A HANDBOOK ON DISEASES TRANSMISABLE BETWEEN MAN AND ANIMALS

(ZOONOSES)

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FORWARD

1. Dr. Kozo Tsukada is one of the Ten Volunteer Veterinary Officers from the Japan Overseas Co-operation Volunteers to be sent to Zambia till 1980. He arrived in Zambia in February 1978 and was posted to Mbala, Northern Province where he worked as Veterinary Officer till January 1980.

2. He whilst in Mbala, developed special interest in Zoonosis and felt that he would make useful contribution to the Veterinary Profession in Zambia in form of a Report on this subject. He thus took most of his spare time in compiling material for this Report.

3. I have no doubt that this Report will be very useful to the Veterinary Staff of Zambia and all staff in allied professions.

Dr. M.N. Shandomo
Acting Director of Veterinary and Tsetse Control Services, Lusaka, February, 1980.

The diseases collectively called zoonoses, are very important to humans especially to those who handle animals, their carcases or specimens as they have a high chance of being exposed to them. I, as a Veterinarian, have had a special interest in zoonoses since I came to Zambia from Japan in early 1978. While I was studying zoonoses I noticed that my colleagues in the Veterinary office also had limited knowledge of them. This finding motivated me to prepare this report on zoonoses which may concern people in Zambia. I hope this report will be useful, to some extent, not only to Veterinary staff but also to other persons such as housewives, farmers, slaughtermen, medical staff and teachers, and be an incentive to competent students to further the study of zoonoses.

I owe a great debt to many people who helped me to prepare this report. I can mention here but some of their names: Dr. B.S. Seghal and Mr. C.B. Hall of the office of WHO Representative for Zambia; Dr. R.N. Mahesh, Dr. G. Siegismund and Mr. B.Y.C. Mutambo of Mbala General Hospital; Mr. Michael Garvey; Mr. R. Chishya and other staff of the Veterinary and Tsetse Control Services, Mbala.

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INTRODUCTION

1.1. Definition of zoonoses

Zoonoses have been defined as "Those diseases and infections which are naturally transmitted between vertebrate animals and man". It is also recognised that there are additional diseases common to animals and man caused by organisms able to live saprophtically or in certain environments. They are mainly fungal diseases, but also include bacterial diseases such as tetanus and listeriosis, and a few helminthic infections such as strongyloidiasis.

1.2 Classification of zoonoses

A classification that is based upon the type of life cycle of the infecting organism and that divides the zoonoses into four categories, has been proposed.**

(a) **Direct zoonoses** are transmitted from an infected vertebrate host to a susceptible vertebrate host by direct contact, by contact with a formite or by a mechanical vector. The agent itself undergoes little or no propagative changes and no essential development change during transmission (e.g. rabies, trichinosis and brucellosis).

(b) **Cyclo-zoonoses** require more than one vertebrate host species but no invertebrate host, in order to complete the developmental cycle of the agent (e.g. the human taeniases, echinococcosis, and pentastomid infections).

(c) **Meta-zoonoses** are transmitted biologically by invertebrate vectors. In the invertebrate, the agent multiplies or develops, or both, and there is always an extrinsic incubation (pregnant) period before transmission to another vertebrate host is possible (e.g. arbovirus infections, plague and schistosomiasis).

(d) **Sapro-zoonoses** have both a vertebrate host and a non-animal developmental site or reservoir. Organic matter (including food), soil and plants are considered to be non-animal (e.g. the various forms of larva migrans and some of the mycosis).

1.3. Socioeconomic importance and control of zoonoses.

About 200 zoonoses are now recognized. Among these of particular importance are rabies, bovine tuberculosis, brucellosis, anthrax, leptospirosis, salmonellosis, several of the more common arthropodborne viral infections, and certain parasitic diseases such as cysticercosis, hydatid disease, and the trypanosomiasis. The number of zoonoses has been increasing as relevant studies have progressed. In fact, most of the infections of man that have been discovered in the last twenty years are shared with lower animals, and a number of other diseases previously thought to be limited to man have been found recently to be zoonoses. Examples of these latter are malaria in some parts of the world and infectious hepatitis. It is probable that most human infections are zoonoses in the requisite ecological conditions.

The economic impact of zoonoses is extremely difficult to determine accurately, but it is known to be considerable. It includes mortality, acute and chronic debilitating illness of humans, loss of life and impairment of productivity of livestock, and consequent effects on the social fabric and economic development. Economic losses caused by brucellosis, bovine tuberculosis, rabies, cysticercosis and hydatidosis are estimated to be hundreds of millions of dollars annually in Latin American countries alone, quite apart from the human suffering and death caused by these diseases.

The cost factor is often paramount in controlling zoonoses, but many other factors must be weighed such as epidemiological, environmental and social. In this connection, it is proposed that the

*WHO Technical Report series No. 169, 1959 (Second report of a Joint FAO/WHO Expert Committee on Zoonoses).

**WHO Technical Report Series, No. 378, 1967 (Third report of a Joint FAO/WHO Expert Committee on Zoonoses).

control of zoonoses should be considered in three main contexts*:

(1) Zoonoses that have serious effects on animal production (e.g. bovine tuberculosis).

(2) Zoonoses that have serious consequences both for man and for economically important animals (e.g. brucellosis, salmonellosis and bat-transmitted rabies).

(3) Zoonoses that have serious consequences in man, but which are much less serious in economically important animals (e.g. leishmaniasis and trichinosis).

In accordance with this classification, the control of the individual zoonoses will be mainly of agricultural interest (group 1) or jointly of public health and agricultural interest (group 2) or only of public health interest (group 3). In any case adequate financial support and close collaboration among different government agencies, particularly the medical and veterinary services, are essential to control zoonoses. All levels of government must be made aware of the importance of zoonoses, and international level collaboration is also important.

The mathematical techniques of operation research to find the most economic manner to use limited resources of manpower and money can be helpful in deciding the kind of campaign that should be undertaken.

1.4 Zoonoses as occupational hazards

The Zoonoses have become over the years, increasingly identified as occupational hazards. Some diseases have significantly higher attack rates on workers in the course of their occupations than on the rest of the population.

Some well known examples that have been long recognized are the occurence of anthrax in carpet weavers, livestock raisers and workers with animal hair in the textile industry. Leptospirosis in ricefield workers, listeriosis in agricultural workers, erysipeloid in animal handlers and fish merchants, tularaemia and trypanosomiasis in hunters and larval migrans in plumbers, trench diggers and others.

The newly added list includes Q fever in the abattoir and rendering plant workers, jungle yellow fever and tick-borne diseases in woodcutters, salmonellosis in food processors, bovine tuberculosis in farmers, Newcastle disease in poultry raisers and processors, and rabies in veterinarians, field naturalist and dog-control employees. An important recent addition to the recognized occupational zoonoses is infectious hepatitis transmitted to man from chimpazees and other subhuman primates in animal handlers and research biologist working with primate colonies.

2. VIRAL ZOONOSES

Table 1.

Viral Zoonoses

Disease	Causative organism	Animals principally involved	Prevalence
Lymphocytic choriomeningitis	Lymphocytic choriomeningitis virus	Mice, dogs, monkeys	World-wide
Herpes B virus disease	Herpes B virus	Monkeys	World-wide

*FAO Agricultural Studies No. 96, 1975, P15 (the veterinary contribution to public health practice).

Herpes T(=M)virus infection	Herpes T(=M) virus	Monkeys	South America
Influenza	Influenza virus Type A	Swine	U.S.A., Europe, Asia, Kenya, Zambia
Newcastle disease	Newcastle disease virus	Chickens	World-wide
Encephalomyocarditis	Encephalomyocarditis virus	Sub-human primates, swine, rodents	World-wide
Foot and Mouth disease	Foot and Mouth disease virus	Clovenfooted animals	World-wide
Cowpox	Cowpox virus	Cattle	World-wide
Pseudocowpox	Pseudocowpox or paravaccinia virus	Cattle	World-wide
Contagious ovine ecthyma	Contagious ovine virus	Sheep, goats	U.S.A., Europe, Australia
Yaba virus infection	Yaba virus	Monkeys	Africa
Rabies	Rabies virus	Vertebrates	World-wide
Vesicular stomatitis	Vesicular stomatitis virus	Cattle, swine, horses	North and South America
Infectious hepatitis	Infectious hepatitis A virus	Monkeys	World-wide
Marburge virus disease	Marburg virus	Blue monkeys	Africa
Eastern equine encephalomyelitis		Horses, birds	North and South America, Philippines
Western equine encephalomyelitis		Horses, birds	North and South America
Japanese B. encephalitis		Mammals, birds	Asia, Australia, New Guinea
St. Louis encephalitis		Birds	North and South America
Venezuela equine encephalomyelitis	Various arboviruses	Horses, rodents	South America
Louping ill		Sheep, goats	England
Yellow fever		Monkeys	Africa, Central and South America
Rift Valley fever		Sheep, goats, cattle	Africa

Kyasanur forest disease	Monkeys	India
Central European tick-born fever (Russian spring, summer encephalitis)	Sheep, goats, birds wild mammals	Russia
Murray Valley encephalitis	Birds	Australia, New Guinea

Lymphocytic choriomeningitis

Lymphocytic choriomeningitis is a viral disease to which mice, many other animals are susceptible. This disease has great historical importance, as it was the first virus disease in which immunological tolerance was observed. In such a condition circulating antibody does not develop when the infection occurs in utero or in the neonatal period.

Disease in animals

Intrauterine transmission is the principal means of spread in a colony mice, although virus is also shed in urine and faeces. Most mice are, therefore, either infected at birth or early in the neonatal period, to become immunological tolerant, and they carry the virus throughout their lives. However only about 20 percent of these mice show signs of infection and less than 2 percent die of the disease. Symptoms of the spontaneous infection in mice include drowsiness, emaciation and roughed fur.

Gross lesions in mice and in other species are rather meager and not especially characteristic, including serious pleural exudation, fatty changes in the liver and enlargement of the spleen. Microscopically, lymphocytic infiltration of the meninges is characteristic. Lymphocytic lungs, usually concentrated around small blood vessels. An immuno-complex glomerulonephritis may develop.

Disease in man

This disease is a hazard to laboratory workers. Man may become infected through the intact skin and conjunctiva or by inhalation or ingestion of the virus. Blood sucking insects may also transmit the disease.

The course of the disease in man is usually two or three weeks and fortunately is rarely fatal.

Swine Influenza

Swine influenza is an acute, highly contageous respiratory disease of swine caused primarily by a virus. Although the swine influenza virus is closely related to the virus of human influenza and it is believed that the first outbreak swine influenza recorded in 1918 in the U.S.A. may have been transmitted from human influenza which was pandemic at that time, the relation between human and swine infections is still unclear. At least there is no evidence in recent years that a strain of swine influenza virus has infected man. In Zambia swine infections were recorded in 1974.

Cause

Although the virus is the primary cause, outbreaks are frequently complicated by haemophilus influenzasuis and sometimes by othe bacteria. Stress, such as cold and inclement weather is an important predisposing factor.

Disease in animals

Transmission: Once outbreaks occur, the disease spreads rapidly within a herd by direct contact. Between epidemics, the swine lungworm, Metastronglus spp., can act as intermediate host and reservoir for the virus. Lungworm eggs containing the virus are passed in the faeces of infected pigs and ingested by earthworms, and the infected earthworms are eaten by pigs. The lungworm larvae then migrate to the lungs. The pigs remain clinically normal and non-infective until the disease is precipitated by stress and the presence of H. influenza suis or others. The virus may also survive between outbreaks in subclinical forms in non-infective carrier pigs.

Clinical findings: The disease usually appears suddenly and whole groups of herd commonly develop signs of illness almost simultaneously. Symptoms include fever, anorexia, muscular weakness, prostration, and respiratory symptoms. The course of the disease varies from 2 to 7 days, recovery occurring almost as suddenly as the disease begins. As a rule the mortality rate does not exceed 4 percent.

Lesions: The specific lesions are restricted to the chest cavity. The lung lesions are characteristic; the atelectatic areas are clearly demarcated, collapsed, and purplish red in colour. Non-atelectatic areas are pale and emphysematous. The respiratory airways contain a copious mucopurulent exudate and bronchial and mediastinal lymph nodes are oedematous, but rarely congested. Pneumonia may also occur.

Diagnosis: The symptoms and lesions provide a basis for the presumptive diagnosis. Definitive diagnosis depends on laboratory tests such as demonstration of significant elevation of antibodies in the sera of swine during the course of an infection, isolation and identification of the virus.

