Domestic Rabbits
Diseases and Parasites

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Domestication of the European rabbit probably occurred in monasteries during the Middle Ages. By the middle of the 17th century, rabbits were commonly raised in England and continental Europe. *Oryctolagus cuniculus*, one of the more successful mammals of the world, is both prolific and adaptable.

Most of the fancy breeds were developed within the past 100 years, and only since the early 1900s has domestic rabbit raising been accomplished in the United States. The first commercial colonies were started in southern California. Meat rationing during World War II gave the infant industry a push.

Today, approximately 200,000 people are engaged in some phase of the rabbit business, and animals are produced in every state of the Union. Meat processors, serving major cities, market more than 10 million pounds annually. Over the years, the breeds have been improved from the long, rangy, low-meat-yield type to the compact, blocky animal of today.

Production has increased from less than 65 pounds of meat per year per doe to more than 120 pounds per doe, and 200 pounds per doe is not unlikely in the future. Feed required to produce 1 pound of meat has been reduced from about 6 pounds to 3.5 or 4 pounds.

During the past 10 years, the rabbit industry has expanded considerably. It may not, as yet, have reached the popularity it experienced during World War II. But the nutritional qualities of rabbit meat are making rabbit more acceptable, and production is increasing.

While the numbers of growers and processors are difficult to obtain, one measure of the expansion can be seen in the number of processing plants now inspected by the U.S. Department of Agriculture. Until 1980, there was only one; in 1985, there were four.

An aid to the expansion of the rabbit industry has been the development of a Rabbit Research Center at Oregon State University. Started in 1978, this center has devoted its entire effort to helping the rabbit raiser become more efficient and productive.

Rabbit raising has continued to be a backyard or part-time business. However, the size of the herds has expanded from a few does to the current average rabbit herd of 20 does—and it is not uncommon to see herds of 300-500 breeding does. As in all facets of agriculture, the profits from rabbit raising depend on management and market. If an area has a steady demand for rabbit meat...
and a stable processor, the rabbit farmer can net a reasonable profit and add to the family income.

The difference between profit and loss often comes down to a person's ability to master the husbandry and disease control techniques necessary for success. Commercial rabbitries averaging fewer than 30 rabbits per cage/year (sent to market) find it very difficult to show a profit; whereas the profitable commercial number is above 40 rabbits per cage/year.

This publication is designed to help ranchers recognize the more common rabbit diseases and to know when professional advice is needed. Diseases are classified according to major cause—bacterial, viral, nutritional, hereditary, fungal, and miscellaneous (including poisoning, tumors, and vices).

**Factors in Prevention and Control**

The only rabbit that will return a profit to its owner is a healthy one. Factors conducive to good health include: body soundness and livability, adequate nutrition, suitable environment, prevention, eradication, and control of transmissible diseases.

**Adequate Nutrition**

The feeding of rabbits is the most important husbandry technique in the rabbitry. It should always be done by the most experienced person whenever possible. Good disease and potential disease problems are discovered during feeding time. Corrective measures for certain diseases are accomplished by changing the amount of feed or the diet itself are best done at the time of feeding.

Much has been learned in the past few years concerning rabbit nutrition. Diets that produce good growth in young and旺旺re, thrive, and produce, are high in energy to meet the requirements of the animals. The digestive tract of rabbits is not capable of processing high-carbohydrate type diets.

*Fast* diets high in starch and simple sugars cause diarrhea and death in fryer rabbits. A simple change to a diet higher in fiber and lower in energy gives adequate growth without the risk of enteric disease.

On the other hand, diets fed to does should provide adequate energy for reproduction, which may not be provided by diets extremely high in fiber. Progressive rabbit raisers are now feeding two diets, one to the growing fryers and another to the producing does. A simple diet that provides good health, growth, and production is preferred but often difficult to find because the needs of the various classes of rabbits are considerably different.

Inadequate nutrition is a costly problem. A decline in normal health may increase susceptibility to diseases, which can lead to heavy monetary losses. In addition, slow growth in the young caused by an inadequate milk supply from the doe or from inadequate consumption of feed can also be costly. Thus, feeding becomes a critical element in successful rabbit raising.

**Suitable Environment**

The term "environment" includes every factor that influences the life of the rabbit. Some of these factors are much soil and location, nearness to other animals, dryness, temperature, amount of sunshine, shelter design, availability of water, and general management. Careful examination and control of the environment are essential for effective disease prevention.

**Preventive, Eradication, and Control of Transmissible Diseases**

If disease prevention has failed and transmissible diseases are established in the rabbitry, heavy mortality may lead to business failure. Growers commonly encounter pasteurellosis, ear mange, and coccidiosis. These infectious diseases are usually introduced in two ways, by contact or by mechanical carriers.

The adult rabbit is the most important contact carrier. An animal may apparently recover from a disease but still shed infectious organisms in the feces, urine, or in droplets inhaled while breathing. Pasteurellosis and liver coccidiosis are important diseases spread by contact. The grower who introduces new stock directly to the herd or who exhibits animals at shows and fairs is most susceptible to disease outbreaks. New or exhibition animals should be held in a special isolation section of the colony until the rancher is reasonably certain that they are disease-free. This quarantine is usually a minimum of 2 weeks.

Rabbits that are carriers of disease are often not recognized because they appear healthy. Tests to pinpoint which animals are carriers are not always practicable. Liver coccidiosis is found when the fryer is dressed out for market, too late to trace back to the doe that produced it. Bacterial cultures of the nasal cavity may show the presence of Pasteurella, but the...
cost of these tests usually prohibits the grower from utilizing them.

When disease prevention has failed, we must consider the means available to control and eliminate the disease. When liver coccidiosis is involved, the adult carrier may be freed from infection by chemotherapy, but the establishment of improved management practices is the only way to eliminate the disease from the herd.

In some cases, it may be necessary to depopulate a herd to eliminate a disease. The time between depopulation and repopulation with clean, healthy animals depends on many factors. Environment plays an important part in the time interval involved.

Mechanical transmission of disease occurs when the infectious agent is accidentally carried from place to place. People are the chief offenders. The grower who treats a sick animal and then moves on to check or count newborn young can be an important carrier of respiratory infection and coccidiosis. Feed salespeople, service representatives, rabbit buyers, and visitors who have made the rounds of other rabbitries may be sources of infection. Avoid visiting other rabbitries if a disease is known to be present. These examples may be considered extreme, yet they happen repeatedly and are definite factors in introduction of disease. Dogs, cats, birds, and rodents have been incriminated as carriers of respiratory infection and may be removed for disinfecting.

Sanitation Program

A constant sanitation program is an important part of disease prevention. A program of cleanliness is required to establish and maintain a safe environment in which animals can live and reproduce. Elimination of disease carriers is the most important environmental factor to be considered in any sanitation program. All feeders should be cleaned periodically. Fecal matter and other organic material protect disease-producing bacteria, viruses, and parasites and nullify the effectiveness of even the most efficient disinfectants. Thorough scraping and washing should precede disinfection.

Feeders and watering devices are sprayed at the same time. The ease of cleaning, the supply of clean water, and the space for rodent-proof feed storage are important items when building a production unit. Proper drainage is another factor. Provision should be made for water runoff from the rabbitry area. Hutchs should be constructed so that individual units may be removed for disinfecting. The

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Sanitation Program

A constant sanitation program is an important part of disease prevention. A program of cleanliness is required to establish and maintain a safe environment in which animals can live and reproduce. Elimination of disease carriers is most important.

Environmental factors must be considered in any sanitation program. Particularly important is the proper type of hutch and shelter construction and its maintenance (Figure 1). The ease of cleaning, the supply of clean water, and the space for rodent-proof feed storage are important items when building a production unit. Proper drainage is another factor. Provision should be made for water runoff from the rabbitry area. Hutchs should be constructed so that individual units may be removed for disinfecting. The number of animals per unit should be adjusted to the area and the environment. Unfavorable environmental factors lower the animal's resistance to disease and facilitate the spread of infection.

