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Tick Infestation and Disease transmission in livestock and human beings

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Abstract
Tick infestations pose a significant threat to livestock and poultry populations globally. These blood-feeding parasites not only impair the quality of skin and hides but also cause irritation and debilitation through their bites. The most critical danger associated with ticks is their role in transmitting a wide range of bacterial, viral, protozoan, and rickettsial diseases to both humans and animals. The economic impact of tick infestations and the diseases they spread is estimated to amount to billions of dollars worldwide.

Keywords: Tick, protozoa, rickettsia, tropics, dollars worldwide, livestock, populations globally

Introduction
Ticks are significant ectoparasites that affect livestock, poultry, companion animals, and humans. They rank second only to mosquitoes in their role as vectors of diseases. Ticks are capable of transmitting a broad spectrum of pathogens, including bacteria, viruses, protozoa, and rickettsial organisms. Diseases transmitted by ticks not only cause illness and death in animals and humans but also pose substantial challenges to animal husbandry. These infections adversely affect the livelihoods of farmers, particularly in developing regions (Perveen *et al*., 2021) [10]. Protozoan diseases such as theileriosis and babesiosis, along with rickettsial infections like anaplasmosis, significantly impact cattle and small ruminants, thereby affecting small-scale farmers in tropical and subtropical regions. The economic burden of these diseases, primarily due to the vector capacity of ticks, particularly ixodid ticks, is a growing concern in Asia, Africa, and Latin America, where the demand for livestock products is rising (Cunha, 2000) [3].
Historically, ticks and the diseases they transmit were associated with wild animals serving as reservoir hosts. However, they have increasingly affected domestic livestock. Factors such as climate change, animal migration, and the introduction of infested animals to new areas have altered the patterns of tick-borne diseases and their vectors. The global impact of ticks now extends beyond livestock, as zoonotic infections such as Lyme disease pose significant public health challenges (Estrada-Pena, 2009) [6].
Soft ticks (family Argasidae) go through several nymphal stages, are nidicolous, and typically reside close to their hosts and surrounding habitats, such as nests, huts, or sheds. The larvae feed on the host briefly before returning to their hiding places. Argas species primarily feed on domestic poultry, while Otobius ticks inhabit the external ear canals of their hosts. These ticks mate away from the host, feed multiple times, and lay eggs in small batches.
Hard ticks (family Ixodidae), which are of significant medical and veterinary importance, can be classified as one-host, two-host, or three-host ticks based on the number of hosts required during their life cycle. In one-host ticks, such as *Rhipicephalus microplus*, all developmental stages from larva to adult occur on a single host. For two-host ticks, the larva molts into the nymph on the first host, while the engorged nymph detaches and molts into an adult on the second host. In the case of three-host ticks, each developmental stage larva, nymph, and adult-requires a different host. These ticks attach, feed until engorged, drop off, and seek a new host for the next stage. Mating occurs on the host, after which the engorged female detaches, lays a large batch of eggs, and subsequently dies (Taylor *et al*., 2016) [17].

Direct effects of Tick Infestation

- Apart from having a major role in transmission of diseases, damage caused by tick bites reduces the quality of skins and hides. The ticks with a short mouth parts like *Rhipicephalus* sp when present in larger numbers on animals can damage hides and skin.
- Ticks with longer mouth parts like, such as *Hyalomma* spp., may induce abscesses due to secondary bacterial infections and blow fly strike .These ticks attach to udder, teats, legs in cattle and heavy infestation may cause loss of teats or lameness.
- Tick paralysis is caused due to paralyzing toxins (holocyclotoxin) in the saliva of certain tick species that causing death of adult cattle (*D. andersoni*) and sheep (*I. rubicundus*). A reversible accending motor paralysis along with nervous symptoms and in extreme cases respiratory faliure.
- A type of tick toxicosis 'sweating sickness', is a generalized eczema-like condition in calves and livestock, induced by the saliva of *Hyalomma* sp.
- Also severe skin infection like bovine dermatophilosis caused due to infestation by *Amblyomma variegatum*, leads to its rejection for upgrading of local cattle with exotic breeds in few tropical countries.

Indirect effects of Tick Infestation

The transmitting ability of tick depends upon its ability to acquire the infectious agent during feeding (blood meal), maintaining the agent for various life stages and then transmitting the agent to other hosts as it feeds next (Brites-Neto *et al*., 2015) [2]. The transmission of diseases is aided by saliva and its components that help in engorgement. There is trans ovarian and transstatial transmission of protozoan and rickettsial organism (Table 1).