Treatment and control: There is no specific therapy for the disease nor are there immunizing agents. Good nursing and antibiotics and sulfonamides can be effective to control secondary infections.

Human Influenza

There is three strains in the human influenza virus; A, B and C. A is closely similar to the swine influenza virus.

After an incubation period of 1 to 2 days there is sudden onset with fever, shivering, headache, profound malaise and severe aching in the back and limbs. Coughing, sneezing and upper respiratory catarrh are usually relatively slight. Remittent fever and general prostration continue for up to a week and the temperature settles by lysis.

Influenza pneumonia has been comparatively rare in the recent years. This condition is due to secondary bacterial infection with Haemophilus influenza, staphylococci, streptococci, etc.

There is no specific treatment. The appropriate chemotherapy is given for bacterial infections. Vaccines are used.

Newcastle disease

Newcastle disease is an acute, rapidly spreading virus disease of domestic poultry and other birds. The disease is widespread in almost every country of the world and one of the most important disease in the poultry industry. Zambia is not an exception, its poultry industry has suffered a lot from this disease.

Cause:

Newcastle disease virus is haemagglutinative paramyxovirus, with strains varying from non-

pathogenic to extremely pathogenic.

Disease in birds:

Transmission: Respiratory exudates and the dejecta of infected birds are the chief means of transmission. The virus can be carried by contaminated food or offal from chickens and on the clothing of farm workers. Recovered birds rarely are carriers. Egg transmission to chicks is uncommon.

Clinical findings: All ages of birds are affected, but chicks are more susceptible. Signs are respiratory or nervous or both, and appear almost simultaneously throughout the flock. Respiratory signs are gasping and coughing. Nervous signs, which may accompany but usually follow the respiratory signs are: drooping wings, dragging legs, twisting of head and neck, circling, walking backward, complete paralysis and clonic spasms in moribund birds. Laying flocks may have complete cessation of production which may be permanent. Eggs abnormal in colour, shape, or surface and watery albumen, are produced. Diarrhea may be seen.

Lesions: Lesions vary considerably, including petechial haemorrhages on the serous membranes, dark red or purplish red haemorrhagic lesions on the intestinal mucosa, diphtheroid necrotic inflammation of the intestinal mucosa, haemorrhages on glandular mucosa of the proventriculus, haemorrhages and inflammation of the respiratory system with opacity and thickening of the air sacs.

Diagnosis: This may be based on the clinical and post-mortem appearance. However the clinical manifestation of the disease can be confused with many other infections and certain cases on poisoning, and no gross or histologic changes can be considered Pathognomonic. Diagnosis requires laboratory tests such as neutralisation, haemagglutination and haemaggluti-tion-inhibition tests.

Treatment and control: No specific treatment has been established. The best control is a combination of sanitation and production of immunity by vaccination.

Disease in man

Human beings exposed to Newcastle disease virus occasionally develop usually a mild influenza-like disease with conjunctivitis persisting 1 - 2 days. Most infections have occured among laboratory workers who handle the virus. Vaccinators and individuals who eviscerate and prepare poultry for market may become infected.

Foot and Mouth Disease

Foot and Mouth Disease is a highly contagious and widespread virus disease affecting principally clovenfooted animals, especially cattle, sheep, goats and swine. The disease is not highly fatal, but the lack of production resulting from the disease and the prohibition on the free movement of livestock and livestock products make it one of the most serious animal diseases in the world. The disease has occured from time to time in Zambia.

Man is only slightly susceptible to the virus of this disease.

Cowpox

Cowpox is a mild eruptive disease of milk cows usually restricted to the skin of the udder and teats. This disease has great historical importance. Jenner, who demonstrated that dairymen who had contracted a pox-like disease on their hands from contact with the teats and udders of cows affected with cowpox were immune to human smallpox, applied the dried contents of cowpox lesions to scarified human skin to produce small innocuous lesions. This was the first successful method of artificial immunization (vaccination).

Disease in cattle

Transmission: The disease spreads through milking.

Clinical findings: The lesions are found only on the teats and udder. The papules develop into vesicles, followed by crusting which may persist for weeks. Microscopically the lesions resemble smallpox with vesiculation and cytoplasmic inclusions.

Cattle are susceptible to vaccinia. Occasional outbreaks, clinically undistinguishable from natural cowpox, have been caused by vaccinia virus introduced by persons recently vaccinated against smallpox.

Diagnosis: Cowpox may be difficult to distinguish from other infections of the teats and udder.Diagnosis can be established by isolation of the virus from the lesions and by serologic tests for its identifications.

Treatment and control: There is no specific treatment. Apart from standard disinfection procedures no drastic control measures are recommended. The disease usually clears up without serious impairment to the health of animals, and therefore, attempts at vaccination may be unnecessary.

Disease in man

Lesions similar to those in cattle are seen on the hand, arm or face of milkers. The disease may be more severe and attended by lymphadenitis and fever, in those who have not previously been vaccinated against smallpox. The transmission occurs during hand milking.

Pseudocowpox (Paravaccinia, milker's nodules)

Pseudocowpox occurs in dairy cows. The disease itself has slight effect upon cattle. The lesions resemble those of cowpox, and are limited to the teats and udders, appearing as red papules and vesicles. The soreness of the lesions makes the animal difficult to milk. The disease spreads to most of the cows that are milked, by milker's hands or through contamination of the milking machines. Healing occurs after several weeks and the disease disappears.

Disease in man

The milker's nodule lesion takes the form of hemispherical cherry-red papules which appear on the hands and sometimes on other parts of the body. The course of the disease may be 4 to 6 weeks. There is usually no generalization of the disease.

Yaba virus infection

Yaba virus infection was first reported in Yaba, Nigeria. The virus, one of poxviruses, produces self-limiting cutaneous "histocytomas" composed of solid sheet of large foamy mononuclear cells which may contain eosinophilic cytoplasmic inclusion bodies. Various species of Old-World monkeys and man are susceptible to the virus.

Rabies

Rabies is highly fatal virus disease of very great importance as a zoonosis. All warm-blooded animals are susceptible, but it is predominantly a disease affecting carnivores and its danger to man is mainly through the bite of the rabid dog.

Cause: The rabies virus has affinity to nervous system and salivary glands. In most cases the virus appears in the saliva of rabid animals, and this fact is very essential for the transmission of the disease through the bite. In addition the virus sometimes appears in the saliva before recognizable signs of the disease have appeared. The virus is destroyed by acids, alkalies, formalin, chloroform

and many other disinfectants and also by sublight (ultraviolet light) and pasteurization. The virus in dried saliva loses virulence within a few hours at ordinary temperatures. Pieces of nerve tissue preserved in 50 per cent glycerol solution will retain virulence for months at refrigerator temperatures.

Transmission: The usual method of transmission is by bites. Airborne infections have also been suggested. The transmission by the ingestion has not yet been demonstrated. Prenatal infection is not clear. The transmission by insect vectors has not yet been demonstrated.

Clinical findings: The incubation period in rabies varies widely in all species. It is believed that the dosage factor is important in respect of the period of incubation and development of the disease. It is also stated that the period of incubation is roughly but not invariably related to the distance from the central nervous system of the location. In dogs the incubation period may be from a few days to 4 months. In man it may vary from 10 days to 6 months or more.

The signs of illness of rabies are similar in all animals, but those in individuals vary widely. Two forms are generally recognized, the furious form and the paralytic form. However, most cases exhibit some manifestation of both forms. In the furious stage, the animal becomes irrational and viciously aggressive. Especially carnivores may attack any other animals and man. In this way the infection can spread. In the stage of paralysis, profuse salivation is characteristic with the throat and masseter muscles paralized. The animal is not vicious and rarely attacks other animals. In both forms, death comes quickly, usually within a few a days. In man and pet animals, the prodromal stages, in which vague changes in temperament occur preceeds other signs. In man, both furious and paralytic forms also occur, the latter being the most common. The course of the disease is short, ony a few days and the mortality is practically 100 percent. Although there are no records of rabies being transmitted by human case, saliva is often infective. Attendants should remember this.

There is no pathognomic gross lesions in rabies.

Diagnosis: Positive diagnosis is established by laboratory examinations including mouse innoculation, the demonstration of Negri bodies (which occur in the cytoplasma of nerve cells in all parts of the brain and spinal cord, but are usually numerous in the hippocampal convolution or Ammon's horn of the cerebrum in carnivores, and Purkinje's cells in cerebellum in herbivores), and by the fluorescent antibody technique.

Differential diagnosis is required against diseases which may develop nervous symptoms such as listeriosis, cryptococcosis, toxoplasmosis, distemper and certain intoxications.

Treatment and Control: No treatment has any effect on the course of rabies. Rabies antiserum and antirabic vaccines are used for prophylaxis in people only when they have been exposed. If rabies is suspected in a dog for instance, the animal should be kept under restraint in a safe place for at least two weeks, during which period if rabies is present the animal would die with characteristic symptoms. Control measures theoretically consists of mass vaccination of dogs, elimination of stray dogs and reduction of excess numbers of wildlife vectors. Mass vaccination of people is not done partly because of the post-vaccinal accidents. It is, in fact, stated that increasing number of stray or uncared for dogs especially in the periurban townships and lack of co-operation from the dog owners as well as a shortage of the vaccine have made rabies control difficult in Zambia.

In this respect proper education of the people may play an important role in controlling the disease. Main wildlife vectors in Zambia are revealed to be jackals which account for 69 percent of all positive cases in wildlife species which, in turn, account for 2 percent of over-all positive cases by the survey held by the Veterinary Wildlife Research section in 1977 which analyzed rabies cases for the past 50 years from 1922 to 1977.

Rift Valley Fever

This viral disease occurs primarily in sheep and cattle, and occasionaly in goats. Man is also highly susceptible. It has been recorded in East and South Africa, Cameroon and Chad. An outbreak was recently recorded in Zambia in 1974 and suspected in 1975 and 1977.

Transmission:

Transmission from animal to animal is generally by mosquitoes including eretmopodites. Transmission from animal to man is by direct contact and transmission from man to man has not been recorded.

Disease in animals:

Clinical findings: The incubation period is 12 hours to 3-days. In lambs, the disease is very acute and highly fatal. They may die within 24 hours after the onset of symptoms which may include high fever and prostration. In adult sheep, abortion is characteristic, but high fever and death may follow. Other symptoms may be vomiting, thick purulent nasal discharge, bloody diarrhea. There may be no signs of illness. In cattle, the disease resembles that in sheep in every way, but the losses are not so high.

Lesions: The most characteristic lesion in animals is focal necrosis of the liver. Other lesions include oedema and subserosal haemorrhages in the gall bladder wall and also haemorrhages in the lymph nodes, subendocardial, subepicardial, and in the gastric and intenstinal mucosa.

Diagnosis: An abortion storm in cattle and sheep together with the high mortality in calves and lambs is suggestive. The present extensive liver necrosis and human infection with characteristic symptoms would support the suspicion. Final confirmation is established by serological test.

Treatment and control: There is no treatment for the infection. Control measures include removal of animals to higher altitudes above the mosquito ranges and vaccination. Control of insect-vector is said to be impractical in an area where the disease is at present enzootic.

Disease in man:

A man who contacts the diseased animals almost invariably becomes infected. Butchers and housewives have also contracted the disease from handling infected meat. In these cases transmission is by direct contact.

The incubation period is a few days and the disease is rarely fatal. Symptoms are expressed as influenza-like including malaise, headache, fever, joint pains, nausea and vomiting and abdominal-distress. A formalin inactivated virus vaccine is available.

3. RICKETTSIAL ZOONOSES

Table 2.

Rickettsial zoonoses

Disease	Causative organism	Major vectors	Animals principally involved	Prevalence
Endemic typhus	R. prowazekii	Lice	Man	World-wide
Trench fever	R. quintana	Lice	Man	Europe, North Africa, Mexico

Murice typhus	R. mooseri	Fleas	Rodents	World-wide
Rocky Mountain spotted fever	R. rickettsiae	Ticks	Dogs, rodents other animals	North and South America
Rickettsial pox	R. akari	Mites	Mice	North America, Russia
Boutonneuse	R. conorii	Ticks	Dogs, rodents	Europe, Mediterranean area of Africa
Queensland tick typhus	R. australis	Ticks	Bandicoots, rodents	Queensland
Siberian tick typhus	R. sibiricus	Ticks	Rodents	Siberia
Scrub typhus (Tsetusgamuchi) fever	R. orientalis	Mites	Rodents	Eastern and southern Asia South West Pacific Island
Q fever	Coxiella burnetti	Ticks	Cattle, sheep goats	World-wide

Q. fever

Q. fever, a rickettsial infection, is important as a human disease producing influenza-like symptoms and rarely endocarditis. The main role played by animals is that of reservoir-hosts.