Water should be fresh, clean, and protected from contamination by urine, fecal matter, and feed. Cleaning water containers frequently is important. Feeders and watering devices are sprayed at the same time. Good feed utilization and waste removal are important in disease prevention. Feed scattered about the rabbitry attracts insects, mice, rats, and birds—all potential carriers of disease. Proper storage of bulk feed will aid the sanitation program. In the small rabbitry or where large quantities of bulk feed are not stored, metal garbage cans with tight lids are good feed-storage containers.

Disinfection

Disinfection” refers to the killing of infectious agents such as bacteria, viruses, and parasites. To facilitate the use of disinfectants, all equipment and other construction should be as simple and easy to clean as possible. Fecal matter and other organic material protect disease-producing bacteria, viruses, and parasites and nullify the effectiveness of even the most efficient disinfectants. Thorough scraping and washing should precede disinfection.

In disinfection of cages, nest boxes, and ancillary equipment, a solution of sodium hypochlorite (bleach) has been found to be both effective and economical. The solution is made by adding an ounce of bleach to a quart of water. This solution is placed in a spray bottle and sprayed on the equipment to be sanitized.

Cages are generally sprayed after they become empty and prior to the next occupant. Feeders and watering devices are sprayed at the same time. Nest boxes are first cleaned and washed, then sprayed with the solution. Any removable equipment can be soaked or rinsed in the hypochlorite solution. There are no disadvantages to using this method of sanitation.

Another disinfectant used by some rabbit breeders is lye water. One 13-
Bacterial Diseases

**Pasteurellosis**

"Pasteurellosis" is the designation for all diseases associated with *Pasteurella multocida*. The disease manifestations are varied and include snuffles, pneumonia, pyometra, orchitis, otitis media, conjunctivitis, subcutaneous abscesses, and septicemia.

**Practices to Maintain Health and Prevent Disease**

The successful grower observes good sanitation and management, feeds an adequate diet of simple ingredients, and gives the animals plenty of fresh water.

Daily inspection of all animals in the herd is important. When sick rabbits are first noticed, the grower should immediately try to determine the cause. The following course of action is suggested:

1. Mark or note pens that contain sick animals.
2. Isolate sick animals. It is best if they can be kept in rooms or buildings separate from health rabbits. Be sure to wash hands and disinfect boots after caring for sick animals. Clean and disinfect any equipment moved from the area of sick animals to the other animals.
3. Care for the sick animal only after all other rabbits in the herd have been cared for to prevent carrying infection from sick to healthy rabbits. If the cause of the trouble cannot be quickly determined, a few typical signs of control have been strict culling. Vaccines have not proven to be effective in commercial rabbitries. By using broad-spectrum antibiotics, such as oxytetracycline, chlortetracycline, or tetracycline, the symptoms can be alleviated in many cases. However, the animal is often a carrier of *P. multocida* and able to infect offspring and neighbors.
4. If a rabbit shows a nasal discharge or matted paws, it is automatically culled from the herd. If the same rabbit sneezes on 2 consecutive days, it should be culled also. If there is a question on a rabbit—whether to cull it—go by the rule of thumb: "When in doubt, cull it out."

In addition to a strict culling program, good ventilation must be provided to control snuffles. There is a direct correlation between the level of ammonia in a rabbitry and the amount of respiratory disease. An effective manure removal system and 10-20 air changes per hour are necessary to reduce the ammonia to an acceptable level.

Antibiotic combinations have been used to reduce symptoms in pet rabbits with some success. If the nasal discharge regresses, care should be taken to avoid stressing the rabbit. It should not be used as a breeder.

Snuffles

The mucous membranes of the nasal sinuses become infected by bacteria in the inspired air or by direct contact with infected animals or contaminated objects. The clinical disease is characterized by a catarrhal (mucus or pus) nasal discharge (figure 2). The extent to which the infection spreads into the lower respiratory passages depends on the virulence (invasiveness) of the bacteria and the susceptibility of the animal. If the disease is confined to the upper passages, the first signs are sneezing followed by a nasal discharge. The inner aspects of the rabbit's forepaws may be caked with exudate because of attempts to wipe the exudate away from the nose. *Pasteurella* bacteria are often found in the nasal sinuses of healthy-appearing rabbits. Stress resulting from a change of temperature, high humidity, pregnancy, and lactation is a primary factor in the development of snuffles.

Treatment of snuffles has not proven to be economically feasible in commercial rabbitries. By using broad-spectrum antibiotics, such as oxytetracycline, chlortetracycline or tetracycline, the symptoms can be alleviated in many cases. However, the animal is often a carrier of *P. multocida* and able to infect offspring and neighbors. Additionally, snuffles are not preventable. The only effective method of control has been strict culling.

Pneumonia

Upper respiratory disease (snuffles) may spread to the lungs and cause pneumonia. Rabbit mortality surveys reveal pneumonia to be present in 25% of the animals examined; it is the greatest single cause of death in mature animals. Signs of pneumonia are...
Figure 2.—Adult showing signs of snuffles. Note discharge from nose.

depression, labored breathing, bluish eye color in albinos, and a nasal discharge. The body temperature is usually above normal.

Gross lesions of the lungs appear as red consolidated areas, sunken purple areas, and abscesses. Consolidated lesions are most often in the anterior lobes of the lungs (Figure 3). A catarrhal exudate is found in the air passages. Abscesses appear with thin fibrous capsules close to the surface of the lungs. Sometimes there are adhesions between the wall of the chest cavity and the lung.

Pneumonia is rarely treated in rabbitries; it is usually a postmortem diagnosis. Broad-spectrum antibiotics have been used with some degree of success with pet and show rabbits.

Pyometra

"Pyometra" means pus in the uterus. Does that are nasal-positive for P. multocida will often be vaginal-positive for the same bacteria, especially if the doe has a nasal discharge. The vagina is thought to be contaminated during the normal practice of coprophagy (eating their own feces; see page 22) or during the kindling process.

Treatment of pyometra is seldom attempted because the disease is usually not noticed until the female is slaughtered. Successful treatment is unlikely. Pets can sometimes be saved by an ovariohysterectomy.

Otitis Media

Middle ear infection of one or both ears causes filling of the tympanic cavity with a purulent exudate. If the process spreads to the inner ear, the equilibrium of the animal is disrupted, and head tilt or wryneck results (Figure 4). Although the Pasteurella bacterium is sensitive to certain antibiotics, treatment is generally not effective because of the isolated location of the infection.

Subcutaneous Abscesses

Pasteurella may cause abscesses in many organs, but abscesses are especially evident when they occur in the subcutaneous tissue. These appear as swellings under the skin. Treatment consists of opening and draining of the abscess and systemic antibiotics.
intestine that is covered with petechial hemorrhages. The hemorrhage is most apt to be observed in the cecum. The causative agent *C. spiroforme* can be isolated on blood agar, but it is an anaerobic-type bacteria and must be grown under anaerobic conditions. Diagnosis of this disease is accomplished by demonstrating the iota-like toxin in the intestinal contents. A mouse bioassay test or an intradermal test in guinea pig skin is commonly used to detect the toxin. Little is known about the transmission of the organism, but it has been shown that the rabbit does not normally have this organism as part of the normal microflora. The type of diet seems to be a factor in the development of the disease. Diets high in fiber will reduce the incidence of the disease. The addition of hay or straw to a low-fiber diet is also beneficial. Antibiotics used in the feed or water will give temporary remission of the symptoms, but when they are removed, the disease reoccurs unless the diet has been changed.

**Mucoid Enteropathy**

The clinical disease affects rabbits of any age and is a chronic diarrheal-type disease that is apt to be observed in the cecum. The causative agent *C. spiroforme* can be isolated on blood agar and grown under anaerobic conditions. Diagnosis of this disease is accomplished by demonstrating the iota-like toxin in the intestinal contents. A mouse bioassay test or an intradermal test in guinea pig skin is commonly used to detect the toxin. Little is known about the transmission of the organism, but it has been shown that the rabbit does not normally have this organism as part of the normal microflora. The type of diet seems to be a factor in the development of the disease. Diets high in fiber will reduce the incidence of the disease. The addition of hay or straw to a low-fiber diet is also beneficial. Antibiotics used in the feed or water will give temporary remission of the symptoms, but when they are removed, the disease reoccurs unless the diet has been changed.

