Transovarian transmission in insects (Arthropoda: Insecta) and ticks (Arthropoda: Acari: Ixodidae).

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Rickettsii in nature, as there is transovarian to eggs and larvae and transstadial transmission of the bacteria present in larvae, to the nymph and adult stages. For transmission to occur, ticks must remain attached to the host's skin for a period varying between six and ten hours, long enough for the bacteria to be reactivated in the salivary gland and then spread throughout the body. Ticks, in addition to being vectors, are also reservoirs [1-19].

In *Amblyomma cajennense* (Fabricius, 1787) (Acari: Ixodidae), the perpetuation of rickettsiae is made possible through vertical transmission, or transovarian, stage-stage transmission transstadial, or transmission through copulation, in addition to the possibility of simultaneous feeding of infected and uninfected ticks in animals with sufficient rickettsemia. Ticks remain infected throughout their lives, generally 18 to 36 months. In humans, Brazilian spotted fever is acquired through the bite of a tick infected with rickettsia, and transmission generally occurs when the arthropod remains attached to the host for a period of 4 to 6 hours [1-6].

Bovine babesiosis is a hemoparasitosis caused by the protozoa *Babesia bovis* (Babés, 1888) (Apicomplexa: Piroplasmida: Babesiidae) and *Babesia bigemina* (Smith & Kilborne, 1893) (Apicomplexa: Piroplasmida: Babesiidae) and which have the tick *Rhipicephalus microplus* (Canestrini, 1888) (Acari: Ixodidae) as their only vector. High temperatures can cause a reduction in oviposition, hatching rate, and longevity of larvae infected by *Babesia* spp., reflecting this transmission, and favoring the appearance of enzootic instability. *Babesia bovis* is a unicellular bovine protozoan that occasionally infects humans. The disease it and other members of the *Babesia* sp. cause is hemolytic anemia known as babesiosis and colloquially called “Texas cattle fever” [1-7].

In ticks, the perpetuation of rickettsiae is made possible through transmission transovarian, stage-stage transmission transstadial, or transmission through copulation, in addition to the possibility of simultaneous feeding of infected and uninfected ticks. Transovarian transmission causes the tick, for example, to remain infected throughout its life and transmit the “Spotted Fever” bacteria to other generations [1-10].

Anaplasma marginale (Kocan, 2007) (Rickettsiales: Anaplasmateceae) organisms belonging to this family are obligate intracellular parasites of erythrocytes found exclusively in vacuoles in the cytoplasm of host cells, a species responsible for malignant disease in cattle and of high importance/distribution in veterinary medicine causing the so-called anaplasmosis or “Bovine Parasitic Disease”, transmitted by *R. microplus* [1-11].

Transovarian transmission of the dengue virus serotypes (DENV-1, DENV-2, DENV-3, DENV-4) in mosquitoes occurs in the laboratory and nature. They observed a higher rate of vertical transmission in *Aedes albopictus* Skuse, 1894 compared to *Aedes aegypti* L., 1762 (Diptera: Culicidae), and transmission was detected by this species [11-15].

The types of viral transmission in mosquito vectors occur through horizontal and (transmission transovarian) vertical transmission processes. In the first, an uninfected female can become infected by feeding blood to a host previously infected by another female infected with the virus. In vertical transmission, the pathogen is transmitted from the infected female mosquito to her offspring, which may be a transovarial virus inside the egg or a virus on the surface of the egg [11-19].

Transovarian vertical transmission can occur when the virus invades the embryonic follicle, infecting the embryo, or also during oviposition, where the virus is transmitted into the eggs from the micropyle (egg opening) at the time the eggs pass through the oviduct. The *A. aegypti* mosquito, due to its importance in the transmission of the dengue virus, has been studied to understand aspects related to vector competence. The ovaries, an important organ involved in vector reproduction and implicated in transovarial viral transmission, have been neglected in analyses of viral infection [12-19].

The first dengue epidemic in Brazil with laboratory confirmation occurred in Boa Vista (RR) between 1981 and 1982 when serotypes 1 were isolated and 4. From 1982 onwards, a campaign was launched intensive fight against the vector, eradicating it and not reporting the epidemic until 1999. Since then, the rates of incidence have been among the highest in the country, with the circulation of serotypes 1, 2, and 3, which characterizes the status as hyperendemic, a critical condition for the occurrence of dengue hemorrhagic fever/syndrome dengue shock [13-19].

The mosquito transmits viruses that cause diseases called arboviruses. Among the most common diseases in this group, the following stand out: Dengue, zika, and chikungunya. Other viruses, in addition to those mentioned, can be transmitted by *A. aegypti*, such as the “Yellow Fever” virus, however, to date, the circulation of this virus occurs strictly in wild areas, where other species of mosquitoes are transmitters. If the female is infected when she lays her eggs, at least 60% of the larvae will already be infected when they hatch. “This is called transovarian transmission”. The *A. Aegypti* mosquito can become infected with dengue, yellow fever, chikungunya, or zika virus through transovarian transmission, from female to larva, or by biting a person who is infected with one of these diseases. Transovarian transmission contributes greatly to epidemics [13-19].