Cause and transmission:

The etiological agent,. Coxiella burnetii, is resistant to many disinfectants and desiccation. A temperature of 145°F for 30 minutes may kill the agent. The reservoir-hosts are cattle, sheep, goats, dogs, cats and donkeys as well as domestic fowls and pigeons from which the agent escapes in milk, placental materials and during meat processing or necropsy.

Transmission to man may be by ingestion or inhalation. The infection from tick to man or man to man may be possible. In animals the transmission is by tick biting, inhalation or ingestion of the agent.

Disease in animals:

C. burnetii produces only mild or subclinical illness in domestic animals which may be pneumonitic.

Disease in man:

Human infection is characterized by fever, toxaemia, cough and a typical pneumonia. Q. fever endocarditis may also occur. Q. fever is essentially an occupational disease being limited mainly to livestock attendants, farm residents and laboratory workers.

Diagnosis: Rarely diagnosed clinically, infection is confirmed serologically.

Treatment and control: Man is treated with tetracyclines. Pasteurization of milk and careful disposal of animal placental reduce infections. An inactivated vaccine has been used to protect laboratory workers.

4. CHLAMYDIAL ZOONOSES

Chlamydial agents may be regarded as belonging to a certain developmental level between viruses and bacteria. They have several common characteristics; containing a common group antigen, susceptible to certain chemotherapeutic and antibiotic agents, having coccoid elementary bodies which undergo development in the cells of the host and the same developmental cycle, containing RNA and DNA, and so on.

Chlamydial agents are associated with numerous disease including trachoma and lymphogranuloma of man, psittacosis, bovine encephalomyelitis, feline pneumonitis etc. Among these diseases, only psittacosis has been recognized as a zoonosis. However several other diseases are also suspected to be possible zoonoses.

Psittacosis (Ornithosis)

Psittacosis is a disease occuring in birds of the parrot family (Psittacidae) and a variety of non-psittasine birds, and in man. The disease has little economic importance but of great importance as a zoonosis. It has been recorded from various tropical areas.

Transmission: Airborne infection seems to be the only one possible route: It has occured from birds to birds, from birds to man and from man to man. The transmission from man to birds has not been recorded.

Clinical findings: In birds, psittacosis is manifested either as a highly fatal pulmonary infection or as a latent infection with only vague clinical signs. In contrast, the disease in man is usually serious and sometimes fatal, and also has respiratory involvement.

Lesions: Lesions in birds include swelling of the spleen in psittacine birds, enlargement of the liver and inflammation of the air sacs in both psittacine and non-psittacine birds.

Diagnosis: This is dependent on sero-immunological laboratory examination.

Treatment and control: Sulfonamides and antibodies have been used for the treatment. Control measures consist of systematic examination of birds and strict isolation of suspected birds, and rigid control of the trade of susceptible birds.

5. BACTERIAL ZOONOSES

Table 3. Bacterial zoonoses

Disease	Causative organism	Animals principally involved	Prevalence
Anthrax	Bacilus anthracis	Ruminants, equines swine	Worldwide
Brucellosis	Brucella arbotus, B. suis, B. melitensis	Cattle, swine, goats, sheep, horses	Worldwide
Swine erysipelas (Erysipeloid in man)	Erysipelothrix insidiosa	Swine, poultry, fish	Worldwide
Leptospirosis	Leptspira spp.	Rodents, dogs, cattle, swine, bandicoots	World-wide
Listeriosis	Listeria monocytogenes	Rodents, sheep, cattle, swine	Worldwide

Table 3. Continued

Disease	Causative organism	Animals principally involved	Prevalence
Pasteurellossis	Pasteurella multocida, P. haemolytica	Mammals, birds	World-wide
Plague	Pasteurella pestis	Rodents	World-wide
Salmonellosis	Salmonella spp.	Mammals, birds	World-wide
Haemolytic streptococcosis	Haemolytic streptococcus	Mammals	World-wide
Tuberculosis	Mycobacterium tuberculosis bovis	Cattle, goats, swine cats	World-wide
	hominis Mycobacterium tuberculosis	Dogs, swine, monkeys	World-wide
	avium Mycobacterium tuberculosis	Poultry, swine, cattle	World-wide
Tularaemia	Pasteurella tularensis	Rabbits, hares, sheep, wild rodents	U.S.A., USSR, Scandinavian countries, Japan.
Vibriosis	Vibro foetus	Cattle, sheep	World-wide
Bacterial food poisoning	Food poisoning salmonella, staphylo.. Clostridium, vibrio, parahae	Ruminants, swine poultry	World-wide
Pseudotuberculosis	Pasteurella Pseudotuberculosis	Rodents, cats, fowls	World-wide
Bacterial dysentery	Shigella spp.	Monkeys	World-wide
Rat-bite Fever	Spririllum minus, streptobacillus moniliformis	Rodents	World-wide (India)
Relapsing fever	Borrelia spp.	Rodents	(India) (Tropical countries)
Actinomycosis	Actinomyces bovis	Cattle, swine, equines, dogs	(Tropical countries)
Nocardiosis	Norcardia spp.	Cattle, dogs mammals.	(Tropical countries)
Glanders	Actinobacillus malle:	Equines	Africa, Asia, South America.
Melioidosis	Pseudomonas pseudomalle:	Rodents, sheep, cattle, cattle, swine	Asia, Australia, Phillippines.

Anthrax

Anthrax is mainly a peracute-subacute infectious septicaemic disease, affecting all animals,

especially ruminants, pigs, horses and man. Carnivores are more resistant and birds are rarely affected. The disease occurs world-wide, but is more common in tropical than in temperate countries. Anthrax has also occured in Zambia. Anthrax was the first to be recognized as a zoonosis and is also of great historical interest in other respects. Robert Koch, in 1876, was the first to isolate the causative organism in pure culture and to produce the disease with the culture. Pasteur, Rous and Chamberland, in 1881, demonstrated active immunization with attenuated anthrax cultures.

Cause:

The causative organism, **Bacillus anthracis**, is a gram-positive, non-motile spore forming, rectangular-shaped bacterium of relatively large size. The bacilli are usually arranged in chain formation but may occur singly or in pairs. The spores are situated centrally in the cell, causing a bulge. When properly stained the bacilli in blood and tissue smears of animals which died of the disease usually reveals a distinct capsule. Anthrax spores are highly resistant to heat, low temperatures, chemical disinfectants and prolonged drying. They may retain their viability for many years in the soil, in waste, on hides and contaminated objects in storage. A toxin is released by the bacilli, which causes oedema and damage to tissue resulting in death.

Transmission:

Animals and man are infected (1) by ingestion of material containing spores or virulent bacilli (2) by infected biting flies or possibly other types of insects (3) by inhalation of spores, especially in man (4) through the skin by contact with the diseased animals in man.

Disease in animals:

Clinical findings: The peracute form, most common in cattle, sheep and goats is characterized by its sudden onset and rapidly fatal course. Victims present a picture of cerebral apoplexy (sudden staggering, difficult breathing, trembling, collapse, etc.) and die, frequently without showing any previous evidence of illness.

In the acute and subacute forms, most common in cattle, sheep and horses, there is first a rise in body temperature and a period of excitement followed by depression, stupor, spasm, respiratory or cardiac distress, staggering, convulsion and death. Bloody discharges may emanate from the natural orifices and oedematous swelling may appear in different parts of the body.

Chronic anthrax is observed most in pigs. There is swelling of the throat and tongue and the lymph nodes enlarge, causing distressed breathing. The mucous membrane becomes red and small haemorrhages appear in the skin.

The cutaneous or localized form characterized by swelling in various parts of the body may occur in cattle and horse when anthrax organisms lodge in wounds or abrasions of the skin, maybe following bites by infected flies.

Lesions: Because of the ability of the bacillus to form spores when exposed to air, a necropsy should never be undertaken except by trained laboratory personnel. A strip of tape or cloth is soaked in blood from cut superficial veins, dried and placed in air-tight container, together with a number of blood smears. Nothing else should be taken from the carcase in the field. There may be oozing or dark viscous blood from the natural openings; rigor mortis is frequently absent or incomplete haemorrhages beneath the skin are common; the spleen usually is greatly enlarged; the liver, kidneys and lymphnodes are usually congested and enlarged.

Diagnosis: Diagnosis is based on clinical symptoms, prevalence and laboratory examination. When anthrax is suspected after a carcase has been opened, a piece of spleen, liver or kidneys can be taken for laboratory examination. Where anthrax is suspected before the carcase is opened a blood specimen on a strip of tape or a wisp of cloth only should be taken together with the blood smears.

Treatment: Penicillin, betamethasone and anti-anthrax serum have been found effective.

Control: Control is achieved by stringent regulations (burning of the carcase or deep burial with quick-lime) and vaccination.

Disease in man:

Percutaneous infection: Man is infected by direct contact with the diseased animals. The lesions become purulent, followed by swelling of the lymphnodes draining the area. Blistering takes place in the center of the region and it becomes a black-brown scab.

Peroral infection: Haemorrhagic enteritis develops.

Air-borne infection: Man is infected when he deals with contaminated bone meal, hide, wool and the like. The organism cause acute bronchopneumonia, which may degenerate into septicaemia with high fever, resulting in death without proper treatment.

Infected man can be treated with penicillin and the anti-serum.

Brucellosis

Brucellosis is a contagious disea :aused by the genus *Brucella*. ***Br. abortus*, *Br. melitensis* and** Br. suis are main species primaril .ffecting cattle, goats and pigs respectively. The disease is characterized by abortion in the female, orchitis and infection of the accessory sex organs in the male, and infertility in both sexes. Man is susceptible to these three species, contracting a disease also called "undulant or Malta fever". Br. canis of dogs has been newly added to the genus and found to be transmissible to man.

Bovine brucellosis is widely spread in Zambia, and the caprine type has also been detected.

Cause:

Brucella are small gram-negative, non-motile micro-organisms, having the appearance of bacilli or coccobacilli. The micro-organisms are destroyed by common disinfectants, pasteurization and by sunlight and desication, but can survive several weeks in damp and shady places. Brucella spp. are identified serologically.

Disease in animals:

Transimission: The disease is transmitted by ingestion of infected materials such as aborted foetus, foetal membranes, vaginal discharges, milk, faeces, or materials contaminated by these, via the respiratory tract, the conjuctiva, the skin and by blood-sucking insects.

Cattle: Localization of Br. abortus in the uterus and placenta and the resulting death and abortion of the foetus are the most obvious manifestation. Abortions occur usually after the 6th month of pregnancy followed by a brown discharge from the uterus. Retention of the placenta together with metritis often follows the abortion and the animal remains temporarily or permanently infertile. Calves may carry the infection without showing symptoms until they become pregnant, when the usual abortion occur. In bulls, clinical signs may be absent, if there are, in the form of orchitis, lack of sexual activity and infertility is the usual result.

Positive diagnosis is based on laboratory examinations. Brucella isolation can be made from the foetal stomach contents, lungs or rectum and the placenta, milk, etc. Blood samples should be taken for agglutination tests. Identification on a herd basis is carried out by "milk ring test".

Abortion may be caused by other infections such as leptopsirosis. trichomoniasis, vibrosis and mycosis. The latter three diseases usually cause abortion before 6 months of pregnancy and the clinical picture is often distinctive from that of brucellosis. Abortions occuring after 6 months of pregnancy are more likely due to either brucellosis or leptospirosis, and these can often be distinguished on clinical grounds.

No effective treatment is available. Antibiotics have the effect of making the organisms disappear, but invariably return when the treatment is terminated.

Control measures are (1) rigid sanitation (2) vaccination and (3) the test and disposal procedure.

Goats and sheep: The causative microoganism is Br melitensis. The picture of the disease resembles that of cattle. Abortions usually occur from the fourth month of gestation onward. Positive diagnosis is by laboratory examinations. There is no adequate treatment. Control procedures are mentioned above for cattle.

Pigs: The causative microorganism is Br. suis. Clinical sings are noteworthy for their variability, and are often absent. Sometimes, lameness, inco-ordination of gait and posterior paralysis is seen. The incidence of abortion is often low, but small litters, stillbirths and weak piglets are common. Infertility may or may not result in both the sow and boar.

