M.Sc. 1st Semester; Course Code: Zoo-09-GE; Unit: II

2.3. Insects as vectors of bacterial and viral diseases of domestic animals

A) Bacterial diseases

ANTHRAX

Anthrax is an infectious disease caused by a bacterium called *Bacillus anthracis*, which can change into spores that can last for a long time in the environment before germinating. It is carried by wild and domestic animals in Asia, Africa and parts of Europe. There are two main types of anthrax. The **cutaneous anthrax** starts as a skin bump that ulcerates, which is not generally a serious illness. The second type is **inhalational anthrax**, is normally less common and symptoms begin as a flu-like illness which progresses to pneumonia, respiratory failure and septicaemia, which can lead to shock and death. There is a third type, **intestinal anthrax**, but this is a very rare form of food poisoning and results in fever and severe gut disease.

Cutaneous anthrax tends to occur through direct contact with the skin or tissues of infected animals. The early stages of the lesion are noticed about 3 days from exposure, although the incubation period can be up to 60 days. Inhaled anthrax usually shows up about 2-3 days after exposure and can be fatal within the next 2-3 days. The spores can be inhaled directly into the lungs. Spores with food cause the intestinal form of the disease. Normally 95 percent of anthrax cases are cutaneous and are caused by direct contact with abrasions on the skin. There have been no known cases of person-to-person spread of anthrax pneumonia and it is not thought to be a significant health risk.

Treatment can be done with Ciprofloxacin and doxycyline are also used as prophylaxis for people who have been exposed. Early treatment is needed if inhaled anthrax is suspected. There is an immunisation against anthrax but it takes five doses of vaccine over the course of a year to get immunity. This makes immunisation too slow to deal with accidental or deliberate exposure. It is normally offered to those who handle infected animals, and laboratory staff who work with the bacteria. Swabs and smears can be taken from infected exposed people and blood can be analysed for the presence of the bacteria.

LEPTOSPIROSIS

It is a bacterial disease that affects humans and animals. It is caused by bacteria of the genus *Leptospira*. Symptoms of leptospirosis include high fever, severe headache, chills, muscle aches, and vomiting, and may include jaundice (yellow skin and eyes), red eyes, abdominal pain, diarrhea, or a rash. If the disease is not treated, the animal could develop kidney damage, meningitis, liver failure, and respiratory distress. In rare cases death occurs. Treatment is done with antibiotics.

ANAPLASMOSIS

Anaplasmosis is a type of tick fever that is caused by invasion of red blood cells by the rickettsial blood parasite *Anaplasma ovis.* In cattle, the disease is caused by *A. marginale* or *A. centrale.* Transmission is through insect vectors, especially horse

flies, ticks and flies. Ticks are the natural vectors and a range of tick species has been shown to be capable of transmitting infection, e.g. *Boophilus, Dermacentor, Rhipicephalus, Ixodes, Hyalomma, Argas* and *Ornithodoros.* There is also some evidence that it can be transmitted to the fetus in the womb. Cattle over 2 years of age become very ill and approximately 50% die unless treated. Usually, once the cattle become infected, and if they survive, stay infected for life. They are "immune carriers"—they do not get sick, but act as a reservoir for other susceptible animals.

The important symptoms are fever, anemia and jaundice or yellowing of the mucous membranes. In cattle, the severity of the disease is directly related to age, with adults showing the greatest difficulty. Additionally, a drop in milk production, weight loss, depression, dehydration, constipation and lack of appetite may be observed. Some animals which recover remain weak and emaciated through life. Most of the sick animals die within a few days of the fever starting, if they are not treated. The use of tetracyclines or imidocarb diproprionate is effective, however, the drug mush be administered early in the disease. Tick control by acaracide dipping is widely used in endemic areas. Anaplasmosis vaccines are readily available and are highly effective. The most commonly used vaccine is a live Anaplasma centrale vaccine used either singly or in combination with Babesia bovis vaccine.

TULAREMIA

It is caused by the bacterium *Francisella tularensis* found in animals, especially rodents, rabbits, and hares. Symptoms of tularemia could include: sudden fever, chills, headaches, diarrhoea, muscle aches, joint pain, dry cough and progressive weakness. People can also catch pneumonia and develop chest pain, bloody sputum and can have trouble breathing and even sometimes stop breathing. Other symptoms include ulcers on the skin or mouth, swollen and painful lymph glands, swollen and painful eyes, and a sore throat.

