O'Lakes Lamb Replacer
   b. 26 ounces canned evaporated milk
       26 ounces reconstituted nonfat dry milk
       2 ounces cod liver oil and an equal amount of whole egg
       (Jack Luick)
   c. Can add baby vitamins to milk when fawns are young
   d. Warm the milk before feeding.

7. Bottle can be a regular baby bottle or a lamb nipple on a bottle.
   To make the hole a little bigger heat the end of a safety pin with
   a flame and stick the hot point through the hole. Fawns like to
   suck, so hole doesn't have to be real big. Wash the bottle well
   after each feeding.

8. At least 2 times a day until the fawn is well trained, rub its rear
   end with warm water on a washcloth to stimulate fawn to pass manure.
   (Cow licks its rear end to do the same thing).

9. After about 5 days old, offer grain to fawn as soon as it finishes
   the milk.
   a. Purina Nursing Chow or,
   b. Purina Calf Manna or,
   c. Quality Texture - best; may have to crush until fawn can
      chew well.
d. Can mix Nursing Chow or Calf Manna with equal parts Quality Texture to start off with.

e. Can put some milk on your fingers, then dip them in the grain and put your fingers in the fawn's mouth to get him to start on the grain.

10. Let fawn graze natural feed.

11. Keep a bucket of water available at all times.

12. Keep the fawn in a clean sanitary area!

13. Pay attention to your fawn. Each one is a little different. If you have problems you can't solve or if your fawn acts sick, call Dr. Dieterich, Fairbanks, 479-7166.
Jack Luick, University of Alaska, Fairbanks, has written two chapters for a book entitled "Nutrition and Food, Section G: Diets, Culture Media and Food Supplements, Vol. I." These chapters dealt with the feeds reindeer eat while grazing on ranges and with feeds that can be used when reindeer are raised in captivity, i.e. in zoos, feedlots and in holding corrals. He also discussed techniques for raising orphaned reindeer fawns and for relocating reindeer from their ranges to farms, zoos, etc.

Dr. Luick obtained permission from the publisher, CRC Press, Inc., to reproduce the chapters for redistribution to the reindeer herders. This was originally accomplished in the Reindeer Herders' Newsletter, December 1979. Because it is appropriate for the Reindeer Health Aide to have access to this information, it is also included in this manual.

Additional information on the feeds that reindeer prefer, i.e. types of hays, grains, seafood meals, concentrates, complete pelleted rations, species of lichens, types of water, physical forms (natural form, pellets, meals), etc., can be found in Dr. Luick's 1976/1977 E.R.D.A. Progress Report and in his 1979 E.R.D.A. Terminal Report. Copies will be sent upon request.
DIETS FOR CAPTIVE REINDEER*

J. R. Luick

INTRODUCTION

In recent years there has been an increasing interest in maintaining reindeer in captivity for nonagricultural purposes. The magic of Christmas with Santa Claus and his reindeer certainly lives in the memories of nearly everyone, including entrepreneurs who establish “Santa Claus Villages” and often train reindeer to pull colorful sleds during the Christmas pageantry. Reindeer have long been seen in zoological gardens and are being used increasingly at research institutes for experimental purposes. In addition, lucrative oriental markets for reindeer antler have stimulated the establishment of reindeer farms where antlers are harvested annually and processed for use as aphrodisiacs and for medicinal purposes.

In the United States, live reindeer are usually purchased in Alaska from Eskimo herders and shipped by air to destinations where plant foods that are typically consumed by freely grazing reindeer are not found in sufficient quantities to provide adequate nourishment. Therefore, reindeer must be adapted quickly to commercial livestock rations; this often leads to fatal nutritional and digestive disorders.

In considering the dietary habits of freely grazing reindeer and the wide variety of plants that are consumed selectively on a seasonal basis, as well as the exotic nature and unusual chemical composition of several of these arctic plants, it seems hardly surprising that more than 60% of these reindeer may die within 2 weeks of departure from tundra ranges. Other factors contributing to this high mortality rate include the stresses of capture and handling, hyperthermia, regurgitation and inhalation of rumen contents, injury and disease, and overdoses of immobilizing agents and tranquilizers.

In the following discussion, consideration is given to the nutritional aspects of hand rearing of orphan calves, capture and shipment, and the maintenance of reindeer on atypical diets. Since there are few published works on which to build a critical and definitive treatise, much of this information is based on personal experiences of the author and on information solicited from veterinarians and managers of commercial reindeer enterprises. Finally, because considerable differences in opinion were expressed in answer to a questionnaire on diets for captive reindeer, the comments of respondents were not summarized, but rather were edited slightly and are presented in tabular form (see tables).

NURSING CALVES

Reindeer calves are born in early spring, often before the snow has disappeared completely. Suckling commences within a few hours after birth and is both frequent and

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* 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 license 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 Ranifer tarandus.

From: Diets for captive reindeer, J. R. Luick, Handbook of Food and Nutrition, Section G, Volume 1, (c) CRC Press, Inc. Used by permission of CRC Press, Inc.
of short duration.\textsuperscript{7} This characteristic behavior has evolved presumably because of the necessity for correlating with the activity patterns of the herd, which, in a freely grazing situation, means spending from 70 to 90\% of the day searching for and consuming food and/or fleeing from insects or larger predators.\textsuperscript{8} The calves also begin to nibble pelleted rations and/or graze the early green vegetation; in fact, the time spent grazing (7\%) already exceeds the time spent nursing (4\%) in the daily activity patterns of 1- to 10-day-old reindeer calves.\textsuperscript{9}

Milk production and, therefore, milk intake of the calves apparently peak not later than 15 to 20 days post partum at about 2.5 l/day (Figure 1).\textsuperscript{10} Reindeer milk is of unusually high nutrient content and contains more total solids, chiefly protein and fat, than the milk of any other large herbivore studied to date.\textsuperscript{11} Using data from Figures 1 and 2, it appears that the energy intake from milk solids alone approaches 4000 kcal/day for a very young reindeer calf of about 5 kg body weight.

The relative contribution of various nutrients in milk and green vegetation changes markedly as the summer grazing season progresses. For example, by 3 to 4 weeks post partum, calves spend a greater fraction of the day grazing (24\%) than nursing (<1\%).\textsuperscript{5} However, the marked decline in milk production shown in Figure 1 should not imply that milk nutrients become an insignificant factor in the daily nutrient intake of the nursing calf. On the contrary, as summer progresses, reindeer milk becomes increasingly concentrated, rising to 35\% total solids by 90 days post partum; at this time, milk intake has fallen from 2.5 to 0.75 l/day.\textsuperscript{10,11} From these data and the energy content of milk during late lactation, it can be calculated that the calf still receives about 1700 kcal/day.
REINDEER MILK

Days Postpartum

FIGURE 2. Composition changes in major organic constituents of reindeer milk during the lactation cycle.11

of milk solids.12 Thus, the very rapid and early growth of the reindeer calf, averaging about 0.3 to 0.4 kg/day from 0 to 90 days of age, is a consequence of several factors, viz., the high intake of milk solids, the marked improvement in nutrient content of plant foods, and the increasing time spent grazing and/or eating pelleted rations that are fed to the adult animals.13-16

ORPHAN CALVES

In contrast to the nursing reindeer calf that grazes within hours of birth, survives the rigors of climatic extremes, and is required to keep up with the movements of the herd, the orphan calf is surprisingly fragile and seems highly susceptible to nutritional and physiological stresses. These stresses can be minimized to some degree through skilled and knowledgeable managerial techniques, i.e., the provision of adequate shade, fresh water, and small paddocks where the calves can graze, exercise, and, most importantly, relax out of sight of humans, dogs, etc. When close confinement is unavoidable, special attention must be given to sanitary conditions, ventilation, and minimizing unnecessary disturbances.

These criteria are of utmost importance during the first 2 weeks of confinement. In two transplants in 1953 and 1959, death losses among wild reindeer calves were 68 and 69%, respectively. All deaths occurred within 2 weeks of capture and, of these, 67% died within 48 hr of capture.17 All calves showed a loss of alertness, appetite, and strength — a pathologic syndrome typical of excessive physiological stress.