Abscess and nodule formation is common in affected organs (testes, seminal vesicles, bones, uterus, spleen, liver, kidneys, lymph nodes and occasionally in the joint capsules and tendon sheaths).

No effective treatment and no suitable vaccines are available. Good sanitation and the test and disposal procedures are employed for the control.

Disease in man:

Man is susceptible to Br. abortus, Br. suis and Br. canis. The symptoms are the same, no matter which type of Brucella is the infecting agent, although infections with Br. melitensis and Br. suis are usually more severe than those with Br. abortus. Infections with Br. canis in man need to be studied further.

Brucellosis in man is an occupational hazard of animal attendants and slaughtermen since infection can be acquired through the skin and mucosae by direct contact with infected animals or contaminated materials. But others can be infected by drinking raw or insufficiently cooked milk. As for Zambia, surveys conducted during 1973 and 1974 revealed that the incidence of bovine brucellosis in the traditional sector was in range of 31 to 64 per cent, and this incidence was coupled with the custom of raw-milk consumption in traditional areas.

Typical "undulant fever" has an incubation period of between one and three weeks, followed by headache, malaise, anorexia, constipation and a bout of fever which usually settles by lysis after about ten days. Coughing and profuse sweating are common and the spleen is usually palpable. After the temperature has returned to normal for a few days, another bout of fever ensues and these episodes may continue recurring at short intervals for many months. During the course of the illness arthritis is common. The joints most commonly affected are the hip, knee, shoulder, ankle and wrist, but occasionally the small joints of the fingers and toes and the spine may be involved.

Chronic brucellosis is on the whole clinically milder. There may be recurrent bouts of drenching night sweat without serious general ill-health, and other clinical features like those of typical undulant fever may also be seen. The mortality is low but recovery from infections is often very slow. Many persons never fully recover from the effects of the disease.

Positive diagnosis is established by blood culture, urine culture, the agglutination test, etc.

Sulfonamides and antibiotics have been used for human brucellosis. Prevention of human infection may be achieved by attention to personal hygiene those handling susceptible animals, pasteurization of milk, disinfection of excreta, particularly urine from patients with the disease, etc.

Swine erysipelas

Swine erysipelas is a disease primarily of swine but also of other animals including man. The human disease caused by Erysipelothrix insidiosa is called erysipeloid. Erysipelas in man is caused by Streptococcus pyogenes. Swine erysipelas has been recorded in Zambia.

Cause and Transmission:

The causative microorganism, **Erysipelothrix insidiosa** (E. rhusiopathiae) is a gram-positive, non-motile, often pleomorphic, curved or straight red shaped agent. It is destroyed by standard disinfectants used at about twice the normal strenghth, and by boiling. It resists sunlight, smoking or pickling.

The disease is transmitted via contaminated food or formites, skin abrasions (main course in man), or by flies.

Disease in swine

Clinical findings: In the acute or setpicaemic form, the onset is sudden with high fever and the disease follows a rapid course. Mortality is between 25 and 75 per cent. There may be areas of haemorrhage on the abdomen, depression, a copious eye-discharge, vomitting, diarrhoea and diamond skin lesions.

In the chronic form, there may be a characteristic vegetative endocarditis in heart valves, manifested by the animal being unable to rise and walk. Chronic arthritis and diamond skin syndrome may be seen.

Lesions: Lesions in the acute form may include typical skin lesions, or petechiation throughout the body, especially in the sub-serous tissue of the kidneys, in the pleura and the peritoneum. In the chronic form, there may be arthritis, congestion and oedema of the lungs, petechiation or ecchymosis of the lung surface, large cauliflower-like masses on the leaves of the heart valves, petechiation and ecchymosis on the atrium and the base of the heart. The kidneys are characteristically enlarged and pulpy, the lymph nodes are enlarged and congested. Gastroenteritis and typical skin lesions may also be noticed.

Diagnosis: Diagnosis is established by clinical findings and laboratory examinations including agglutination test, haemagglutination-inhibition test and complement fixation test.

Treatment and control: Penicillin, hyper-immune serum and betamethasone have been used. The vaccine is available. Good hygiene and management may not be reliable so much in the case of swine erysipelas.

Disease in man:

E. insidiosa infection of man is known as erysipeloid. Wounds are the main source of the infection, which mostly occurs in the slaughter house.

After an incubation period of 1 to 5 days, the skin at the point of innoculation becomes swollen, painful and red. If untreated the process may extend to involve the entire hand. Most cases follow a mild course to recovery within 2 to 4 weeks. The diffuse or a generalized form may occur accompanied by fever and joint pains. A septicaemic form has also been recorded.

Antiserum and penicillin have been used, for the treatment.

Leptopsirosis

Leptospirosis is the name given to a disease which manifests itself in a large number of different ways in almost all domestic animals, man and wildlife including rodents.

Cause:

Leptospira is an extremely slender spiral microorganism, 10 to 40 microns long and hooked at one end, visible only with the aid of the dark-ground illumination or when special silver impregnation stains are used. There are about 130 serotypes, of which 4 of the most important are L. icterohaemorrhagiae, L. canicola, L. grippotyphosa and L. pomona.

Moisture is essential for survival of the microorganism outside the host. The microorganism has been frequently recovered from healthy animals. Recovered animals continue to excrete the microorganism, particularly in the urine, for very long periods.

Transmission:

(1) Direct contact (a) with urine, most important in man (b) venereal spread, often in pigs (c) transplacental, in cattle, pigs and man (d) ingestion (e) inhalation. (2) Indirect contact with infected soil, food stuffs and pasture. (3) Insect vectors such as ticks.

Disease in animals:

Clinical findings: There is nothing to indicate that a particular leptospira is associated with a specific syndrome in any particular animal. (1) Sub-clinical infection (pigs, cattle and wildlife). (2) Acute type (fever, anorexia, loss of milk production, jaundice and haemoglobinuria). (3) Abortion, retention of the placenta and mastitis (cows, sows, ewes and mares). (4) Moon blindness or periodic ophthalmia in the horse and cataract in pigs.

Lesions: At necropsy there may be jaundice, haemoglobinuria, sub-serous and sub-mucous haemorrhages, intestitial nephritis, and necrotic foci in the liver of aborted foetuses. Foetal membranes are thick, oedematous, brown and necrotic.

Diagnosis: Diagosis is based on clinical findings and identifying the spirochaeta by dark-ground illumination or silver impregnation stains of specimens of the blood or urine.

Differential diagnosis: Cattle-babesiosis, anaplasmosis, haemoglobinuria and jaundice due to other infectious haemolytic disease, and brucellosis. Pigs-brucellosis. Sheep and goats-chronic copper poisoning and anaplasmosis. Horse-infectious euqine anaemia and abortion due to salmonella abortus-equi.

Treatment and control: Many antibiotics have been used. The control is by vaccination and ordinary hygienic procedures.

Disease in man:

Many types of the organisms can be transmitted to man, by ingesting food or drink contaminated with rat urine or by immersion in contaminated water, since the spirochaeta is able to gain entry through the mucosa or minor skin abrasions.

After an incubation period of one to two weeks three phases may develop. Although symptoms vary depending on the type of the spirochaeta. During the "febrile stage" there is a rapid onset of fever, headache, pain in the back and limbs and congestion of the conjuctivae. In the "jaundiced stage" appearing during the first week, there is the profound prostration, heavy albuminuria, purpuric rash, and sometimes haemoptysis, havematemisis, melaena, or bleeding from the gums. There is usually leucocytosis. The last is the "convalescent stage".

Diagnosis is established by identifying the spirochaeta, from blood or urine. Many types of antiboitics have been used for the human infections. The anti-serum may also be used.

Preventive measures include improvement of environments, especially elimination or rodents as the urine from them is the important source of human infections, and precaution to aboid direct contact with a dirty pool of water where leptospira may dwell.

Listeriosis

Listeriosis is a sporadic, specific, bacterial infection most commonly manifested by encephalitis or meningo-encephalitis is adult ruminants, speticaemic with focal hepatic necrosis in young ruminants and monogastric animals, and by septicaemic with myocardial degeneration

or focal hepatic necrosis in fowls.. The various manifestations of infection occur in all various susceptible species. Abortion may occur in all susceptible mammals. Man is also highly susceptible and the infection is sometimes fatal.

Cause and transmission:

The organism, **Listeria monocytogenes**, is a small, motile, grampositive, non-sporeforming, extremely resistant, slightly clubbing organism. It is ubiquitous, having been isolated from at least 42 domestic and wild mammals, 22 species of birds, as well as fish, crustaceans, insects, sewage, water, feedstuffs and earth.

The natural reserviors of the organism have not been determined, nor has the mode of transmission.

Disease in animals:

Clinical findings: The clinical manifestations of listeriosis are tremendously diverse including abortion, meningeal or encephalitic infection, and septicaemic infection.

Abortion (Listeric abortion) occurs in all species of pregnant animals including man, but principally of importance in cattle and sheep.

Abortion usually occurs in the last quarter of gestation without signs of infection in the dam. The foetus dies in utero and may be severely autolyzed when finally expelled.

Encephalitis — Encephalitis is considered most characteristic of the disease in ruminants. The lesions in the central nervous system can be recognized only by microscopic eximination and are confined to the brain stem, particularly the medular oblangata and spinal cord.

Septicaemia — Generalised listeriosis is considered frequent in newborn, infants and monogastric animals. The characteristic lesion in this form is focal necrosis of the liver and less frequently of the spleen, lymph nodes, lungs, adrenals, myocardium, gastro-intestinal tract and brain.

Diagnosis: There is no satisfactory antemortem diagnostic test. Listeriosis can be confirmed only by isolation and indentification of the specific etiological agent.

Treament and control: A satisfactory therapeutic agent has not yet been found, however the sulfonamides, penicillin, chlortetracycline, terramycin etc have been reported effective.

In an outbreak, affected animals should be segregated. If silage was being fed, use of that particular silage should be discontinued as silage has been incriminated as a possible disease transmitting factor.

Disease in man:

Manifestation of listeric infection in man includes death of the foetus, meningitis or meningo-encephalitis, conjuctivitis, endo-carditis and urethritis. Although it is clear that animals are reservoirs, all suspected materials should be handled with care, such as aborted foetuses and the milk of cows following abortion.

Pasteurellosis

Although pasteurellosis is the designation for all animal diseases with organisms of the genus Pasteurella, in this section pasteurellosis includes only diseases of animals and man associated with **Pasteurella multocida.** Past. multocida is one of the most common organisms found in infected wounds resulting from animal bites. Past. multocida infections have been recorded in Zambia especially in cattle and poultry.

Cause:

Pasteurella multocida is very small, gram-negative, non-sporeforming and bipolar appearance. The organism is killed easily by sunlight and ordinary disinfectants, and much more sensitive to antibiotics and sulfa drugs than most gram-negative organisms.

Disease in animals and man:

Past. multocida can produce a variety of diseases in different species of animals, including Asian and African haemorrhagic Septicaemia of ruminants, fowl cholera, rabbit septicaemia, swine plague, and shipping fever in cattle. The organism is also found in animal bite wounds in animals and man, and in occasional respiratory and other infections of man. It may be a commensal in the throats and noses of domesticated and wild mammals and birds of a wide variety of species. There is marked degree of specificity for different host species.

Salmonellosis

Salmonellosis is the name given to a disease condition caused by the genus **Salmonella.** All the known species are pathogenic for man, animals, or both, and wide variety of diesease are associated with salmonella. Some species are host-specific; S. typhi and S. paratyphi in man, S. gallinarum and S. pullorum in fowl, S. abortus-ovis in sheep and S. abortus-equi in horses. Salmonellosis is very common in domesticated animals and poultry in Zambia.

Cause and transmission:

Salmonella are gram-negative, usually motile, non-sporeforming rod-shaped microorganisms. They have little resistance to sunlight, drying or heat, but may survive for months in wet, warm areas.

The source of infection is the faeces of infected animals which can contaminate feed, water, milk, fresh and processed meats from abattoirs, plant and animal products used as fertilizers or feedstuffs, pasture and so on.

Disease in animals:

Clinical findings vary according to species of animals, type and number of microogarnisms, and susceptibility of individuals. There may be enteritis, abortion, septicaemic symptoms, pneumonic symptoms, nervous symptoms and arthritis.

Salmonellossis can be susptected on the basis of gross and histo-pathologic findings, however, isolation of the causative agent in association with lesions is necessary for confirmation.