**Septicemia**

This form of pasteurellosis is usually an overwhelming blood stream infection of short duration without clinical signs, resulting in death. Tissue changes are limited to a few hemorrhagic areas on the heart and pericardium, swelling of the spleen, and slight congestion of the upper digestive tract. The lack of clinical signs and short duration do not allow time for suitable treatment.

### Enteritis

"Enteritis" is a group designation much like "Pasteurellosis." Any diarrheal-type disease that kills rabbits is generally placed in this grouping. In the past, the group designation has often been called "enteritis complex," as many different symptoms were observed, but there was no unifying factor was death as the final result of the syndrome. More recently, specific diseases have been described; they will be discussed under this general heading of enteritis.

### Enterotoxemia

Enterotoxemia is an acute diarrheal disease of young rabbits 4-8 weeks of age. Rabbits are often observed to be normal one day and dead the next day with evidence of diarrhea. This acute death is due to a very deadly toxin produced by the bacteria, *Clostridium spiroforme*. Young rabbits die in 24-48 hours; occasionally adult and junior breeders are affected, but their dying could take as long as 96 hours.

The typical lesions of enterotoxemia seen at necropsy are a fluid-filled intestine that is covered with petechial hemorrhages. The hemorrhage is most apt to be observed in the cecum. The causative agent *C. spiroforme* can be isolated on blood agar, but it is an anaerobic-type bacteria and must be grown under anaerobic conditions. Diagnosis of this disease is accomplished by demonstrating the iota-like toxin in the intestinal contents. A mouse bioassay test or an intradermal test in guinea pig skin is commonly used to detect the toxin. Little is known about the transmission of the organism, but it has been shown that the rabbit does not normally have this organism as part of the normal microflora. The type of diet seems to be a factor in the development of the disease. Diets high in fiber will reduce the incidence of the disease. The addition of hay or straw to a low-fiber diet is also beneficial. Antibiotics used in the feed or water will give temporary remission of the symptoms, but when they are removed, the disease reoccurs unless the diet has been changed.
Due to their tolerance by the rabbit and specific action, antibiotics of the tetracycline group are the best drugs for treating listeriosis. Therapy should be started early with adequate dosages. Penicillin and erythromycin are also used. In treating pregnant rabbits, antibiotics probably will not prevent fetal death, and females saved by antibiotics may be sterile as a result of the infection. The most effective prevention of losses is immediate isolation of diseased pregnant animals. Pregnant females and those does that have recently delivered young are most susceptible. Males and nonpregnant females rarely contract listeriosis by the oral route.

**Necrobacillosis**

*Fusobacterium necrophorum*, an aerobic bacterium in farm animals, is considered a secondary invader rather than a primary cause of disease. Lesions first appear on the lower lip, which becomes swollen, purulent, and painful to the touch. Later, abscesses are seen that contain a foul, purulent material. These abscesses are enclosed in tough, fibrous capsule, with little tendency to rupture and drain. The disease progresses to ulceration and necrosis of the skin and subcutaneous tissue in the region of the face, head, and neck. When the abscesses drain, the animal becomes emaciated and dies after several weeks.

Inadequate sanitation in the rabbitry, especially dirty cages, is prerequisite to this disease. Sick rabbits often have purulent nasal discharges, but previous illness may not always precede the outbreak. Bacteria are shed in the feces of carrier rabbits and clinically ill animals.

Necro bacillosis naturally occurs in rabbits, causing anorexia, depression, and rolling movements. These signs may persist for several days or weeks, and complete recovery is rare. Sick pregnant females have large uterine swellings, lose weight, and may abort. Survivors generally are useless for breeding because of uterine damage and pyometra (pus within the uterus).

The most consistent sign at necropsy is liver necrosis, but lesions consist of a few pinpoint foci to almost complete destruction of the liver. The mesenteric lymph nodes may be enlarged and reddened. In cases of metritis, the uterine wall is thickened, the mucous membrane may be covered with a grayish exudate, and the fuses are decomposed or mummified. When infected fuses are retained in the uterus, a severe metritis develops.

**Listeriosis**

*Listeria monocytogenes* causes a septicemic infection in young animals, a meningo-encephalitis in adults, and metritis and fetal mortality in pregnant does.

In septicemia, death can be sudden and without previous illness. Generally the rabbit is depressed, weak, has a nasal discharge, and may have convulsions. Nervous signs include incoordination, loss of equilibrium, and rolling movements. These signs may persist for several days or weeks, and complete recovery is rare. Sick pregnant females have purulent metritis, lose weight, and may abort. Survivors generally are useless for breeding because of uterine damage and pyometra.

When the disease is recognized and treated in its early stages, recovery is usual; when there is extensive ulceration and abscission, death ensues. The organism is sensitive to penicillin.
may become bluish accounting for the name "blue-breast" that is sometimes used.

Cutaneous lesions in young animals appear as small abscesses and later develop into firm caseous nodules (figure 7). These abscesses are usually found on the lower abdomen, on the inner aspects of the forelegs, and on the lower jaw. Small white nodules may also be found in the lungs and heart. The *Staphylococcus* organism may also cause bronchopneumonia. The lungs appear consolidated with numerous necrotic lesions. The bronchi and trachea may contain a mucopurulent exudate.

Bacteria enter the skin through broken or abraded areas following birth; transmission occurs from mother to young. *Staphylococci* live in the nasal passages of rabbits, and the close contact associated with kindling (birth) and nursing offers opportunities for both direct contact and aerosol transmission.

Mastitis results from invasion of the milk glands by the disease-producing bacteria. The glands and teats become red and swollen and may advance to blue-black tissues, which are feverish to the touch. The doe may refuse to nurse her young and generally loses her appetite. Young from does with mastitis should not be fostered out to her appetite. Young from does with mastitis may not be fostered out to other nursing does because the disease will be transmitted to the doe. Mastitis may also result from abortion to the teats or insufficient removal of milk when too few young are left left with the doe or when the young are weaned too soon.

The septicemic form of staphylococcosis results in pancyte death in young rabbits, primarily those still in the nest box. Death is so rapid that few if any lesions are observed. Occasionally small suppurative pockets or abscesses (figure 7) are seen on the skin of dead kits or littermates. Diagnosis is usually dependent on isolating *S. aureus* from the heart blood. The organism generally enters the young kit from infected milk from mammary glands or it may enter the body through abrasions or scratch wounds that become contaminated with *S. aureus*.

*Staphylococci* may be sensitive to several antibiotics including penicillin, tetracyclines, streptomycin, and furadantin; however, some strains of the organism are resistant to one or more of these drugs, and laboratory tests may be necessary to determine which drugs should be used.

Mastitis

Mastitis is most commonly caused by *Staphylococcus aureus*; it is discussed under "Staphylococcosis," page 10.

**Conjunctivitis (Weepy Eye)**

Conjunctivitis is a common malady of young rabbits raised under crowded conditions. Mature does and bucks will also occasionally be affected. Red, swollen eyes with a copious exudate are characteristic of this disease. In young rabbits, the eyelids are often stuck shut (figure 8). It may affect only one eye or both. The bacteria most often isolated is *Staphylococcus aureus*, with *Pasteurella multocida* a close second. Conjunctivitis is treated by opening the eye if stuck shut, cleaning the surrounding tissues, flushing the eye with sterile saline or boric acid solution, and applying an ophthalmic ointment containing an antibiotic.

Conjunctivitis sometimes becomes a chronic problem in show rabbits, where the lacrimal secretions cause a loss of fur at the medial canthus of the eye. This condition is sometimes alleviated by repeated flushing of the lacrimal duct with an antibiotic solution. This is best accomplished under anesthesia with a small gauge cannula inserted into the opening of the lacrimal duct found on the lower eyelid near the medial canthus.

**Treponematosis**

Treponematosis, some called "vent disease," spirochetosis, or rabbit syphilis, is caused by *Treponema cuniculi*. Other members of the genus include *T. pallidum*, the cause of human syphilis. Some of the early work on human syphilis was done with rabbits. After finding that rabbits had a natural spirochete, *T. cuniculi*, the validity of this early work in rabbits was questioned.