Fortunately, not all shippers have been as unsuccessful, at least during the capture and relocation phases. Thus, reindeer calves captured and flown from tundra ranges to southern Canada experienced low mortality rates. These calves were blindfolded, confined in large burlap sacks (tied around the neck), and force-fed a reconstituted dairy calf-milk replacer during transport.19

At least three options can be considered for the feeding of orphan reindeer calves, i.e., imprinting of the orphan calf onto a foster reindeer nurse cow, bottle feeding of reindeer milk, and bottle feeding of reconstituted dry milk solids. However, in practice, only the last option offers a practical solution. The foster cow technique is difficult to achieve, not
so much because of a reluctance by the young calf to imprint onto the cow, but rather because of the refusal of the cow to accept another calf (author's personal observation). Ironically, when no overt attempt is made by man to achieve imprinting, most reindeer cows do indeed tolerate nursing by a strange calf (termed "cross-nursing" or "thief-sucking"). Attempts at cross-nursing increase until the calves are 5 weeks old, but are usually unsuccessful in the absence of the cow's own calf.7

Bottle feeding of reindeer milk in sufficient quantity to provide adequate nutrition for the calf is most difficult, chiefly because of the difficulties in hand milking untrained reindeer cows.11 Even with trained cows, the volume of milk obtained by hand stripping, regardless of whether oxytocin is used, is far less than the amount needed (or normally available).15 In addition, growth of the donor cow's own calf may be compromised if its daily intake diminished significantly.

Table 1 shows two dietary programs that have been used with some success in hand rearing reindeer calves. In each instance, the objective was to simulate natural conditions as closely as possible. Reconstituted cow or sow milk replacer, bottle fed five to seven times daily, provided the basal ration. This was supplemented with a pelleted dairy calf grain ration, green vegetation, and fresh, clean water. The calves also ate hay, straw, and/or excelsior bedding, but even at this early age they characteristically preferred lichens over all other forages.17

High mortality rates of bottle-fed reindeer calves is largely due to digestive disorders of bacterial or nutritional origin. The former seems especially lethal to the calves and requires prompt professional treatment. Simple nutritional diarrhea, i.e., scouring, has been controlled by adding small amounts of baby rice cereal* to the reconstituted milk.1 Jones suggests that this disorder is related to the high fat content of the milk and failure to encourage the consumption of natural forage by limiting the volume of milk offered to the calves.17

Table 1
COMMENTS ON DIETS FOR ORPHANED REINDEER CALVES

<table>
<thead>
<tr>
<th>Diet A</th>
<th>High-energy, medicated, milk replacer,® reconstituted as for dairy calves, bottle fed five times daily. Dairy calf concentrate mix® offered ad libitum. Fresh, clean water and salt block always available. Hand-cut green vegetation, mostly willow (Salix sp.) and fireweed (Epilobium angustifolium), fed twice daily.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet B</td>
<td>Milk replacer constituted as follows: 26 oz canned evaporated milk, 26 oz reconstituted nonfat dry milk solids, 2 oz (equal parts by volume) cod liver oil and whole egg that have been beaten previously into an emulsion. Bottle fed seven times daily. Calves ate green vegetation, hay, straw, and excelsior bedding, but refused a dairy calf grain supplement. Lichens were preferred to all other forages.</td>
</tr>
</tbody>
</table>

*Gerber Instant Baby Rice Cereal, Gerber, Freemont, Michigan.
CAPTURE AND TRANSPORT

All shippers seemingly agree that the successful translocation of reindeer depends almost entirely upon two criteria: (1) an adequate supply of lichens ("reindeer moss") must be provided as the principal foodstuff during the early phases of the operation, and (2) excitation must be minimized during the capture, handling, and loading of reindeer.

Lichens are usually hand picked or raked from the tundra range lands and bagged for feeding during the 3- to 4-week interval between capture and successful transition to a livestock ration. Considering that an adult reindeer will eat 2 to 5 kg of lichens (dry weight) per day, a relatively small shipment of ten reindeer should be provided with about 900 kg (1 ton) of bagged lichens. Lichen picking is tedious, time consuming, and, therefore, costly. In addition, dried lichens are bulky, will shatter if compressed, and should always be moistened before being offered. Lichens can be pelletized and will still be eaten, but, unfortunately, suitable pellet mills are not generally available in the far North.

The importance of supplying lichens during translocation is related to their high acceptibility by reindeer and to their availability (lichens are the only natural reindeer food that can be harvested in large quantities in the vicinity of the corrals). In addition, the reindeer's ruminal microflora and microfauna are well adapted to fermenting lichens. On the other hand, lichens are a very poor source of essential dietary nutrients. Table 2 lists feeding techniques used during capture and transport, and especially during the important transition from tundra food plants to commercial livestock rations.

TRANSITION RATIONS

The transition from tundra vegetation to a completely atypical dietary regimen is usually accomplished by gradually decreasing the proportion of lichens in the daily feed: the rate should be adjusted to the amount of lichens on hand. Serious digestive and physiological disorders will almost certainly occur if the transition is rapid, and especially if the new ration differs greatly in chemical composition from tundra food plants. For example, the transition to a low-protein, high-fiber, pelleted horse ration is more likely to be successful than a change to a high-protein, high-energy dairy cattle concentrate. Reindeer should have access to an abundant supply of fresh water and, if possible, be allowed to feed on grass and/or legume pastures. From a management standpoint, all shippers agree that every effort must be made to minimize handling and other causes of stress during this critical transitional phase.

MAINTENANCE RATIONS

In considering feeding programs for captive reindeer, first it must be acknowledged that there is little likelihood of simulating the nutrient intake patterns of freely grazing reindeer on tundra ranges. In the natural state, reindeer selectively eat perhaps hundreds of different grasses, sedges, herbs, forbs, woody plants, and many species of lichens particularly in winter. Moreover, the chemical and nutrient compositions of food plants vary enormously with season. For example, the crude protein, crude fiber, and calcium content of winter diets, approximately 3, 18, and 2%, respectively, of dry matter shifts to about 20, 10, and 8%, respectively, on lush summer pastures. The ability to tolerate these dietary changes may be viewed as an evolutionary adaptation that has enabled reindeer to occupy a unique ecological niche, and it is now quite clear that they do not reflect a similarly unique, cyclical pattern of dietary requirements. Reindeer have long been maintained in captivity on widely differing dietary regimens (Table 3) and climatic circumstances, none of which even closely approximate natural conditions. They
grow and reproduce on most common livestock feeds, (Tables 4 and 5), are subject to the usual nutritional disorders and diseases of domestic livestock (Table 6), and respond favorably to the medical tactics of the veterinary practitioner (Table 7).

Thus, success in maintaining reindeer in captivity lies chiefly in skilled and knowledgeable management of the herd. As summarized by Abrams, the nutritional aspects of management include the provision of a multicomponent diet with variations of formulation from time to time, gradual changes in dietary programs to prevent digestive upsets, and close attention to food hygiene. Rations should be procured frequently and in relatively small quantities to assure high quality and should not be stored under conditions of high temperature or humidity, nor exposed to air for long periods of time. Similarly, reindeer in temperate climates require shade for protection from thermal stress, trees or rubbing posts to facilitate cleaning and polishing of antlers prior to rut, and an area within the paddock where they can relax with a sense of security and privacy.

ACKNOWLEDGMENTS

The author wishes to thank the following persons who most generously provided much information on practical aspects of raising captive reindeer: D. Branger, Top Hat Ranch, Roscoe, Montana; R. Butcher and G. Carruthers, Santa’s Village, Santa Cruz, California; Dr. R. Dieterich, Research Veterinarian, University of Alaska, Fairbanks; Dr. L. Griner, San Diego Zoo, San Diego, California; Dr. I. McEwan, University of British Columbia, Vancouver; Dr. A. Oeming, Alberta Game Farm, Edmonton; Dr. H. Saegesser, Director, City Deer Park “Dahlholzli,” Bern, Switzerland; Dr. H. Wackernagel, Basel Zoological Gardens, Basel, Switzerland.
COMMENTS ON PROCEDURES TO ENSURE SUCCESSFUL TRANSLOCATION FROM TUNDRA TO FARM

Capture and Transport

1. Capturing reindeer must be done carefully to minimize stress. It should be done in winter, preferably not in summer or fall heat. Blindfold the animals when first transferring from field to crate. For shipping, crate them and bag up enough lichens and mosses to feed enroute. Stress will be too high for them to eat any other domestic feeds during this critical period. Do not use tranquilizers or immobilizing agents because they "mask" respiratory problems, hyperthermia, etc. that develop during handling. Administer long-acting penicillin, 6 to 8 cc per reindeer, to counteract shipping fever. Reindeer will always eat snow in winter, but often will not find a water tub on dry ground in a new biotype such as a zoo. Zoos would do best to box stall new arrivals until such time as they adapt to a new diet rather than to place them immediately into small, cement-floored, paddocks with no retreat.

