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Parasitic Diseases and the Role of Vector Insects

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Abstract: Vector-borne diseases are illnesses caused by pathogens transmitted to humans and animals through vectors such as parasites, viruses, and bacteria. More than 700,000 people die annually from diseases like malaria, dengue fever, schistosomiasis, African trypanosomiasis (sleeping sickness), leishmaniasis, Chagas disease, yellow fever, Japanese encephalitis, and onchocerciasis. These diseases predominantly affect populations in tropical and subtropical regions and disproportionately impact the poorest communities. Since 2014, major outbreaks of dengue fever, malaria, chikungunya, yellow fever and Zika virus have affected many populations, claimed lives and overwhelmed health systems in many countries. There are other diseases that cause chronic suffering, lifelong morbidity, disabilities and sometimes stigmatization, such as chikungunya, leishmaniasis and lymphatic filariasis. Medical Entomology is the scientific study of insects and arthropods that transmit diseases to humans and animals. It focuses on understanding the interactions between vectors (e.g., mosquitoes, flies, lice, fleas, ticks, and mites) and the pathogens they carry. For instance, mosquitoes transmit malaria parasites, while other arthropods like ticks can transmit pathogens causing diseases such as Lyme disease and babesiosis. Some arthropods also secrete toxins that can lead to neurological issues, allergies, infections, and eczema. The field of Medical Entomology was significantly advanced by the work of Sir Patrick Manson in the late 19th century. In 1878, Manson discovered that the filarial parasites responsible for lymphatic filariasis develop within mosquitoes before being transmitted to humans. This was one of the earliest demonstrations of a pathogen's development within an insect vector, marking a pivotal moment in the history of Medical Entomology.

Keywords: Medical Insects, Parasites, Parasitic Disease, Entomology.

Review Paper

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INTRODUCTION

Most of the disease-carrying animals belong to the arthropod phylum, which includes about 85% of the known animals, In addition to arthropods, there are other species belonging to other phyla of animals that transmit pathogens or act as a secondary provider or as a reservoir animal for pathogens, and one of the best examples of this is snails that belong to the mollusca division of the animals, which constitute many types, including the secondary hosts of flatworms that parasitize on humans or animals and cause them diseases. Also, many vertebrates of the phylum Chordata act as carriers of pathogens, secondary hosts, or storage animals for pathogens, cows, pigs, dogs, cats, and other carnivores are the secondary hosts for single worms and water sac worms that infect humans [1]. In addition, many ferocious animals such as dogs, cats, wolves, etc., and bats transmit rabies to humans, and even birds, some of which are a reservoir animal for some microorganisms causing human diseases such as hemorrhagic fever and meningitis, but if we compare the number of these animals mentioned with those that belong to the arthropod phylum, we find that they are few and at the same time they do not constitute most of the danger that threatens an epidemic, as is the case for arthropods which at the same time transports or secondary support or is a reservoir for a large number of pathogens for humans and animals .Therefore, most of our talk about disease-carrying animals will be about species belonging to the arthropod phylum [2].

The Arab countries are afflicted with diseases transmitted by arthropods such as malaria, kalazar, the

Baghdad pill, meningitis, rabies, hemorrhagic fever and snail game an important role in the continuity and spread of some diseases transmitted by arthropod animals, which are found in some countries, such as elephantiasis (Sudan, Egypt and Somalia), river blindness (Mauritania, Somalia, Sudan and Yemen) and African sleeping sickness (Somalia and Sudan) Hemorrhagic fever such as Raafat Valley fever, West Nile fever (Egypt and Sudan) and epidemic typhus (Libya, Egypt and Jordan) Relapsing fever (Libya and Egypt) and polio meningitis. These diseases pose a threat to the health of more than two hundred million people in the Arab countries and even the neighboring Islamic countries. The presence of arthropod species does not necessarily mean the spread of the disease or its settlement unless other factors are present with it so that it is easy to reach these animals and pathogens to humans on the one hand and to animals that store pathogens on the other [2, 3].

The Basics of Parasitic Diseases

Pathogens

The pathogens transmitted by insects and other arthropods are distributed and spread among a number of animal division .In addition, rickettsia, bacteria and fungi outside the animal kingdom, these parasitic and disease-causing organisms vary greatly in size and life features according to the taxonomic position among the organisms [3]. When we take into account human or animal diseases, insects are the carriers, while humans or animals are the carriers it is the reservoir, so the first is responsible for the transmission and spread of pathogens while the second is the source of infection. There may be cases in which the verse is reflected in the injured person.

Malaria or yellow fever, which comes and enters an area free of such diseases it transmits and spreads disease from one area to another, so here the person is the carrier of the pathogens, just as lice and ticks may be the animals that store the pathogens. A parasite is an organism that lives or hosts a host and obtains its food from or at the expense of its host. As defined by the CDC, parasites can cause disease in some cases, it leads to death, but if detected early, it can be treated with its own medications [4]. Parasites can be defined as living organisms that make their home on other living organisms as a form of parasitism. It obtains its nourishment from the portion of what its host organism eats. But its presence in humans causes many diseases, among the most prominent types of parasites that cause diseases to humans are protozoa, helminths, and ectoparasites [5].

Ectoparasites This type of parasite can be found in the environment surrounding humans, and the most prominent examples of it are (ticks, fleas, lice and mites) Which lives on the surface of the human body and clings to his body and then begins to dig into his skin.

