CONSERVATIONISTS have discovered that wild animals are more subject to diseases and parasites than most people realize. Some of the problems raised by this situation are important to livestock producers and the general public as well as to those interested in our wildlife resources.

Most of the studies of diseases of wildlife have been carried on primarily in relation to human welfare and the transmissibility of these diseases to domestic livestock rather than for the benefit of wildlife itself. Today the emphasis is changing somewhat, and wildlife diseases are being studied as a necessary part of conservation.

Despite the views of many older writers, losses among wild species from disease are very considerable. The isolation of many wild animals in places remote from human habitations and their general tendency to scatter rather than to concentrate make it difficult to obtain information on the mortality from disease among them. It is also a characteristic of wild animals, when they are sick, to secrete themselves in dense cover or in burrows, thus making their discovery unlikely; and scavenger insects, birds, and animals rapidly dispose of carcasses in exposed places, so that shortly after their death little trace of them remains. Nevertheless, from time to time epizootics, or severe outbreaks of disease, of varying degrees of de-

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1 J. E. Shillinger is in Charge, Section of Disease Investigations, Division of Wildlife Research, Fish and Wildlife Service, Department of the Interior.
Structiveness have been found to occur in practically all species of wildlife thus far studied.

In this article, cross references will be made to other articles in the Yearbook in which specific diseases are discussed at greater length in relation to domestic animals.

**BACTERIAL DISEASES**

The disease in cattle known as brucellosis (p. 501), or Bang's disease, and also commonly referred to as contagious abortion, is a rather common infection among certain big-game ruminants. There has been little opportunity to examine many specimens from the wild, but studies made of those under semicontrolled conditions on large fenced ranges and in parks have revealed a fairly high degree of incidence. The course of the disease in buffaloes is similar to that in domestic cattle. After infection has been established in a herd for some time the rate of loss of calves is not high, but reactors can be detected by agglutinins in the blood serum.

Isolated infecting agents and the agglutinins found indicate that the organisms present in infected buffaloes and elk are identical with *Brucella abortus* of cattle, but because of the vicious nature of the wild animals and the danger to the attendants, as well as to the beasts themselves, occasioned by repeated handling, no organized effort has been made to eradicate brucellosis from these big-game groups by the removal of reactors. Immunization of herds by calf vaccination, however, is being put in practice where feasible. Thus it is planned eventually to be able to maintain herds of buffaloes and elk free of infection to be used for restocking.

On various occasions hemorrhagic septicemia (see p. 526) has been responsible for extensive losses among deer and buffaloes. Deer of the eastern white-tailed species, as well as the mule deer of the West, are not infrequently victims and large concentrated herds may suffer very great losses. The infection attacks adults as well as fawns. On autopsy the same pathological picture as that in domestic stock is evident. An especially effective protective bacterin has been produced from a highly virulent organism that has been isolated from buffaloes.

Tuberculosis (see p. 237) has been frequently diagnosed in deer, foxes, wild ducks, and wild pheasants, but it is not considered likely that it is spread extensively among wild species. There is ample opportunity, however, for such animals as deer and foxes to be infected by domestic cattle and for wild birds to acquire the disease from domestic poultry.

Where large wild ruminants are fed by attendants, as they have often been in Jackson Hole, Wyo., for example, losses are frequently caused by organisms associated with pollution of the soil. One of the most destructive of these is *Actinomyces necrophorus*, which infects through abrasions of the mucous lining of the mouth, causing necrobacillosis, or necrotic stomatitis. This organism is a common

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1 Italic numbers in parentheses refer to Literature Cited, p. 1225.
inhabitant of moist, loamy soils, especially where there are accumulations of animal droppings or decaying vegetation.

The growth of the organism in the wound produces a general swelling of the part affected, followed by a rather rapid degeneration and destruction of adjacent tissues. In young animals death usually takes place soon, but adults may survive a more chronic type of the disease for a considerable period. Fawns raised in enclosed pens have shown as high incidence of this disease as have domestic calves kept in an insanitary environment.

To control losses in elk it is recommended that the animals be discouraged from congregating in concentrated herds and that if it is necessary to feed them they be fed at new places each day. Hay containing sharp awns or bearded that may penetrate the animals' gums should not be given them. Small pens in which fawns are confined should be kept as sanitary as possible.

On several occasions malignant edema has been diagnosed in deer (8, 9). The outbreaks were limited to comparatively small areas and short periods of time, but during their progress losses were marked. The disease usually makes its appearance on ranges where animals have been abundant for some time.