The Zika virus (ZIKV) is a flavivirus whose main vector is the *A. aegypti* mosquito. It is mainly transmitted by the bite of female mosquitoes when they have infectious viral particles in their saliva, a route known as horizontal transmission. However, transovarian or vertical transmission of the infected parent generates infected offspring, and sexual or venereal transmission of the virus is passed through copulation is also possible between mosquitoes [14-19].

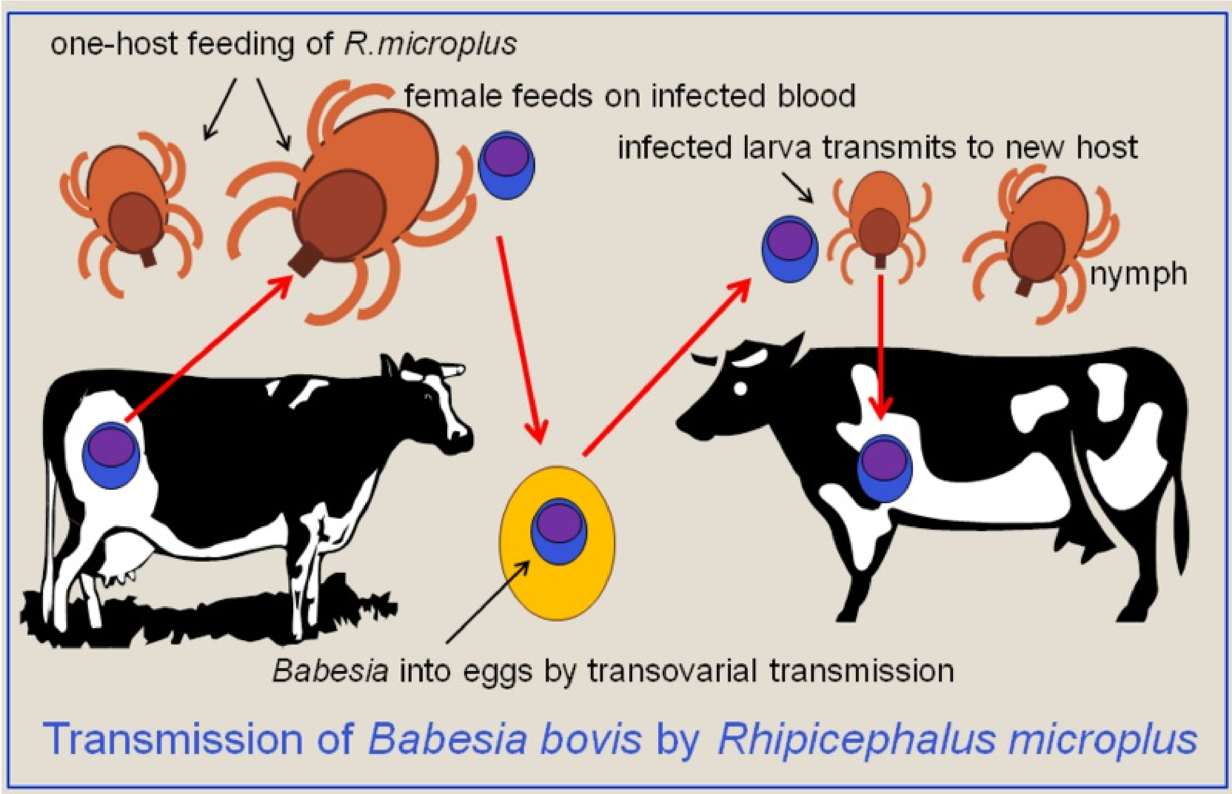

Figure 1. Diagram of basic paths of transmission of a*Babesia bovis* (Babés, 1888) (Apicomplexa: Piroplasmida: Babesiidae) protozoan parasite by a one-host hard tick such as *Rhipicephalus microplus* (Canestrini, 1888) (Acari: Ixodidae).

Sources: Own work, Alan R Walke and https://en.m.wikipedia.org/wiki/File:Babesia-bovis-transmission.png.

Transmission of yellow fever in wild areas is maintained through the infection of monkeys and transovarian transmission in the mosquito itself. Human infection occurs when an unimmunized person enters savannah or forest areas. Once infected, the person can, upon returning, serve as a source of infection for *A. aegypti*, which can then initiate the transmission of yellow fever in urban areas [15-19].

Salmonellosis is caused by the bacteria *Salmonella* spp., eggs can be infected in two ways: through contaminated excreta as *Salmonella* colonizes the cecum and then contaminates the shell, which is porous; or due to internal contamination of the egg, since Salmonella can travel from the intestine to the ovaries through transovarian transmission, contaminating the yolk [15-19].

Candidatus (Liberibacter) asiaticus (LAS) and *Liberibacter americanus* (LAM) bacteria, the latter being found only in Brazil. They are gram-negative bacteria, limited to the phloem, belonging to the alpha subgroup of proteobacteria. Transmission of this disease can occur through grafting of infected plant materials by the parasitic plant *Cuscuta* L. Convolvulaceae) or by the Asian citrus psyllid, *Diaphorina citri* Kuwayama, 1908 (Hemiptera: Psyllidae) and transmit the bacteria to their progeny (transovarian transmission) [15-19].

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