Objectives of the Study:

1. The discovery of microorganisms and their relationship to diseases and the fact that they are the cause of many diseases.
2. Exploring the relationship between insects and some other small animals in the transmission and dissemination of these Pathogens.

Definition and Types of Parasites

Parasites are smaller than the host and less effective and do not kill the host quickly, but the longer the period, the better for the parasite. Among the parasites that parasitize insects:

A. **Filters:** They cause multiple diseases that eventually kill the host.
B. **Bacteria:** That secrete certain toxins on the breadwinner, the best examples of which are: *Bacillus thurigesis*, it is one of the bacteria that form blackboards, so it can be bred in large numbers and mixing the blackboards with inert powders to make fogging powders or wettable powders, used as pesticides in fogging and spraying on insects, and they were used against mosquito larvae, but most of them are used against agricultural insects [3].
C. **Protozoa**: such as Nosema and Microsporidia, which cause damage to fatty bodies and make the insect sick.
D. **Fungi:** Such as *Coelomomyces*, and infects and kills the larvae before the pupa's role, and prevents the ovaries from developing in adult females if they reach this stage.
E. **Nematodes:** Especially in the family Mermithidae, they infect and kill the larvae and are now on the way to generalizing their use against the black fly (Simuliidae).

Protozoa:

This type of parasite lives and reproduces in the blood or tissues by the bites of mosquitoes and flying insects, these vectors are found in soil and water [6].

Transmission and Life Cycle of Parasites

The arthropod animals that transmit parasitic diseases belong to the following classes of insects and arachnids:

1- The order of half-winged insects

These insects are called (bugs) and include several families, but what concerns us here are only two families, the family of bed bugs Cimicidae (and the family of killer bugs Reduviidae).

Although bed bugs live with humans and parasitize on human blood or some other animals, we do not know that they transmit pathogens between humans or animals.

Killer bugs are insects with sucking mouth parts, most of them live predatory insects and other small animals, the important species are those that enter human

homes, while those that live under the bark of trees or in bird nests and wild animal caves do not pose a danger in transmitting diseases, but they may They act as storage animals [1].

The genera that organize important medicinal types are:

1. *Panstrongylus* species with short heads and antennae located between the eyes.
2. Triatoma species with short heads, but antennae located in the middle of the head far from the eyes.
3. *Rhodnices* species with long heads and antennae located near the top of the head.

Important and famous carrier species
One of the most important and famous types
Rhodinius prolixus in Guyana, Guatemala, Nicaragua, Panama, Suriname, and Venezuela
Pangatrongylus megistus in Brazil
Triatoma dimidiata Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Venezuela
Triatoma infestans in Argentina, Bolivia, Brazil, Chile, Paraguay, and Uruguay
Triatoma maculata in Brazil, Colombia, Guyana, and Venezuela
Triatoma brasiliensis in Brazil
Triatoma Sordida in Argentina, Bolivia, Brazil, Chile, Paraguay and Uruguay.

The disease transmitted by these insects is called Chagas disease, and sometimes it is called American trypa nosoma disease, as it spreads in Central and South America and threatens about 10 million people in those areas. The disease is chronic and endemic among the poor and the rural population and there are no therapeutic drugs, and it causes death. The disease may be transmitted from the mother to the fetus or through blood transfusion, but the main and important way is through the types of blood-sucking bugs mentioned previously [3].

Insects get parasites from infected blood, human or domestic animal blood and come from the same house. The feeding period takes 10-25 minutes. Insects may excrete fecal waste during feeding. There are several types of animals that act as storage animals, all of which are carnivores, such as the armadillo, opossum, some other rodents, and even some predators and monkeys.

The culprit is *Trypanosoma cruzi*, and it is from the group that is transmitted through the feces of blood-sucking insects and not through the bite, as the parasite passes through all stages of its growth in the stomach of the bug and after 6-15 days, the flagella form (leptomonad) is present in the hind gut of the insect.

Vector Insects: Types and Characteristics

The Arthropod animals that transmit diseases belong to the following classes of insects and arachnids

1. Red cockroach class of insects
2. The order of sucking lice from insects
3. Order of two-winged insects
4. The order of the halves of the wings of insects
5. The order of fleas from insects
6. Order Acarids of arachnids

Also, the pathogens transmitted by these animals are due to various groups of parasitic organisms and animals, namely:

1. Leaks: They are very small objects that have not been able to be seen by any optical magnifier yet.
2. Rickettsial: organisms larger than filters and smaller than bacteria.
3. Bacteria: They are single-celled organisms without a clear nucleus.
4. Primary: They are one-celled organisms with a limited nucleus.
5. Nematodes: They are advanced animals.

Diptera and the Diseases They Transmit

This order is one of the most important insects ranks from a medical point of view and its relationship to the transmission of pathogens, as it contains large numbers of insects that feed on blood or secretions, fluids and feces. The larvae of some types live parasitically wholly or partially on the tissues of live animals [6].