Broad-spectrum antibiotics and sulfonamides are used for the treatment. Control and prevention are difficult, as salmonella survive for long periods in the environment, and recovered animals

act as reservoirs of infection. Sanitary management and avoiding stress factors to animals such as changes in feed and transportations may reduce the rate of infection. Vaccines are used for some types of infection.

Disease in man:

Apart from the two host-specific diseases, S. typhi infection (typhoid fever) and S. paratyphi infection (paratyphoid fever), S. cholerae-suis primarily of pigs causes the most severe infection and is similar to typhoid fever or paratyphoid fever.

Salmonella, often originating in birds of mammals, are responsible for a specific food poisoning in man. These organisms produce a toxin which causes severe gastro-enteritis with nausea, vomitting, cramps and diarrhoea. Fatalities are uncommon, but explosive out-breaks can be very alarming and involve large number of people.

Haemolytic streptococcosis

The genus Streptococcus is divided into two groups, haemolytic and non-haemolytic. Certain of the haemolytic streptococci are pathogenic for man and animals. Some of the more important pathogenic streptococci are listed below. Haemolytic streptococci are often found in animals in Zambia.

Streptococci are gram-positive, non or rarely motile, non-sporeforming, spherical or avoid microorganism found in pairs or chains of varying length or in tetrads. They are, as a rule, rather easily destroyed by chemical disinfectants, by heat, and drying.

Numerous types of sulfonamides and antibiotics have been used for the treatment. Sensitivity tests may have to be employed to select the most effective agent. Vaccines have also been tried for certain infections.

Table 4.

Streptococcal infection*

Lancefield group	Species	Disease
A	S. pyogenes	Scarlet fever in man. Various pyogenic infections. Occasionally a cause of bovine mastitis.
B	S. agalactiae	Bovine mastitis.
C	S. equi	Strangles.
	S. zooepidemicus	Various pyogenic infections.
	S. dysgalactiae	Bovine mastitis.
	S. equisimilis	Respiratory infection in man.
	S. genitalium	Equine genital infection and abortion.
D	S.faecalis	Usually not pathogenic.
E	S. uberis	Bovine mastitis.
	Streptococcus spp.	Cervical lymphadenitis in swine.
	Streptococcus spp.	Various species in these groups have been isolated from infections of the respiratory and genital-mucous membranes of man and animals and bovine mastitis.

* cited from Smith Jones and Hunt, Veterinary Pathology, table 12-3

Tuberculosis

A chronic disease caused by infection with acid-fast microorganisms belonging to the genus **Mycobacterium.** The disease affects practically all species of warm-blooded animals. The lesions and symptoms are similar regardless of species.

Mycobacterium bovis, M. avium, M. tuberculosis are three tubercular bacilli responsible for most cases in cattle, poultry and man respectively. M. tuberculosis (the human type) is most specific, and rarely produces a progressive disease in the lower animals other than primates and occasionally, dogs, cattle, swine, and parrots. M. avium (the avian type) is the only one of importance in birds, but is also pathogenic for swine, cattle and sheep, though natural infection in the latter is rare. M. bovis (the bovine type) is the most cosmopolitan and is capable of causing a progressive disease in almost all warm-blooded animals.

The disease is contracted by inhalation of contaminated droplets, by ingestion of contaminated discharges such as milk, urine or faeces, or maybe via skin abrasions.

Disease in animals:

The symptoms exhibited depend on the extent and the location of the lesions. There may be progressive emaciation, pulmonary syndrome, enlargement of superficial lymphnodes, abortion and tubercules of the udder. Lesions including proliferative inflamation or granulative inflamation, tubercules and exudative inflamation may be found in any organs and lymphnodes.

Diagnosis is made by the tuberculin test, etiological examination and by clinical findings.

Chemotherapy has been of little value in the control of tuberculosis in farm animals, however it has recently been economically feasible to treat cattle with isoniazid. Other principal control measures of tuberculosis are: (1) test and slaughter (2) test and segregation.

Disease in man:

Man is susceptible to the bovine type which can be transmitted mainly through contaminated or insufficiently cooked milk, as well as the human type.

Symptoms may be fever, coughing, sputum, sweating at night, variable appetite, loss of weight, fatigue, increased palpitation, gasping, pain in the chest or there may be no obvious specific symptoms.

The principal of treatment are well established and include general measures to raise resistance, specific treatment, local measures to the Lungs, etc.

Vibriosis

Vibriosis is a disease mainly of cattle and sheep, characterized by infertility and abortion, but abortion and septicaemia in man have also been recorded. The disease has occured from time to time mainly in cattle in Zambia.

Cause:

The causative agent, **Vibrio foetus,** is rather pleomorphic, most commonly seen in comma and S-shaped form, gram-negative, motile, non-sporeforming organism. It is killed in 5 minutes at 58°C and is easily destroyed by desiccation, direct sunlight and standard disinfectants. However it can survive very low temperatures, an important factor in its spread by artificial insemination.

Although disease in both sheep and cattle are caused by V. foetus, there are a number of distinct bio-types of the microorganism, and infection in one animal species is not generally transmitted to the other. Moreover, there is at least one non-pathogenic type which can be present in an animal without causing disease.

Transmission:

In cattle transmission occurs by coitus especially via infected bulls, but infected cows can carry the infection for long periods. Artificial insemination using semen from infected bulls is also a potent means of spread. In sheep ingestion is the most important route of infection. Man may contract the infection by direct contanct with infected animals or contaminated materials.

Disease in animals

Cattle: The infection is principally characterized by temporary infertility and irregular oestrus cycle. Abortion may occur before 6 months of pregnancy, but abortion rate is generally low. Infected bulls do not show any symptoms. Recovered cows are usually resistant to reinfection. The lesions of vibriosis in cattle are subtle. Oedema is the most common placental lesion, although it is not manifest by clinical signs.

Sheep: In outbreaks of bovine vibriosis the percentage of ewes having abortion or immature lambs may be high. The placenta may be intensely invaded, becomes necrotic, and detached. Recovered ewes are usually resistant to reinfection, but may carry the infection for certain periods.

Diagnosis: In cattle, positive diagnosis is established by isolation of V. foetus from the female genital tract, the stomach contents of aborted foetuses or from the prepuce of bulls, the vaginal mucus agglutination test, transmission test, and by immunofluorescence procedure in bulls. Diagnosis in sheep requires isolation of the microorganism.

Treatment and control: Infection tends to die out in females, but this does not happen in bulls. Antibiotics may be used for infected females. Antibiotics cream may be injected into the prepuce of infected bulls. Rigid checking of bulls, whether they are used for artificial insemination or natural services is essential for effective control.

Purchased cattle should be segregated and tested before being added to the herd.

Disease in man:

Abortion, febrile illness, septicaemia and so on have been reported in pregnant women, infants and elderly people. The disease is not common in man.

Pseudotuberculosis

Pseudotuberculosis is principally a disease of guinea pigs, other rodents and birds caused by **Pasteurella pseudotuberculosis.** However rare infections with it have been reported in many species of mammals including cattle, sheep, goats, horses, pigs, monkeys, and man. It is believed to occur throughout the world.

Natural infection is supposed to occur through ingestion of the causative organism. Infections in animals can occur as rapidly fatal acute septicaemia in which a few specific lesions are encountered, or more usually as a subacutre or chronic infection characterized by discrete, white or gray nodules in the liver, spleen, lungs and lymph nodes. Diagnosis usually requires isolation and identification of the agent.

Pseudotuberculosis in humans is recognized as occurring quite often in Europe as an enteric form causing symptoms of appendicitis. It may produce severe and fatal infections in man.

It is said that no medical treatment or vaccine is availabe.

Rat bite fever

Rat bite fever is a disease of man caused by microorganisms, **Spirillum minus** or **Streptobacillus moniliformis.** Transmission is mainly by rat biting but milk-born epidemic has been once reported. The disease in rats is not well understood.

Disease in man:

(1) **Spirillum minus infection (sokodu):** The wound by rat biting will heal in 1 to 2 weeks and then other clinical signs will appear including pain and inflamation at the point of the wound, sudden rise of temperature and skin rashes. Fever recurs intermittently at about one week intervals for a few months.

(2) **Streptobacillus moniliformis infection (haverhill fever):** The latent period is a few days. Fever is not intermittent, but continues for a few weeks to several months. Skin rashes and arthritis may occur.

Glanders

Glanders is a contagious, usually chronic, disease of equines characterized by the presence of nodules which develop into ulcers in the respiratory tract and on the skin. It occasionally infects man. This, once wide spread, age-old disease has been eliminated widely by the use of the "mallein test", although it still occurs especially in certain Asian countries, and also in Mexico and Ethiopia.

Cause and transmission:

The causative organism, Actinobacillus mallei, is a non-sporeforming, gram-negative, slender rod. It is killed by 55°C for 10 minutes, desiccation, sunlight and ordinary disinfectants. Transmission occurs principally by ingestion, but also by inhalation and through wound infection. The nasal discharges are the main source of contamination of surroundings.

Disease in animals:

Clinical findings: There are two forms, acute and chronic, the acute being mainly in mules and donkeys. The respiratory mucosa and lungs are most frequently affected. Nasal involvement is indicated by a copious and persistent nasal discharge which is first catarrhal, later purulent. Ulceration often occurs in the nasal mucosa. Pulmonary infection may be indicated by chronic cough. Cutaneous involvement ("farcy") produces indolent ulcers in the skin, with thickening of the superficial lymphatics, sometimes leading to abscesses in superficial lymph nodes. The nasal lesions appear as shaped scars. The pulmonary lesions are usually discreted granulomatous nodules resembling tubercules but occasionally they coalesce.

Diagnosis:

The characteristic nasal and skin lesions may lead to definite diagnosis. In the earlier stage of the disease. diagnosis is established by the use of the "mallein test".

Treatment and control:

Sulphadizine or suphadimidine is used. There is no suitable vaccine. Total elimination is carried out by the "mallein test".

Disease in man:

The infection is not very common, however several cases have occured in persons caring for glanderous animals. The disease is characterised by swelling and pain at the point of infection such as the hand, lip, or eye, swelling of the neighbouring lymph glands, development of nasal and mouth ulcers, development of abscesses and pustules in the skin, joint inflamations, and general symptoms accompanied by fever. The cases usually end fatally in 2 to 4 weeks.

Actinomycosis

Actinomycosis is a local or systemic chronic suppurative and granulomatous disease chiefly of cattle, swine, horses, dogs and man. It occurs throughout the tropical world.

Cause and transmission:

The anaerobic causative microorganism, Actinomyces bovis, has morphological characteristics similar to both bacteria and fungi; filamentous form is gram-positive and club shaped bodies are gram-negative. The micro-organism is killed at 60°C in 10 minutes and is susceptible to ordinary disinfectants. Transmission is through small wounds in the mouth and by aerial infection.

Disease in animals:

Clinical findings: The course is chronic. There are painless bony swellings sometimes to a large extent, which arise on the lower edge of the mandjble or on the maxilla and eruptions at one or more points in the surface of the skin concerned, with pus oozing out. The pus is of a sticky mucoid, nonodorous and yellow, containing numerous very small sulphur-like granules. Sometimes adjacent soft tissues become involved, fast hard-swelling and later softening and erupting. Less frequently the lungs, alimentary tract, udder, testes, etc are involved causing pneumonia, diarrhoea, mastitis, orchitis, etc.

Diagnosis:

This depends on identification of the sulphur-like granules in the pus, and the causative agent. Actinobacillosis and staphyloccosis must be differentiated.

Treatment:

This consists of local and general injections of anti-biotics, sulfonamides, etc, and of surgical removal of the lesion.

Disease in man:

There are three clinical varieties: (1) Actinomycosis of the jaw is the commonest type. Infection through the mucous membrane of the gum leads gradually to woody induration of all the tissues of the jaw and overlying skin, through which multiple sinuses eventually discharge. There is little pain or constitutional upset and regional lymph nodes are not usually involved. (2) Ilecaecal actinomycosis — causes a hard irregular mass in the right iliac fossa and in time fixation to the overlying skin and sinus formation occurs. The disease may spread to the liver, spleen and other organs and is frequently fatal. (3) Actinomycosis of the lung is the least common type. Cough, dysponea, fever, and pain in the chest occur and in the later stages induration and sinuses appear in the chest wall.

