The Pharma Innovation Journal 2022; SP-11(6): 144-146

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(6): 144-146

www.thepharmajournal.com
Received: 06-03-2022
Accepted: 10-04-2022

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Parasitic interface in wild animals

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Abstract
Wild animals under natural condition are susceptible to almost all diseases as other animals, particularly parasitic infection. Parasites can affect animal survival and reproduction directly through pathological effect (blood loss, tissue and organ damage, abortion, congenital malformation and death) and indirectly by reducing the host immunity and affecting the physiological condition. The wild ruminants are natural prey base for wild carnivores. Parasites play a major role in the natural ecology of free ranging wild animals with effects ranging from negative impacts on host population size to the evolution of host behaviors to combat parasites. Parasitic prevalence is an important parameter to monitor the health of free-ranging wild herbivores. Future researches with advanced techniques are required to evaluate the impact of GI parasites in wild animals.

Keywords: Wild animals, parasitic infection, spillover, ecology

Introduction
Infectious diseases are the third most important driver of population decline of wildlife (Bengis *et al*., 2004) [14] after hunting and habitat degradation. Diseases that are shared between species also represent a potential burden to the whole ecosystem, affecting biodiversity, changing behavior or composition of animal populations, and even relegating species to the fringe of extinction (Williams *et al*., 2002) [15]. Corona virus Disease (COVID-19), (Severe Acute Respiratory Syndrome - Coronavirus-2) caused by SARS-CoV-2 of the family Coronaviridae, reported in December 2019 and rapidly spread worldwide. This disease was declared as pandemic and Public Health International Emergency by World Health Organization. COVID-19 was reported from all corner of globe. Researchers worldwide are pacing with high efforts to counter the further spread of such type of pathogens and design effective vaccines and therapeutics/drugs to save mankind. Few of the studies have shown the potential of the animal-human interface and zoonotic links in the origin of SARS-CoV-2. Exploring the possible zoonosis and revealing the factors responsible for its initial transmission from animals to humans will pave ways to design and implement effective preventive and control strategies to counter the COVID-19 (Tiwari *et al* 2020) [5]. The emergence of emerging infectious diseases with zoonotic potential has dominated research on wildlife pathogens over recent years. As a result, not only studies on the biodiversity and ecology of parasites been neglected but also efforts to control them have been impaired. The research focus has been directed toward humans and domestic animals. However, there is also a need to obtain greater understanding of how these emerging pathogens interact with sets of organisms living together in wild ecosystems Pathogen maintenance within wildlife populations and spill-over to livestock has been reported as a precursor to disease emergence in humans. Diseases have been documented as a major cause of local extirpation of a number of wild animal species in India. Until and unless different epizootiology cycle of various parasitic infections is delineated and it is difficult to plan out measures to eradicate these diseases from free-ranging wild animals (Jones *et al*., 2008) [16]. In livestock, economic losses are caused by gastrointestinal parasites in a variety of ways: They cause losses through lowered fertility, reduced work capacity, involuntary culling, a reduction in food intake, lower weight gain, lower milk production, treatment cost, and mortality in heavily parasitized animals (Fikru, 2006) [6]. Wild animal under natural condition is susceptible to almost all diseases as other animals, particularly parasitic infection. Parasites can affect animal survival and reproduction directly through pathological effect (blood loss, trauma, tissue and organ damage, abortion, congenital malformation, and death) and indirectly by reducing the host immunity and affecting the physiological condition (Sengar *et al*. 2017) [3].

The wild ruminants are natural prey base for wild carnivores; however, the sustenance of wild ruminants in protected habitat depends upon their agility and alertness (Kiziewicz 2013) [2]. Diseases manifestation in animals may reduce the body potentials leading to morbidity and mortality. Parasites play a major role in the natural ecology of free ranging wild animals, with effects ranging from negative impacts on host population size to the evolution of host behaviors to combat parasites. Previous studies also showed that parasites regulate population dynamics and may be responsible for extensive population decline (near extinction) of some host species. The parasitic infestation may negatively influence the health of the animals (Bhaydiya *et al* 2021) [1].

Predisposing Factors

The role of wildlife in the transmission of parasitic zoonoses Wild and domestic animals near the protected areas share the same pasture land and water holes which increases the chances of parasitic infection. This can be further supported by finding of Mandal *et al*. documented that grazing area and water holes shared by cattle and free ranging chital in Mudumalai Wildlife Sanctuary increased the prevalence of parasitic infection. The variation in topographical location of the protected area appears to influence the rate of prevalence. *Neospora caninum* infection is present in wildlife, especially in red deer. This has important implications in the prevalence of infection in cattle farms (Almeria *et al*. 2013).

Type of Parasites

Many species of ectoparasites and endoparasite such as ticks, mites, lice and helminths, cestodes and trematodes etc. have been found in the wildlife and domestic animals, they cause various zoonotic infections. Strongyles, Strongyloides, Trichuris, Amphistomes, Coccidia, Moniezia, Fasciola were found to most prevalent parasites in most of the wild ruminants could be due to more favorable environment for the development of the preparasites stages in the hot and humid environmental condition of natural forest areas. In hillocks and swampy meadows where snail population, which serves as intermediate host for flukes, is abundant in natural water sources facilitating higher concentration of metacercaria, the infective larval stage, on the pasture.