The families and genera that include types of insects that transmit diseases to humans are:
A - Culicidae mosquitoes and includes the following genera (*Anopheles, Aedes, Culex, Mansonia, Psorophora, Sabetha, Theoboldia (Culisita)*
b-Phlebotomidae, includes the genus *Phlebotomus*
C- Ceratopogonida, including the genus *Culicoides*
The black fly Simuliidae includes the genus *Simulium*
C- Housefly Muscidae includes the following genera (*Musca, Clossina, Stomoxys*)
H - Horse flies Tabanidae, including genera (*Tabanus, Haematoponta, Chrysops)*

Diseases Transmitted by Mosquitoes

1- Malaria

The name malaria is given to four closely related diseases caused by four types of primary parasites, all of which belong to the genus Plasmodium. These types sometimes infect monkeys, and vice versa, some types of malaria may infect humans, but this does not happen at all, and if it happens, it is very rare in nature. Therefore, malaria is a human disease. The human being is the breadwinner and the only reservoir of infection [1]. All types of disease include cases of shivering and certain chills. Then a fever followed by periods without shivering.
A- *Plasmodium malariae*
b- *Plasmodium vivax* triple malaria
C- *Plasmodium falciparum* virulent malaria
C- *Plasmodium ovale*

The infectious form of the sporozoite is transmitted to the bloodstream of humans with the saliva of the vector mosquito. The sporozoite travels with the blood to the liver, attacking the liver cells and going through one or more asexual cycles that include the division of one parasite into a number of individuals. In this role the patient does not show symptoms of the disease, The blood circulation (or in the liver) takes about a week in hot areas, after which parasites attack the blood and enter the red blood cells, and there they go through reproductive division cycles. Which causes a rise in temperature, then the sex gametes are formed, which remain in red blood cells without growth or division until the mosquito takes them with the blood [7].

In the mosquito's stomach, the male gamete unites with the female gamete to form the fertilized gamete Ookinete, which is transmitted through the cells of the mosquito's stomach wall and its cells to settle under the peritoneum, forming a small sac called the oocyst. It can be seen 4 days after taking an infectious meal. Inside the oocyst, spindle-shaped individuals called Sporozoites are formed, which are released after the sac bursts, where they spread in the body cavity of the mosquito and most of them reach the cavity of the salivary glands and remain there and be a source of infection [8, 9].

One of the symptoms of malaria is an enlargement of the spleen, whose cells produce antibodies in people who do not die. These antibodies are able to confer healing on the patient.

The parasite does not harm or harm the mosquito, but the presence of the mosquito is important to complement the life cycle, and this is what makes malaria abound in some areas and less in others.

2- Filariasis

These diseases are not severe and do not cause death, but their importance comes from the side effect of them, which is called (elephant disease), and this disease is the severe inflation that occurs to the limbs or prominent parts of the body such as the breast and scrotum. Injuries increase in slums from the edges of cities where open sewers are prepared good habitat to breed carrier mosquitoes [1].

The filariasis diseases are cases caused by nematodes belonging to either the genus (*Wuchereria*) or *Brugia*, the type *Bancrofti* in the first genus is of special importance, as it spreads in the tropics in abundance and affects only humans. As for the types of the second genus, it spreads in Southeast Asia and includes species that affect animals only. The adult worm is a filamentous worm that lives in the connective and lymphatic tissues. The fertilized females lay a number of microscopic larvae that alternate between peripheral and internal blood.In the lung and major vessels, these microscopic larvae cannot grow and reach adulthood until they pass an invertebrate animal, the mosquito. Lymphatic and as a result the vessels expand and the flesh expands to large sizes and to elephantiasis. Many nematodes live in the soil or parasitize on plants, and they are called snake worms [1-9].

Filariasis worms infect the tissues of the breadwinner and are transmitted by blood-sucking bi-winged insects and are evolutionarily advanced in the case of mosquitoes. The vertebrate animal is the main breadwinner because sexual reproduction does not occur except in vertebrate animals. In the stomach of mosquitoes, some microscopic larvae are digested and some of them are excreted with feces. A number of them can from penetrating the stomach to the body cavity and finally reaching the chest muscles.

It penetrates through it, and the larvae grow in these muscles, going through one or two molts before becoming infectious and able to infect humans again. The mature larvae move and roam inside the body cavity until they reach the proboscis. When the mosquito feeds, the larva breaks through the body wall at the end of the proboscis and enters the human body usually in the place of a mosquito bite.

In the human body, the larvae move towards the lymph nodes, where the larvae grow and reach adulthood after 3 months or more. Types of anovlin or kyolsin. The high number of larvae in the stomach of mosquitoes hinders them from digestion, and in the muscles hinders them from flying [10].

Types of Mosquitoes That Transmit Yellow Fever

Aedes aegypti in coastal cities
Aedes africanus in the forests of Africa lives and circulates at night in the highest trees.
Aedes Simpsoni in the forests of Africa live and fly in the day and in the edges of the forests
Haemagogus Spegazzini in the tropical forests of America
Aedes leucocelaenus in the tropical forests of America
Sabethes Chloropterus in the tropical forests of America

The incubation period for yellow fever in humans and monkeys is 4-5 days, after this period the cold appears in the peripheral blood and the cold remains in the blood for two days, during which time humans and monkeys are infectious to mosquitoes. The flu must multiply in the stomach of mosquitoes in order for their numbers to reproduce so that they can cross the wall from the stomach to the blood cavity in the mosquito, and from there to the salivary glands, through which it returns to humans or monkeys [1-10].

Types of Mosquitoes That Transmit Dengue Disease:

Aedes aegypti worldwide
Ae. Albopictus in Southeast Asia
Ae. Scutellaris in the Pacific Islands and New Guinea

Yellow fever is the most important type of hemorrhagic fever.