Disease can spread by being bitten by an infected tick, deerfly or other insect, eating or drinking contaminated food or water, breathing in the bacteria, *F. tularensis*. Tularemia is not known to be spread from person to person. The disease can be fatal if it is not treated with the right antibiotics. The drug of choice for treating tularemia is streptomycin or gentamicin, although other antibiotics also are also effective.

Several precautions can protect individuals from tularemia.

- Avoid drinking, bathing, swimming or working in untreated water where infection may be common among wild animals.
- Use impervious gloves when skinning or handling animals, especially rabbits.
- Cook the meat of wild rabbits and rodents thoroughly.
- Avoid being bitten by deer flies and ticks.

RELAPSING FEVER

Louse-borne relapsing fever

Borrelia recurrentis is the only agent of louse-borne disease. *Pediculus humanus,* is the specific vector. Louse-borne relapsing fever is more severe than the tick-borne variety. It occurs in poor living conditions, famine and war conditions.

Mortality rate is 1% with treatment but 30-70% without treatment. Diagnosis includes severe jaundice, severe change in mental status, severe bleeding, and prolonged QT interval on ECG.

Lice that feed on infected humans acquire the *Borrelia* organisms that then multiply in the gut of the louse. When an infected louse feeds on an uninfected human, the organism gains access when the victim crushes the louse or scratches the area where the louse is feeding. *B. recurrentis* infects the person via mucous membranes and then invades the bloodstream. Cattle lice can spread the disease in animals.

Tick-borne Relapsing Fever

Other relapsing infections are acquired from other *Borrelia* species, such as *Borreliahermsii* or *Borrelia parkeri*, which can be spread from rodents, and serve as a reservoir for the infection, via a tick vector. *Borrelia hermsii* and *Borrelia recurrentis* cause very similar diseases although the disease associated with *Borrelia hermsii* has more relapses and is responsible for more fatalities, while the disease caused by *B. recurrentis* has longer febrile and afebrile intervals and a longer incubation period. Tick-borne relapsing fever is found primarily in Africa, Spain, Saudi Arabia, Asia, and certain areas in the Western U.S. and Canada. It is *Borrelia duttoni* transmitted by the soft-bodied African tick *Ornithodoros moubata* that is responsible for the relapsing fever found in Central, East and southern Africa.

BOVINE TUBERCULOSIS

There are three types of TB – human, avian, and bovine. Human TB is rarely transmitted to non-humans, avian TB is typically restricted to birds, and bovine TB – or cattle TB – is the most infectious, capable of infecting most mammals. Bovine TB is caused by the bacterium *Mycobacterium bovis*, which is part of the *Mycobacterium tuberculosis* complex. Bovine TB is spread through the exchange of respiratory secretions between infected and uninfected animals. Bacteria released into the air through coughing and sneezing can spread the disease to uninfected animals. Non-cerviid animals are most likely to contract TB from feeding on infected tissues from deer carcasses.

Bovine TB is a chronic disease and it can take years to develop. *M. Bovis* grows very slowly and only replicates every 12-20 hours. The lymph nodes in the animal's head usually show infection first and as the disease progresses. Lesions will begin to develop on the surface of the lungs and chest cavity. Non-cerviid animals do not develop the disease as extensively and lesions are usually not found in lungs or other tissues. Infected lymph nodes will contain one or more necrotic nodules, which may vary in size and be filled with yellow-green or tan pus. Coughing, nasal discharge, and difficulty in breathing can result in cases where the lungs become severely affected. In some instances, superficial lymph nodes in the neck will develop large abscesses that may rupture and drain through the skin.

Diagnosis is done by removal of suspicious looking lymph nodes for further testing. *M. Bovis* is unique among the bacteria because they have a lot of waxy

material in their cell walls. Because of the waxy material (known as mycolic acid), the usual stains for looking at bacteria with a microscope do not work. Since there are no effective vaccines for the disease, a combination of wildlife disease surveys and deer management strategies are being used to eliminate the disease in wild deer. Humans can be skin-tested to determine if they have been exposed to TB.