Climate and environment

Environmentally mediated parasitic diseases such as malaria, schistosomiasis, hookworm, onchocerciasis, and Chagas disease result in high morbidity and increased mortality, the latter particularly associated with malaria, and affect millions of people living in tropical and subtropical regions (Hotez *et al*, 2006) [8]. Moderate temperature and more humidity between the soil and the herbage favor the survival of eggs and free-living stages of parasites. The higher rate of prevalence during the rainy season is due to the existence of a suitable microclimate for the survival and propagation of free-living larval stages of parasites at several places. The parasites ova, snails, and other intermediate host get a favorable humid sub-tropic climate for development in the plane grazing areas with shallow temporary stagnated water. The animals congregate at the greens available around the periphery of such areas and naturally acquire more infection.

Interphase area

Interference with ecosystem such as deforestation, construction of roads, buildings, check dams, agriculture, the formation of ecological mosaics, tourism, etc., changed the habits of wild animals. Endoparasite fauna in wild animals and consequent detection of infection in these animals might suggest that there could be proximity to and interactions with domestic animals (Thompson *et al*, 2009) [4]. The high prevalence encountered may be explained by the existence of favorable climate condition which supports prolonged survival of infective nematode larvae on Interphase pasture (Mathews F, 2009) [9]. In this Panna tiger reserve and its surrounding Senger *et al* (2017) reported wild herbivores and livestock are not came to close contact, but they using same pasture for grazing.

Agriculture and livestock farming near the forest area

With the increasing human population with extensive agriculture and livestock/ animal husbandry practices near the natural forest areas, humans and their domestic animals have regularly been coming into regularly contact with wild animals in their habitats. This type of closer contact facilitates the spread of infectious agents and parasites to new hosts and environments, leading to establishing new relationships between hosts and parasites and new ecological niches in the disease transmission chain (Correa and Passos, 2001) [13].

Gap in manure technology

The another cause of parasitic infection is due to delays and gaps in manure management in most of the villages areas which can further helpful for organic farming as well another source of income to farmers. There are various factors which determined the use of fertilizers, but there is need to analyze the gap in nutrient supply, capacity of soil and nutrient requirement for agriculture land.

Anthelmintic resistant

With advancement of livestock farming and veterinary care a regular deworming is perform end in intensive as well as extensive type of management which leads to parasitic resistance and resistant pathogens spillover to wild animals due sharing of pasture and water bodies.

Urbanization / habitat destruction and scarcity of food and water

Urbanization has diminished the resources and grazing lands of free living animals. In addition, extensive construction works are carried out near the conserve protected areas which create disturbance in natural forest and due to these anthropogenic factors animals' moves from protected areas/forest to human dominating landscape.

Epidemiology of Parasites Interactions in Wild Animals

Prevalence

Parasitic infection in wild ruminants, primates, carnivores as well reptiles has been reported in many countries. Gastrointestinal parasites are the most common type of parasites found in wild animals suffering from infection. Gastrointestinal parasites among wild animals have been reported by different workers all over the world (Senger *et al* 2017, Bhaydiya *et al* 2019, Fikru *et al* 2006, Dishane *et al* 2021) [1, 6, 12].

Susceptibility of species parasitic infection reports were observed in all type of wild animals including free ranging as well as captive. Ruminants are more susceptible to the development of gastrointestinal parasites infection.

Control measures

The higher rates of prevalence of parasites are due to the suitable macro and microclimate for the survival and propagation of free-living eggs, larval stages, oocyst of parasites, and intermediate hosts at several places. The parasitic ova, cysts, snails, and other intermediate hosts get a favorable humid sub-tropic climate for development in the plain grasslands, grazing areas with temporary stagnated water. The animals grazing around the periphery of these areas can naturally acquire more infection (Voyles *et al*., 2015) [11]. However, low-grade infections can propagate and develop the disease, hence could not be neglected. In most of the study observed wild animals did not show any obvious clinical signs, suggesting that low to moderate infection at the subclinical level may be present in these animals. This shows that an undetermined number of wild animals may be parasitized without even showing outward or overt physiological signs of infection (Opara *et al*., 2010) [10]. Comparative assessment of gastrointestinal parasites in free-ranging ruminants is helpful in the formulation of a preventive strategy to overcome the disease burden but also useful in maintaining a healthy population of wild herbivores in forests.

Conclusion

The prevalence of gastrointestinal tract (GIT) parasites infection in wild herbivores are common. The intensity of infestation by parasites can varies from low to heavy infestation. Management of diseases is an important component to wildlife conservation, considering that most species are already threatened due to habitat fragmentation and loss, diminished genetic diversity, overexploitation of herbivores themselves or their predators, and persecution by humans. Wild animals are also susceptible to lethal or debilitating pathogens, and co-infections can exacerbate clinical disease. Previous studies reported wild animals were exposed to parasites that are known to be pathogenic. Parasitic prevalence is an important parameter to monitor the health of free-ranging wild herbivores. Future researches with advanced techniques are required to evaluate the impact of GI parasites in wild animals.

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