Meningioma

There are several diseases in this group, including eastern and western meningitis, St. Louis and Venezuela. These filariasis usually infect birds and are transmitted by species of *Culex* that feed on birds. These filariasis also infect horses. In the Far East there is a similar disease called meningococcal meningitis japonica [3].

Bone-Breaking Diets

Dengue is usually not fatal and the disease is characterized by redness and horrific pain in the joints. In recent years, diseases have appeared in Africa and Asia similar to the purposes of dengue disease. Several of them have been named with words that describe the bombing of the bone or the bombing of the joint from these names Chikungunya (Nyunk Bnog), Billy Bailey.

The parasites carried by insects and other arthropods are a heterogeneous group that contains RNA. It has been possible to classify them on the basis of antibodies into several general groups such as A - B - C. The filters multiply in mosquitoes in abundance. In the case of yellow fever, it does not need more than 3-4 days, and in dengue, 5-8 days. In cases that recover, the antibodies can eliminate the flu within a few days, so there is little left to infect other numbers of insects [2].

The cold spreads after it multiplies in the cells lining the stomach of mosquitoes to other sites such as the salivary glands and the nervous system. The period required for the insect to be contagious depends on the temperature as well as the type of insect, as it appears that mosquitoes are not affected by the cold [6].

Most of the mosquitoes that transmit the infiltrate belong to the subfamily Culicinae. In addition to the subjective sensitivity and food preference, the species depends on the environment and behavior, for example the infiltration of yellow fever in the forests depends on the species of mosquitoes that live in the forests, but the species that live in cities remain important in the spread of this disease in cities, in a few cases, some types of Anopheles may transmit yellow fever and brittle fever in some parts of the world and birds act as a storage animal for meningitis [3-10].

Diseases Transmitted by Ticks

Ticks are vectors for several serious diseases that affect both humans and animals. These diseases are caused by bacteria, viruses, or parasites. Some of the most common tick-borne diseases include:

1. **Lyme Disease**: Caused by the *Borrelia burgdorferi* bacteria, it is the most common tick-borne disease. Symptoms include fever, fatigue, joint pain, and a characteristic bull's-eye rash. If left untreated, it can lead to long-term complications like arthritis and neurological problems.
2. **Rocky Mountain Spotted Fever**: This disease is caused by the *Rickettsia rickettsii* bacteria. Symptoms include fever, rash, and flu-like symptoms. It can be severe or even fatal if not treated promptly.
3. **Anaplasmosis**: Caused by the *Anaplasma phagocytophilum* bacteria, it affects both humans and animals. Symptoms include fever, chills, muscle aches, and headache.
4. **Babesiosis**: This parasitic infection is caused by *Babesia* species and affects red blood cells. It can cause symptoms such as fever, chills, fatigue, and anemia.
5. **Ehrlichiosis**: Caused by the *Ehrlichia* bacteria, this disease affects white blood cells and causes symptoms similar to flu, such as fever, headache, and muscle aches.
6. **Tick-Borne Encephalitis (TBE)**: This viral infection affects the central nervous system, leading to symptoms such as fever, headache, and in severe cases, neurological damage, including meningitis or encephalitis.
7. **Tularemia**: Caused by the *Francisella tularensis* bacteria, tularemia can result in fever, ulcers, and swollen lymph nodes. It can be contracted from ticks or contact with infected animals.
8. **Babesia (in Animals)**: In animals, Babesia causes a disease known as "Texas Cattle Fever," which leads to severe anemia, lethargy, and in severe cases, death.

Prevention of tick-borne diseases includes using tick repellents, wearing protective clothing, performing tick checks after outdoor activities, and removing ticks promptly with proper techniques.

Diseases Transmitted by Flies

There are two groups of diseases transmitted by flies, according to the types of flies that carry them:

The first group is transmitted by blood-sucking flies such as tsetse flies, horse flies and stable flies. Diseases are transmitted by taking pathogens from disease and infected people when they bite them and taking blood for nutrition. Therefore, insects are necessary and necessary for the spread of these diseases. The best example of these diseases is African sleeping sickness, which is transmitted by the tsetse fly. Horse flies and stable flies transmit more animal pathogens than human diseases such as anthrax, although some types of horse flies transmit loaloa disease, which affects humans in West Africa. To a large extent, what we saw in river blindness and elephantiasis, all these diseases are transmitted by blood-sucking flies [11, 6].

Mechanisms of Disease Transmission

The filthy breeding habits, feeding mechanisms, and random movement between waste make certain types of insects that coexist with humans, such as flies and cockroaches, effective vectors for human intestinal protozoan parasites. Fly control is closely linked to a decrease in the occurrence of such diseases. The mechanical transmission of human parasites by flies has not received sufficient scientific attention.

The feeding mechanisms and filthy reproductive habits of insects like flies, cockroaches, and dung beetles make them effective vectors for human intestinal protozoan parasites [6]. In particular, families like Sarcophagidae (flesh flies), Muscidae (houseflies and toilet flies), and Calliphoridae (blowflies and bottle flies) live in close association with humans as bothersome scavengers and pests [5-12]. Filthy flies breed in animal dung, human feces, i.e., dung-eating flies, garbage, and decaying organic matter [5-13].