Lists of diseases

Disease	Pathogen(s)	Animals involved	Mode of transmission
African sleeping sickness	*Trypanosoma brucei rhodesiense*	range of wild animals and domestic livestock	transmitted by the bite of the tsetse fly
Anthrax	*Bacillus anthracis*	commonly - grazing herbivores such as cattle, sheep, goats, camels, horses, and pigs	by ingestion, inhalation or skin contact of spores
Brucellosis	*Brucella* spp.	cattle, goats	infected milk or meat
Cat-scratch disease	*Bartonella henselae*, *Bartonella quintana*	Cats	bites or scratches from infected cats
Variant Creutzfeldt–Jakob disease	PrP^{vCJD}	Cattle	eating meat from animals with bovine spongiform encephalopathy (BSE)
Cysticercosis & Taen iasis	*Taenia solium*, *Taenia saginata*	commonly - pigs and cattle	consuming water or food contaminated with the tapeworm eggs (cysticercosis) or raw or undercooked pork contaminated with the cysticerci(taeni asis)
Cryptococcosis	*Cryptococcus neoformans*	commonly - birds like pigeons	inhaling fungi

Ebola virus disease (a haemorrhagic fever)	*Ebolavirus* spp.	chimpanzees, gorillas, fruit bats, monkeys, forest antelope and porcupines	through body fluids, organs
Other haemorrhagic fevers (Marburg viral haemorrhagic fever, Lassa fever, Crimean-Congo haemorrhagic fever, Rift Valley fever)	Varies – commonly viruses	varies (sometimes unknown) - commonly camels, hares, hedgehogs, cattle, sheep, goats, horses and swine	infection usually occurs through direct contact with infected animals
Echinococcosis	*Echinococcus* spp.	commonly - dogs, foxes, wolves, sheep, and rodents	eating organs contaminated with cystsof the tapeworm
Foodborne illnesses (commonly diarrheal diseases)	*Campylobacter* spp., *Escherichia coli*, *Salmonella* spp., *Shigella* spp. and *Trichinella* spp.	animals domesticated for food production (cattle, poultry)	raw and/or undercooked food made from animals
Histoplasmosis	*Histoplasma capsulatum*	birds, bats	inhaling fungi
Influenza	*Influenza A virus*	horses, pigs, domestic and wild birds, wild aquatic mammals such as seals and whales, minks and farmed carnivores	droplets transmitted through air
Leptospirosis	*Leptospira interrogans*	rats, mice, dogs	direct or indirect contact with urine of infected animals
Rabies	*Rabies virus*	commonly - dogs, bats, monkeys, raccoons, foxes, skunks, cattle, wolves, coyotes, mongooses and cats	through saliva by biting, or through scratches from an infected animal
Tularemia	*Francisella*	lagomorphs (type A) and	ticks, deer flies,

	tularensis	rodents (type B)	and other insects
Tuberculosis	*Mycobacterium bovis*	infected cattle, deer, llamas, pigs, domestic cats, wild carnivores (foxes, coyotes) and omnivores (possums, mustelids and rodents)	milk, exhaled air, sputum, urine, faeces and pus from infected animals
Trichinosis	*Trichinella spiralis*, *Trichinella britovi*	rodents, pigs, horses, bears, walruses	eating infected meat
Leprosy	*Mycobacterium leprae*	mainly armadillos but mangabey monkeys, rabbits and mice too	any contact with armadillos including urine, faeces and pus from infected animals, the soil infected by armadillo can make you sick too and of course eating infected meat
Chagas disease	*Trypanosoma cruzi*	armadillos, Triatominae(kissing bug)	bite
Toxocariasis	*Toxocara cani s*and *Toxocara cati*	dogs, cats	exposure to feces
Toxoplasmosis	*Toxoplasma gondii*	cats, livestock, poultry	exposure to cat feces, and undercooked meat

B) viral diseases

SWAMP FEVER

Equine Infectious Anaemia (EIA), also known as swamp fever is a horse disease caused by a retrovirus and transmitted by bloodsucking insects. The EIA virus is mechanically transmitted from one horse to another by the bloodsucking horse flies, deer flies *(Tabanus),* stable flies (*Stomoxys* spp.), mosquitoes and possibly midges. Symptoms include recurrent fever, weight loss, an enlarged spleen, anemia, and swelling of the lower chest, abdominal wall, penile sheath, scrotum, and legs. Horse tires easily due to a recurrent fever and anemia, may relapse to acute form even several years after the original attack.