The length of the incubation period is not known, but in severe cases infected animals survive only a few days after the first symptoms are recognized. The causative organism is *Clostridium septique*, and the symptoms produced are somewhat like those of blackleg (see p. 523). Swellings of the large muscles of the quarters occur, with gaseous cavities and a bloody exudate, or discharge, in the tissues just beneath the skin. The internal organs do not always show pronounced changes, though sometimes the lungs and spleen are grossly affected and there are bloody effusions into the abdominal cavity.

The organism is widely distributed in the soil, and pollution with animal wastes furnishes an ideal environment for its multiplication. Dispersal of concentrations of deer and removal of the animals, if possible, from the areas where losses are prevalent are therefore recommended.

Among the diseases of wildlife transmissible to man, tularemia, caused by the organism *Pasteurella tularense*, has attracted nationwide attention (fig. 1). Because the infection in a large proportion of the cases in human beings has been traced to wild rabbits, the disease is frequently called rabbit fever. Investigations have shown, however, that a great variety of animals, including some species of birds, are susceptible to the infection (see p. 295). Rodents and related groups of mammals are especially susceptible. The carnivorous mammals are somewhat less likely to become infected, but they do not entirely escape.

The causative organisms, which are transmitted from animal to animal and from animal to man either by direct contact or by the bites of insects and ticks, are widespread in nature. Severe epizootics of tularemia occur among cottontail rabbits and cause extensive losses over large areas; and although the disease may or may not be the

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cause of the periodic decline of certain game species, its ravages among dense populations of certain groups are marked. At present, control measures in the wild are not practicable.

![Liver and spleen of a rabbit affected with tularemia.](image)

**Figure 1.**—Characteristic appearance of the liver and spleen of a rabbit affected with tularemia. Multiple white spots on these organs are an indication of the disease.

Human beings may reduce the likelihood of contracting the disease by avoiding contact with sick rabbits or other animals and by protecting themselves against the bites of ticks and deer flies.
FILTRABLE VIRUS DISEASES

Foot-and-mouth disease, or aphthous fever (p. 263), is probably the most important of the diseases shared by domestic stock and wildlife. The great infectivity of the virus of this disease for wild cloven-footed animals has long been recognized in European countries, and extensive losses of deer (7) from foot-and-mouth disease occurred in this country several years ago.

Lameness and soreness, with the formation of small swellings filled with fluid above the hoof and between its halves, as well as around the muzzle and within the mouth, are the symptoms of foot-and-mouth disease in deer, as in cattle and swine. Since the disease is not now present in the United States, it is not an immediate menace to deer. The highly infectious nature of the virus, however, demands that special consideration be given to the big-game ruminants as well as to the domestic species in the event that it is again introduced into this country.

Experimentation thus far indicates that treatment is of little avail in stamping out an epizootic of this disease, and hence slaughter and deep burial are prescribed for its eradication. In the single known American outbreak affecting deer, this plan was used, and despite the wide ranging habits of the affected animals it was completely effective.

The devastating disease of horses known as encephalomyelitis (see p. 375) is caused by a filtrable virus that investigations have shown is sometimes present also in wild pheasants (12) and semiwild pigeons (4) as well as in various other wild birds and mammals. The occurrence of such a pathogenic, or disease-producing virus, in wild, free-flying species is a serious obstacle to adequate control or eradication of the disease, and the readiness with which the virus is carried from one animal to another by mosquitoes adds to the menace of infection from wild reservoirs of the disease.

In several sections of the United States cottontail rabbits with long, horny, tumorous growths have been observed. Most often seen about the head, these hard outgrowths are usually referred to by hunters as "horns." They are caused by a filtrable virus and can be produced on test animals with invariably fatal results.

A less dangerous fleshy type of tumor caused by a filtrable virus is found on the feet and legs of cottontails and is mildly infectious among domestic rabbits also. It is not fatal to either group and in domestic rabbits produces an immunity or protection against the fatal virus disease myxomatosis, which is very destructive to commercially raised rabbits.

PROTOZOAN DISEASES

In various parts of the country a protozoan, *Leucocytozoon anatis*, which lives in the blood, has been observed to cause extensive losses among young wild ducks. This organism appears to infest adult birds without causing serious injury, but when it is transferred to the young the mortality may be high. It is transmitted by bites of the blackfly (*Simulium venustrum*), an insect that has a wide distribution
and breeds in rippling streams. The mortality rate is said (10) to be 10 to 100 percent for young ducklings and less than 1 percent among adults.

According to investigations conducted at the University of Michigan leucocytozoa (p. 1018) are equally infectious for domestic and wild ducks, and numerous cases are recorded in which the infection was traced from penned birds of domestic as well as wild species to free-flying waterfowl.

