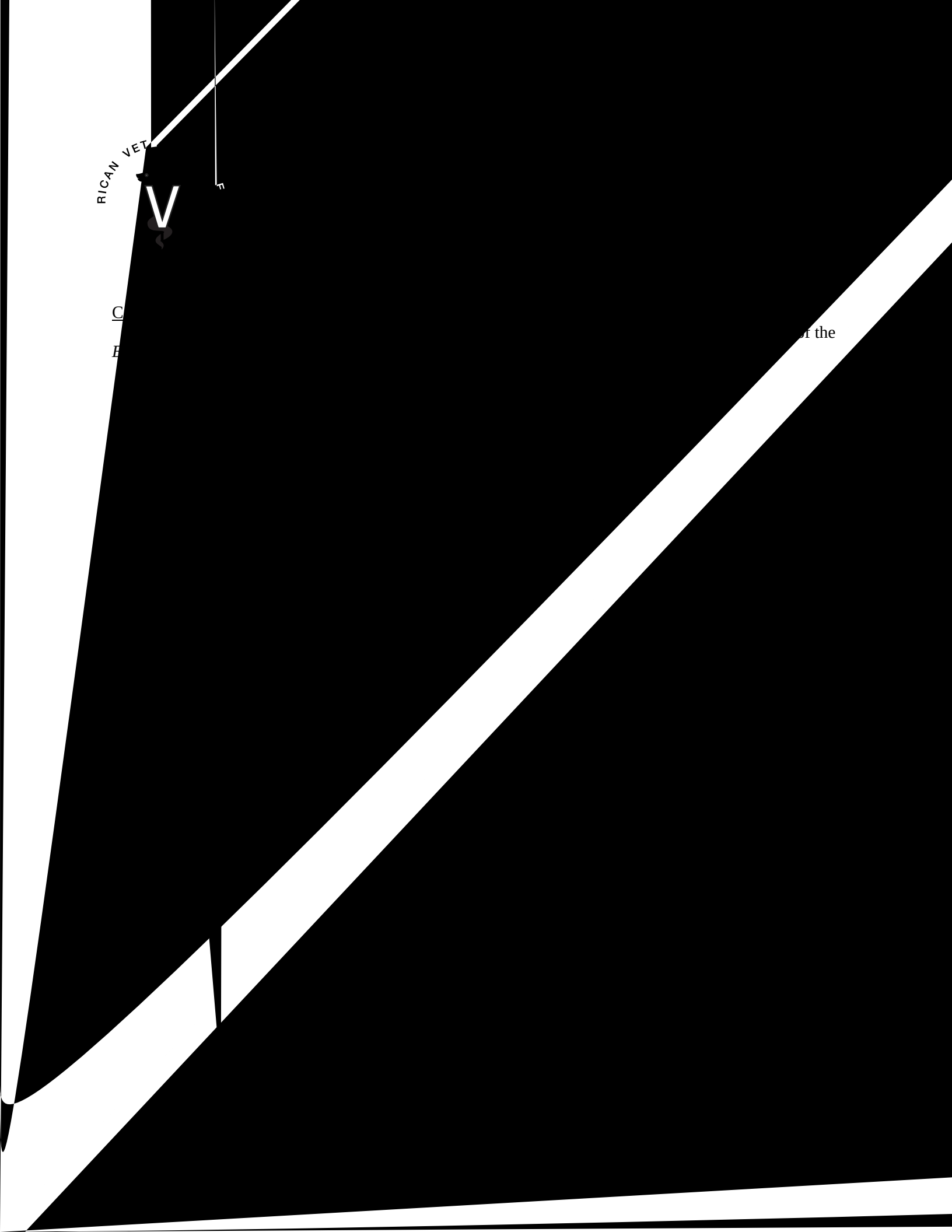
RICAN VET
V

exports from the country were denied. The losses associated with this incident have been estimated at 3-4 billion U.S. dollars. Not a single case of plague was confirmed by a laboratory during this incident, leading experts to question whether an outbreak really occurred.

The majority of cases of plague are bubonic plague. Buboes are acutely swollen, very painful lymph nodes, and are always present in this form of plague. Other forms of plague are septicemic plague (also called fulminant septicemic plague), primary pneumonic plague, and secondary pneumonic plague.