The EIA virus is a slow acting virus of the lenti-retrovirus group. Retroviruses cause leukemia in cats, mice and cattle, arthritis, pneumonia and neurological diseases in small ruminants and acquired immune deficiency syndrome (AIDS) in humans. These viruses localize and multiply in macrophages of many organs, especially in the spleen, liver, kidney, and lymph nodes, where they take over the cell and sit and wait to become activated. Upon activation, the cell reproduces more viruses, which bursts free from the cell to infect other cells. This causes recurring cycles, in which the horse seems normal and then ill. There is no known treatment that can eliminate the virus from the body. To date there are no satisfactory vaccines for EIA. The Coggins' test is an agar gel diffusion (AGID) test, which is a practical diagnostic test for identifying horses infected with EIA. This test is used to detect the EIA antibody.

EQUINE ENCEPHALOMYELITIS

Equine encephalomyelitis is an inflammation of the brain and spinal cord that affects horses but is also deadly for humans. The virus was isolated, characterized, and vaccines were produced in the 1930s. The viruses responsible for causing these diseases are members of a family of viruses called the alphavirus. The mosquito transmits the virus from small infected animals such as birds and rodents to horses. The warm, humid weather of the summer is good for mosquito breeding and this is when outbreaks are more common. Transmission of EEE is not horse to human, but bird or rodent to human via the mosquito.

Approximately two days after equine infection with encephalomyelitis, there is an infection and low-grade fever. The first apparent signs are at four to five days. At that time, the animal generally has a fever and rapid heart rate, is showing signs of anorexia, depression, and variable other neurological signs. As the illness progresses the brain stem and spinal cord are affected. Muscle weakness becomes apparent and there are behavioural changes and dementia. Notable symptoms include aggression, head pressing, wall leaning, compulsive circling, and blindness. Other signs might include uncontrolled twitching of the eyeball, and facial muscle paralysis. As the disease progresses, a semi-comatose and convulsive state occurs. Death usually follows two or three days later. If the animal survives, residual nervous system

problems result. Encephalomyelitis vaccines are available for horses from several different companies. They are packaged as single or combination vaccines.

AFRICAN HORSE SICKNESS

African horse sickness (AHS) is a highly infectious non-contagious, vector born viral disease affecting all species of Equidae. It is classified as an Orbivirus of family Reoviridae, of which there are 9 serotypes. All serotypes are distributed throughout Africa, although there is a variation in their temporal distribution. It is endemic to the African continent, and is characterised by respiratory and circulatory damage, accompanied by fever and loss of appetite. The disease manifests in three ways, namely the lung form, the heart form and the mixed form. The lung (dunkop) form is characterised in the following manner:

- Very high fever (up to 41 degrees).
- Difficulty in breathing, with mouth open and head hanging down.
- Frothy discharge may pour from the nose.
- Sudden onset of death.
- Very high death rate (90%).

The heart (dikkop) form is characterised in the following manner:

- Fever, followed by swelling of the head and eyes.
- In severe cases, the entire head swells.
- Loss of ability to swallow and possible colic symptoms may occur.
- Terminal signs include bleeding in the membranes of the mouth and eyes.
- Slower onset of death, occurring 4 to 8 days after the fever has started.
- Lower death rate (50%).

This disease is spread by insect vectors such as midges but can also be transmitted by species of mosquitoes including *Culex, Anopheles* and *Aedes*, and species of ticks such as *Hyalomma* and *Rhipicephalus*. There is currently no treatment for AHS. Control of outbreak in an endemic region involves quarantine, vector control and vaccination.

JAPANESE B-ENCEPHALITIS

This is a fatal disease of pigs, horses, sheep, birds and man. The infection is caused by a flavivirus, a single stranded RNA virus. It is transmitted by the bite of the *Culex tritaeniorhynchus* mosquito. The virus multiplies at the site of the bite and in regional lymph nodes before viraemia develops that can lead to inflammatory changes in the heart, lungs, liver, and reticulo-endothelial system. The endemic area for Japanese encephalitis spreads across Asia from Pakistan to the coast of Siberia and includes Japan. The incubation period is 6 to 16 days. There is fever, headache, nausea, diarrhea, vomiting, and myalgia, which may last for several days. This may be followed by a spectrum of neurological disease ranging from mild confusion, to agitation, to overt coma. It is more common in children, while headache and

meningism are more common in adults. Tremor or other involuntary movements are common.