2. It helps if you have natural reindeer moss (lichens) to mix with grains. Offer free choice and bed down on high-quality alfalfa hay. New deer adapt faster if they are mixed with deer already adapted. Adaptation is not a serious problem. We do not use tranquilizers, immobilizing agents, or shipping fever vaccine but do administer penicillin; dihydrostreptomycin to all reindeer before departure.

3. Immediately after capture, feed lichens and green vegetation and allow the reindeer to cool off in an isolated corra for 4 or 5 days, then ship in crates, minimize stress, never ship in warm weather, minimize the use of drags for restraint and give cattle-type shipping fever vaccine and penicillin/dihydrostreptomycin or long-acting penicillin before departure.

4. When shipping large numbers of hobbled reindeer (not crated), it is usually necessary to administer tranquilizer: (xyazine and acepromazine) as well as an immobilizing agent (e.g., etorphine). However, despite close medical attention, death losses can be very high (> 50% within 24 hr of arrival), especially when the reindeer experience excessive stress during capture and handling. Etorphine antagonist diprenorphine (M50-50) should be given upon arrival at destination.

Transition to Maintenance Rations

1. Sprinkle fine-quality leafy alfalfa hay into the lichens and spread on ground. Put new arrivals with reindeer already conditioned to eat commercial foods. Do not put alfalfa hay in a hopper, but spread on ground. It works superbly well. Commence feeding pelleted grain mix and a commercially available deer pellet immediately.

2. Add lichens to the new feeds, then gradually decrease the amount of lichens until the reindeer are completely adjusted to the new feed.

3. Gradually increase the daily ration of livestock-type pelleted feed; no problem.

4. Transition accomplished by adding increasing amounts of a low-protein, low-energy, high-fiber pelleted complete ration to the basal lichen diet.

Table 3

DIETARY PROGRAMS FOR MAINTAINING REINDEER IN CAPTIVITY

1. Best-quality green second-cut alfalfa hay, 10 lb/reindeer/day. Supplemental feed consists of 50% deer pellets and 50% special pelleted grain mixture (60% oats, 20% wheat, 20% barley with vitamin A added). Mineral-protein blocks, browse (willow and white poplar in summer), and fresh water, free choice. Thibenzole® added to water regularly. It has been very successful in every way.

2. Reindeer are fed chiefly a pelleted complete horse ration, "Round-Up™" (Albers Milling Co., Los Angeles, Calif.) herbivore pellets (Albers Milling Co.), Sudan grass hay and occasionally Omolene® (Ralston Purina Co., St. Louis, Mo.) Alfalfa hay has been offered in the past, but reindeer did not eat it.

3. Large amounts of fine grasses and browse in the natural state (pasture), free choice; second- and third-cut alfalfa hay free choice; pelleted grain supplement, 2 lb/animal/day. Clover pastures are very good.

4. Lichens are the basic ingredient of reindeer diets in most European zoos. Grass and/or alfalfa hays are also fed and supplemented with a concentrated, pelleted feed (Basel Zoological Gardens, Basel, Switzerland).

5. Purina Cattle Starter No. 1 (Ralston Purina, St. Louis, Mo.) is available at all times and provides excellent growth in reproduction. Reindeer are allowed to graze mixed vegetation pastures in summer. Salt blocks and water are also available free choice.

6. Aim for a low-protein diet, supplemented with alfalfa or clover hay. Feed twice daily and provide pastures for grazing.
Table 4
COMPOSITION AND PROXIMATE ANALYSES OF SOME SUCCESSFUL REINDEER RATIONS

<table>
<thead>
<tr>
<th>Basel Zoo(^a)</th>
<th>Rice bran (14.4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oats (15)</td>
<td>Salt, trace mineralized (1)</td>
</tr>
<tr>
<td>Barley (24)</td>
<td>Molasses (1.4)</td>
</tr>
<tr>
<td>Wheat (14)</td>
<td>Mineral mix (2)</td>
</tr>
<tr>
<td>Wheat bran (10)</td>
<td>Crude protein (10)</td>
</tr>
<tr>
<td>Alfalfa meal, dehydrated (19)</td>
<td>Crude fat (5)</td>
</tr>
<tr>
<td>Peanut meal (9)</td>
<td>Crude fiber (12.6)</td>
</tr>
<tr>
<td>Soybean meal (11)</td>
<td>Total digestible nutrients (64.6)</td>
</tr>
<tr>
<td>Linseed meal (2)</td>
<td></td>
</tr>
<tr>
<td>Salt (1)</td>
<td></td>
</tr>
<tr>
<td>Dicalcium phosphate (2)</td>
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</tr>
<tr>
<td>Limestone (1)</td>
<td></td>
</tr>
<tr>
<td>Binder (1.5)</td>
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</tr>
<tr>
<td>Minerals and vitamins (0.8)</td>
<td></td>
</tr>
<tr>
<td>Crude protein (18)</td>
<td></td>
</tr>
<tr>
<td>Crude fat (2.4)</td>
<td></td>
</tr>
<tr>
<td>Crude fiber (7)</td>
<td></td>
</tr>
<tr>
<td>Total digestible nutrients (66)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>University of British Columbia(^b)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn (35)</td>
<td>Rolled corn and/or barley(^e)</td>
</tr>
<tr>
<td>Bran (15)</td>
<td>Ground oats, barley and/or corn(^e)</td>
</tr>
<tr>
<td>Alfalfa meal, dehydrated (11.6)</td>
<td>Cottonseed and/or soybean meal(^e)</td>
</tr>
<tr>
<td>Soybean meal, 48% (8.7)</td>
<td>Wheat, middlings</td>
</tr>
<tr>
<td>Herring meal, 72% (6.4)</td>
<td>Beet pulp pellets</td>
</tr>
<tr>
<td>Iodized salt (1.2)</td>
<td>Salt</td>
</tr>
<tr>
<td>Rock phosphate, defluorinated (1.2)</td>
<td>Molasses</td>
</tr>
<tr>
<td>Molasses (8.7)</td>
<td>Crude protein (16 min)</td>
</tr>
<tr>
<td>Beet pulp (1.16)</td>
<td>Crude fat (3 min)</td>
</tr>
<tr>
<td>Minerals (0.3)</td>
<td>Crude fiber (8 max)</td>
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<tr>
<td>Crude protein (15 min)</td>
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</tr>
<tr>
<td>Crude fat (2.5 min)</td>
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</tr>
<tr>
<td>Crude fiber (6.5 max)</td>
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<tr>
<td>Total digestible nutrients (58–60)</td>
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<table>
<thead>
<tr>
<th>Santa's Village(^c)</th>
<th>Scandinavian Supplementary Feed(^g)</th>
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<tbody>
<tr>
<td>Beet pulp (33.4)</td>
<td>Cereal grains (41)</td>
</tr>
<tr>
<td>Barley, ground (23.9)</td>
<td>Ground hay (25)</td>
</tr>
<tr>
<td>Oats, ground (23.9)</td>
<td>Molasses beet chips (10)</td>
</tr>
</tbody>
</table>

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\(^a\) Basel Zoo, Switzerland; fed as pelleted supplement with grass or alfalfa hay.
\(^b\) Vancouver, British Columbia; University of British Columbia deer ration =36-57, Buckerfields Ltd., Vancouver, British Columbia, fed as a pelleted, complete ration.
\(^c\) Santa Cruz, California: "Special Mixture," Gunter Bros., Morgan Hill, Calif., fed as a complete pelleted ration, but supplemented occasionally with alfalfa hay.
\(^e\) Varying proportions depending upon availability and price.
\(^f\) Edmonton, Alberta; fed as a supplement to choice, alfalfa hay.
\(^g\) Complete ration used to supplement poor range diets, especially during severe winters.
Table 4 (continued)
COMPOSITION AND PROXIMATE ANALYSES
OF SOME SUCCESSFUL REINDEER RATIONS