They are commonly found in urban and rural areas where unhealthy conditions prevail and are usually rare when sanitary conditions are enforced (14). Outbreaks of foodborne diarrheal diseases in urban and rural areas are closely associated with the seasonal increase in the abundance of filthy flies, and the enforcement of fly control is closely linked to a decrease in the number of such diseases [14]. Among these species, health and sanitation regulatory bodies have listed 21 types of flies as agents causing gastrointestinal diseases [15, 16]. These species include *Hermetia illuscens, Megaselia insulana, Eristalis Tenax, Piophila casei, Fannia canicularis, Musca Locala, Muscina Stabulans, Stomoxys calcitrans, Calliphora viscina, Calliphora vomitoria, Chrysomya putoria, Cynomyopsis cadaverina, and Cochliomyia macellaria* [16].

Flies also transport larger particles, such as parasitic worm eggs, on their exoskeletons, while they can ingest and transfer the cystic stages of human intestinal protozoa. It is less likely for human protozoan parasites to be transmitted via the larval and pupal stages of insects that reproduce in stages such as larvae [9-15]. Transmission through the life cycle refers to the passage of the infectious agent from the egg stage to the adult stage of the insect. This is because the pupation process involves significant reorganization of the digestive tissues, leading to the development of a new digestive system [9]. This has been confirmed in practical experiments. Toxoplasma gondii cysts were isolated from larvae and pupae of houseflies reared on contaminated cat feces, but not from newly emerged adult houseflies. Similarly, Cryptosporidium parvum cysts were found in the digestive tracts of larvae raised on contaminated substrates, and within pupae, but not in or on adult flies [16]. However, even if flies are sterile when they emerge from the pupa, they will quickly acquire pathogens from contaminated substrates they develop on through direct contact [9].

Vector-Parasite Relationship

The intermediate host of internal parasites serves as both habitat and food source. Since the host is also temporary, the transition between hosts is essential for the parasite's survival and reproduction. Parasite transmission is divided into three general categories: vector transmission, transmission by live vectors, and transmission via intermediate hosts [11-16].

Some parasites have direct life cycles; they produce cysts or larvae that reproduce and colonize new hosts, generating more parasites. Other parasites use vectors, such as blood-feeding insects, to transfer infectious stages to new hosts. In some parasites, immature stages develop into infectious stages in intermediate hosts. When the appropriate predator (i.e., the definitive or specific host) consumes the intermediate host and the parasite it contains, the immature parasite develops into an adult parasite in the gut or body cavity of the definitive host. The parasite then produces eggs, which are typically excreted with feces, making them available for potential new intermediate hosts [11-17].

Among the parasites transmitted through intermediate hosts are tapeworms, flukes, nematodes, roundworms, and hookworms. There are many variations in the life cycle of the intermediate host and definitive host, but regardless of what happens in the rest of the life cycle, the intermediate host must be consumed for the transition to occur. Due to this, the behavior of the intermediate host can affect the success of transmission in unexpected ways. Predator-prey interactions involving intermediate and definitive hosts are critical for the parasite's survival and reproduction. Without predation by the definitive host, the parasite cannot develop or reproduce. Therefore, changes in the behavior of the intermediate host due to parasitism could be considered an adaptive trait for the parasite if it aids in transmission [18, 11].

Host-Vector-Parasite Interactions

The interaction between the parasitic vector and the host is a complex process that involves biological, chemical, and physical interactions. Understanding these interactions can help in developing strategies to combat diseases caused by parasites. Some key points regarding this interaction:

Biological Interactions

1. *Invasion*: The parasite invades the host by penetrating the skin or mucous membranes.
2. *Reproduction*: The parasite reproduces within the host, leading to an increase in the number of parasites.
3. *Adaptation*: The parasite adapts to the host's environment, allowing it to survive and persist.

Chemical Interactions

1. *Enzymes*: The parasite secretes enzymes that help digest the host's tissues.
2. *Hormones*: The parasite can affect the host's hormones, leading to changes in behavior or biology.
3. *Toxins*: The parasite may secrete toxins that affect the host's health.

Physical Interactions

1. *Attachment*: The parasite attaches to the host's surface, allowing it to remain and persist.
2. *Penetration*: The parasite penetrates the host's tissues, allowing it to access nutritional resources.
3. *Interaction with the Immune System*: The parasite interacts with the host's immune system, which can lead to an immune response [6-8].

Examples of Parasite-Host Interaction:

1. *Malaria*: The malaria parasite invades the red blood cells of the host, leading to the disease.
2. *Rabies*: The rabies parasite invades the host's nervous system, leading to the disease.
3. *Tapeworms*: Tapeworms feed on the nutrients in the host's intestines, leading to malnutrition.

5. Preventive Measures and Control Strategies

Preventive Measures against Parasitic Infections and Control Strategies include several aspects:

1. Personal Hygiene: Wash hands regularly, especially after using the bathroom and before eating.
2. Avoid Contaminated Water: Avoid drinking contaminated or untreated water.
3. Avoid Contaminated Food: Avoid eating raw or undercooked food.
4. Use of Insecticides: Use insecticides in areas where parasitic vectors are present.
5. Wear Protective Clothing: Wear protective clothing, such as masks and gloves, when handling animals or contaminated materials.

Control Strategies

1. Vaccination: Vaccinate individuals at risk of parasitic infections.
2. Chemotherapy: Use antiparasitic medications to treat infected individuals.
3. Control of Vector Insects: Use insecticides and other methods to control parasitic vectors.
4. Improve Sanitation: Improve sanitation and provide clean water to prevent the spread of parasites.
5. Education and Awareness: Educate people on how to prevent parasitic infections and the importance of controlling them.