Nocardiosis

Nocardiosis is usually a chronic infection caused by soil-born organisms of the genus Nocardia which are aerobic, gram-positive, non-motile and filamentous with some species being acid-fast, occuring most frequently in cattle and dogs but also in a large variety of animals including poultry as well as man. The disease is characterised by generalized purulogranulomatous nodular lesions. Bovine nocardiosis is well known in the Sudan and suspected in other African countries. Little is known about the mode of transmission.

Disease in animals:

Cattle: Nocardial mastitis with enlarged mammary glands and often small draining sinuses, is predominant. Bovine farcy characterized by granulomatous swelling of lympatic vessels and lymph nodes, abortion, pulmonary and generalized infections have been recorded.

Dogs: Granulomatous swellings are seen frequently on the extremities of dogs. The lungs and bronchial lymph nodes nearly always contain suppurative and granulomatous lesions.

Diagnosis:

Microscopic examination of smears made from pus, sputum, or a biopsy specimen may identify the etiological agent. Cultures are required especially for diagnosis of mastitis in cattle, using clumps in the milk. Seroimmunological methods may be employed.

Treatment:

Sulfonamides, antibiotics and some others have been used. Advanced cases frequently end fatally.

Disease in man:

Respiratoty involvement is most common, however cerebral and general infections have also been recorded.

6. PROTOZOAL ZOONOSES

Table 5. Protozaol zooneses

Disease	Causative organism	Animal principally involved	Prevalence
Toxoplasmosis	Toxoplasma gondii	Mammals, birds	World-wide
Leishmaniasis Visceral	Leishmania donovani	Dogs	New and Old World.
Cutaneous	Leishmania tropica	Dogs, rodents	Mainly Old World
Mucocutaneous	Leishmania braziliensis	Dogs, wild mammals	Central and South America
Trypanosomiasis	Trypanosoma cruzi	Dogs, small mammals	Central and South America
	Tyrpanosoma rangeli	Dogs, monkeys	South America
	Trypanosoma rhodesiense	Game animals	East Africa
Balantidiasis	Balantidium coli		World-wide
Coccidiosis	Isospora spp.	Dogs	World-wide
Pneumocystis infection	Pneumocystis carinii	Rodents	World-wide
Malaria	Plasmodium knowlesi	Monkeys	Malaya, Phillipines
	Plasmodium simium	Monkeys	Brazil
	Plasmodium cyanomolgi	Monkeys	Phillipine, Taiwan, Malaya, Ceylon, India, Cambodia, Pakistan.

Toxoplasmosis

Toxoplasmosis is a protozoan infection caused by **Toxoplasma gondii**. The organism is found rather commonly in man and in domestic and wild animals and birds throughout the world, but the disease is not very common.

Cause:

Toxoplasma gondii is now classified as a coccidium. The sexual phase (schizogony and gametogony with formation of oocysts) takes place only in intestinal epithelium of the cat family. Trophozoites and tissue cysts, developed asexually, occur in all homothermic animals. The proliferative active trophozite is an obligately intra-cellular, motile organism, invading and multiplying in any nucleated cell which eventually bursts, liberating toxoplasms. The tissue cyst, measuring 30 to 150 microns is found in the brain, eye, heart and muscle tissue in the chronically infected. This cyst is usually a spherical collection of closely packed, viable toxoplasmas.

The trophozoites and the tissue cysts are killed by conventional disinfectants and by desicattion or heat above 50°C to 60°C. The oocyst is highly resistant, which may remain infectious for up to 17 months in a humid environment, however it is also killed by heat above 50°C to 60°C.

Transmission:

Two forms of transmission exists, congenital and acquired. In congenital infection, the mother usually suffers from an asymptomatic of subclinical infection, but the infection often becomes clinical in the offspring. Although the natural mode of acquired infection has not yet been determined, the infection may be acquired by ingestion of contaminated or infected raw or under-cooked meat, or via the respiratory tract.

Clinical findings:

Most infections seem to run a latent course. Generally the young is more likely to be the victim of the infection than the adult.

In animals, a wide diversity of manifestation have been attributed to toxoplasmosis. The organisms most often affect the brain, myocardium, lymph nodes, lungs, intestinal muscularis, pancreas, or liver, hence symptoms of toxoplasmosis may be referable to involvement of any one or more of these organs.

In man, toxoplasmosis is recognized most frequently as a congential infection of the new-born, manifested by encephalitis, chorioretinitis, lymphadenopahty, myocarditis, pneumonia, and meningo-encephalitis have been observed.

Diagnosis:

Clinical examination can give only presumptive diagnosis. Confirmation is established by the isolation of organisms, the neutralization test, the complement-fixation test or the Sabin-Feldman dye test.

Treatment and control:

No completely satisfactory treatment for toxoplasmosis is known. Some sulfonamides and others have been used. A vaccine is not yet available for toxoplasmosis. Preventive measures may include, adequate cooking of meat, good sanitary habits, special caution to sero-negative animals attendants, etc, and destruction of infected animals.

Pneumocystosis

Pneumocystosis is an infection caused by Pneumocystis which inhabits the pulmonary alveoli of man and rodents, and under certain condition causes severe disruption of respiratory function. Infants or children suffering from disorder of the lypmphoreticular system of immune mechanisms and aged persons with malignant lymphoma or disease of bone marrow, especially if treated with corticosteroid, may contract the disease.

The organisms may be seen with the light microscope as spherical cysts about 4.5 microne in diameter. Some cysts contain intracystic bodies up to 8 bodies.

Coccidiosis

Coccidiosis is a disease produced by coccidia, which have world-wide distribution. The disease causes a great damage to animal and poultry husbandries. Man also suffers from coccidiosis, however the relation between human and animal infections has not yet been understood.

The causative coccidia in human infections are **Isospora hominis, I. belli and I. natalensis.** Symptoms are mild diarrhoea, abdominal distress and eosinophilia, and in general, the infections appear to be self-limited and last only a few weeks. Some infections seem to have an asymptomatic course. A few hundred cases of human coccidiosis have been reported from various parts of the world including Africa.

Balantidiasis

Balantidiasis is an enteric disease usually of man and swine, caused by a large ciliated protozoa, **Balantidium coli.** The protozoa is a natural inhabitants of the digestive tract of swine, man and occasionally of other vertebrates, however under undetermined circumstances, B. coli will invade the intestinal mucosa, penetrate into the submucosa, and locate itself particularly in lymphoid nodules. The tissue penetration may cause an ulcerative colitis and severe bloody diarrhoea. Human infection is usually acquired from swine through the contamination of food stuff, fingers, etc, with pig faeces. Carbarson and tetracyclines have been used for human infections.

Trypanosomiasis

Trypanosomiasis is the name given to a group of diseases caused by protozoa of the genus Trypanosoma. There are a large number of species in the genus, and they are widely distributed in nature. Almost all domestic animals and many wild species are affected with one or more of the trypanosomes as well as man. The disease has greatly influenced human life and animal husbandry in Tsetse infested areas including Zambia.

Cause and transmission:

Trypanosomes are elongated, flagellated protozoa which frequent the blood of many vertebrate and inverterbrate hosts and localize in tissues, sometimes in a non-flagellated form with an ovoid or round body. They require both vertebrate and inverterbrate host to complete the life cycle, and the latter acting as vectors of the infection. The most important invertebrate hosts are tsetse-flies, especially **Glossina spp.** The pathogenesis of trypanosomiasis in man or animals is not thoroughly understood. The mechanism which induce disease or cause death are essentially unkown.

Three species of Trypanosoma are incriminated as causes of zoonoses; **T. cruzi** which is the causative agent of South America trypanosomiasis of man, **T rangeli** that is the only known instance in which a trypanosome is apparently non-pathogenic in the vertebrate host such as man and dogs but is pathogenic in the invertebrate host, occuring in South America, and **T. rhodesiense** which causes East African sleeping sickness of man.

Trypanosoma rhodesiense:

This species has been found in Zambia, Rhodesia, Tanzania, Malawi and other countries in Africa. The main source of human infection with **T. rhodesience** is man, but is believed that game animals play an important part as a reservior host.

Clinical findings include fever, anaemia, enlarged and tender lymph nodes in the neck and elsewhere, splenomegaly, pleomorphic skin rashes and eventually the central nervous system.

Diagnosis is established by identifying the trypanosoma in the blood, bone marrow, or materials obtained by lymphnode puncture. Controlling disease transmitting insects is an essential measure in controlling trypanosomiasis.

Leishmaniasis

Leishmaniasis is an infection of man and animals with protozoan organisms of the genus **Leishmania.** Three species are recognized as important pathogens: **L. donovani,** the cause of visceral leishmaniasis, **kala azar** or dum dum fever; **L. tropica,** the agent of cutaneous Leshimaniasis, Oriental sore or Delhi sore, and **L. braziliensis,** the cause of mucotaneous or American leishmaniasis, espundia and several other names.

Leishmania occur in vertebrate hosts in the leishmanial form that is a small ovoid protozoa having neither flagellum nor undulating membrane. In the tissue of vertebrate host the cells of the parasites invade cells and multiply in them, particularly cells of the reticulo-endotherial system in the skin, mucosa, lymph nodes, spleen, liver, bone marrow, etc. They are taken by leucocytes, especially large mononuclears, thus enter the blood stream and ultimately destroy the leucocytes. The parasites require an intermediate host, sandflies (Phlebotomus), to complete their life cycle. In the inveterbrate host or in cultures the parasites assume various shapes, and have a flagellum.

Visceral leishmaniasis (L. donovani)

The infection occurs naturally in man, gods, cats, cattle, sheep, horses and squirrels. It has a wide geographic distribution including countries bordering the Mediterranean, Kenya, Sudan, India, China and South American countries. In man, the incubation period may be several months, but may be as long as three years. The illness usually starts insidiously and runs a long chronic or relapsing course. There are bouts of fever accompanied by night sweats, enlargement of the spleen, liver and sometimes lymph nodes too, anaemia and leucopenia. In the later stage the patient may become grossly wasted.

In dogs, similar general symptoms to those in man are observed, namely anaemia, emaciation and ultimately death occurs, diarrhea being a terminal clinical sign. On post-moterm examination there is enlargement of the spleen, liver and lymph nodes. Cutaneous lesions may occur, with ulceration development on the lips and eyelids. In chronic cases a chronic eczema may be seen and skin ulceration may be evident.

Cutaneous leishmaniasis (L. tropica)

The infection occurs naturally in man, various wild rodents and dogs in countries bordering the Mediterranean. The first detectable lesion occurs from 3 days to 6 weeks after sand-fly bite, appearing as a reddish papule which gradually develops a crust, forming a shallow ulcer. The ulcer gradually enlarges and may reach several centimeters in diameter. In an uncomplicated case the ulcer heals in from 2 to 12 months leaving a deeply pigmented, depressed scar. The infection is very seldom fatal.

The disease in dogs is similar to that in man, ulcers being found on the skin.

Diagnosis, treatment and control:

Positive diagnosis is established by indentification of the causative organisms. Antimony compounds are effective against leishmaniasis. Control measure include treatment and control and/or elimination of dogs and other reservoirs, vaccination of man and control of sand-flies.

7. TREMATODE ZOONOSES

Table 6. Trematode zoonoses

Disease	Causative organism	Animals principally involved	Prevalence
Fascioliasis	Fasciola hepatica F. gigantica	Ruminants	World-wide
Schistosomiasis	Schistosoma Japanicum S. mansoni	Mammals, monkeys	Far East, Tropical Africa, South America.
	S. haematobium	Monkeys	South Africa, Western Asia, Southern Europe, Australia.
	S. mattheei	Cattle, sheep, antelope	South Africa, East Africa.
Paragoniamiasis	Paragonimus westermani and other species	Cats, dogs, wild animals	Africa, Eastern Asia.
Cercarial dermatitis	Schistosoma spp.	Birds, mammals	World-wide
Fasciolopsiasis	Fasciolopsis buski	Swine	China, South East Asia, Philippines.
Heterophyiasis	Heterophye heterophyes	Cats, dogs	Egypt.
Echinostomiasis	Echinostoma ilocanum	Cats, dogs, rodents	South East Asia.
Amphistomiasis	Gastrodiscoides hominis	Swine	India, China, Indo-China.
Metagonimiasis	Metagonimus yokogawa	Dogs, cats	Balkans, Eastern Asia.

Fascioliasis

Fascioliasis is a disease caused by Fasciola hepatica and F. gigantica which cause significant damage in domestic animals especially cattle, sheep and goats, but also occur in other mammals including man.