<table>
<thead>
<tr>
<th>Norwegian Reindeer Research Institute</th>
<th>Crude protein (10.9)</th>
<th>Crude fat (2.7)</th>
<th>Crude fiber (9.3)</th>
<th>Nitrogen-free extract (58.6)</th>
<th>Ash (5.9)</th>
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<tbody>
<tr>
<td>Barley, ground (40)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Young grass, ground (25)</td>
<td></td>
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<tr>
<td>Oats, ground (17)</td>
<td></td>
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<tr>
<td>Wheat bran (15)</td>
<td></td>
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<tr>
<td>Soybean oil (3)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Crude protein (11% min; includes not more than 2-5% equivalent protein from N.P.N.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude fat (1% min)</td>
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<tr>
<td>Crude fiber (21% max)</td>
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</table>

<table>
<thead>
<tr>
<th>Institute of Arctic Biology</th>
<th>Oats</th>
<th>Wheat middlings</th>
<th>Wheat bran</th>
<th>Beet pulp</th>
<th>Barley</th>
<th>Yellow corn</th>
<th>Alfalfa meal, dehydrated</th>
<th>Soybean meal</th>
<th>Cane and beet molasses</th>
<th>Linseed meal</th>
<th>Meat scraps</th>
<th>Added vitamins</th>
<th>Minerals</th>
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</thead>
<tbody>
<tr>
<td>Plant protein products</td>
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<td>Grain products</td>
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</tr>
<tr>
<td>Processed grain by-products</td>
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<tr>
<td>Roughage products</td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>Cane molasses</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Alfalfa meal</td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

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^ Fairbanks, Alaska; Purina Cattle Starter (V), #1 (G), fed as a complete ration.
^ Roscoe, Montana; fed as a supplement to alfalfa hay and grass pastures.
^ Harstad, Norway; fed as complete ration when winter range feeds are unavailable or inadequate.
### Table 5

**COMMENTS ON SPECIFIC FEEDS FOR REINDEER**

#### Grass Hays

1. These are useless, unpalatable to the reindeer, and offering no worthwhile nutrition.
2. Over the years the reindeer have been offered various grass hays but only ate small amounts.
3. Very poor unless cut when very immature and fine.
4. We feed common meadow hay.
5. Grass hays seem to be of little nutritional value for reindeer since there is much waste when fed as long hay in bunkers. Recently found that Kentucky nugget bluegrass was almost as good as Cattle Starter No. 1 for a winter ration.
6. Reindeer will eat grass hays, especially brome, wheatgrass, timothy, and bluegrass.

#### Alfalfa Hay (“Long”)

1. For best results we use second-cut, very green and leafy alfalfa hay. It must be spread on the ground, preferably in winter on snow. Reindeer eat the green leaves almost immediately and thrive on them.
2. Reindeer ate only small quantities of alfalfa hay.
3. We use second- and third-cut alfalfa; the reindeer selectively graze the leaves but not the stems.
4. Yes, we feed some alfalfa hay.
5. No experience.
6. We feed either alfalfa or clover hay.
7. Alfalfa hay is “too rich” for reindeer.

#### Alfalfa Hay (Pelleted or Cubed)

1. This takes more time to become accustomed to, but they will eventually accept it and do well.
2. We do not feed cubed or pelleted alfalfa hay.
3. Very good when adapted to it.
4. No experience.
5. Cubed alfalfa hay has been suspect in laminitis cases.

#### Cereal Grains (e.g., Crushed Oats)

1. Once conditioned to grains, it is a “must” for them. They consume amazingly high quantities and relish it. Five gal will feed ten reindeer at a serving, twice a day.
2. We feed Omolene® (Ralston Purina Corp., St. Louis, Mo.); three animals receive 8 qt/day.
3. Very good when adapted to it.
4. Are accepted.
5. We never feed as such, but they do make up part of our pelleted ration.
6. Corn is okay; best to crush or roll grains before feeding; cottonseed meal is “too hot.”

#### Salt

1. If you have them in a cobalt-deficient area, use this kind of salt since it has iodine in it. Absolutely necessary at all times.
2. We offer salt blocks, some have been mineralized.
3. When fed free choice, reindeer will eat small amounts.
4. Included in our pelleted ration.
5. Offered free choice as a mineralized salt block.

#### Mineral Mixtures

1. Use a good protein-mineral mixture in the form of a block that can be chewed.
2. Very poor luck with getting reindeer to eat.
3. Included in pellets.
Table 5 (continued)

COMMENTS ON SPECIFIC FEEDS FOR REINDEER

Water

1. We regulate the water supply in summer so that we can use a low level vermifuge treatment like Thibenzole® to keep parasite infestations to a minimum. This is impossible to do when reindeer have access to any residual ground water.
2. We use automatic water dispensing devices.
3. Free choice.
4. Accessible at all times.
5. Important to have an ample supply of good fresh water available at all times.

Complete Rations such as Purina or Albers Feeds

1. Once they become accustomed to such feed, it is perfectly fine. Others insist that beet pulp is the answer, but we have not used it.
2. We have fed horse pellets Omolene (Ralston Purina, St. Louis, Mo.), 8 qt/day for three animals; herbivore pellets 3 qt/day for three animals; also “Round-Up”® (Albers Milling Co., Los Angeles, Calif.).
3. Some pellets are very good, especially if they contain sugar-beet pulp pellets.
4. Use of pelleted, concentrated rations to supplement hay rations is standard technique.
5. We feed pelleted rations almost exclusively and prefer a high-roughage, low-protein ration similar to horse feeds, i.e., “Round-Up” (Albers Milling Co., Los Angeles, Calif.) or to early feedlot rations, i.e., Purina Cattle Starter No. 1 (Ralston Purina Co., St. Louis, Mo.).
6. Works fine.
7. We feed complete pelleted rations but take great care to mix well; drying must not occur at a temperature that is too high; watch for mildew, off flavors, etc.

Medicated Feeds

1. Not necessary unless treating for bacterial diarrhea or other disease requiring antibiotic therapy.
2. We do not feed.
3. We do not feed.
4. We do not feed.
5. Have fed medicated feeds unintentionally with no obvious problems or advantages.

Toxic Feeds

1. Never use musty, dusty, moldy alfalfa hay or heavy amounts of barley. Grain feeding should not be overdone. Care should be taken until the animals are accustomed to it. It can cause bloat and foundering.
2. No evidence.
3. No problems when good husbandry practices are used.
4. Never feed “hot rations” to stressed reindeer directly “off the range.”

Feeds Leading to Nutritional or Digestive Problems

1. None if the diet is based chiefly on superior quality, green, leafy, tender, second-cut alfalfa. Reindeer approach this as they would lichens.
2. No evidence.
3. Some coarse roughages will plug the digestive tract at the stomach outlet.
4. Reindeer, as well as other ruminants, must be adapted slowly and carefully to new dietary programs that differ significantly from typical arctic range land diets in chemical composition, nutrient content, palatability, etc.
Table 6
COMMENTS ON NUTRITIONAL DISORDERS AND OTHER DISEASES OF REINDEER

Digestive Upsets

1. Occurs from poor hay and excessive grain; reindeer become "semibloated." Drench with mineral oil.
2. Yes. catarrhal gastroenteritis; ulceration and peritonitis.
3. Yes, diarrhea from excessive alfalfa and too little browse.
4. No cases.
5. Several cases occurred when recently shipped reindeer were fed a dairy cattle complete ration (high protein) and/or a feedlot beef cattle finishing ration (high energy) with no adaptation to the feed. Syndrome included bloat and central nervous system involvement, i.e., goose stepping and/or staggering. Laboratory studies showed no pathogens or pathogenic processes.

Bloat

2. No cases.
3. No cases.
4. No cases.
5. No classical cases, but bloated reindeer are seen when stressed reindeer are fed high-energy, high-protein rations without prior adaptation.

Impaction of Gastrointestinal Tract

1. No cases.
2. It does occur.
3. It can occur when reindeer eat excessive amounts of coarse browse.
4. No cases.
5. At least two cases of abomasal impaction; one blockage of entry into omasum.

Peritonitis and/or Rumenitis

1. No cases.
2. No cases.
3. No cases.
4. Two cases.
5. Several cases of two distinct types: low grade from infestations of *Setaria yehi* (abdominal worm); rumenitis type, usually from enteric type of organisms, e.g., *Escherichia coli*, etc.