Control Strategies for Parasites in Animals

1. Vaccination: Vaccinate animals at risk of parasitic infections.
2. Chemotherapy: Use antiparasitic medications to treat infected animals.
3. Control of Vector Insects: Use insecticides and other methods to control parasitic vectors.
4. Improve Animal Healthcare: Improve animal healthcare and provide good nutrition to prevent the spread of parasites.

There are four very important families in transmitting diseases:

The stinging stinger family, stinging midge, black flies, and the mosquito family. There are some families that include medically important species, but their importance does not come from the fact that they transmit diseases, but rather from the fact that they themselves may fall on the face, eyes, nose or ears, causing great inconvenience. Some of them may even cause sensitivity, itching, and itching in the eyes and nose, which sometimes leads to painful infections such as These insects belong to the family Psychodidae, the family of Chironomidae and some genera in the family Ceratopogonidae, as well as the giant mosquitoes belonging to the family Tipulidae and their members resemble mosquitoes, but in large sizes some may fear them as mosquitoes, and this is all their importance [19].

Diseases Transmitted by *Phlebotomidae*

Sergentomyia its types depend on small animals, so it is not medically important. *Phlebotomus* is the important genus that includes species that attack humans and milk animals, so it is important in transmitting several pathogens, namely leishmaniasis, three-day fever and Carrion's disease, while the third genus *Lutzomyia* spreads in the Americas only.

The stinging stinger species transmits several important and widespread diseases among humans on almost all continents, as well as among animals. It transmits a three-day fever disease, which is caused by a cold and spreads in the Mediterranean, the near and Middle East. This disease is mild and not dangerous. The vector type is *Ph. Papatsai* Cold is transmitted through eggs, and one of the diseases transmitted by species of the genus *Lutzomyia* is Carrion's disease and the cause is the bacteria *Bartonella bacilliformis*. The fever is severe and may be fatal. If the person is cured, the disease leaves an ugly trace called *viru*. These two diseases are not as important as the diseases caused by the leishmaniasis species of primary flagellates, which are widespread in tropical and subtropical regions [1, 2].

The Nature of Leishmaniasis

1. The oriental pill or cutaneous leishmaniasis (in Iraq it is called the Baghdad pill, in India it is

called the Delhi pill, in Syria it is the Aleppo pill and in Algeria it is the Biskra pill)
2. Kala azar or visceral leishmaniasis.
3. The Brazilian bean.

There are two types of cutaneous leishmaniasis in the ancient world, the first is in the countryside and uses rodents as a storage animal and causes wet sores, the second type is found in cities and causes dry sores and in South America ugly complications spread to the mouth and nose where they attack the soft bones and cartilage and cause them damage and it is called Asfanda .Visceral leishmaniasis is found in tropical and subtropical regions [1, 2].

The pathogens of Leishmania are primary flagella, and some of these species infect insects alone. The parasitic cycle is as follows: In vertebrates, the parasites are in the form of spherical cells without flagella called Amastigina, but after the mite takes the parasite with blood while feeding on an infected person, the parasite grows into an oblong shape It carries a flagellum called Promastigina, the parasite multiplies in the stomach of the hares, and the new infection is through excretion in cases of primitive species.

In human infection, the parasite individuals return to the anterior position of the digestive canal, where it can reach the human after being regurgitated by the feeding insect, The parasite in humans returns to its first form and reproduces by dividing the vertebral and invertebrate providers[20].

Types of Stinging Wormwood That Transmit Diseases:

1. *Phlebotomus Papatasi*, the most common species found near humans and their domestic animals and attacks humans inside and outside homes.
2. *P. sergenti* members of this species are found in homes and stables, and their effectiveness increases in summer from sunset until midnight.
3. *P. Longlcuspis* is found in many stores that differ in terms of environment and geography. Individuals are active during all hours of the night.
4. *P. alexandri* numbers are few, regardless of where they are, such as inside homes, stables, or in the open.
5. *P. pernicious* this species is restricted to existence
6. *P. ariasi* the species is restricted to existence
7. There are other, but less important, species *P.bergeroti, P. chabandi, P. chadlii*

Black Fly and River Blindness

River blindness is spread in Central and Western Africa and in Latin America. The disease is caused by a nematode and the vector is a species of black fly belonging to the family Simuliidae, as the types of this genus attack humans to feed on blood and cause disturbance The black fly acts as a secondary host and a vector for river blindness disease, because the insect reproduces in the running water in streams and tributaries of rivers, so the disease spreads in these shops and for this reason it was given the name river blindness disease. The causative agent is a nematode worm called *Onchocerca volvulus*, which is a family of filariae worms.Chronic gradual and not severe, in some severely endemic areas, the percentage of blindness reaches 25% of men, and this causes a great delay and a heavy loss of agriculture and production to the point of insufficiency. The infected usually carry a number of adults of the worm that may reach 100 and may live for 15 years, Adults do not cause any harm to the affected person other than some swelling or tubercles on the surface of the body [1-3].

Females give a large number of microscopic larvae, which live for a year or two in the skin blood vessels. The reaction of the infected to the dead larvae causes itching, wrinkling of the skin as a result of damage to the elastic layer. The most important harm to infection is blindness. The parasite is adapted to parasitize on humans and does not it is known that there is a custodian host for it. The larvae penetrate the wall of the insect's stomach and reach the muscles, and two molts occur in the insect, after which the size and stage are contagious [6].