There is a great deal of confusion concerning the incidence of treponematosis in rabbits. Recent reports indicate that it is much more common in commercial rabbitries than had previously been accepted. In fact, serological tests have demonstrated antibodies to *T. cuniculi* in a high percentage of adult rabbits. Lesions in these rabbits were seldom observed. Transmission of the organism was originally believed to be by sexual contact, and this method is still thought to be primary; however, vertical transmission from mother to offspring has now been demonstrated. Vertical transmission would account for the rabbits 6-8
weeks of age that show evidence of treponematosis.

Lesions of treponematosis may resemble those of injury, fungal infection, and ectoparasites. A correct diagnosis is important since the disease is transmitted primarily by breeding, and an isolated case may lead to an outbreak among the breeding stock. Exchange of infected bucks may spread the infection among colonies.

The first signs are usually small blisters around the external sex organs. Lesions involving the nose, mouth, and ears also occur in both sexes. They are irregular in shape, tan-brown, and either edematous or dry and scaly. Sometimes weeping, coalescing vesicles are found. Facial and other lesions are usually secondary and the result of reinfection by contact with genital-anal lesions when the animal cleans itself. All lesions show many spirochetes by special microscopic (dark-field) examination.

Spirochetes are also found in regional lymph nodes, and they seem to survive in this tissue much longer than on the skin surface. Old lesions heal completely without scarring, but recovered rabbits are susceptible to later infection.

The spread of spirochetosis can be prevented by examining the genitals of both sexes before mating and by eliminating rabbits with lesions. The organism is sensitive to arsenicals and penicillin. Three subcutaneous injections of benzathene penicillin G (100,000 IU/kg) of body weight are necessary to eradicate treponematosis from a rabbit herd. Injections are given at weekly intervals, and all rabbits must be treated, regardless of the presence or absence of lesions.

Hutch Burn

Hutch burn is often confused with rabbit syphilis and is difficult to differentiate from these diseases without the use of a dark-field microscope. With this microscope, spirochetes of treponematosis are easily seen. Hutch burn affects the membranes of the anus and genital region. They become very red and chapped. The major cause is wet and dirty cage floors that come in contact with these membranes. The area soon becomes secondarily infected with pathogenic bacteria and becomes very sore. Antibiotic salves and ointments will hasten healing, but cleaning and drying the floors are essential to prevent reoccurrence.

Pseudotuberculosis

Pseudotuberculosis is a fairly common disease in rabbitries with questionable sanitation. The causative agent is a bacterium, Yersinia pseudo
tuberculosis. Granulomatous nodules resembling tuberculosis are observed at necropsy throughout the intestine and occasionally in the parenchyma of the liver, lungs, or spleen. The organism, which seems to thrive in filthy conditions, enters the host through contaminated food or water. The disease is a chronic, debilitating-type of condition with signs of poor appetite, depression, slow developing emaciation, and eventual death.

Treatment of this disease is seldom effective. Prevention can be accomplished by good sanitation procedures including disinfecting cages, nest boxes, and ancillary equipment. This disease has been diagnosed in people and other animals; therefore, affected rabbits should be destroyed and not marketed.

Tularemia

Tularemia, sometimes called rabbit fever or deer fly fever, is an infectious disease of wild animals and people that is caused by Francisella tularensis. Tularemia can be carried by many wild and domestic animals, certain birds, deer flies, and ticks. It is an important malady of wild rabbits, not the domestic or raised rabbit.

Infected wild rabbits appear sluggish in movement and are visibly sick. Yellow or white spots on the liver in splenic are common lesions. Diagnosis is made by bacterial culture or suspect lesions. Domestic rabbits are susceptible to infection, but the organism under laboratory conditions, but the disease has not been reported naturally occurring in commercial rabbitries.

Viral Diseases

Myxomatosis

Myxoma virus was first isolated in South America from diseased laboratory rabbits; but it was later found to be a widespread natural infection in wild rabbits. In wild brush rabbits (Sylvilagus bachmani), it causes only mild tumors, which regress after several weeks; the disease is fatal only in very young. In contrast, the disease can completely wipe out some susceptible populations of domestic rabbits.

Confirmed cases of myxomatosis follow the geographical distribution of the California brush rabbit, which is limited by the Pacific Ocean, the Columbia River in Oregon, the Cascade-Sierra Nevada Mountains, and the tip of the peninsula of lower California.

Transmission of the disease by mosquitoes led to the name "mosquito disease." Myxomatosis is also referred to as "big head disease" because of edema around the eyes, ears, lips, and nose in the early stages of the infection.

Clinical signs include lusterless eyes with a purulent discharge and elevated body temperature. Edema of the ears causes them to become heavy and pendulous (figure 9). As the disease progresses, edema of the anogenital region and a nasal discharge
occurs; death follows in 10-12 days. In the few cases that survive, widespread subcutaneous gelatinous tumors develop all over the body.

Occasionally, acute outbreaks of myxomatosis occur wherein rabbits die in 24-48 hours. About the only clinical signs observed are a slight redness in the conjunctival membranes and an increased temperature (about 108°F).

Rabbits dying from myxomatosis exhibit no characteristic gross visual changes by which the infection can be definitely diagnosed. Usually, there is congestion and consolidation of the lungs, and the spleen is enlarged, dark red, and pulpy. The cut surface of each edematous subcutaneous tissue is white, gelatinous, and glistening; when pressed, clear fluid exudes.

Microscopic tissue examination or virus isolation is required for a definite diagnosis of myxomatosis. Large eosinophilic cytoplasmic inclusion bodies in the conjunctival membranes are observed microscopically. This finding, along with lymphoid depletion of the spleen and the appropriate clinical signs, are all evidence of myxomatosis.

The virus is spread by direct contact and by biting insects such as mosquitoes and fleas, which act as mechanical vectors. Control consists of prompt identification of the disease and destruction of infected animals. Practices that reduce mosquito populations, such as draining or splitting breeding areas, should be followed. Screening the entire rabbitry is an effective but costly operation. Antibiotics are not effective in treating sick animals. An attenuated vaccine has been used in Europe for prevention of myxomatosis; however, it is not allowed for use in the United States. The only effective measures available for controlling myxomatosis in California and Arizona are culling and slaughter. Suspect rabbits undergo a rectal temperature check. If rabbits with a temperature greater than 104°F are immediately killed and the carcass buried on the premises. This method, along with implementing a control program for insects, has been successful in stopping several major outbreaks in large rabbitries.

Rabbit Pox

This rare disease can occur with or without clinical disease being manifested. In either case, the lesions include lymphadenitis, papular nodules on the mucous membranes, and orchitis. Mortality is highest among the unweaned young, and may reach 75%. Rabbit pox virus is rarely a cause of epizootics, but is usually very serious when it does occur. Vaccination with vaccinia virus confers immunity.

Fibroma

Rabbit fibroma virus was isolated from nodules beneath the skin of wild cottontail rabbits. These fibromas (growths) were transmitted to both wild and domestic rabbits. It was once believed that fibroma virus only infected wild rabbits; however, an outbreak has been reported in a commercial rabbitry.

In the cottontail rabbit, fibroma virus causes a benign tumor that progresses within a few weeks. Young domestic rabbits, on the other hand, develop small subcutaneous nodules to diffuse inductions involving muscle and tendon. The external skin area becomes red and swollen. Death is frequent in unweaned young.

The nodules are firm and irregular, and may have a protruding white streak. Young animals, the tumors become more widespread over the body and often coalesce. There may be involvement of the kidneys, liver, intestinal tract, bone marrow, and mesentery.

The role of mosquitoes and other insects as vectors of rabbit fibroma virus has been established. Given the proper environment (such as an epizootic level), the cottontail rabbit and domestic rabbit, an adequate mosquito population, this virus disease could result in significant economic loss of young domestic rabbits.