Cardiovascular Disease

1. No evidence.
2. No evidence.
3. One case (myocardial aortic calcification).
4. Three cases (cardiac insufficiency, pericarditis, and defective septum).
5. One case (coronary thrombosis with necrosis).

Capture-confinement Stress

1. Can be severe and cause high mortality; most severe in warm weather; isolate and allow to relax.
2. Stress syndrome associated with capture and transport is called "Capture Myopathy" and is similar to White Muscle Disease. Microscopic examination definitely shows muscle involvement.
Internal or External Parasites

1. Common moose tick, *Dermacentor albipictus*, infests reindeer in wooded areas in their paddocks. If infestation is severe, spray thoroughly with sheep tick eradicator.
2. No cases or not diagnosed.
3. No cases or not diagnosed.
4. No cases or not diagnosed.
5. Yes, including stomach and intestinal nematodes, adult intestinal tapeworms, larval tapeworms in liver and muscle, lung worms, setaria, nasal bots, and warbles.

Face or Jaw Abscesses

1. Occasionally, not typical actinomycosis rather jaw abscesses that headed and were drained; not common.
2. No cases.
3. No cases.
4. Two cases of lump jaw, hard bone; did not respond to treatment; died.
5. Generally resulting from trauma and wearing halters; respond well to treatment.

Brucellosis

1. No cases.
2. No cases.
3. No cases.
4. No cases.
5. One case, sacrificed.

Abortion

1. No cases.
2. No cases.
3. No cases.
4. One case.
5. One case.

Pneumonia

1. Yes, especially during hot summers. Successfully treated with penicillin and streptomycin.
2. No cases.
3. Unspecified number.
4. Six cases diagnosed in 25 years.
5. Several cases.

Johne's Disease (Paratuberculosis)

1. No cases.
2. No cases.
3. No cases.
4. No cases.
5. No cases.
6. Several cases; poor response to treatment.
Foot and Leg Problems

1. No foot rot but cases of joint abscesses and/or laminitis are treated with antibiotics.
2. Few cases, not a major problem.
3. Few cases, not a major problem.
4. Few cases, not a major problem.
5. Few cases, not a major problem.

Other

1. Navel infections; treat with iodine ointment, not liquid solution; infection quickly involves brain and lack of coordination of extremities.
2. Nitrate poisoning on early spring pastures previously heavily fertilized; several deaths.

Comments on the Most Serious Health Problem

1. Parasite infestation is constant, requires frequent treatment; scouring due to parasites, bacterial infection, and coccidiosis. No other diseases are considered a serious problem.
2. High neonatal deaths of nonspecific causes. Low rate of reproduction.
3. No single disease problem is evident but combined occurrence of the diseases encountered is serious.
4. No specific problem.
5. Parasites are a continuing problem; malnutrition and infections from various stresses associated with use in research studies.

Comments on the Principal Causes of Death in Reindeer Herds

1. Bloat from poor alfalfa hay and old age; highest mortality in neonatal calves.
2. Pneumonia, especially during cold rainy and sleeting weather in spring. Two died from stomach impaction from eating very coarse browse. One death from hair ball. One died from foot rot that did not respond to treatment.
3. Various, no single cause is especially noteworthy. About 50% death loss among young calves; lameness generally precedes death in older animals.
4. Newly arrived animals die chiefly from a capture-stress syndrome. Herd reindeer die from a great variety of causes. No specific disease problem.
Table 7
COMMENTS ON PREVENTATIVE MEDICINE

Vaccinations
1. We vaccinate only for the various clostridia using the commercial named vaccine, Coopvax.®
2. We do not vaccinate.
3. We vaccinate against leptospirosis.
4. We give hyperimmune-gamma globulin to newborn calves (7 cc “Bovigam,” Berna schweiz, Serum v. Impfinstitut, Bern C.H.).
5. We do not vaccinate.

Antibiotics
1. Use tetracycline in grain if needed. This is a soluble powder that they normally will not hesitate to eat with grain.
2. Penicillin/dihydrostreptomycin when body temperature indicates (e.g., for pneumonia); good results obtained.
3. Penicillin/dihydrostreptomycin, kanomycin, and tetracycline are used as needed.

Worm Medicines
1. We use either oral drench procedures with Thibenzole® (in drinking water) or, if tapeworms are the problem, we catch the animals and orally drench with Teniatol®. Check feces for evidence of parasites on a regular basis.
2. We do not administer.
3. Yes, Thibenzole.
4. “Telmin” twice a year: 20 mg/kg body weight original Janssen product, Cilag-chemie AG, Schaffhausen C.H.
5. We prefer injectable Ripercol® for control of both intestinal and lung worms.

Control of Warble Flies, Mosquitos, etc.
1. Only animals shipped from the Arctic have a warble fly problem. During the first year, we remove the larvae by hand; after that nothing develops here.
2. No problem at our location.
3. No problem after leaving Alaska.
4. All reindeer are injected with Warbex® in late October for control of nasal and warble bots.

REFERENCES


15. Luick, J. R., Diets for Freely Grazing Reindeer, found elsewhere in this volume.


29. Oeming, A., personal communication.
DIETS FOR FREELY GRAZING REINDEER*

J. R. Luick

INTRODUCTION

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 6- to 8-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 grazing 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 mosquitoes, 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, Skogland, and White et al. 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 and Glinka, respectively (Table 1).

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. 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).

* 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(04-1)-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 license 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.

From: Diets for freely grazing reindeer, J. R. Luick, Handbook of Food and Nutrition, Section G, Volume 1, (c) CRC Press, Inc. Used by permission of CRC Press, Inc.
Table 1
RANGE USE BY REINDEER IN SOUTHERN NORWAY

<table>
<thead>
<tr>
<th>Plant community</th>
<th>Annual use (%)</th>
<th>Period of high intensity use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lichen heaths</td>
<td>60.0</td>
<td>December through April (95%)</td>
</tr>
<tr>
<td>Grassy meadows</td>
<td>14.5</td>
<td>Early spring and late fall (50%)</td>
</tr>
<tr>
<td>Salices and herb snow beds</td>
<td>22.5</td>
<td>Early and late summer (95%)</td>
</tr>
<tr>
<td>Bogs</td>
<td>3.0</td>
<td>Midsummer (45%)</td>
</tr>
</tbody>
</table>

Table 2
FOOD PLANTS COMMONLY SELECTED BY REINDEER AND CARIBOU

Arboreal lichens
- Alectoria jubata
- A. oregana
- Evernia mesomorpha
- Parmelia physodes
- P. saxatilis
- 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. uncinalis
- Peltigera spp.
- Stereocaulon spp.
- Thamnolia vermicularis

Rock lichens
- Umbilicaria hyperborea

Herbs and forbs
- Artemisia arctica
- A. richardsonii
- Equisitum spp.
- Hedysarum spp.
- Hespericum lanatum
- Lupinus spp.
- Oxypotris spp.
- Pedicularis spp.
- Petasites frigidus
- Polygonium bistorta

Saxifraga oppositifolia
Shrubs
- Betula glandulosa
- B. nana
- Dryas integrifolia
- D. octapetala
- Salix arctica
- S. glauca
- S. lanata
- S. ovalifolia
- S. pulchra
- S. rotundifolia
- S. scirpoides

Grasses
- Arctophila fulva
- Calamagrostis spp.
- Deschampsia spp.
- D. octapetala
- 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 oxycoccos
- V. uliginosum
- V. vitis-idaea

3 Relative contribution to daily food intake varies seasonally with availability and stage of maturity of the various plant species.
<table>
<thead>
<tr>
<th>Item</th>
<th>n</th>
<th>Crude protein</th>
<th>Crude fat</th>
<th>Crude fiber</th>
<th>Ash</th>
<th>N-free extract</th>
<th>Kcal/100 g</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fungi</strong></td>
<td>2</td>
<td>34.76</td>
<td>4.76</td>
<td>20.80</td>
<td>8.12</td>
<td>31.55</td>
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<td>1</td>
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<tr>
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<td>Dryas octopetala</td>
<td>n=2</td>
<td>13.2</td>
<td>5.2</td>
<td>19.3</td>
<td>3.3</td>
<td>54.5</td>
<td>-</td>
</tr>
<tr>
<td>Salix sp.</td>
<td>n=1</td>
<td>21.9</td>
<td>1.6</td>
<td>-</td>
<td>4.3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>S. spp.</td>
<td>n=15</td>
<td>20.99</td>
<td>3.10</td>
<td>16.66</td>
<td>6.53</td>
<td>52.74</td>
<td>-</td>
</tr>
<tr>
<td>S. pulchra</td>
<td>n=2</td>
<td>23.8</td>
<td>1.9</td>
<td>10.1</td>
<td>4.4</td>
<td>60.0</td>
<td>497</td>
</tr>
</tbody>
</table>