Control measures consist in eliminating the habitats of the vector flies or, in the case of penned birds, the avoidance of hatching out ducklings during the period in midsummer when the flies are abundant. Screening the pens to prevent the flies from infecting the young ducklings is recommended for places where such a practice is feasible.

Examination of sharp-tailed grouse from the North Central States, where losses were occurring, showed a malarial organism (Plasmodium pedioecetae) in the red blood cells (13). Of 130 birds from one area in North Dakota, 53 showed the infection. Studies of this malaria are in progress to ascertain its importance and its relationship to losses in other wild and domestic birds. It is transmissible to the bobwhite quail but apparently not to chickens. While naturally affected grouse were observed to live for several weeks with chronic infections, artificially infected grouse developing acute cases died in a much shorter time.

It has been demonstrated (1) that the blood parasite Anaplasma marginale, recognized in recent years as the cause of a widespread disease in cattle (see p. 579), is infectious also for the Columbian black-tailed deer. It has not been shown that anaplasmosis is seriously pathogenic to the deer, and it may be that these animals serve as reservoirs from which the infection can be transmitted to livestock. The studies made have been too limited to demonstrate the distribution of the disease, but it appears possible that other kinds of big game also may carry the infection.

PARASITIC DISEASES

The possibility of the transmission of external parasites from domestic stock to wild animals and vice versa has aroused much conjecture. As to mange, no differences in the causative mites occurring on animals of the respective groups have been detected. Individual strains of these parasites appear to have a preference for certain species of animals, although under the microscope the strains show similar characters. It has not been determined whether host preference itself may be relied upon for differentiation or whether in suitable situations the mites may be cross-transmitted.

In the Southern States, where stockmen have been plagued by summer losses of farm animals due to screwworms, or larvae of the fly Cochliomyia americana (see p. 313), conservationists have also observed losses among deer and other wildlife. Infestation usually follows skin wounds, many of which are caused by ticks. The losses among deer are widely distributed throughout the South and in some localities are quite heavy. Where domestic and wild animals are
permitted to remain unattended, several broods of the flies may be produced each season, thus building up a very heavy degree of parasitism. Whenever these flesh fly larvae become numerous in a wound the damage is extensive, resulting in rapid destruction of the flesh and even of bone tissue (fig. 2). When vital parts are reached, death may follow within a few days.

Several kinds of roundworms of domestic stock are parasitic in important wildlife species, causing injury to organs and damage to health comparable to that seen in livestock (see p. 113).

The lungworm of domestic cattle (Dictyocaulus hadweni) is also common in wild ruminants (2), having been recorded in this country from the buffalo, moose, elk, reindeer, and three species of deer. Likewise the lungworm common to sheep (D. filaria) is parasitic in the eastern white-tailed deer and the western black-tailed deer.

The stomach worm of sheep and cattle (Haemonchus contortus) (3), which causes anemia and unthriftiness is a common parasite of deer, becoming very numerous under conditions of overpopulation and contributing to the heavy winter losses that occur when feed is scarce and living conditions difficult.

**POLLUTION**

Extensive waste of wildlife has been observed as a result of water pollution, which in many instances has rendered the aquatic environ-
ment uninhabitable. Much damage is done to fishes, although aquatic mammals and birds suffer also (fig. 3). Chief among the sources of pollution are city sewage; wastes from sawmills, paper mills, creameries, and canneries; seepage from abandoned mines and oil works; and chemical waste products from dye works and smelters.

Pollution by oil and certain toxic substances sometimes causes widespread destruction. Even a very thin film of oil on the water used by waterfowl will adhere to the plumage and mat the feathers, so that the birds are unable to fly or to protect themselves from cold. Poisonous chemicals may adhere to the aquatic vegetation on which waterfowl feed, causing death by direct action. In this manner lead deposits released from smelters have been known to result in considerable losses.

**BOTULISM, OR FOOD POISONING**

Waterfowl and shore birds, especially those in the western lake regions (6), are frequent victims of botulism. This disease is caused by the toxic substances produced by the bacterium *Clostridium botulinum*, type C, an organism that thrives best in an alkaline environment where there is an abundant supply of decaying organic matter and a reduced oxygen content. Subsidence of water, leaving pools little affected by flowage or wind action, is frequently followed by extensive outbreaks of this disease. Birds feeding in these pools ingest sufficient toxin with their food to cause progressive weakness, paralysis, and death. Losses have sometimes been enormous.

The best-known control measure is to manipulate the water level so as to prevent stagnation in shallow places. Areas in the danger regions where an ample supply of fresh water is not available during late summer and fall should be drained completely dry if possible.
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