The adult fluke found in the liver, bile ducts and gallbladder is 20 to 30 mm. long and about 13mm. wide in F. hepatica and up to 75mm. long and about 12mm. wide in F. gigantica, flatted and leaf-like and usually reddish-brown. It is hermaphroditic and reproduced by depositing ova in the biliary passage, through which they reach the intestine and are expelled with faeces. Each ovum produces a free living form, a miracidium, which penetrates the body of one of several varieties of snails where encystment and asexual reproduction take place through several stages, the parasites finally emerging from the snail in motile forms known as cercariae which usually encyst on plants or other vegetation. In this form, called metacercariae, the parasites are ingested by hosts; when they reach

the intestines they excyst, penetrate the wall and migrate to the liver, eventually developing to maturity in the biliary passages.

Clinical findings:

No appreciable damage is done during passage through the intestinal wall or the peritoneal cavity, the principal lesions occurring in the liver.

Acute fascioliasis primarily in sheep results from a traumatic hepatitis produced by the simultaneous migration of large numbers of immature parasites if the number of metacercariae ingested is great. Animals may die very quickly, leaving lesions such as the enlarged, pale and friable liver, accompanied with haemorrhagic tracts on the surface and throughout the substance, and fibrinous clots in the liver surface and throughout the peritoneal cavity.

In chronic facioliasis which is more common in animals and man, and usually not fatal, symptoms are hardly specific, consisting of anaemia, emaciation diarrhoea and constipation, reduced milk secretion, submandibular oedema, etc. Cirrhosis develops. The bile ducts stand out white, greatly thickened and firm and they may be calcified.

Diagnosis:

This depends on identification of eggs of the parasites in the fecal sample. At necropsy, the nature of the liver damage is almost diagnostic. Adult flukes are readily seen in the bile ducts, and in their immature stages flukes may be squeezed or teased from the cut surface.

Treatment and control:

Remedies include carbon-tetrachloride, hexachloroethane, nitroxynil, oxyclozanide, diamphnethide, refoxanide, bithionol, etc. Control measures for animal infections involve the use of anthelmintics, isolation of animals from infected animals and snails, pasture drainage to destroy snail habitats and the use of molluscicides. As ingestion of metacercariea with water or plants is the source of human infections, avoiding consumption of raw water or vegetable can control the infection in man.

Schistosomiasis (Bilharzia)

Schistosomes occur in almost all mammals including man, birds and widespread throughout the world. This disease is however, of major importance to man.

There are four species of Schistosoma which are nominated as zoonosis: S. **haematobium**, occuring in Africa, Western Asia, Southern Europe and Australia; S. **mansoni**, occuring in tropical Africa and South America; S. **japonicum**, occuring in Far East; and S. **mattheei**, occuring in South Africa. Of these four, only in S. **japonicum** infections do animals play an important role as reservoirs for human infection. Usually only monkeys apart from man are susceptible to S. **haematobium** and S. **mansoni**. S. **mattheei** is found in sheep, with which man becomes infected rarely.

Schistosomes are very small, unisexual trematodes which live in blood vessels of their hosts. The females are slender round worms, 1.4 to 2.0 cm. in length. The males are shorter and thinner than the females.

The adult female, after copulation with male within the lumen of a vein, moves against the venous blood stream into small venules where she deposits the ova. Schistosomes that live in the messenteric veins (S. japonicum, S. mansoni, and S. mattheei) deposit their ova in venules of the intestine, while those that dwell in pelvic veins (S. haematobium) utilise venules of the urinary bladder. The ova so deposited rupture the capillary walls and move through the tissues toward the lumen of the intestine or the urinary bladder. The ova then leave the body of the host with the faeces or the urine. Upon reaching of favourable external environment, a single ovoid ciliated organism, a

miracidium, quickly escapes from the ovum. The miracidium swims about in the water until it finds a suitable intermediate host, a fresh-water snail whose body it penetrates. Within the body of the snail numerous tiny fork-tailed organisms, cecariae, develop from one miracidium through the tissue of the snail. Upon meeting with a final host, the cecariae penetrate the skin and enter small peripheral veins to be carried by the venous circulation to the lungs where it is believed they either break through the lung parenchyma, migrating directly to the live, or reach the arterial system to be carried to the liver. Within the intrahepatic portal system the flukes grow in size, then eventually migrate to the portal, mesenteric or pelvis veins.

Clinical findings:

After an incubation period of about three months, S. haematobium infestation causes haematuria, frequency, and dysuria. Though the illness is usually mild the symptoms are intractable.

S. mansoni infestation has a shorter incubation period of about two months, followed by coughing, headache, malaise, fever and rigors, abdominal pain, and enlargement of the liver and spleen. The general symptoms are usually followed by diarrhoea, with blood and mucus in the stools, due to the ulcerative and polypoid lesions in the colon. Urticarial and other skin rashes are often found and eosinophilia is common. Cirrhosis of the liver with ascites is a late complication.

Diagnosis:

The clinical diagnosis can be confirmed by demonstration of schistosoma ova in the faeces of urine, or by histologic examination of biopsy specimens of rectal mucosa, liver or other affected organs. At necropsy the adult parasite may be found in veins. The typical ova in granulomas are demonstrable by histologic examination of specimens collected at necropsy or biopsy.

Treatment and control:

Tartar emetic and other trivalent antimony compounds, and xanthine derivatives have been used in man and animals. Control measures include sanitation, treatment of infected hosts and elimination of snails. However, none of these three measures seem to be easily performed in infected areas.

Paragonimiasis

This is a disease caused by "lung flukes" of the genus Paragonimus. **Paragonimus westermani** and other species parasitize both man and animals such as pigs, dogs, cats, cattle and wild carnivores, found in the lungs but occasionally in the brain, spinal cord and other organs.

The parasites are small, reddish-brown, egg-shaped and hermaphroditic, measuring 8 to 12mm. long and 4 to 6 mm. in diameter, and having a spiny cuticle. The need first and second intermediate hosts to complete its life cycle: a fresh-water snail and a fresh-water crab or crayfish. Eggs are laid in the cysts developed from dilated small brochioles and when the cysts rupture they push up from the lungs with mucus, and are found either in the sputum or in the faeces. Eggs finally develop into an infective form, a metacercariae, passing through two suitable intermediate hosts. The final host becomes infected by eating infected crustacea or drinking infected water. The young flukes migrate from the intestine into the lungs of the final host, but some may also enter organs such as the brain and the spinal cord. In the lungs the host forms a cyst wall around the flukes which develop to their maturity.

The parasites in the lungs are not usually of great importance but those which lodge in the brain and other organs can cause trouble.

Diagnosis of lung case is readily made by finding the eggs in the sputum or faeces. In other cases diagnosis may be extremely difficult. The complement fixation test and the intradermal test have been developed.

Bithionol has been used in human subjects for the treatment. Control measures consist of extermination of snails, consumption of well-cooked fresh-water crustacea and ordinary hygienic procedures.

Cercerial dermatitis

The condition is variously known as "swimmer's itch", "clam digger's itch", "Gulf coast itch", etc.

It is caused by penetration of cercariae of non-human schistosomes into the skin of man, producing, on first exposure, a mild erythema, but on repeated exposure, a marked reaction with pruritus, vesicle formation and marked papule formation. It usually takes about a week for the condition to subside. A number of species of schistosomes have been incriminated.

8. CESTODE ZOONOSES

Table 7. **Cestode zoonoses**

Disease	Causative organism	Animals principally involved	Prevalence
Echinococcosis Hydatidosis	Echinococcus granulosus	Dogs, wild carnivores domestic and wild ungulates.	World-wide
	E. Maltilocularis	Foxes, dogs, rodents	World-wide
Multiceps infection Coenuriasis	Multiceps multiceps	Ruminants	World-wide
Beef tapeworms (infection)	Taenia saginata	Cattle	World-wide
Fish tapeworm infection (Diphyllobothriasis)	Diphylobothrium latum	Dogs, fish-eating animals	World-wide
Rat tapeworm (Hymenolepiasis)	Hymenolepis nana H. diminuta	Rats, mice	World-wide
Dog tapeworm (Dipylidiasis)	Dipylidium caninum	Dogs, cats	World-wide
Inermicapsifer infection	Inermecapsifer madagascariensis	Rodents	Africa, Cuba
Sparganosis	Psendodyllisean tapeworm	Cats, carnivores, mice, other vertebrates	Japan, Taiwan, Indo-China
Bertiella infection	Bertiella studeri	primates	Around the Indian Ocean.

Echinococcosis (Hydatidosis)

This is a disease caused by the intermidiate stage of **Echinococcus spp.**, a tapeworm of dogs, carnivores and wild ungulates, occuring in man, sheep, goats, cattle, horses, swine, etc. In man, echinococcosis is particularly serious and treatment except for surgical operation is known, however in domestic animals this disease is rare. The adult tapeworm is usually harmless to the host, except when it occurs in large numbers.

The adult tapeworm is only about half a centimeter in length. It lives in the intestine of the final host. The ova are swallowed by the above-said intermediate host. The larvae then penetrate the intestinal wall and may reach any part of the body, especially the liver and lungs, but also the brain, and develop into the cystic form. The final host becomes infected by ingestion of raw offal containing fertile cysts.

Diagnosis:

Diagnosis of hydatid infection in the living subjects is difficult. The hydatid cysts be identified by pathogenic examination of tissues removed at exploratory laparotomy or at necropsy. Immunodiagnostic tests are used in human medicine.

Treatment and Control:

Treatment of hydatid cyst is either by removal of the whole cyst or by marsupialisation of the cyst. Preventive measures include regular treatment of dogs for tapeworms, destruction of hydatids found in slaughtered animals and washing hands after handling dogs. Dogs should get no raw offal to eat.

Multiceps infection (Coenuriasis)

Multiceps multiceps occurs in dogs and related species, growing up to 100 cm. in length. The larval stage, Coenuris cerebralis develops into the form of cysts measuring to 5cm. or more in diameter, only in the brain and spinal cord of sheep, goats, cattle, horsekind and occasionally in man. Infection of the final host, the dog occurs by ingestion of coenuri in the brain or spinal cord of intermediate hosts.

Beef tapeworm infection

Taenia saginata frequently occurs in the small intestines of man, while the intermediate stage is found in cattle. The worm is usually 4 to 8 rarely up to 15m. long.

When the eggs are ingested by cattle, oncospheres are liberated and bore through the intestinal wall, enter the blood stream, and come to rest ultimately in the connective tissue between muscle fibers, especially in the masseter muscle, the heart, tongue and diaphragm, although they can be found in almost any other muscles. Having arrived at their destination they grow into bladder worms or cysticerci, **Cystercecus bovis**. The cysticerci appear when mature as pearly white oval nodules, 7.5mm. by 6mm. at meat inspection or postmortem examination. However they are inconspicuous and can easily be overlooked. Man is infected by eating uncooked or rare beef. Adult tapeworm may cause abdominal discomfort diarreha, or abnormal appetite in man.

Diagnosis:

Diagnosis of animal infection with the larval stage is made after the animal has been slaughtered by finding the cysticerci. Antemortem diagnosis is not possible except by serological methods which are, however, not sufficiently specific to be of much value.

Treatment and Control:

Treatment of animals infected with the larval stage of the parasite is not feasible. The cysticercus is killed by cooking all parts of the meat to 135°F or more, i.e. till meat is uniformly grey, and by low temperatures which freeze the liquid in the bladder, for which up to 10 days at -8 to -10°C are necessary.

Pork tapeworm infection

Taenia solium is found in the small intestine of man. The larval stage occurs in pigs but occasionally in dogs and man, too. The adult worm is 3 to 5m. long.

The life cycle is similar to **Taenia saginata** except that the intermmediate hosts are principally pigs, but dogs and man can also become infected with the larval stage of the worm. The cysticerci, **Cysticercus cellulosae** measuring 6 to 8mm. long, are found chiefly in the muscle of heart, tongue, forearm, thigh and neck, but may also occur in many other parts of the body.

Clinical findings:

The adult worms in the intestine of man do not cause such severe effects, however, this species is particularly dangerous when cysticercosis develops. The effects depend on the location of the cysticerci in the body. A few in the muscles or subcutaneous tissues are nothing to worry about, but chiefly as the result of mechanical pressure, they may create unpleasant disturbances when they locate in the eye, heart, spinal cord, brain, or other delicate organs.

Infected pigs show no signs as a rule. Dogs with cysts in the brain may show symptoms resembling of rabies.

