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Understanding the Implications of *Plasmodium* on Wildlife Health and its Possible Control Measures

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ABSTRACT

Plasmodium has a significant impact on wildlife biodiversity, evolution, and conservation. There are more than 100 species of *Plasmodium* that infect both humans and animals and cause the disease malaria. The *Plasmodium* parasite is transmitted by mosquitoes (Anopheles) and causes infections in birds, mammals, reptiles, amphibians, and several others. The infection leads to fevers, anemia, organ damage, and even death. As different host species are susceptible to infection to various degrees, some develop immunity while others do not. 35 different *Plasmodium* species are recognized as legitimate species. The three species of *P. gallinaceum, P. juxtanucleare,* and *P. durae* are most dangerous to poultry. A variety of wild bird species are susceptible to infection by the *P. relictum* protozoan parasites, the source of avian malaria. *Plasmodium* needs both vertebrate host and invertebrate vector to complete their life cycle. In wild animal *Plasmodium* life cycle take place through different phases. When an infected mosquito bites a wild animal and injects sporozoites into its circulation, the lifecycle of the parasite begins. The animal's liver is where these sporozoites move, reproduce, and give rise to thousands of merozoites. Male and female gametocytes are produced by a few merozoites. Male and female gametocytes combine inside the stomach of the mosquito to generate zygotes, which then grow into ookinetes. Many studies have been carried out to understand the Pathogen-host connection, ecology, epidemiology, and climate change effect on *Plasmodium*. *Plasmodium* infection can be controlled by using strategies such as Immunization, Monitoring, Habitat management techniques, and Management of the host. It's essential to manage the mosquito population to stop the *Plasmodium* from spreading. Insecticides or biological control strategies can also be used to achieve this.

Introduction

Microscopic members of the *Plasmodium(p)* genus are the parasites that cause malaria. There are more than 100 different species of *Plasmodium* that have infected an extensive of animal species, including different types of mammals, reptiles, and birds [1]. Major elements like host species have a significant impact on the ecology of *Plasmodium* in animals. *Plasmodium* infections can cause a variety of health problems in wild animals, including anemia, organ failure, and neurological problems. These health problems can make it hard for affected animals to obtain food, to run away from predators, and to regulate their body temperature. An animal may occasionally become more vulnerable to other diseases and infections as a result of *Plasmodium* infections. This parasite causes malaria, a disease spread by mosquitoes [2]. Numerous species in this genus infect a huge variety of vertebrate taxa, such as birds, reptiles, and mammals. Since their discovery in the 1940s, the parasites that infect rodents, specifically the *P. Muridae P. berghei, P. chabaudi, P. vinckei, and P. yoelii*, have received the greatest attention from researchers and have been used as biological models to study a range of elements of the biology of malarial agents and how they interact with their hosts (vertebrate and arthropod vectors) [3].

Major species of *Plasmodium*.

- *P. ovale*
- *P. relictum*
- *P. falciparum*
- *P. malariae*
- *P. vivax*

The life cycle of *Plasmodium*

The *Plasmodium* needs both a vertebrate host and an invertebrate vector to complete its life cycle. Parasite infection could change the characteristics of insect vectors by increasing biting rates or vertebrate hosts, for example, the case for malarial parasites of the genus *Plasmodium.*, which infect a range of vertebrate species, by impairing their defensive behavior or enhancing their attraction to vectors, which in turn would increase host-parasite contact rates and consequently parasites. For instance, it is also reported that animals with *P. falciparum* gametocytes, the transmissible form of malaria were more attractive to mosquitoes.[4]. On a wild animal, such as a monkey or a bird *Plasmodium* goes through a number of phases. When an infected mosquito bites a wild animal and injects sporozoites into its circulation, the lifecycle of the parasite begins. The animal's liver is where these sporozoites move, reproduce, and give rise to thousands of merozoites. Red blood cells are infected once the merozoites are discharged into the circulation. Merozoites proliferate inside red blood cells, causing the cells to burst and release additional merozoites into circulation. Male and female gametocytes can be produced by a few of the merozoites. When a mosquito feeds on the blood of an infected animal, it may pick up these gametocytes. Male and female gametocytes combine inside the stomach of the mosquito to generate zygotes, which then grow into ookinetes. Following this, the ookinetes break through the gut wall and develop oocysts on the outside of the Thousands of sporozoites are released by the oocysts into the mosquito's body cavity. When a mosquito feeds on blood, the sporozoites go to the mosquito's salivary glands, where they can spread to humans or other wild animals. The lifecycle of *Plasmodium* in a wild animal and that of *Plasmodium* in people are comparable [5]. However, there may be variations in the exact species of *Plasmodium* and the host wild animal, resulting in variations in the onset and severity of the illness.