Herpes Virus

Virus III or Herpesvirus cuniculi of rabbits exists as a latent infection in some stock lines of domestic rabbits. The virus does not produce a natural disease, nor are other species of animals susceptible. A virus with characteristics of the herpes group has been recovered from rabbits with respiratory signs. Its role as a pathogen has not been elucidated, but its association with respiratory disease may be important.

Another herpes virus that may be responsible for producing lymphoid tumors in cottontail rabbits has recently been isolated from these rabbits.

Rabbit Papilloma

Rabbit papilloma virus was identified as the causative agent of wartlike growth on the skin of cottontail rabbits (figure 10). The domestic rabbit and the jackrabbit are susceptible to experimental infection. The virus can be recovered from lesions on cottontail rabbits, but not from papillomas on domestic rabbits. Naturally occurring virus has been found in domestic rabbits in southern California, but the virus produces evidence of a generalized illness.

The most common sites of papillomas are the ears and eyes; and the growths vary in size and conformity. The growths are velvety, and the upper surfaces are irregular and often split. The lower portions of the growth are smooth and fleshy to the touch. As the warts become older, they increase in size, become more cornified, and are hard to the touch. In this stage, they are easily scratched off by the rabbit or knocked off when handled. Papillomas removed in this way leave a free-bleeding surface, which heals without complications.

Rabbit papilloma virus is probably spread by free-flying insects such as the mosquito; there is no virus multiplication in insect tissue. Transmission of the virus from lesions of cottontail rabbits to domestic rabbits is most likely.

Oral Papilloma

Wartlike growths in the mouth, especially on the lower surface of the tongue, are caused by a virus (one of the papovaviruses) different from the rabbit papilloma virus. Several spontaneous outbreaks of this disease have occurred, but all have been in the States of New York and Massachusetts. The growths on the tongue usually regress without specific treatment.

Viral Enteric Diseases

During the past decade, several viruses have been isolated from rabbits with diarrhea. Rotavirus, coronavirus, and adenovirus have all been incriminated in enteritis outbreaks. The clinical signs and pathology of the viral enteric diseases are very similar to those described under the section on...
bacterial diseases. It is not clear whether viruses are acting as the primary agent (with pathogenic bacteria as secondary invaders) or whether natural outbreaks of enteritis can be caused by these viral entities alone. A great deal of work is currently being done to try and answer the questions of viral pathogenicity and immunology.

**Fungal Diseases**

Two main groups of fungi, *Trichophyton* and *Microsporum*, are found on the rabbit and reproduce disease of the skin and fur under certain conditions. Not only may rabbits serve as reservoirs for human infection, but also people may transmit their fungus infection to rabbits. Because they produce a similar disease known as ringworm, the two organisms will be discussed together in this section.

Fungus infections cause patchy areas of hair loss and thickened skin covered with yellow, dry crusts (figure 11). The hairs may be broken close to the skin surface and become matted. The name “ringworm” is suggested by the circular lesion that often develops from the outward growth of the fungi. Lesions are usually found on the nose, ears, eyelids, and feet. Their size varies, and in severe cases whole areas of the body may be involved.

The infection is usually most severe in the nursing young; single small lesions are more likely found in the adult. Diagnosis of fungus infection depends on finding fungi in skin and hair scrapings and by culture. Examination under Wood’s (ultraviolet) light may indicate *Microsporum*, but not *Trichophyton*.

Infection of the young probably occurs in the nest box. The nest-box material becomes contaminated with fungus from the adult, and minor skin abrasions allow the fungus to become established on the young. During nursing, the young are in direct contact with skin and fur around the teats, and the fungus is easily transferred to the mouth and nose regions of the infants. These same fungal organisms are found on dogs, cats, domestic livestock, and wild rodents around farm buildings.

Fungal infections must be differentiated from other types of skin problems, such as mite infestations, hair pulling, fist wounds, moulting, and vitamin deficiencies. If ringworm is suspected after an evaluation of the lesions and clinical history, a skin scraping should be performed. The scraping should come from the periphery of the lesions, treated with 10% potassium hydroxide and examined under a light microscope with reduced illumination. Fungal forms are easily identified by trained personnel.

When small numbers of animals are involved, a topical antifungal medication may be useful. It is applied directly to the affected areas. In larger outbreaks, an oral or systemic medication is preferred. Griseofulvin, an antifungal drug, is the medication of choice. Each animal should receive 12 milligrams (mg) per pound body weight per day for at least 15 days. The drug is dissolved in water and administered to the rabbit by gastric intubation. During treatment a fungicidal dust such as sulfur should be added to the nest-box material.

Griseofulvin can be added to the feed at the rate of 370 mg per pound of feed and fed to all rabbits in the herd for a period of 2 weeks. While this is an extremely effective and easy way to treat ringworm, it presents a problem: The drug has never been cleared for use in rabbit feed in the United States and, therefore, can not be added to the feed by a commercial feed company. This situation may be resolved in the near future.
Parasitic Diseases

Rabbits are susceptible to a number of parasites, but only a few are of economic importance. The problems caused by all these parasites are greatly influenced by methods of feeding, handling, or housing. If these are satisfactory, and if recently acquired animals are quarantined for a few days and checked for disease, most economic parasitisms can be avoided.

Prevention and Control

The best preventive measures are sanitation, good housing, adequate food ration, and an understanding of potential parasite problems. Where good husbandry is the rule, rabbits are rarely infested with parasites in significant numbers. Modern pens are so constructed that they can be kept clean and free from the infective forms of parasites. The proper cleaning of cages and use of good disinfectants, together with a good diet, are the keys to parasite control. Prevention of parasite infection is far cheaper and preferable to treatment.

External Parasites

Ear Mites

Psoroptes cuniculi, the common ear mite of rabbits, causes ear mange or canker. This condition is a very common parasitic disease in commercial rabbitries.

The mites live in the ear canal and cause damage to the skin lining this area. An exudate of brown, waxy material soon covers the inner ear (figure 11). This dark encrustation consists of cellular debris, keratin, dried blood, and mites in varying states of development.

The complete life cycle of the mite takes less than 3 weeks, and a severely infested ear may contain as many as 10,000 mites. In severe cases, the entire inner surface of the ear may be involved, as well as the side of the head, the neck, and even the shoulders. Severely affected rabbits lose flesh, fail to reproduce, and succumb to secondary infections.

Treatment of ear mite infestations requires perseverance and a plan. If ear mites are detected in one rabbit, it is likely to be in others in the herd also. To rid the herd of this bothersome parasite, all rabbits in the herd must be treated regardless of whether ear mites are detected. Treating just the one rabbit will result in treating one or two rabbits a week continuously. Most any mineral-oil-based ear mite medication containing a parasiticide is effective. Using a plastic medicine dropper, 2 or 3 drops of this solution is placed in both ears of all adult and potential replacement rabbits in the herd. Massaging the base of the ear after administering the medication will distribute the drug throughout the surface of the ear canal. If rabbits are severely infected, with a large amount of debris in the ear canal, the ear must be cleaned with cotton-tipped applicators and tweezers prior to drug application. Rabbits with noticeable ear-mite infestations are treated every day for three treatments, every other day for three treatments, and then weekly for three treatments. Rabbits without noticeable ear mites are treated monthly for three treatments.

Fur Mites

Cheyletiella parasitivorax and Listrophus gibbus are two common mites inhabiting the skin areas of rabbits. In healthy, well-fed rabbits they seldom cause a problem and are rarely noticed. If a rabbit becomes sick or is underfed, alopecia, sores, or scabs may develop in the neck or dorsal trunk areas. Intense itching may occur, which causes constant scratching with the hind legs and undoubtedly the loss of hair and injury to the skin. Diagnosis of fur mites is best accomplished by doing a skin scraping of the affected area with a scalpel blade dipped in mineral oil. The resulting debris is then examined micro-
Figure 12. Treating ear mites with a cotton swab soaked in medicated oil.

scopically for evidence of mites and eggs. Treatment of ear mites in a few rabbits can be done by applying a cat flea powder at weekly intervals for several treatments. If a fur mite infestation becomes a hered problem, then all rabbits are dipped in a 0.5% malathion solution at 10-day intervals for two treatments.