Japanese Encephalitis-VAX was a formalin-inactivated vaccine derived from mouse brain against Japanese B Encephalitis, produced since 1992 by BIKEN (Japan). The new vaccine available in the UK is the Japanese Encephalitis Green Cross vaccine (GC vaccine).

SWINE POX

Swinepox is a worldwide disease of pigs caused by a virus of the family Poxviridae and the genus Suipoxvirus, which can survive outside the pig for long periods of time and is resistant to environmental changes. Symptoms include small circular red areas 10-20mm in diameter that commence with a vesicle containing straw-coloured fluid in the centre. After two to three days the vesicle ruptures and a scab is formed which gradually turns black.

The disease is most frequently seen in young pigs but all ages may be affected. After an incubation period of 1 week, small red areas may be seen most frequently on the face, ears, inside the legs, and abdomen. These develop into papules and, within a few days, pustules develop that change into small vesicles. The centres of the pustules become dry and scabbed and are surrounded by a raised, inflamed zone. Later, dark scabs form, giving affected piglets a spotted appearance. These eventually drop or are rubbed off without leaving a scar. The early stage of the disease may be accompanied by mild fever and dullness. Virus is abundant in the lesions and can be transferred from pig to pig by the biting louse *(Haematopinus suis).* The disease also may be transmitted, possibly between farms, by other insects acting as mechanical carriers. Recovered pigs become immune. There is no specific treatment. Eradication of lice is important.

FOWL POX

Fowl pox is a worldwide disease of poultry caused by viruses of the family Poxviridae and the genus Avipoxvirus. There are two forms of the disease. The first is **cutaneous form(dry pox)** that is spread by biting insects, especially mosquitoes that causes lesions on the comb, wattles, and beak. The second form is **diphtheritic form (wet pox),** which is spread by inhalation of the virus and causes a diphtheritic membrane to form in the mouth, pharynx, larynx, and sometimes the trachea. Symptoms include weight loss, reduced egg production, lesions, small whitish or yellowish areas, nodules or scabs, raised white or opaque nodules which may join to form yellow, cheesy, necrotic lesion. The virus, abundantly present in the lesions is transmitted by contact to pen mates through abrasions of the skins. Mosquitoes and other biting insects can have a mechanical role in the transmissions. Modified live fowl pox virus vaccines are available commercially.

COW POX

Cow pox is a disease of the skin that is caused by a virus known as the Cow pox virus. The pox is related to the vaccinia virus, and got its name from dairy maids touching the udders of infected cows. The cow pox virus is within the family Poxviridae and the genus *Orthopoxvirus*. The ailment manifests itself in the form of red blisters and is transmitted by touch from infected animals to humans. When it is gone, the person is immune to small pox. Cow pox virus has been found only in Europe and in adjacent parts of the former Soviet Union. Despite its name, the reservoir hosts of cow pox virus are rodents, from which it can occasionally spread to cats, cows, humans, and zoo animals, including large cats and elephants. Transmission to humans has traditionally occurred via contact with the infected teats of milking cows. However, currently, infection is seen more commonly among domestic cats, from which it can be transmitted to humans.

The pathology of the skin lesions caused by cow pox virus is similar to that of small pox. However, there is greater epithelial thickening and less rapid cell necrosis. There is also more involvement of the mesodermal tissues. The most significant pathological feature of cow pox is the presence of two types of cytoplasmic inclusion bodies: irregular B-type inclusion bodies, and numerous large, homogenous, acidophilic, A-type inclusion bodies.

Human cow pox usually responds to treatment with antivaccina immunoglobulin. However, this should be restricted to the most severe cases. Usually, the lesions regress spontaneously. Identification and isolation of animals infected with cow pox can help decrease the incidence of human infections.