\*n = Number of analyses used to compute mean values.
Table 5
DETERGENT FIBER ANALYSIS OF PLANT MATERIAL
CONSUMED BY REINDEER AND CARIBOU

Values are Expressed as g/100 g Dry Matter

<table>
<thead>
<tr>
<th>Sample</th>
<th>Cell contents</th>
<th>Cell wall contents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hemi-cellulose</td>
</tr>
<tr>
<td><strong>Dryas integrifolia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>leaves/stem base</td>
<td>64.6</td>
<td>2.3</td>
</tr>
<tr>
<td>inflorescences</td>
<td>53.8</td>
<td>-2.0</td>
</tr>
<tr>
<td><strong>Salix arctica</strong></td>
<td>81.5</td>
<td>2.1</td>
</tr>
<tr>
<td>S. lanata</td>
<td>79.4</td>
<td>2.7</td>
</tr>
<tr>
<td>S. ovalifolia</td>
<td>68.8</td>
<td>3.9</td>
</tr>
<tr>
<td>S. pulchra</td>
<td>72.9</td>
<td>9.8</td>
</tr>
<tr>
<td><strong>Carex aquatilis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live leaves/10% dead</td>
<td>41.8</td>
<td>36.5</td>
</tr>
<tr>
<td>Inflorescences + stem</td>
<td>42.5</td>
<td>36.0</td>
</tr>
<tr>
<td><strong>Eriophorum angustifolium</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live leaves/10% dead</td>
<td>31.5</td>
<td>43.3</td>
</tr>
<tr>
<td>Inflorescences + stem</td>
<td>42.5</td>
<td>36.0</td>
</tr>
<tr>
<td><strong>Arctophila fulva</strong></td>
<td>32.3</td>
<td>38.8</td>
</tr>
<tr>
<td>Dupontia fisheri</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live leaves/10% inflorescences</td>
<td>54.9</td>
<td>25.4</td>
</tr>
<tr>
<td>Inflorescences + stem</td>
<td>37.9</td>
<td>31.1</td>
</tr>
<tr>
<td><strong>Artemisia richardsonii sp.</strong></td>
<td>57.7</td>
<td>13.1</td>
</tr>
<tr>
<td>Pedicularis sp.</td>
<td>74.1</td>
<td>5.1</td>
</tr>
<tr>
<td>Saxifraga oppositifolia</td>
<td>73.1</td>
<td>-8.5</td>
</tr>
<tr>
<td><strong>Cetraria cucculata</strong></td>
<td>68.4</td>
<td>27.8</td>
</tr>
<tr>
<td>Cladonia alpestris (Coal Creek)</td>
<td>17.0</td>
<td>78.3</td>
</tr>
<tr>
<td>C. alpestris (Nome)</td>
<td>16.7</td>
<td>81.0</td>
</tr>
</tbody>
</table>
**Table 6**

**DRY MATTER DIGESTIBILITY* of individual and mixed specimens of plants selectively grazed by reindeer and caribou**

**In vitro digestibility technique**

<table>
<thead>
<tr>
<th>Plant</th>
<th>Sample</th>
<th>Source of Inoculum</th>
<th>Caribou</th>
<th>Reindeer</th>
<th>Mean</th>
<th>Reindeer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dryas integrifolia</td>
<td>Leaves/stem base</td>
<td></td>
<td>33</td>
<td>33</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Heads</td>
<td></td>
<td>21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. octopetala</td>
<td>Leaves and stems (alpine)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salix arctica</td>
<td>Leaves/buds</td>
<td></td>
<td>71</td>
<td>52 ± 2</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>S. lanata</td>
<td>Live leaves</td>
<td></td>
<td>34 ± 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. ovalifolia</td>
<td>Leaves/buds</td>
<td></td>
<td>35</td>
<td>46 ± 6</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>S. pulchra</td>
<td>Leaves/buds</td>
<td></td>
<td>54</td>
<td>54</td>
<td>54</td>
<td>24 ± 0.3</td>
</tr>
<tr>
<td>S. reticulata</td>
<td>Leaves/buds</td>
<td></td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carex aquatilis</td>
<td>Live leaves</td>
<td></td>
<td>56</td>
<td>68 ± 4</td>
<td>62</td>
<td>39 ± 2</td>
</tr>
<tr>
<td>Eriophorum angustifolium</td>
<td>Live leaves</td>
<td></td>
<td>48</td>
<td>59 ± 3</td>
<td>55</td>
<td>32 ± 3</td>
</tr>
<tr>
<td>E. vaginatum</td>
<td>Inflorescences + stem</td>
<td></td>
<td></td>
<td>56 ± 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grasstherefina</td>
<td>Mature leaves</td>
<td></td>
<td>28 ± 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arctophila fulva</td>
<td>Live leaves</td>
<td></td>
<td>56</td>
<td>72</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>Dupontia fisheri</td>
<td>Live leaves</td>
<td></td>
<td>56</td>
<td>79 ± 2</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inflorescences</td>
<td></td>
<td>67</td>
<td>70</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Herbs Artemisia richardsoniana</td>
<td>Leaves</td>
<td></td>
<td>62</td>
<td>66 ± 3</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>Bray spp.</td>
<td>Whole plant</td>
<td></td>
<td>68</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Oxytropis sp.</td>
<td>Live leaves</td>
<td></td>
<td>70</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parnava nudicalis</td>
<td>Whole plant</td>
<td></td>
<td>67</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pedicularis sp.</td>
<td>Inflorescence + leaves</td>
<td></td>
<td>64 ± 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saxifraga oppositifolia</td>
<td>Inflorescence + leaves</td>
<td></td>
<td>33 ± 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lichens</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alectoria nigricans</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cetraria cucullata</td>
<td></td>
<td></td>
<td>74 ± 3</td>
<td>48 ± 1</td>
<td>68</td>
<td>77 ± 9</td>
</tr>
<tr>
<td>C. islandica</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cladonia alpestris</td>
<td></td>
<td></td>
<td>27 ± 14</td>
<td>16 ± 7</td>
<td>21</td>
<td>16 ± 3</td>
</tr>
<tr>
<td>C. arbuscula</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
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<tr>
<td>C. rangiferina</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>C. uncialis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>44</td>
</tr>
<tr>
<td>Lobaria limata</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>Peltigera aphthosa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>44</td>
</tr>
<tr>
<td>Stereocaulon apineum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>Thamnolia vermicularis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>59</td>
</tr>
</tbody>
</table>

*Percent ± S.E.

b Rumen inoculum was obtained from tranquilized caribou and reindeer grazing at Prudhoe Bay, Alaska, or reindeer gave a mixed diet containing 67% (dry weight) lichens, 8% Carex aquatilis, and 25% brome hay. The food was ground in hammermill and thoroughly mixed.
Table 6 (continued)
DRY MATTER DIGESTIBILITY\(^a\) OF INDIVIDUAL AND MIXED SPECIMENS OF
PLANTS SELECTIVELY GRAZED BY REINDEER AND CARIBOU\(^b\) \(^{1,4}\)

<table>
<thead>
<tr>
<th>In vitro digestibility technique</th>
<th>Source of inoculum</th>
<th>Caribou</th>
<th>Reindeer(^b)</th>
<th>Mean</th>
<th>Reindeer(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mosses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Hylocomium splendens</em></td>
<td>Entire gametophyte</td>
<td>19 ± 6</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Sphagnum magellanicum</em></td>
<td>Entire gametophyte</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Entire gametophyte</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Esophageal egesta</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Dras heath</em></td>
<td>Reindeer No. 12</td>
<td>49 ± 3.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Dupontia brook bank</em></td>
<td>Reindeer No. 31</td>
<td>50 ± 0.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Eriophorum meadow</em></td>
<td>Reindeer No. 10</td>
<td>62 ± 0.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Eriophorum meadow</em></td>
<td>Reindeer No. 12</td>
<td>49 ± 1.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>Reindeer C2</td>
<td>37 ± 2.2</td>
<td></td>
<td></td>
<td>45 ± 1.0</td>
</tr>
<tr>
<td></td>
<td>Reindeer C3</td>
<td>43 ± 1.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7
SEASONAL CHANGES IN THE CHEMICAL COMPOSITION AND CALORIC CONTENT OF
IMPORTANT REINDEER FORAGE PLANTS NEAR NOME, ALASKA\(^2\)