Cuterebrid Flies
Larvae of *Cuterebra* flies are common subcutaneous parasites of wild rabbits but infrequent parasites of domestic rabbits. The adult fly appears whenever populations of wild rabbits exist. Rabbits are infected when the fly deposits eggs on the fur. Grub worms hatch from these eggs and burrow into the skin to form warbles. The larvae grow under the skin and may get as long as three-quarters of an inch (figure 13). When full grown, the grubs leave the skin, drop to the ground, and develop into adult flies. The warbles cause little trouble when they are found in small numbers. The larvae can be removed by enlarging the opening in the skin and drawing them out with tweezers. The wound then should be painted with an antibiotic.

Fleas and Ticks
Rabbits are not commonly infested with fleas; however, the rabbit flea, *Spilopsyllus cuniculi*, and the dog and cat fleas, *Ctenocephalides canis* and *C. felis*, occasionally have been reported on rabbits. There are four stages in the life cycle of these fleas—egg, larva, pupa, and adult. The eggs are deposited on bedding and in cracks of the nest boxes and develop into larvae in a short time. These larvae then form pupae from which the adult fleas emerge. Control is aimed at killing the adults on the host and the immature forms in the nest box. To destroy adult fleas, dust the animals with a commercial preparation of pyrethrin or rotenone. Dusting should be repeated at several times during a 2-week period. Immature forms can be controlled by burning old nest-box litter and scrubbing nest boxes with hot water and household bleach.

The rabbit tick, *Haemaphysalis leporispalustris*, is a common parasite of wild rabbits, but is rarely found on domestic rabbits because their housing is not compatible with the life cycle of the tick; however, this tick is one of the reservoirs of tularemia. This is a serious human disease, and care should be taken to ensure that wild rabbits are not allowed access to areas in which domestic rabbits are being raised.

Figure 13.—*Cuterebra* larva. An eraser on a pencil is shown for size comparison.
Internal Parasites

Coccidiosis

Coccidiosis is a prevalent parasitic disease of domestic rabbits. It is caused by a microscopic protozoan parasite that invades the intestine or liver. In these locations, the parasite multiplies extensively, and then sheds eggs in the feces. At least four species or types of coccidia live in the intestine, and one species grows in the liver.

Not all species of coccidia are equally harmful, and rabbits tolerate moderate numbers of some without displaying illness. The most dangerous of the intestinal forms are *Eimeria magna*, *E. media*, *E. perforans*, and *E. irresidua*. These produce diarrhea, poor appetite, weight loss, and sometimes death. *E. irresidua* evokes the most severe tissue damage. In some cases, patches of epithelium die and slough away from the intestinal wall.

The diagnosis of coccidiosis depends on the finding of the oocysts (eggs) in the feces or intestinal contents. However, experience is needed to judge if sufficient numbers of parasites are present to account for the disease signs, since other disorders may produce similar signs.

Control of intestinal coccidiosis depends largely on management practices that minimize the danger of fecal contamination of feed, water, and hutch floors. Wire-bottomed floors greatly reduce the hazard presented by solid floors or slots. However, wire floors should be brushed daily with a wire brush to ensure that the feed material falls through the wire. This breaks the life cycle of the organism. Feeders should be designed so that fecal contamination is held to a minimum. An automatic water system is recommended. Oocysts passed out in the feces require moisture and warmth to sporulate and become infective (figure 14). Dry, wire floors and automatic water systems hinder sporulation of the parasite.

Treatment has only a temporary effect on intestinal coccidiosis, but it may be useful in controlling outbreaks. When indicated, a ration containing 0.025% sulfadimethoxine may be fed for 2 or 3 weeks to reduce the numbers of the parasites to a level where control can be accomplished by proper management. Intestinal coccidia develop a tolerance to the drug if used continuously, so treatment is not suggested unless clinical disease appears.
but disfigurement of the liver makes it unmarketable; hence this type of coccidiosis is always of economic significance.

Liver coccidiosis is acquired in the same manner as intestinal coccidiosis. The control measures are also similar; however, liver coccidiosis can be controlled more easily by proper management. When the disease does occur, feed containing 0.025% sulfaquinon oxaline is an effective treatment. It can be fed at this level for 3 weeks; it should be used only until management control measures can be introduced.

**Encephalitozoonosis**

*Encephalitozoon cuniculi* (a protozoan parasite) is the cause of a mild but longstanding disease in rabbits. The condition was first described as a chronic encephalitis and later as a spontaneous paralytic disease. A chronic nephritis caused by the parasite was overlooked for many years, but current studies indicate that many apparently healthy aniamis have kidney lesions related to this infection. These lesions vary from cortical scarring with small, multiple, indented gray areas on the surface to a granulomatous nephritis (figure 16). The scars extend from the cortical surface to the medulla.

Encephalitozoonosis is an infectious, colony infection. The organisms are passed in the urine and transmitted when there is urinary contamination of feed or water. Transmission may also occur to unborn rabbits in the uterus when the doe has the disease. The disease can be controlled by providing good sanitation and preventing contamination of feed and water by urine. No treatment is available.

Diagnosis of encephalitozoonosis in a rabbit herd is difficult. It is usually done serologically by observing histologic lesions at necropsy. Recently, serologic tests have been developed that can help with the diagnosis in a rabbit. An *Encephalitozoon* infection can be detected by an indirect fluorescent antibody test, a skin test with a carbon immunoassay utilizing clinic ink. These tests may be helpful in ante-mortem diagnosis and also in screening rabbits to point out possible carriers or infected animals.

**Toxoplasmosis**

Toxoplasmosis is a protozoan disease of rabbits caused by *Toxoplasma gondii*. The disease has been reported worldwide in both domestic and wild rabbits. The disease is probably more common than reported, as antibody tests on rabbit herds have shown that as many as 50% of the clinically normal rabbits have been exposed.

There are two forms of the disease. An acute form in which the rabbit develops anorexia, fever, lethargy, and diarrhea (in a few days), central nervous system symptoms ranging from ataxia or posterior paralysis to generalized convulsions. Death usually occurs about 1 week after the symptoms are first noted. In the chronic form, the disease occurs over a much longer period of time. In fact, it may be latent with no symptoms for many months. It may be both a progressive disease that may end in posterior paralysis and death.

Transmission of the disease may occur in two ways. Cats have the ability to shed the parasite in their stool. Cats may contaminate stored rabbit feed by defecating in it; then the contaminated rabbit feed is ingested by the rabbit. The other way the parasite can be transmitted is through the placenta of the pregnant doe to her offspring.

At necropsy, the lesions of this disease vary somewhat. In the acute form, there is extensive necrosis of the lymph nodes, liver, spleen, and lungs. This is generally observed histologically, but grossly the organs may be swollen, and necrotic small white foci may be observed. The parasitic organism is often found in these necrotic foci with the aid of a microscope. In the chronic form, gross lesions may be inapparent with microscopic lesions, and organisms often confined to the central nervous system.

**Roundworms**

Only one roundworm presents a problem in domestic rabbits. Several more have been reported in wild rabbits, but these rarely occur in domestic rabbits. The oxidin, *Parasitus ambiguus*, is the most common parasite of domestic rabbits, but it does not affect other animals or people.

These worms are thin, listening, white, and a 0.1 inch long. They are often seen on the surface of freshly passed feces or through the wall of the cecum when animals are slaughtered. Ordinarily, pinworms do little harm. As the parasites become inactive, they pass out of the cecum as fecal pellets are formed. These parasites are spread from animal to animal by ingestion of feed and water contaminated by the droppings of infected animals. Management methods used to control coccidiosis are effective against pinworms. When treatment is necessary, piperazine citrate is effective when administered at 100 mg/100 milliliters (ml) drinking water for 1 day. Reinfection occurs readily.

**Tapeworms**

Tapeworms occur in rabbits as adults in the intestine and as larval forms in the liver and abdominal cavity. The adult forms are very rare in hutch-raised rabbits, but larval forms are occasionally observed.