Diagnosis:

The cysticerci can sometimes be felt under the tongue of animals. Most usually the infection in the pigs is detected at meat inspection or postmortem examination. In the human field diagnosis is established by identification of segments or ova of the tapeworm in the faeces, and serological tests have been used for diagnosis of cerebral cysticercosis. Radiographic diagnosis is also employed in the human field.

Treatment and Control:

There are no remedies which are effective against the cysticercus except for surgical removal. Cysticercus cellulosae may be killed by freezing pork at 14 to 18°F continuously for 4 days. Heating pork at 113 to 122°F kills the cyst. Chilling, roasting and pickling the meat may fail to kill the cyst.

Fish tapeworm infection (Diphyllobothriasis)

Fish tapeworm infection is the infection of **Diphyllobothrium latum**, a tapeworm of man, dogs, cats and other fish-eating animals. The first intermediate host is a fresh-water crustacean, and the secondary intermediate host is a fresh-water-fish, including pike, trout, salmon, perch and others. The definitive host becomes infected through eating raw insufficiently cooked fish.

This tapeworm measuring 2 to 10m. long, parasitize the intestines of the definitive host and cause abdominal pain, loss of weight, progressive weakness and occasionally severe anaemia by assimilating large quantities of vitamin B12. However the pathogenecity of D. latum for dogs and cats is not well known.

Control of D. latum infection in man depends mainly on careful cooking of fish. The practice of feeding raw fish to dogs and cats should be discouraged. Pollution of lakes etc, with faeces is to be taken into account. Diagnosis is rather easily done by faecal examination for eggs.

Rat tapeworm infection (Hymenolepiasis)

Two species of the family Hymenolepidiae are parasitic in man.

Hymenolepis nana:

This is the dwarf tapeworm in the intestines of man, rats and mice. The entire worm is only 25 to 40mm. long. Unlike almost all other tapeworms, this tapeworm has no intermediate hosts. However eggs of rodents will develop in man and vice versa.

Prevention, therefore would seem to depend primarily on preventing access of mice or rats to food.

Hymenolepis diminuta:

This occurs in rats and mice, and much less common in man. It is 2 to 6cm. long or longer. This species requires an intermediate host, a grain-infecting insect including the larva, nymph and adult of various species of moths, earwigs, cockroaches, fleas, beetles, and millipedes. Human infection results from eating food in which rat or mouse droppings are present.

Clinical findings and diagnosis:

Heavy hymenolepis infections may cause enteritis, anorexia, headache, anal pruritus and abdominal distress. Diagnosis of hymenolepis infection can be easily done by faecal examination for eggs.

Dog tapeworm infection (Diphylidiasis)

The causative tapeworm, **Diphylidium caninum** is the commonest tapeworm of dogs, but also occurs in cats, foxes and occasionally in man. It may be up to 50cm. long and stay in the small intestine of the hosts. The intermediate hosts are fleas: the dog flea: Ctenocephalides canis, the cat flea; C. felis, and the human flea; Pulex irritans. The final host acquires the parasite by swallowing the infected flea: The human cases, which occur mainly in young children are probably due to the accidental ingestion of such fleas when they play with dogs and cats.

9. NEMATODE ZOONOSES

Table 8. Nematode zoonoses **Nematode zoonoses**

Disease	Causative organism	Animals principally involved	Prevalence
Larva migrans	Ancylostoma braziliense and other species	Cats, dogs	World-wide
	Angiostrongylus cantnensis	Rats	The Pacific area
	Anisakid spp.	Fish	Europe
	Gnathostoma spingerum	Cats, dogs, other vetebrates	Asia
	Toxocara canis and other ascarid species	Dogs, other vetebrates	World-wide
Trichinosis	Trichinella spiralis	Swine, rodents, canivores	World-wide
Ancylostomiasis	Ancylostoma brazilense	Cats, dogs	Worl-wide
	Ancylostoma caninum	Dogs, foxes	World-wide
Ascariasis*	Ascaris lumbricoides var suum	Swine	World-wide
Capillariasis	Capilaria hepatica	Rodents	World-wide
Dracunculosis	Dracunculus medinensis	Dogs, horses, cattle other animals	Southern to Western Asia; Africa
Filariasis	Brugia malayi	Primates, other animals	Asia
	Dirofilaria ssp. and occasionally other species.	Cats, dogs other animals	Warm climates.

* Ascaris lumbricoides va. suum of swine is now believed to be distinct from Ascaris lumbricoides of man.

Table 8 continued — Nematode zoonoses

Disease	Causative organism	Animals principally involved	Prevalence
Oesophagostomiasis	Oesophagostomum apiostomum	Primates	West Africa
Strongyloidiasis	Strongyloides stercoralis and occasionally other species.	Dogs, cats	South America, Panama, Oceania, Japan.
Ternidens infection	Ternidens diminutus	Primates	Africa, Celebes.
Trichostrongylosis	Tricostrongylus colubriformis and occasionally other species.	Ruminants	World-wide

Larva migrans

This is the disease condition produced by larvae of nematodes in the aberrant host, not in the specific host.

Visceral larva migrans:

This condition is observed usually in man, especially in children and mainly caused by the larvae of **Toxocara canis**, and intestinal parasite of dogs and foxes. The entity is characterised by the chronic granulomatous lesions, associated with larvae of the parasite, in the inner organs of children, especially the liver, lungs, brain, eye, etc.

The young children contract the disease by ingesting the soil contaminated with the worm eggs. The diagnosis is based on clinical symptoms or finding the larvae in biopsy specimens of liver tissue etc. There is no effective treatment.

Visceral larva migrans also occur in animals. Other nematodes which cause visceral larva migrans include **Toxocara leonina** of dogs, cats and foxes, **T. cati** of cats and the wild feline, **Capillaria hepatica** of rodents and **Lagochilascaris minor** of the wild feline.

Cutaneous larva migrans (Creeping eruption):

This condition occurs in man and other hosts. The larvae of the nematodes enter the skin and migrate in it, causing papules, inflamed tracks, sometimes with thickening of the skin and pruritus. The larvae of **Ancylostoma braziliense** of dogs and cats frequently cause this condition in man.

Other species which may cause the condition are **Uncinaria stenocephala** of dogs and foxes, **Ancylostoma caninum** of dogs and cats, **A. duodenale** of man, **Necater americanus** of man, **Bunostomum phlebotomum** of cattle and species of **Strongyloides** and **Gnathostoma.**

Trichonisis

A very small nematode, **Trichinella spiralis**, is an intestinal parasite as an adult, but the principal excitants of symptoms and lesions are the larvae which burrow through tissues and encyst in striated muscles. The worm is found in man, swine, carnivores and rodents. The female is 3 to 4mm. long. The male is 1.5mm. long.

The life cycle is initiated when the host ingests raw or undercooked flesh containing encysted larvae. The infected larvae are released from the ingested muscle by the action of digestive juices, then mature quickly through four moults. After copulation the male dies, but the female which is

viviparous having trichina embryos in the uterus, burrows deeply into the mucous membranes and deposits a large number of larvae. The larvae then enter the blood stream and reach especially the voluntary muscles. They invade the muscle bundles and encyst, and remain throughout the life of the host. Further development of the parasite follows upon ingestion of the infected muscle by another host. Man usually becomes infected from eating raw or undercooked pork, while pigs are most commonly infected by being fed on garbage containing infected pork scraps etc.

Clinical findings:

The infection of Trichinella spiralis usually does not cause clinical signs in animals but it often gives serious trouble in man. The most important pathogenic effects are produced by the larvae in the muscles. The clinical signs are very variable and include diarrhoea, fever, stiffness and pain in the affected muscles, dyspnea, hoarseness, oedema of the face, deafness, etc. Leukocytosis with eosinophilia is characteristic.

Diagnosis:

In the human a provisional diagnosis may be made on clinical signs. Larvae may be detected by examination of muscles taken by biopsy. Search for adult worms in faeces and larvae in the blood or cerebrospinal fluid are not reliable. A number of immunological tests have been used.

The diagnosis in animals is mainly done at meat inspection. A European meat inspection practise utilises bits of fresh skeletal muscle, usually diaphram, which are compressed between two slides and examined under low magnification. Larvae are easily recognized in these preparations if the infection is heavy enough and is in the last stage.

Treatment and Control:

Thiabendazole has been demonstrated to be effective against both adult intestinal and larval muscle phases. Trichinella larvae can be killed quickly by a temperature of 55°C or by quick freezing at −18°C to −34°C for 24 hours. Control measures include sufficient cooking of pork, forbidding the feeding of raw garbage or flesh to pigs and strict meat examination at the slaughter house.

Capillariasis

A slender nematode, **Capillaria hepatica** found in the liver of mice, rats, dogs and other animals, may accidentally infect man. The worms are very thin and 4 to 12cm. long.

The life cycle is more or less direct though eggs trapped in the liver of the infected host must be liberated by the digestive processes of a second host, the eggs then pass to the soil. Infection of a third host is by ingestion of the embryonated eggs.

Subacute hepatitis accompanied with eosinophilia has been recorded in human infections.

Dracunculosis

Dracunculosis is an age-old and remarkable human parasitism produced by the "guinea worm", **Dracunculus medinensis**, occurring in dry climates, southern to western Asia and western, central and eastern Africa. The infections are also found in animals such as horses, cattle and dogs but the animal infection does not play an important role for the human infection.

The male is 12 to 29mm. long, but the female may become very large, 1 to 4m. long. The adult female lives in the subcutaneous connective tissues of the host, and deposits her living larvae through a small orifice in the skin at the apex of the small nodule formed by the parasite. The larvae are extruded at times when the lesion is in contact with water, especially in step-wells or reservoirs, in which their intermediate hosts, a cyclops, dwell. The larvae become infective in these crustaceans and reach the next definitive host by being drunk with the intermediate hosts. The infective larvae are released from the intermediate host in the intestine of the definitive host. The larvae then presumably migrate through the tissues, become mature and copulate, and then only the female parent reaches the

subcutis. Shortly before the parasite comes to the subcutis, the host may show symptoms such as urticaria, nausea and vomiting, diarrhoea, giddiness and fainting.

Ternidens infection

Ternidens **deminutus** is believed to be a common parasite in man and monkeys in southern East Africa. The worms are blood suckers and resemble hookworms.

Trichostrongylosis

The species of the genus Trichostrongylus are small, measuring 4 to 6mm. long, slender, pale reddish-brown worms, found in small intestine and abomasum of cattle, sheep, goats and occassionally in other mammals including man. There are many species widespread throughout the tropics, where human Trichostrongylus infections are believed to be fairly common. The reason of a high incidence of the infections is supposed to be attributable to the close association of man and animals. Since the infections are, however, usually very light they are of little consequence in man, but in animals the infections are often serious problems.

The life cycle of Trichostrongylus is direct; the eggs pass to the ground in the faeces, hatch into filariform larvae, develop through larval stage in the soil, and produce infection in a new host by being ingested with fresh grass. There is no migratory stage and adults are found in the abomasum or small intestine.

10. FUNGAL ZOONOSES

Dermatomycoses (Ring worm, Tinea)

Many species of fungi can infect both animals and man, but only in the case of dermatomycoses do animals play a positive role in the human infection or vice-versa.

Dermatomycoses are the infection of the skin, hairs and nails caused by dermatophytic fungi. The infections occur in all animals and man throughout the world. Dermatophytes comprise three genera: Trichophyton, Microsporum and Epidermophyton.

Lesions of dermatomycoses are limited to hairs, nails, epidermis and dermis, including broken hairs, exudation from the lesion, desquamated epitherium and crusts. Itching is generally not a feature of primary dermatomycoses, however it occurs when secondary bacteria infect.

Dermatomycoses are usually seasonal, the season coinciding with the period when the skin remain wet for long enough. There is always a possibility of human infection when people contact any species of animals which suffer the infection, and vice-versa.

11. ARTHROPODIC ZOONOSES

Table 9. **Arthropodic zoonoses**

Disease	Causative organism	Animal principally involved	Prevalence
Mites			
Acariasis	Sarcoptes spp.	Mammals	World-wide
Fleas			
Tunga infections	Tunga penetrans	Mammals	The tropics
Flies			
Myiasis (Srew-worms infection)	Cochliomyia, Cordylobia, Dermatobia, Gastrophilus, Hypoderma, Oestrus, and other genera.	Mammals	World-wide

Table Continued

Disease	Causative organism	Animals principally involved	Prevalence
Tongue worms and allies Pentastomid infection	Linguatula spp., Armillifer spp., and Porocephalus spp.	Vertebrates	World-wide