FOOT & MOUTH DISEASE

Foot-and-mouth disease (FMD) or hoof-and-mouth disease is a highly contagious and sometimes fatal viral disease of domestic animals such as cattle, water buffalo, sheep, goats and pigs, as well as antelope, bison and deer. It is caused by foot-and-mouth disease virus. Seven main types of Foot and Mouth Virus are believed to exist that belong to thegenus Aphthovirus of the family Picornaviridae. Picornaviruses are tiny viruses (27-30 nm across) that are not enveloped with an icosahedral capsid and contain a single strand of positive sense RNA.

The disease is characterised by high fever that declines rapidly after two or three days; blisters inside the mouth that lead to excessive secretion of stringy or foamy saliva and to drooling; and blisters on the feet that may rupture and cause lameness. Adult animals may suffer weight loss from which they do not recover for several months as well as swelling in the testicles of mature males, and in cows, milk production can decline significantly. Symptoms of the Foot and Mouth in Cattle include, Slobbering and smacking lips, Shivering, Tender and sore feet, Reduced milk yield, Sores and blisters on feet and raised temperature.

DISEASE CARRYING INSECTS LIST

If an insect is carrying a virus or other disease, it can transmit it to humans and animals through saliva when it bites or through its feces. Insects that carry diseases are called vectors and are more common in less developed countries. Controlling insect population around humans and animals helps to reduce the transmission of disease. Use building materials that are pest-proof, eliminate pest food sources and use physical traps or poison.

Fleas

Fleas may carry Murine typhus and bubonic plague. People living in the western and southwestern United States are at the highest danger of contracting bubonic plague from fleas. In addition, fleas may carry filarial worms or heartworms that infest dogs and tape worms that attack cats, dogs and occasionally humans. Fleas are wingless insects that feed on blood and most commonly infest domestic dogs and cats. To control flea infestation, it is important to treat all animals and their indoor and outdoor environments simultaneously.

Mosquitoes

Mosquitoes have been vectors of malaria and yellow fever for thousands of years. Today, they are known for carrying Lyme disease and West Nile virus to both humans and animals. In addition, humans are at risk of contracting St. Louis encephalitis, and horses may contract eastern equine encephalitis. In the United States, organized pest control has managed the mosquito population and minimized the risk of spreading disease from mosquitoes. Other control measures include regular cleaning of pools, birdbaths and other water containers, and minimizing stagnant, dirty water. In addition, using bug repellent will help deter existing mosquitoes.

Flies

Some flies, including common houseflies and sand flies, do not bite. However, their presence may be a sign of uncleanliness. Although it does not bite, the housefly is still a disease vector for bacteria such as *Shigella spp.,* which causes dysentary; *Salmonella spp.,* which causes typhoid fever; Vibrio cholera, which causes cholera and traveler's diarrhea. These bacteria are transmitted when the fly regurgitates into human food while the fly is eating. Good sanitation and disposing of food waste are effective ways to control fly population around humans. Tsetse flies are vectors of sleeping sickness or African Trypanosomiasis.

Ticks

Ticks feed on blood and may be vectors of diseases including tularemia, Lyme disease and Rocky Mountain spotted fever. Ticks do not fly or jump; rather they climb onto grasses or branches and attach themselves to a host that walks by. Check yourself, your children and your pets for ticks and promptly remove them. In addition, use a tick or insect repellent, and treat your pets with a collar or topical tick-and-flea treatment.

Conenose Bugs

Conenose bugs, also referred to as kissing bugs, are vectors for American Trypanosomiasis or Chagas' disease. Although kissing bugs do bite, this protozoan

disease is transmitted by contact with the bugs' feces. Keep kissing bugs away from you and your pets by sealing gaps around doors, around windows and between the living area and the attic. Keep pets indoors at night and keep all pet areas clean. If you suspect an infestation, contact a pest control operator to apply a chemical insecticide.