The rabbit tapeworm *Cittotaenia variabilis* is uncommon in domestic rabbits. It is flat, ribbon-shaped, and made up of numerous segments. It has a head with four suckers with which the worm attaches to the lining of the intestine. Rabbits harboring a few tapeworms show no signs of the disease. When many tapeworms are present, diarrhea and emaciation may occur. Control is readily accomplished by good sanitation.

The larval forms of tapeworm most often found are those of *Taenia*...
**Nutritional Diseases**

**Pregnancy Toxemia**

Also known as "ketosis," this disease, a toxemia of pregnancy that is most commonly noted in first-litter females. Signs of ketosis are dullness of the eyes, sluggishness, respiratory distress, prostration, and death after 1 to 4 days. The disease occurs in the last week of pregnancy and is much more prevalent in obese animals. The probable cause is starvation. For some reason, there is a loss of appetite and failure to eat. This may be the result of minor digestive upset (hairballs in the stomach are common), an abrupt reduction in exercise, or a ration containing too little digestible carbohydrate. When carbohydrate energy declines, body fat is mobilized for energy, and ketone bodies are produced which enter the bloodstream. The liver becomes fatty and appears brown and soft.

Birth of the litter or abortion is apt to be curative if either occurs shortly after the onset of signs. Injections of fluids containing glucose may reverse the breakdown of body fats and halt production of ketones. Junior does should not be too fat when bred for the first litter.

**Vitamin A Deficiency**

Low-grade vitamin A deficiency adversely affects the reproductive performance of the female, often before other signs are noted. Premature degeneration of the ovum and reduced numbers of fertilized ova result. Resorption of the fetus or abortion during late gestation is also noted.

Rabbits born to females fed a diet deficient in vitamin A may be hydrocephalic at birth. Hydrocephalus, also called "water on the brain," is char-

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**Figure 17.** Rabbit liver with several cysticerci attached (arrow).

**Figure 18.** Life cycle of the dog tapeworm.
Hereditary Diseases

Vitamin E Deficiency

Infant mortality, characterized by death of entire litters at 10 days of age without clinical signs prior to death, has been associated with vitamin E deficiency. Affected litters do not reveal any gross lesions or diagnostic significance. Proving females become less fertile, and incoordination progresses. The problem can be avoided since adequate supplemental vitamin E feed is adequate. Alfalfa hay is a suitable source of vitamin E. Commercial rations, and 8-9 mg/100 grams (g) feed is adequate.

Hydrocephalus

Hydrocephalus is caused by low maternal blood levels of vitamin A throughout the gestation period. When maternal blood levels fall below 20 micrograms (μg) per 100 ml serum, hydrocephalus appears in a large percentage of the young. Commercial diets, in general, supply adequate levels of vitamin A; however, the vitamin does deteriorate after prolonged storage of alfalfa hay.

Recently, it has been shown by workers at Oregon State University’s Rabbit Research Center that excess levels of vitamin A can cause the identical signs and symptoms caused by deficiency of the vitamin. Low fertility, abortions, resorption, and hydrocephalus were all seen in does given excessive vitamin A in the diet. Excess vitamin A may be a problem if a vitamin premix is added to rabbit diets containing high levels of alfalfa hay.

Glaucoma

Glaucoma occurs in both laboratory and commercial rabbit colonies. This condition is of interest to ophthalmologists because of its similarity to congenital glaucoma in humans, and the rabbit may serve as a useful animal model.

Glaucoma appears first as a light-bluish cloudiness on the cornea. One or both eyes may be affected. Progressive opacity follows, and protrusion of the eyeball becomes noticeable. Corneal opacity may lead to blindness.

Glaucoma is probably the result of an abnormal drainage mechanism and the inability to maintain normal fluid relationships in the eye. It is a semethal defect that is transmitted as a recessive trait.

Malocclusion

Malocclusion of the incisors has been recognized as a common problem in rabbit colonies. The parental formulas of rabbit incisors 2/1, canines 0/0, premolars 3/2, and molars 3/3. Constant chewing and grinding keep the incisors evenly in normal animals. These teeth continue to grow and depend on constant grinding against opposing teeth to maintain their shape. If there is a malposition of the jaw, broken teeth, or malnutrition, overgrowth will occur in the cheek teeth similar to that which occurs in the incisors.

Signs of malocclusion are gradual loss of appetite and weight. Both sides of the mouth may become stained with saliva. Animals become progressively listless, dehydrated, and unable to chew properly. Complications are abscessed teeth, growth of teeth into the upper jaw, and death from starvation.

Malocclusion of the incisors can be corrected temporarily by cutting back the teeth so the animals can eat and attain good condition prior to slaughter.

However, these animals should never be used as breeding stock as most types of malocclusion are inherited. Young rabbits will occasionally pull on the cage wire or feeders with their teeth and cause misalignment, which results in malocclusion. This trait is not inherited, but it is difficult to differentiate from inherited malocclusion. Therefore, the best solution is to regard all malocclusion as inherited. The excessive malocclusion genes can be eliminated from a breeding herd by selective breeding.

Splay Leg and Ataxia

Splay leg in rabbits is due to a simple recessive genetic factor. The condition is similar to the hip dysplasia found in certain breeds of dogs.

The disease is characterized by an inability to put weight on one or both hindlegs, and may even involve all four limbs. The limbs are twisted so that the animal exhibits a double-jointed posture. The animals are not paralyzed. They eat normally, appear to be well, and move by wriggling along on their belly and chest. The pathologic effects are limited to the hip and shoulder.

Ataxia (muscle incoordination) resembles splay leg in some respects. It is, however, a lethal recessive genetic factor. The disease usually appears when the animal is 2-3 months of age and runs its course in 30 days. In ataxia, the nervous system is involved, and at first the animal may not be able to use its hindlegs effectively. Later the animal cannot move, and its body temperature drops below normal until death ensues.
Miscellaneous

Cannibalism

Most cases of cannibalism are the result of the diet being inadequate in either quality or quantity or because the doe was disturbed following kindling. Proper feeding and seclusion at kindling will usually prevent the tendency. A valuable doe that destroys her first litter should be given another chance. If she continues, she should be culled from the breeding population.

Heat Prostration

Heat prostration results from prolonged exposure to excessive heat. Losses may be high in females due to kindle or in baby rabbits if the nest boxes are poorly ventilated. Just before dying, the animals breathe rapidly and become comatose.

Adult animals suffering from the heat may be relieved by spraying them with water or placing a wet burlap feed sack on the cage floor for the animals to rest on. Bedding and fur should be removed from the nest box to allow free circulation of air in the boxes for the kits.

In locations subject to high temperatures, overhead water sprinklers help to reduce the air's temperature by evaporation. Aluminum-roofed sheds help to reflect the heat, and burlap sacks soaked in water can be hung from the edges of the roofs to shade and cool the air.

Draining water lines or crocks and refilling with cold water for immediate consumption also help in reducing the rabbits' body temperature. Changing breeding schedules to reduce the number of late-pregnancy does in the hottest part of the summer is also a desirable practice.

Broken Back

This condition is characterized by sudden paralysis with no apparent cause. Paralysis begins posterior from the middle of the back and may be complete or partial. The animal moves with its front legs and drags the hindquarters. The urinary bladder may become greatly distended. Paralyzed animals have a displaced or slipped vertebra. Malposition of the vertebra may be caused by improper handling, using a tattoo box too short for the size of the animal, or by injuries occurring in the cage. Many injuries occur at night when predator animals invade the rabbitry. In an effort to evade the predator and protect the young, the adult "stamps" firmly with its hindfeet. As a result, the vertebra becomes displaced, and the spinal cord becomes damaged.

Adult rabbits have been observed to cause a luxation of the vertebrae by sudden quick movements when startled by a person entering the rabbitry. This is especially true if background noise (such as a radio) is not available and the person is a stranger. If the rabbit is completely paralyzed, it is generally killed. However, some success has been observed in cases with partial paralysis (some motor function or sensory capability) by placing the rabbit in a small cage for 30 days. The objective of the small cage is to limit the rabbit's activity and allowing time for repair of the partial injury.