Table 1: Disease transmission and harmful effect of ticks

Tick	Harmful effect/Transmits
Argas persicus	*Borrelia anserina, Aegyptonella pullorum*
A. reflexus	Anemia (pegion), *Aegyptonella pullorum*
Otobius megnini	Severe otitis in livestock
Amblyomma americanum	Screw worm, Tularaemia, Human ehrlichiosis
A. hebraeum	Cowdriosis of ruminants, *Theileria mutans* African tick-bite fever in man (*Rickettsia africae*) severe local reactions (secondary bacterial infections leading to loss of udder quarters in cattle)
A. variegatum	Cowdriosis and Dermatophilosis of ruminants *Theileria mutans*, Thogoto virus, *Rickettsia africae* (Human) secondary bacterial infections leading to lameness and loss of udder quarters (Cattle)
Rhipicephalus annulatus	*Babesia bovis* and *Babesia bigemina, Anaplasma marginale*
Rhipicephalus decoloratus	*Babesia bovis* and *Babesia bigemina, Anaplasma marginale*
Rhipicephalus microplus	*Babesia bovis, Theileria equi, Anaplasma marginale*
Rhipicephalus appendiculatus	*Theileria parva, Theileria taurotragi,* Nairobi Sheep Disease virus, Thogoto virus
R.bursa	*Babesia ovis, Babesia bigemina, Anaplasma marginale, Anaplasma ovis*
R. evertsi	*Babesia caballi* ; *Theileria equi, Anaplasma marginale,* Tick paralysis in animals (toxin)
R.sanguineus	*Ehrlichia canis, Babesia vogeli, Hepatozoon canis, Rickettsia conorii* (human)
Dermacentor andersoni	*Anaplasma marginale, Rickettsia rickettsii,* paralysis toxin, Powassan encephalitis virus, Colorado Tick Fever, Virus,
D. marginatus	*Babesia canis, Rickettsia slovaka, Coxiella burnetii*
D.nitens	*Babesia caballi*
D. reticulatus	*Babesia caballi, Babesia canis,* Rickettsia sibirica, *Rickettsia slovaka*
D. variabilis	*Anaplasma marginale, Rickettsia rickettsii,* Paralysis toxin in animals, humans
Haemaphysalis leachi	*Babesia canis*
Haemaphysalis longicornis	*Babesia bovis, Babesia gibsoni, Theileria buffeli, Rickettsia japonica*
H.punctata	*Babesia major, Babesia motasi, Theileria buffeli*
Hyalomma anatolicum anatolicum, H. anatolicum excavatum, H. asiaticum asiaticum, H.dromedari	*Theileria annulata* (secondary bacterial infections leading to loss of udder quarters in cattle)
H. marginatum marginatum	*Theileria annulata,* Crimean-Congo Haemorrhagic Fever
H. truncatum	Crimean-Congo Haemorrhagic Fever virus, Sweating sickness, *Rickettsia mongolotimonae*
Ixodes holocyclus	Paralysis in animals and humans, *Rickettsia australis*
I.ovatus	*Rickettsia japonica*
I.persculatus	Tick-borne encephalitis virus, Lyme disease
I. ricinus	*Babesia bovis, Babesia divergens, Babesia microti,* Tick-borne encephalites, Louping ill virus, Lyme disease, Tick-borne fever and Granulocytic ehrlichiosis
I. rubicundus	Tick paralysis in sheep (Karoo paralysis toxin)
I. scapularis	Lyme disease in human beings, Granulocytic ehrlichiosis, Equine ehrlichiosis, *Babesia microti*

Tick infestation in different host

The economic impact of tick infestations, associated diseases, and control measures for *Rhipicephalus microplus* alone is estimated at \$13.9-18.7 billion annually worldwide (Betancourt, 2017) [1]. In dairy cattle, tick infestations can reduce milk production by approximately 90 liters per lactation per cow. A single engorged female tick can decrease milk yield by up to 8.9 mL (Rodrigues and Leite, 2013) [14].

Bovine anaplasmosis, caused by *Anaplasma marginale*, affects erythrocytes and is biologically transmitted by at least 20 tick species worldwide, including *Rhipicephalus* spp. *Dermacentor* spp., and *Ixodes ricinus*. Soft ticks like *Argas persicus* and *Ornithodoros lahorensis* have also been implicated. Male ticks can serve as long-term reservoirs for *A. marginale* under favorable environmental conditions.

Economically significant *Theileria* species infect cattle and small ruminants through ixodid ticks, including *Rhipicephalus*, *Amblyomma*, *Hyalomma*, and *Haemaphysalis*. Globally, *Theileria annulata* (tropical theileriosis) and *T. parva* (East Coast fever) are the most critical pathogens, causing substantial losses in cattle production (Dehuri *et al*., 2022) [5].

Ticks also hinder international trade in live animals and animal products like meat, milk, leather, and skins. Diseases such as bovine babesiosis, *Rhipicephalus microplus* is a primary vector, while in some countries, *Rhipicephalus decoloratus* plays a role. *Babesia divergens* transmitted by *Ixodes ricinus*, can result in severe symptoms, including seizures, paralysis, and death.