Transmission

Plague is transmitted primarily by fleas (primarily the rat flea) as part of a cycle involving maintenance and amplifying hosts. Enzootic (maintenance) rodent hosts (e.g., rats, ground squirrels, and other rodents) tend to be relatively resistant to the disease, and serve as reservoirs of the bacterium. Fleas that bite these animals become infected, and spread the disease to other, potentially more susceptible, animals. The organism can survive for up to 396 days in some fleas.

Epizootic (amplifying) hosts include those species with low to moderate resistance (e.g., rock squirrels, some mice species, voles, gerbils, marmots, and prairie dogs). When infected, the epizootic hosts have high numbers of plague bacteria circulating in the bloodstream, and fleas that bite these animals are more likely to become infected with the plague. Prior to human epidemics of naturally occurring plague, rats are usually observed dying in large numbers; the death of the rats, and the subsequent loss of the flea's host, results in increased human flea bites. Prairie dogs are very susceptible to infection, but are not common sources of human infection because their fleas are not likely to feed on humans even in the absence of prairie dogs.

After a blood meal from an infected host, the bacteria multiply in the flea's stomach. The flea's stomach and esophagus become blocked by clumps of bacteria and protein; as a result, the blood from subsequent host feedings cannot get into the stomach and digestive tract. The flea remains hungry, but the blood that is sucked from the new host cannot pass; the new blood becomes mixed with the infected clumps in the digestive tract, and is regurgitated back into the host. This infects the new host with the *Y. pestis* bacteria.

Birds of prey (raptors) may assist in the spread of plague through transport of infected fleas or prey. Infection of carnivores (such as dogs and cats) is most likely due to ingestion of plague-infected animals rather than fleabites. Similarly, ingestion appears to be the source of the disease in goats, sheep, and camels. Carnivores are effective transporters of infective fleas to other rodent populations and to humans. Most human plague cases result from the bites of infected rodent fleas that are brought home by free-roaming pets. Although dog and cat fleas bite humans, they do not significantly contribute to the spread of the disease to humans.

The bubonic and septicemic forms of plague are not transmitted directly among humans. Bubonic plague has been transmitted to humans by domestic cats. Cats become infected with the plague bacteria by eating the infected rodent, then transfer the infection to humans by bite or scratch wounds.

Pneumonic plague is spread by inhalation of or direct contact with infected respiratory droplets. Human-to-human spread from individuals with plague pneumonia has not occurred in the United States since 1925; however, respiratory tract infection has resulted in a small number of cases from exposure to domestic pets (primarily cats) with plague pneumonia and/or plague pharyngitis. Direct contact with infected human or animal blood and tissues is another route of transmission. Human-to-human transmission via fleas is rare and has been observed only in heavily infested environments. Use of *Y. pestis* as a biological weapon would most likely involve aerosolization of the bacterial agent.

Types and clinical signs of plague in animals and humans

Plague primarily affects wild and domestic rodents. Rabbits and hares are sometimes affected. Cats are also very susceptible. Domestic dogs, coyotes, raccoons, badgers, skunks, and black bears are considered highly resistant to the plague. Rare cases have developed in goats, sheep, and camels.

Rodents In rodents, the disease may take acute, subacute, or resolving forms. In the acute form, rodents develop hemorrhagic buboes and splenic enlargement, and succumb within 3 to 5 days of infection. Rodents affected by subacute plague develop necrotic buboes (buboes containing dead tissue) and

necrotic nodules in the liver, spleen, and lungs, with death 6 or more days after infection. Clinical signs in the acute and subacute forms include nasal bleeding, petechiae (pinpoint hemorrhages), abscess formation, and inflammation of the lungs. The resolving form of plague is characterized by lymph node enlargement with formation of areas of pus and dead tissue.

Cats Abscesses, buboes (especially underneath the jaw and in the throat/neck region), lethargy, and fever are typical signs in cats infected with *Y. pestis*. Secondary pneumonia may also be present. Postmortem lesions include nodules of dead or dying tissue in the spleen and liver and pneumonia with pus formation. Mortality is approximately 50% among experimentally infected cats.