Impact of *Plasmodium* on wild animals

There is a dearth of fundamental understanding of how *Plasmodium* affects wild animals since some species have pre-erythrocyte stages and others have zoonotic potential. The effects of parasites on avian reproduction are amplified. The most of mosquitoes in research have focused on the role of human disease vectors. However, in more recent years, they have served as a pathogen vector, harming animals. Numerous studies have been conducted as a result, focusing on the climatic change, ecology, epidemiology, and evolution of the pathogen-host relationship [6]. Haemosporidian parasites (Haemosporida) are pervasive in certain animal species that are capable of inflicting serious infections on both blood-sucking insects and their bird hosts [7].

However, there is a knowledge vacuum about vector-borne viruses that harm animals, making it imperative to first examine the variety of taxa using genomic tools and their life cycles.

Impact of *Plasmodium* on wild birds:

The protozoan parasites that cause avian malaria, known as *P. relictum* can infect a range of wild bird species. [8].

P. relictum: This specie has been found in wild birds most frequently and is one of the most extensively dispersed species. It is known to cause serious illness in certain of its hosts and has been found in a number of bird species around the globe. In continental locations, where mosquitoes are more prevalent, avian malaria is frequent; nevertheless, it is absent from the isolated island. The parasites were identified as *P. relictum* on the basis of morphology [9]. To discriminate, however, the microscopic identification is insufficient in various *Plasmodium* species. Particularly in the initial and ongoing stages of infection, it calls for a wealth of knowledge and expertise. [10]. Lack of host specificity in *Plasmodium*

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infection has been demonstrated by a number of studies. This indicates that *Plasmodium* is more prone to switch across different species of bird hosts. Compared to sub-adult groups, adult birds were shown to be more infected, perhaps due to the timing.

Impact of *Plasmodium* on mammals:

1. The majority of *P*. infections in wild animals are species-specific, which means that each *P. species* is designed to infect a particular species of mammal. *P. knowlesi* [11] for instance, is a species that mostly infects macaque monkeys, whereas *P.berghei*, is a species that mainly infects mice [12]. Several *P.* species, including some that infect both people and animals like wild mammals, it is important to note. For instance, various species of African primates, such as chimpanzees and gorillas, have been shown to have *P. falciparum*, which is the most dangerous variety of *Plasmodium* in humans. Such interspecies infections are, however, quite uncommon and frequently do not lead to the parasite being transmitted in wild animal populations on a long-term basis. It has been asked if animal malaria could be considered as a true zoonosis. The possibility that man may get malaria from some non-human primates has long been acknowledged. Though natural transmission of a non-human P. species to humans was previously believed to be extremely rare, the first case of a naturally acquired *P. knowlesi* infection was described. This demonstrated the infectivity of the simian malaria parasites in humans through anopheline mosquitoes. [13] , however, it wasn't until that 120 (57.7%) cases of malaria were found to be caused by single or multiple *P. knowlesi* infections that simian malaria was acknowledged as a problem for human public health.

Control factor:

The parasitic protozoan genus *Plasmodium* is responsible for the transmission of malaria to a wide range of species, including people and wild animals. The complexity of wild animals' environments and the variety of their hosts make it difficult to manage *Plasmodium* in these species. Nevertheless, there are a number of important elements that can aid in reducing *Plasmodium* infection in wild animals, such as its main vector being the mosquito, which can be controlled. So, it's essential to manage the mosquito population to stop the *Plasmodium* from spreading. Insecticides or biological control strategies can also be used to achieve this.

- **Management of the animal's environment**: The habitat of wild animals can have a big impact on how *Plasmodium* spreads. Mosquito populations can be lowered by managing habitats, such as by removing standing water sources [15]. Habitat management techniques, such as removing standing water sources, can cut down on mosquito breeding grounds and assist in reducing *Plasmodium* spread
- **Immunization**: Immunization is a successful method for stopping the spread of *Plasmodium* in wild animals. In managing *Plasmodium* in animals, a number of experimental vaccines have been produced with encouraging results.
- **Monitoring:** Monitering *Plasmodium* in wild animal populations can aid in the early detection and containment of epidemics. The identification of regions with high *Plasmodium* transmission rates and the implementation of appropriate control measures can both be aided by routine surveillance.
- **Management of hosts**: *Plasmodium*-infected wild animals can serve as disease reservoirs, causing the illness to spread. Controlling the number of infected hosts can therefore aid in reducing *Plasmodium* transmission.
- **Habitat management techniques:** Techniques such as removing standing water sources, can cut down on mosquito breeding grounds and assist in reducing *Plasmodium* spread.

All things considered, a combination of these elements may aid in the management of *Plasmodium* in wild animals. When putting control measures in place, it is crucial to take into account the distinctive qualities of each species and habitat.

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