In small ruminants, certain tick species can cause paralysis and toxicosis. Severe lameness has been observed when ticks attach around the coronary band. Additionally, the hides of sheep, goats, and cattle often sustain damage due to tick infestations. Ticks such as *Otobius megnini* and *Ornithodoros coriaceus* are known to cause ear irritations and injuries, potentially leading to permanent nerve damage or death from meningitis (Gnad and Mock, 2001) [7]. Ticks are vectors for several common diseases, including babesiosis, anaplasmosis, theileriosis, and heartwater. *Anaplasma ovis*, transmitted by *Rhipicephalus bursa*, *Dermacentor* spp., and *Haemaphysalis sulcata*, causes hemolytic anemia in sheep and goats. *Anaplasma phagocytophilum*, the agent of tick fever in sheep, is spread by *Ixodes* spp. Babesiosis, a disease caused by *Babesia ovis*, *B. motasi*, *B. taylori*, and *B. ovis*, is highly pathogenic and is transmitted by ticks from the *Rhipicephalus*, *Haemaphysalis*, and *Dermacentor* genera. Theileriosis, caused by species such as *Theileria ovis*, *T. lestoquardi*, *T. luwenshuni*, and *T. uilenbergi*, can be particularly severe. *T. lestoquardi* is known to cause lymphoproliferative disease with high morbidity and mortality. This pathogen is transmitted by *Hyalomma* spp. and *Rhipicephalus bursa*. Heartwater, a rickettsial disease affecting domestic and wild ruminants, is caused by *Ehrlichia ruminantium* and is transmitted by *Amblyomma* spp.

Domestic pigs are also vulnerable to tick infestations, with common tick genera including *Dermacentor*, *Ixodes*, *Amblyomma*, *Ornithodoros*, and *Otobius*. African swine fever, a viral disease with severe economic implications, is transmitted by soft ticks of the *Ornithodoros* genus. These ticks can remain infectious for extended periods through mechanisms like transstadial, venereal, and transovarial transmission. Another tick-borne disease in pigs is tularemia, a zoonotic illness caused by *Francisella tularensis*. This bacterium is transmitted both vertically and horizontally by ticks, with species such as *Amblyomma americanum*, *Dermacentor andersoni*, *D. variabilis*, and *Ixodes* spp. acting as vectors.

Hard ticks, including species of *Dermacentor*, *Ixodes*, and *Amblyomma*, are commonly found on horses. The severity of symptoms in horses depends on infestation levels, which can lead to localized or generalized hypersensitivity reactions. Symptoms such as nodules, papules, scabs, ulcers, erosions, and hair loss are often observed at bite sites. Horses can suffer from tick-borne diseases like equine granulocytic anaplasmosis and equine piroplasmosis (Rees, 2004) [13].

Birds are also affected by ticks, which can transmit a variety of pathogens worldwide. Pathogens such as *Borrelia anserina*, *Staphylococcus aureus*, *Salmonella Pullorum*, and *Escherichia coli* have been isolated from *Argas persicus*. Literature reports indicate that ticks can transmit diseases like salmonellosis, mycoplasmosis, leukocytozoonosis, aegyptianellosis, pasteurellosis, avian encephalomyelitis, borreliosis, and avian cholera (Shah *et al*., 2004) [15]. Tick bites damage the skin by penetrating with the hypostome, causing epidermal injury and blood vessel rupture. The resulting edema, cell infiltration, and extensive hemorrhage can reduce food absorption and lead to weight loss in affected animals. Poor carcass quality affects marketability, a significant concern in the poultry industry. Soft ticks feed multiple times during their nymphal stages, potentially causing blood loss, wasting, and fatal anemia. For instance, three to four *Argas persicus* ticks per bird can consume about 18.5 mg of blood per day, leading to substantial economic losses in poultry production (Khan *et al*., 2001) [9].

The first human tick-borne disease discovered was *B. burgdorferi* in 1982, after which almost fifteen bacterial pathogens have reported (Parola and Raoult 2001) [11]. The increasing numbers of tick transmitted diseases pose a grave risk for public health. Also recreational activities in tick-infested areas have resulted in an increased number of cases of humans bitten by ticks in Europe and America. Most of the human diseases transmitted by argasid ticks are caused by *Borrelia* species that produce relapsing fevers. Soft ticks transmit *Borrelia spirochaetes* to humans, which is confused with malaria and so its potentialy as tick transmitted disease and public health significance is undermined. *Ixodes* spp. transmits European tick-borne encephalitis, Russian spring summer encephalitis while Crimean-Congo haemorrhagic fever (transmitted by *Hyalomma* spp.) is prevalent across Africa, Asia and Europe, causing mortality. In India, a deadly flavivirus, causing Kyasanur forest disease (transmitted by *Haemaphysalis* spp.) has led to mortality every year (Gray *et al*., 2002) [8].

Conclusion

In most of the domestic animals and birds, ticks transmit protozoan and rickettsial diseases, the recovered animals though retain the infection and remain immune for a long time. In general, where such diseases are endemic, the local livestock to various degrees, become tolerant, but not refractory to the infection. The environmental and meteorological conditions affect the tick abundance and endemic stability. Exotic livestock, introduced from regions where the diseases donot exist, are far more susceptible to most tick-borne diseases.

Conflict of Interest

Not available

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Not available

Reference

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