<table>
<thead>
<tr>
<th>Species</th>
<th>Month</th>
<th>Protein (N x 6.25)</th>
<th>Fat (%) ether extract</th>
<th>Crude fiber (%)</th>
<th>Ash (%)</th>
<th>Nitrogen-free extract Kcal/100 g</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Betula nana</em></td>
<td>March</td>
<td>5.3</td>
<td>2.6</td>
<td>29.3</td>
<td>1.3</td>
<td>61.5</td>
</tr>
<tr>
<td>June</td>
<td>26.0</td>
<td>2.2</td>
<td></td>
<td>13.2</td>
<td>4.6</td>
<td>54.0</td>
</tr>
<tr>
<td>August</td>
<td>16.0</td>
<td>3.5</td>
<td></td>
<td>16.3</td>
<td>2.8</td>
<td>61.4</td>
</tr>
<tr>
<td></td>
<td>16.6</td>
<td>1.3</td>
<td></td>
<td>24.5</td>
<td>4.3</td>
<td>53.3</td>
</tr>
<tr>
<td></td>
<td>August</td>
<td>12.9</td>
<td>1.8</td>
<td>28.5</td>
<td>4.0</td>
<td>52.3</td>
</tr>
<tr>
<td><em>Cetraria cucuilata</em></td>
<td>June</td>
<td>2.4</td>
<td>1.9</td>
<td>3.6</td>
<td>1.2</td>
<td>90.9</td>
</tr>
<tr>
<td>August</td>
<td>2.2</td>
<td>2.6</td>
<td></td>
<td>7.0</td>
<td>1.2</td>
<td>87.0</td>
</tr>
<tr>
<td><em>C. islandica</em></td>
<td>March</td>
<td>2.4</td>
<td>0.8</td>
<td>6.6</td>
<td>1.2</td>
<td>89.0</td>
</tr>
<tr>
<td>June</td>
<td>2.6</td>
<td>0.3</td>
<td></td>
<td>3.3</td>
<td>1.1</td>
<td>92.3</td>
</tr>
<tr>
<td>August</td>
<td>2.6</td>
<td>1.1</td>
<td></td>
<td>8.4</td>
<td>1.2</td>
<td>86.7</td>
</tr>
<tr>
<td><em>Cladonia rangiferina</em></td>
<td>March</td>
<td>2.7</td>
<td>1.0</td>
<td>30.3</td>
<td>1.1</td>
<td>64.9</td>
</tr>
<tr>
<td>June</td>
<td>2.9</td>
<td>0.4</td>
<td></td>
<td>27.7</td>
<td>2.3</td>
<td>66.7</td>
</tr>
<tr>
<td>August</td>
<td>2.7</td>
<td>0.4</td>
<td></td>
<td>26.9</td>
<td>0.8</td>
<td>69.2</td>
</tr>
<tr>
<td><em>C. gracilis</em></td>
<td>March</td>
<td>2.8</td>
<td>1.0</td>
<td>29.8</td>
<td>1.1</td>
<td>65.3</td>
</tr>
<tr>
<td>August</td>
<td>2.4</td>
<td>0.6</td>
<td></td>
<td>31.6</td>
<td>1.0</td>
<td>64.4</td>
</tr>
<tr>
<td><em>C. sylvatica</em>(^b)</td>
<td>March</td>
<td>2.5</td>
<td>1.4</td>
<td>21.9</td>
<td>1.1</td>
<td>73.1</td>
</tr>
<tr>
<td>June</td>
<td>2.2</td>
<td>0.7</td>
<td></td>
<td>26.8</td>
<td>1.2</td>
<td>69.1</td>
</tr>
<tr>
<td>August</td>
<td>2.0</td>
<td>0.6</td>
<td></td>
<td>22.2</td>
<td>0.9</td>
<td>74.3</td>
</tr>
<tr>
<td><em>Eriophorum angustifolium</em></td>
<td>June</td>
<td>16.1</td>
<td>1.3</td>
<td>21.5</td>
<td>5.6</td>
<td>55.5</td>
</tr>
<tr>
<td>August</td>
<td>12.1</td>
<td>2.0</td>
<td></td>
<td>20.7</td>
<td>3.1</td>
<td>62.1</td>
</tr>
<tr>
<td><em>Salix pulchra</em></td>
<td>June</td>
<td>25.2</td>
<td>1.6</td>
<td>8.6</td>
<td>4.9</td>
<td>59.7</td>
</tr>
<tr>
<td>August</td>
<td>22.4</td>
<td>2.1</td>
<td></td>
<td>11.5</td>
<td>3.8</td>
<td>60.2</td>
</tr>
<tr>
<td><em>Vaccinium uliginosum</em></td>
<td>March</td>
<td>6.0</td>
<td>3.1</td>
<td>35.9</td>
<td>1.3</td>
<td>53.7</td>
</tr>
<tr>
<td>June</td>
<td>23.4</td>
<td>2.2</td>
<td></td>
<td>11.0</td>
<td>4.0</td>
<td>59.4</td>
</tr>
<tr>
<td>August</td>
<td>13.2</td>
<td>2.0</td>
<td></td>
<td>16.5</td>
<td>2.5</td>
<td>65.8</td>
</tr>
</tbody>
</table>

\(^a\) 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 *Eriophorum angustifolium*. 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 2 to 3 days following birth; consequently, they gain body weight rapidly, whereas the adult females remain in poor body condition. During early spring, reindeer spend about 50% of the day searching for and consuming plants. Eating rates, estimated at 70 to 90% of grazing rates, amount to about 10 hr/day during late winter, but increase to nearly 19 hr/day during late spring, when plant foods become more abundant and are of increasing nutritional value.

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, *Betula glandulosa* and *B. nana*. Lichens are also eaten selectively, when available in sufficient quantity. According to Kelsall, grasses and sedges make up 28.1% of the daily food intake of Canadian reindeer, lichens 31.3%, and shrubs 31.2%; herbs and forbs are little grazed. 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%) to compensate for the relatively low biomass of lichens. Person and White et al. 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% of the vegetative biomass, were never found in significant amounts in rumen contents or egesta collected from esophageal fistula. Thus, in midsummer, when food plants attain peak nutritional content and quality and reindeer spend about 35% 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.

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. Mushrooms are so highly prized that the intense search for them often leads to straying and even stampeding of commercial herds of semidomesticated reindeer. Pegau has determined that 35% of the edible lichen biomass may be destroyed in this way during close herding of reindeer on the heaths. 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.\textsuperscript{13,19}

**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 (6- to 8-months) winter grazing period.\textsuperscript{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 or more.\textsuperscript{20} This does not imply that reindeer thrive under these conditions. On the contrary, the very low protein (~2 to 3% DM), ash (~2% DM), and fat (1.5%) content and the high crude fiber (45%) of lichens (Table 3) results in a considerable loss of body substance (but not necessarily body weight) during prolonged winter grazing.\textsuperscript{4,13,21} 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.\textsuperscript{4,22,23}

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.\textsuperscript{23} Skogland states that reindeer spend about 62% of the day searching for and eating lichens, and various workers have estimated that lichen consumption rates are approximately 2 to 5 kg per day per animal.\textsuperscript{1,2,4,25} The

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

\textsuperscript{a} Values for proximate analysis and mineral content are taken from Keisall\textsuperscript{1} and Luick,\textsuperscript{31} respectively.