Infectious larvae crawl into the cavity of the insect's body until they reach the end of the lower lip or the lips, and as a result of friction, they fall on the scratched human skin due to the insect feeding, and then take their way through the blood to under the skin, where they reach the stage of puberty and cause small swellings and begin to lay the larvae, the period of maturation of the larvae in the insect depends on heat and may not need more than a week in warm conditions.

Diseases Transmitted by Horse Flies

The types of horse flies belong to the Tabanidae family from under the order of the short antennae, the most important species that cause disease transmission belong to the following genera *Heamatopota, Tabanus, Chrysops*, the family is global spread from tropical to temperate regions.

The causes of some diseases are transmitted mechanically, such as anthrax and anaplasmosis that may infect humans, as well as sora disease, which rarely affects humans. These species transmit tularemia (*pasteurella tularensis* bacteria).

From horses, rabbits and rodents to humans. It also transmits flaria worms, Loa Loa. This disease spreads in West Africa, except for Central Africa, until Uganda and South Sudan. Microscopic larvae are found in the peripheral blood during the day, when the fly takes

blood for feeding a large portion of the microscopic larvae move through the stomach wall to the chest muscles where they molt twice and grow to the sedate shape and after 10-12 days they turn towards the lower lip and from there to the new person.

In humans, the larvae reach maturity and live under the skin. The most important vector species are *Chrysops silacca, Chrysops dimidiata, Chrysops discalis*, and *Chrysops distinctipennis* [1-3].

[12] found that the horse fly is a carrier of three types of trypanosomes with a percentage of 7% when examining blood samples from cattle in Range land Ngaoundere Adamawa Cameroon *T. theileri* (4%) and *T. vivax* (3%). were also detected in cattle (7%).

The mechanical transmission of various pathogens by tabanid flies has been known for decades [13]. This mode of transmission may either occur through contamination of mouthparts or regurgitation [14, 15].

Bovine trypanosomiasis is considered as one of the most important cattle diseases in Adamawa region of Cameroon [16].The report of [17], revealed the occurrence of mechanical vectors (Tabanids and *Stomoxys*) of bovine trypanosomiasis in the Adamawa plateau. DNA extracted from South African Tabanus par and *Tabanus taeniola* tested positive for the presence of *Trypanosoma congolense* (Savannah) and *Trypanosoma theileri* whilst one member from T. par was positive for *Trypanosoma brucei* species. DNA extracted from Zambian tabanid flies tested positive for the presence of *Besnoitia* species at 1·27% (2/157), *Babesia bigemina* 5·73% (9/157), *Theileria parva* 30·11% (30/157) and 9·82% (14/157) for *Trypanosoma evansi*. This study is the first to report on relationship of *Babesia* and *Theileria* parasites with tabanid flies [18].

Horse fly

African sleeping sickness

The tsetse fly lives in vast areas of western and central Africa sub-Saharan Africa, in many of these areas the fly transmits the pathogens of African sleeping sickness between people and transmits another disease that spreads among domestic animals called nagana. It is of great importance in plowing the land and agriculture.

There are two types of sleeping sickness caused by two different types of parasites. In West Africa, the disease appears in two different cycles, the first in which the parasite spreads in the blood and causes great invasion, anemia and relaxation. After several years, the second role of the disease appears when the parasite penetrates into the spinal cord. One of the important symptoms of this severe role it is lack of appetite, relaxation, lying down, then fainting and death. The disease has nothing to do with wild animals. The second type of disease is what we see in Zambia and Zimbabwe [21].

In this type, the occurrence and emergence of the disease is faster and death occurs due to blood poisoning and without damage to the nerves. This type of disease has a relationship with wild animals that serve as his reservoir animals, man is not here as a reservoir animal, especially during epidemics, because of the duration and speed of the disease [1-19] [6].

The pathogens of the disease are two types of primary flagellates belonging to the genus *Trypanosoma*, which in turn belongs to the same family to which the genus *Leishmania* belongs. These parasites live in the blood of all vertebrates. They are transmitted by the blood-sucking tsetse fly and infection occurs through the bite of this insect. It may be transmitted through Mouth parts are contaminated, but the second infection goes through a special cycle of growth in the vector before it is transmitted to humans again and is contagious when the fly is contagious and remains so throughout its life. Parasites multiply in the anterior alimentary canal or stomach and migrate to the salivary glands. This cycle takes about twenty days, the cause of the disease in West Africa is called *Trypanosoma gambiens*, and the cause in Zambia and Zimbabwe is called *T.rhodesienses*.

The insect that transmits the disease is a fly larger than the house fly and belongs to the same family. All species belong to one genus, Glossina, where this genus is divided into the following groups according to habits and characteristics:

1. Fusca group (tsetse fly in the forest (examples are *Glossina fusca, G. Brevipalpis* and *G. Longipennis)*
2. Morstan group (tsetse fly in meadows), such as (*Glossina morsitans, G. pallidipes*, and *G. Swynertoni)*
3. A group of tsetse (tsetse fly on rivers and in forests) of the important species that transmit diseases (*Glossina forcipes, G. palpali* and *G.tachinoides*) [20-3].

Flea Diseases

1- Plague

One of the most important diseases transmitted by the flea is the plague, a disease famous in history, which has often caused affliction, misery and death for human beings over the ages, as it left a clear and significant impact and results when it came to a certain area.