LIST OF DISEASES CAUSED BY INSECTS

Invertebrates are very common vectors of disease. A vector is an organism which spreads disease from one host to another. Invertebrates spread bacterial, viral and protozoan pathogens by two main mechanisms. Either via their bite, as in the case of malaria spread by mosquitoes, or via their faeces, as in the case of Chagas' Disease spread by Triatoma bugs or epidemic typhus spread by human body lice. Many invertebrates are responsible for transmitting diseases. Mosquitoes are perhaps the best known invertebrate vector and transmit a wide range of tropical diseases including malaria, dengue fever and yellow fever. Another large group of vectors are flies. Sandfly species transmit the disease leishmaniasis, by acting as vectors for protozoan *Leishmania*species, and tsetse flies transmit protozoan trypansomes (*Trypanosoma brucei gambiense* and *Trypansoma brucei rhodesiense*) which cause African Trypanosomiasis (sleeping sickness). Ticks and lice form another large group of invertebrate vectors. The bacterium *Borrelia burgdorferi*, which causes Lyme Disease, is transmitted by ticks and members of the bacterial genus *Rickettsia* are transmitted by lice. For example, the human body louse transmits the bacterium *Rickettsia prowazekii* which causes epidemic typhus.

Although invertebrate-transmitted diseases pose a particular threat on the continents of Africa, Asia and South America, there is one way of controlling invertebrate-borne diseases, which is by controlling the invertebrate vector. For example, one way of controlling malaria is to control the mosquito vector through the use of mosquito nets, which prevent mosquitoes from coming into contact with humans.

List of diseases spread by invertebrates.

Disease	Vector	Causative organism	Host	Symptoms	Area	Treatment
African horse sickness	Culicoid midge	*Orbivirus*(virus)	Equids	Fever, lung, heart or mucous membrane symptoms.	Europe, Africa	Vaccination
Babesiosis	Tick	*Babesia*(protozoan)	Human, cattle	Fever then red urine	South Europe and Africa	Antibiotics
Bluetongue disease	Culicoid midge	*Orbivirus*(virus)	Cattle, sheep	Fever, salivation, swelling of face and tongue	Europe, Africa	Vaccination
Chagas disease(Ame	Various assassin	*Trypanosoma cruzi*(protozoan)		Mild symptoms, then chronic heart or brain	Central and	Antiparasitic drugs;

rican trypanosomiasis)	bugs of subfamilyTriatominae			inflammation	South America	treatment of symptoms
Dengue fever	Mosquito	Flavivirus (virus)		Fever thenarthritis	(Sub) tropics and South Europe	Observation / supportive treatment
Tick-borne encephalitis	Tick	Tick-borne encephalitis virus		Ill with flu thenmeningitis	Central and North Europe	prevention and vaccination
Heartland virusdisease	Tick	Heartland virus		Fever, lethargy, headache,myalgia, diarrhea, nausea, loss of appetite, anorexia,thrombocytopenia,leukopenia,arthralgia	Missouri and Tennessee, USA	Supportive treatment
Leishmaniasis	Sandfly	*Leishmania*(protozoan)		Fever, damage to the spleen andliver, and anaemia	South hemisphere and Mediterranean Countries	Treatment of infected
Lyme disease	Tick	*Borrelia burgdorferi*(bacterium)	Deer, human	Bull's-eye pattern skin rash around bite, fever, chills, fatigue, body aches, headache, joint pain. Sometimes neurological problems.	Europe, North Africa, and North America	Prevention and antibiotics
Malaria	Mosquito	*Plasmodium*(protist)	Human	Headache then heavy fever	(Sub) tropics	Prevention and anti-malaria
Plague	Flea		Rats, Human			Prevention and Antibiotics
Pogosta disease Synonyms: Karelian fever Ockelbo disease Sindbis fever	Mosquito	Sindbis virus		Skin rash, fever, in severe cases -arthritis	Scandinavia, France, Russia	Unknown
Rickettsial diseases: Typhus	Tick, lice	*Rickettsia*species (bacteria)		Fever with bleeding around the bite	Global	Prevention and antibiotics

rickettsialpox Boutonneuse fever African tick bite fever Rocky Mountain spotted feveretc.						
African trypanosomiasis(sleeping sickness)	Tsetse fly	*Trypanosoma brucei*(protozoan)	Wild mammals, cattle, human	Fever, joint pain, swollen lymph nodes, sleep disturbances	Sub-Saharan Africa	Various drugs
Filariasis	Mosquito	*Wuchereria bancrofti*	human	Fever, swelling of limbs	Africa, Asia.	Various drugs
West Nile disease	Mosquito	West Nile virus	Birds, human	Fever, headaches, skin rash, body aches.	Africa, Asia, North America, South and East Europe	None