Sore Hocks

Sore hocks are inflamed bare spots, devoid of fur, found on the bottom surface of the hindlegs (figure 20). In more severely affected cases, secondary infections with Staphylococcus occur. Both front and hind feet may become involved. As the hocks of the hind feet become painful, the animal throws more weight to the front feet, adding stress to the front feet and causing them to become affected. Very dirty hutch floors and the irritating action of urine ammonia are predisposing factors. The breed of the rabbit is also a factor in the development of sore hocks as the disease is seen more often in large breeds than in smaller breeds. Rex rabbits are also prone to the disease because of thin foot pads.

Treatment of sore hocks is non-productive. Even if one is successful, the lesion almost always returns, and...
the animal is seldom useful as a breeder. The best method of treatment is prevention. Prevention is accomplished in three ways. First, all affected breeders should be culled from the breeding herd because of a genetic predilection for sore hocks (thickness of the foot pad). Second, cage floors should be cleaned daily and manure never allowed to hang on cage floors. Third, cage floors should be constantly inspected for rough spots or rusty areas.

Milkweed Poisoning

The leaves and stems of the woollypod milkweed, *Asclepias eriocarpa*, are toxic to the rabbit. The leaves are greenish yellow and broad, and the underside is covered with a woolly growth (figure 21). Leaves may be found in wheat or oat straw, but never in rice straw. The milkweed plant grows only in the Pacific Southwest.

When rabbits eat the leaves or stems of the plant, they develop a paralysis of the neck and shoulders. The head is tucked down between the front legs, and the nose rests on the floor. The back is arched higher than normal. As neck muscles become paralyzed, the animal is unable to lift its head or to control its legs. The front legs extend to the sides while the hind legs extend outward and forward. In more advanced stages, the head lies flat on the floor, the ears droop to the sides, and any movement is jerky and unsteady. Eventually, the animal becomes completely paralyzed and succumbs to starvation. In the early stages, the animal can be saved if it can be force fed and given water.

Tumors

Spontaneous tumors in the rabbit are rarely reported because the animals are slaughtered before they reach an age at which tumors are most apt to occur. With the increasing use of the rabbit as a laboratory animal, interest in these growths can be expected. Tumors have been observed in the uterus, kidneys, blood vessels, lymph nodes, bones, testicles, skin, and other organs. Adenocarcinomas of the uteri are not uncommon in does over 2 years of age. Usually they are multiple and occur in both uteri. Most cases of lymphosarcoma (tumors of cells from lymph nodes) have been in mature females. Neoplastic cells are found in numerous body organs, but the most outstanding lesions are in the kidneys. Tumors originating from embryonic cells from the kidneys (embryonal nephroma) are observed with some frequency in domestic rabbits.

Fur Eating and Hairballs

Several rabbits in a hutch may eat body fur, eyelashes, and whiskers. Single rabbits eat fur on their sides, back, and rump. The cause is generally a deficiency of fiber. Diets high in cereal grains and low in alfalfa often have a low fiber content. As the rabbit's digestive system is designed for handling large amounts of fiber, a deficiency in the diet causes the animal to seek another source of fiber, and hair chewing begins. Increasing the fiber in the diet will almost always eliminate the problem. Overcrowding in a cage can also cause hair loss, but it is mainly from fighting.

Rabbits also eat small amounts of hair by licking or grooming themselves. The hair may accumulate in the stomach and form hairballs. These usually cause no disease, but they may obstruct the stomach. When obstruction occurs, the rabbit quits eating, loses weight, and may die.

If a hairball is suspected, the administration of 10 ml of pineapple juice, by stomach tube or medicine dropper 3 days in a row, is helpful in causing a breakup of the hairball and passage through the digestive system.

The pineapple juice contains bromelain, an enzyme that causes partial digestion of the hair. Feeding hay or
straw during the pineapple juice treatment is also helpful.

**Coprophagy**

The process of taking soft fecal pellets from the vent and swallowing them intact is a natural physiological procedure for the rabbit that should not be misinterpreted as a nutritional condition or deprived appetite. Coprophagy is practiced at night by tame rabbits and during the day by wild rabbits in their burrows. Fermentation of the feces in the large intestine supplies an abundance of certain B vitamins to the fecal pellets, probably improves the quality of the protein in the soft pellets, and improves fiber breakdown by bacterial action. By permitting a second passage of food through the digestive tract, the rabbit gains additional nutritive value from the food.

**Yellow Fat**

Yellow fat is not an abnormal condition nor the result of an infectious process. It is included here only to prevent misunderstanding or association with a disease condition. Yellow fat is a genetic trait determined by a recessive gene. Alfalfa and other green feeds contain xanthophyll, a fat-soluble compound that is yellow in color. Animals with the yellow fat gene lack an enzyme that reduces (changes) the xanthophyll pigment to a colorless product. Therefore, the xanthophyll is deposited in the body fat, making it yellow. White fat in meat rabbits is preferred to yellow fat.

**Winter Breeding Depression**

Every common occurrence in rabbitries in cold climates is a decrease in productivity during the winter. The syndrome usually has as its common elements: small litters born, abortions, weak litters; that can’t nurse, does that don’t have enough milk, and does that will not breed. Any of these factors lead to a decreased number of fryers towards the end of the winter. Although many causes for this syndrome have been postulated, the basic problem is inadequate nutrition.

The breeding does (and sometimes bucks) require more energy in cold weather to keep warm. If one is using a restricted feeding program where rabbits are not fed all they want, the amount of feed should be increased in cold weather. If this doesn’t happen, the doe does not have enough energy to provide heat for warmth and energy for the reproduction process. Therefore, reproduction is suspended until adequate nutrition is once again available. This usually will happen as warmer weather arrives. Thus, we have a winter breeding depression that is really brought about by a deficiency of feed.

The treatment for this syndrome is either to increase the amount of feed (usually to about double) or to increase the amount of energy in the diet by increasing the amount of carbohydrate or fat.

**How to Pack and Ship Specimens for Laboratory Diagnosis**

The best way for rabbit ranchers to obtain an accurate diagnosis is to take the dead animals, or two or three sick animals showing typical signs, to the nearest animal diagnostic laboratory. The pathologist can supply any additional information the pathologist may need, and this is usually only convenience that dead animals may be shipped.

**Shipping Dead Animals**

If you don’t take your rabbits to a diagnostic laboratory because of distance, the next best thing is to send the dead rabbits to the laboratory.

As it is against postal regulations to send live rabbits, the carcasses must be made dead. If you can’t take your rabbits to a diagnostic laboratory because of distance, the next best thing is to send the dead rabbits to the laboratory.

The best way for rabbit ranchers to obtain an accurate diagnosis is to take the dead animals, or two or three sick animals showing typical signs, to the nearest animal diagnostic laboratory. Then they can supply any additional information that the pathologist may need, and this is usually only convenience that dead animals may be shipped.

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**Accompanying Information**

Letters that do not contain sufficient information are a problem to the pathologist. In some diseases, a complete history is more useful than the carcass. The accompanying letter should contain the following information:

1. Number of rabbits on the ranch.
2. Number of sick or dead animals.
3. Age and sex of affected animals.
4. Description of the disease as you observed it. For example, rabbits develop watery diarrhea, quit eating and drinking, and die in 1 or 2 days.
5. Dates of first losses and subsequent losses.
6. Incidence of infection (whether it is in just one house or pen, or scattered throughout the rabbitry).
7. What treatment, if any, has been given.
8. Type and brand of feed used for past 6 months.
9. Type of housing (whether the rabbits are kept on wire or solid floors).
10. Any other information that might help explain the outbreak.

It is best to telephone the laboratory so the staff can be alerted to the arrival of the specimen. Should further information be necessary, it can be obtained at that time.

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**Use pesticides safely!**

Pesticides are discussed in this publication (see malathion, page 15). When you use this or any pesticide, observe these rules:

- **Wear** protective clothing and safety devices as recommended on the label. Bathe or shower after each use.
- **Read** the pesticide label—even if you’ve used the pesticide before. Follow closely the instructions on the label (and any other directions you have).
- **Be cautious** when you apply pesticides. Know your legal responsibility as a pesticide applicator. You may be liable for injury or damage resulting from pesticide use.

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