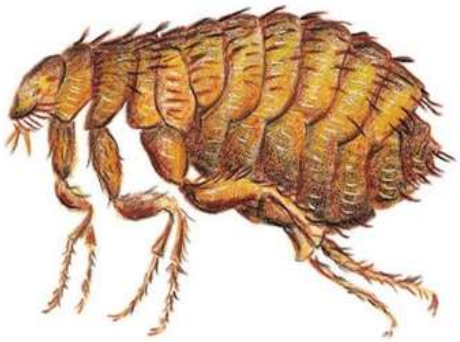
Plague is basically a disease of rodents, and it remains and continues in an endemic manner, sometimes reaching the point of epidemic, transmitted between these rodents by fleas. A large number of them [1-23].

The black rat lives in rural and wooden houses and may reach modern homes, and this means that it is close to humans, then the last step occurs, which is the transmission of fleas from infected and dead rats to humans. Killing is denied in most cases, the body can resist bacteria and reduce them a lot, but they remain in certain places from the hip and under the armpit, causing bubonic plague. Bubonic plague is not transmitted to other people, sometimes a severe infection of the lung occurs, causing a very dangerous pneumonic plague because the bacteria spread in this case with cough droplets and are transmitted through the air. The bacterium that causes plague is *Pestis yersinia*, a type of *Bacillus*, and it is not known whether it is a parasite of milkmaids or an arthropod parasite. It appears that its parasites on rodents and then on fleas were very old. They develop in arthropods so that they have part of a life cycle that fleas need, all that happens in the flea is that bacteria multiply in the animal's stomach, forming a mass of bacteria with each other that block the digestive canal to some extent, so the flea cannot swallow it or swallow a new meal. He became hungrier, the more he attacked the main breadwinner for food [13].

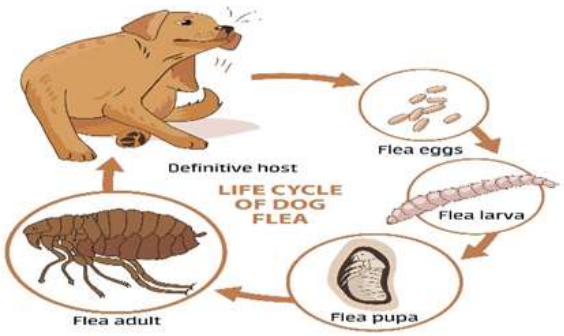
The flea takes the blood, but the blood does not go beyond the area that is blocked by the bacteria mass, so it goes back to the vertebral breadwinner. This process helps to take pieces of the bacterial mass and when it is transferred to the vertebrate animal that is the breadwinner, it causes infection. If the mass of bacteria continues to block the digestive canal, the flea eventually dies of starvation. He does not resist hunger for more than a week. The death of the flea does not happen because of his illness from the bacteria. However, the formation of the bacterial mass means that it has not reached the state of coexistence between the flea and the bacteria to the extent that the flea does not harm the flea. Here, the case is a double intrusion that harms the breadwinners together to some extent [24-26].

The most dangerous flea species are those belonging to the genus *Xenopsylla* as they live on rodents and are transmitted without delay to humans, so they are the most important types of plague carriers.

One of the most important medicines that have been widely used against the plague is sulfonamide and antibiotics. The risk of an epidemic among domestic rodents is that the plague may reach humans if the rodents are present in abundance and with their parasites of the genus *Xenopsylla* so it is necessary to combat rodents with good construction and pesticides such as pesticides Anticoagulants such as warfarin and bracomin or fast pesticides such as zinc phosphide [1-13].



Flea adult



Life cycle of flea

2- Endemic Typhus

It is called flea-borne typhus or rat typhus and the cause of this disease is *Rickettsia typhi* organisms *Rickettsia mooseri*. Through excretions of fleas contaminated with Rickettsia, which fall on the skin and enter the blood through itching and scratching, or by reaching the soft epithelial tissues such as the eye organization and the lining of the mouth and nose.

Endemic typhus is a disease of rodents originally, especially rats. It is transmitted between these animals by the genus *Xenopsylla* and some species of some other genera, and sometimes even some species of other rodent lice and the nipple of tropical rats [3].

The disease is transmitted to humans by the following types:

Xenopsylla cheopis, Nosopsyllus fasciatus, Ctenocephalides Canis , Ct. felis felis , Pulex irritans

3- Tapeworms

Like the worm *Dipylidium caninum*, it is found on dogs and cats, but it sometimes infects humans, and the other type, *Hymenolopis diminuta*, infects rats, and sometimes it reaches humans. The flea penetrates from the wall of the alimentary canal through the body cavity where it remains.

They remain in the same store until the pupa in the flea and finally to the adult flea, where it turns into infective larvae (Sstasarcoid). Vertebrate animals get worms by swallowing fleas while cleaning themselves. Children may get them when they play and kiss cats and dogs, so they swallow the fleas on them [26]. Isolation of the tapeworm *Raillietina georgiensis* from the body cavity of the ant *Pheidole vinelandica* in Georgia.

4- Some Other Diseases

There are some of the few important diseases transmitted by fleas, but they do not play a major role in transmitting them. These diseases include:

Pasteurella =(Francisella) tularensis- Rickettsia Conori , Rickettsia Pavlovskyi , Coxiella burneti

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