Dogs Dogs inoculated orally with *Y. pestis* react only with fever. All orally infected dogs have developed antibodies and recovered.

Humans Symptoms of the bubonic form of plague usually develop within 2 to 8 days of the insect bite and include sudden onset of headache, fever, chills, and weakness. A bubo may develop in any regional lymph node site, but most often appears in the axillary (underarm), cervical (neck), or inguinal (groin) regions, approximately 24 hours after the symptoms are first observed. The skin overlying the bubo is frequently reddened, warm, and edematous.

Some individuals may develop septicemia without a bubo (primary septicemic plague), or septicemia may occur secondary to bubonic plague. Gangrene (hence the name "black death"), coagulopathies (blood clotting disorders), and multiple organ failure may result from advanced plague septicemia.

Secondary pneumonic plague develops in less than 5% of patients with bubonic or primary septicemic plague. This occurs when bacteria spread to the lungs via the blood (hematogenous spread). Symptoms in patients with pneumonic plague include cough, chest pain, bronchopneumonia, labored breathing, and hemoptysis (blood in the fluid produced by coughing).

Primary pneumonic plague caused by inhalation of *Y. pestis* is rare, but has been reported after handling cats with pneumonic plague. In addition to respiratory disease, patients with pneumonic plague often show gastrointestinal signs such as nausea, abdominal pain, vomiting, and diarrhea. Patients with primary pneumonic plague rarely develop buboes.

Other types of plague in humans include plague meningitis and plague pharyngitis. Plague meningitis results from blood-borne spread of the bacteria into the membranes that cover the brain and spinal cord. Plague pharyngitis results from inhalation or ingestion of the bacteria, and is usually seen with swelling of the local lymph nodes.

The case fatality rate (the number of symptomatic patients that die from the disease) for untreated bubonic plague in humans is about 50-60%. Untreated primary septicemic plague and pneumonic plague are almost always fatal. Modern therapy has markedly reduced fatalities from bubonic plague. Pneumonic and septicemic plague cases also tend to recover if recognized ao i reduced fplagues

rodents to prevent the fleas from abandoning the dead rodents in search of new hosts for feeding). Preventing contact between domestic hosts and wild rodent sources of infection is also important. Cats and dogs should be kept indoors to minimize their risk of exposure to potentially infected rodents and their fleas. Year-round rodent control should include rodent-proofing all structures and eliminating potential sources of food and shelter for rodents. Pets should be treated regularly with products that kill fleas.

Infection precautions for humans include the use of insect repellents and protective clothing. Proper precautions (e.g., gloves and good hygiene practices) should be followed when handling sick or dead animals. In areas where plague has previously been confirmed, owners should seek immediate veterinary attention if their pets exhibit signs consistent with plague. Direct contact with sick pets (especially face-to-face contact) should be avoided.

A US-licensed vaccine was discontinued in 1999 and is no longer available. In other parts of the world killed vaccines and live, attenuated plague vaccines are available. Seven days of postexposure antibiotic therapy (doxycycline, ciprofloxacin, or chloramphenicol) is recommended for asymptomatic individuals (those not showing signs of disease) that have or have had close (less than 2 meters) contact with pneumonic plague victims.

Treatment

Historically, the treatment of choice for bubonic, septicemic, and pneumonic plague has been streptomycin; however, this drug is no longer readily available. FDA-approved alternatives include tetracycline and doxycycline. Gentamicin, ciprofloxacin, sulfonamides, and chloramphenicol have also been successful in animal studies or clinical cases, but are not FDA-approved for this use. Antibiotic resistance (primarily to the tetracycline drugs) is rare, but has been reported. Nearly all fatal cases have been associated with delays in diagnosis and/or treatment.

Infection control

For animals and humans, plague is a reportable disease in the United States. Local and state health departments, federal animal health officials, and the CDC's National Center for Infectious Diseases, Meningitis and Special Pathogens Branch should immediately be notified of any suspected cases. In addition, diagnostic laboratories should be in
b in

Europe and by Japan during World War II. The first indication of an attack would most likely be a sudden outbreak of severe pneumonia and sepsis. The presence of blood in the coughed secretions of previously healthy patients with fever, cough, shortness of breath, chest pain, and rapid death would suggest the possibility of plague.