\textsuperscript{b} Sun-cured, ground alfalfa hay (N.A.S. Ref. No. 1-00-111) as reported in United States-Canadian Tables of Feed Composition, National Academy of Sciences Publication 1684, Washington, D.C. 1969.
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 25% 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. 1) and/or three species of long hay, *Poa pretensis* (Kentucky Nugget Bluegrass), and *Festuca rubra* (mixed Arctared red fescue), and *Calamagrostis canadensis* (Bluejoint reedgrass). 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

### Table 9
**DIETS FOR SUPPLEMENTING OR REPLACING NORMAL FEEDING REGIMES OF REINDEER DURING PERIODS OF SEVERE UNDERNUTRITION**

<table>
<thead>
<tr>
<th>Supplemental ration3,24</th>
<th>Complete ration A3,33</th>
<th>Complete ration B3,7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea (50%)</td>
<td>Cereal grains (41%)</td>
<td>Ground barley (40%)</td>
</tr>
<tr>
<td>Dicalcium phosphate (30%)</td>
<td>Ground hay (25%)</td>
<td>Ground oats (17%)</td>
</tr>
<tr>
<td>Minerals (20%)</td>
<td>Ground straw (15%)</td>
<td>Wheat bran (15%)</td>
</tr>
<tr>
<td></td>
<td>Molasses beet chips (10%)</td>
<td>Soybean oil (3%)</td>
</tr>
<tr>
<td></td>
<td>Wheat bran (5%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dicalcium phosphate (1.7%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Iodized salt (0.3%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vitamins (2%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mineral mixture (trace)</td>
<td></td>
</tr>
</tbody>
</table>

3 This ration is mixed with lichens and fed ad libitum to reindeer as a supplement to typical winter diets.
that are fed supplemental and/or complete rations during severe winter weather (Table 9).\textsuperscript{13,27,23}

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\textsuperscript{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.

REFERENCES

33. Borodzin, E., personal communication.
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
One that lasts a short time

ANATOMICALLY
Referring to the structure of the animal

ANATOMY
Science of the structure of the animal body

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
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 man 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 man 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**
One 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
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONJUNCTIVITIS</td>
<td>Reddening of the white of the eye</td>
</tr>
<tr>
<td>CONTAGIOUS</td>
<td>Can be spread from one animal to another</td>
</tr>
<tr>
<td>CONTAMINANT</td>
<td>An unwanted object, usually a bacteria</td>
</tr>
<tr>
<td>CYST</td>
<td>Fluid-filled sac</td>
</tr>
<tr>
<td>DIAGNOSIS</td>
<td>Determining the nature of the disease</td>
</tr>
<tr>
<td>DIAPHRAGM</td>
<td>Muscle separating the abdominal cavity from the chest cavity</td>
</tr>
<tr>
<td>DISARTICULATE</td>
<td>Separation of a joint</td>
</tr>
<tr>
<td>DISCHARGE</td>
<td>Fluid oozing from an opening</td>
</tr>
<tr>
<td>ECTOPARASITE</td>
<td>Parasite on the outside of an animal such as fleas, ticks, lice and mites</td>
</tr>
<tr>
<td>ENDOPARASITE</td>
<td>Parasite living inside an animal such as lungworms, tapeworms, roundworms, etc.</td>
</tr>
<tr>
<td>EPIDIDYMIS</td>
<td>Structure attached to the testicle in which the sperm are stored</td>
</tr>
</tbody>
</table>
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
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Histologic</td>
<td>Microscopic study of the structure of tissues and their cells</td>
</tr>
<tr>
<td>Hormones</td>
<td>Chemicals produced by the body to regulate specific body functions</td>
</tr>
<tr>
<td>Humerus</td>
<td>Upper front leg bone; extends from the scapula to the radius</td>
</tr>
<tr>
<td>Hydatid Cyst</td>
<td>Fluid-filled sac containing immature <em>Echinococcus</em>; usually found in liver or lung</td>
</tr>
<tr>
<td>Infection</td>
<td>Invasion and multiplication of germs in the body</td>
</tr>
<tr>
<td>Incisor</td>
<td>One of the front four teeth; adapted for cutting</td>
</tr>
<tr>
<td>Inflammation</td>
<td>Protective response of the body to injury; characterized by heat, swelling, redness and pain</td>
</tr>
<tr>
<td>Injection</td>
<td>The act of forcing a liquid (usually a drug or medicine) into the body with a syringe and needle</td>
</tr>
<tr>
<td>Intestines</td>
<td>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</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>ISOLATION</td>
<td>Removal and growth of a disease-causing agent for identification</td>
</tr>
<tr>
<td>KIDNEYS</td>
<td>One on each side of the backbone in the small of the back; filters blood to keep body fluids balanced; selects out unwanted materials and eliminates them from the body in the urine</td>
</tr>
<tr>
<td>LARVAE</td>
<td>Immature worm or fly</td>
</tr>
<tr>
<td>LESION</td>
<td>Abnormality caused by bacteria, viruses, parasites or chemical or physical injury</td>
</tr>
<tr>
<td>LIVER</td>
<td>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; it is essential for life</td>
</tr>
<tr>
<td>LUMBAR</td>
<td>Pertaining to the back between the chest and the pelvis</td>
</tr>
</tbody>
</table>
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.

MANDIBLE  Lower jaw

MAXILLA  Upper jaw

METACARPAL  Lower front leg bone

METATARSAL  Lower rear leg bone

MEDIA  "Food" used to grow bacteria in the laboratory

MICROORGANISM  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
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>OMASUM</td>
<td>Third stomach in a reindeer</td>
</tr>
<tr>
<td>ORGAN</td>
<td>A group of cells organized together in the body to perform a particular function</td>
</tr>
<tr>
<td>OVARY</td>
<td>Make eggs for reproduction; two in normal females</td>
</tr>
<tr>
<td>OVIDUCT</td>
<td>Tube that carries eggs from the ovary to the uterus</td>
</tr>
<tr>
<td>OXYGEN</td>
<td>A gas that is essential for animal life; it is carried by the blood from the lungs to the rest of the body</td>
</tr>
<tr>
<td>PARASITE</td>
<td>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</td>
</tr>
<tr>
<td>PATHOGENIC</td>
<td>Causes disease</td>
</tr>
<tr>
<td>PATHOGENICITY</td>
<td>Ability to cause disease</td>
</tr>
<tr>
<td>PATH REPORT</td>
<td>Pathology report; report of the history and examinations performed to determine the cause of death of an animal</td>
</tr>
</tbody>
</table>
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 Virus disease usually carried by dogs, wolves, foxes, etc. in their saliva; transmitted to man 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 metacarpal

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; 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**
Breast bone

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

**TESTICLE**
Two in normal males; makes sperm which fertilize eggs in the female for reproduction

**THORACIC**
Referring to the chest

**TIBIA**
A bone of the upper rear leg between the femur and metatarsal
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>TISSUE</td>
<td>A group of cells that together make a particular structure</td>
</tr>
<tr>
<td>TRACHEA</td>
<td>Windpipe; carries air (with oxygen) into the lungs and out of the lungs (with carbon dioxide)</td>
</tr>
<tr>
<td>TRAUMA</td>
<td>Injury</td>
</tr>
<tr>
<td>TREATMENT</td>
<td>A drug or medicine given to an animal to kill disease-causing germs</td>
</tr>
<tr>
<td>TURBINATE</td>
<td>Bones in the reindeer nasal cavity</td>
</tr>
<tr>
<td>ULCER</td>
<td>A break or hole</td>
</tr>
<tr>
<td>UNDULANT FEVER</td>
<td>Brucellosis in man; symptoms include fever, aches and pains; can be treated with antibiotics</td>
</tr>
<tr>
<td>URETER</td>
<td>Tube carrying urine from the kidney to the bladder</td>
</tr>
<tr>
<td>UTERUS</td>
<td>Organ that receives and holds the fertilized egg to develop into the fetus</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>VACCINE</td>
<td>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</td>
</tr>
<tr>
<td>VAS DEFERENS</td>
<td>Tube that carries sperm from the testes to the penis</td>
</tr>
<tr>
<td>VEINS</td>
<td>Carry blood from the parts of the body to the heart</td>
</tr>
<tr>
<td>VENTRICLE</td>
<td>One of the lower, thick-walled chambers of the heart that pump blood out to the body</td>
</tr>
<tr>
<td>VERTEBRA</td>
<td>One of the sections of bone of the backbone</td>
</tr>
<tr>
<td>VIRUS</td>
<td>Tiny, tiny germ, smaller than bacteria; can not be seen with ordinary microscopes</td>
</tr>
<tr>
<td>VISCERA</td>
<td>Internal organs of the body</td>
</tr>
<tr>
<td>ZOONOSIS</td>
<td>Disease that can be transmitted from animals to man</td>
</tr>
</tbody>
</table>