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Babesia microti Studies in México

AUTHORS DETAIL

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INTRODUCTION

In North America, the cases of human babesiosis exceeds 20,000; it is considered as an emerging zoonotic disease mainly caused by *Babesia (B.) microti* (Yang et al. 2021). Wild rodents and hard ticks of the *Ixodes* genus are involved in the life cycle of this parasite. Wild rodents of several genera, including *Peromyscus*, are widely distributed in México (Ceballos 2014) and *Ixodes* ticks are also present in the country (Hoffman and López-Campos 2000). In this respect, *Ixodes (I.) scapularis* not only transmits *B. microti*, it also transmits *Borrelia burgdorferi* the causative agent of Lyme disease (Illoldi-Rangel et al. 2012; Feria et al. 2014). To date, there is no published information on the presence of *B. microti* in wild rodents in Mexico, which are a source of infection in humans. Taking into consideration the One Health focus for controlling parasitic diseases, the objective of this study was to determine the presence of *B. microti* in wild rodents from three Mexican natural parks located in the states of Mexico, Guerrero and Michoacán, through PCR amplification of the 18S rRNA gene.

Etiological Agent

Babesia microti is one of the causative agents of babesiosis in mammals (Kreier and Baker 1987) and a tick vector, generally of the *Ixodes* genus, is involved in transmission of this parasite to mammals. Briefly, when the infected tick bites a mammalian host, generally a wild mouse *Peromyscus* spp. transmits sporozoites to it, which then penetrate a red blood cell; once there, they transform into trophozoites, which generates mature merozoites and these, rupture the red blood cell to penetrate more erythrocytes. When a susceptible tick vector bites the infected mammal, the cycle continues (Westblade et al. 2017). Fig. 1 and 2 show a blood film of a mouse infected with *B. microti* and a simplified life cycle of the parasite, respectively.

Babesia microti Life Cycle

In the life cycle of *B. microti*, the interaction of *I. scapularis* with *Peromyscus* mouse is essential for the maintenance of the parasite in nature. The adult stages of *I. scapularis* feed primarily on deer (*Odocoileus virginianus*), which do not serve as reservoirs for *B. microti*, they feed again in the fall and in the spring, after which the ticks lay eggs. These eggs hatch in the summer, and the larvae feed primarily on wild mice; at this moment, the tick can acquire *B. microti*. The infected larvae overwinter and molt to become nymphs in the spring. Then, the nymphs feed on hosts from May through July. The nymphs that have fed molt into adults in the fall, completing the tick life cycle. In areas where human babesiosis is endemic, the ticks feed primarily on *Peromyscus* wild mice (Kreier and Baker 1987; Telford et al. 1993; Homer et al. 2000).

Material and Methods

Wild mice were captured from Michoacán State, México State, and Guerrero State (Fig. 3) and DNA was extracted from obtained samples and kept in the DNA and Tissue Bank of the Emerging Infectious Diseases Laboratory (IMSS), followed by a descriptive cross-sectional study. For this, DNA was extracted from liver, ear or heart of these rodents, which previously euthanized in accordance with the Norma Oficial Mexicana NOM-062-ZOO (1999). From the samples, the *B. microti* 18S rRNA gene of was amplified, using the Gray type strain of the parasite as a positive control, and a 1.5% agarose gel electrophoresis of the PCR products was carried out to perform purification and product sequencing for comparison with Gen Bank sequences (Persing et al. 1992).

RESULTS

The amplified samples showed 99% similarity to *B. microti*. Regarding the percentages of positivity in 190 DNA's examined by state for *B. microti*, there were 16.9% (14/84) from the State of Mexico; 16.6% (12/71) from Guerrero and 8.6% (3/35) from Michoacán.

The percentages of the 21 positive rodents were as follows: 28.6% for *Peromyscus megalops*, 23.8% for *Peromyscus* sp., 14.3% for *P. maniculatus*, 9.5% for *P. beatae*, 4.8% for *Mus musculus* and 14.3% for *Megadontomys* sp. (Fig. 4).

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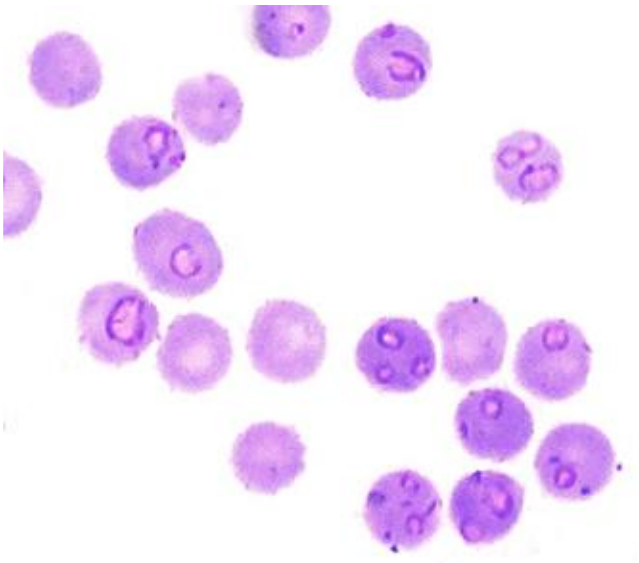

Fig. 1: Blood smear of a mouse infected with the Gray strain of *Babesia microti* stained with Giemsa stain, showing trophozoites (Photograph by Carlos R. Bautista-Garfias).

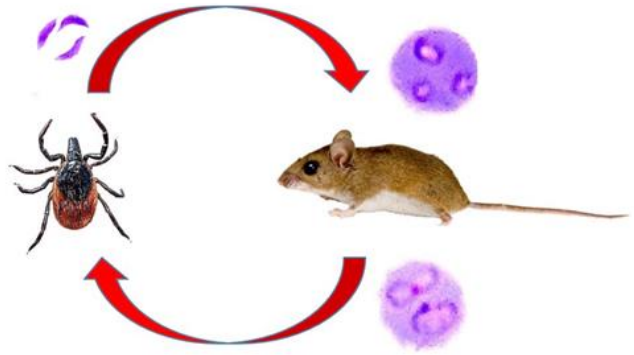

Fig. 2: *Babesia microti* simplified life cycle (Figure designed by Carlos R. Bautista-Garfias). Left: the vector *Ixodes* spp. and a *B. microti* sporozoite; right: wild mouse *Peromyscus* spp. (reservoir of the parasite), and *B. microti* trophozoites inside red blood cells.

Fig. 3: Map of México showing the States where wild rodents were captured for this study.

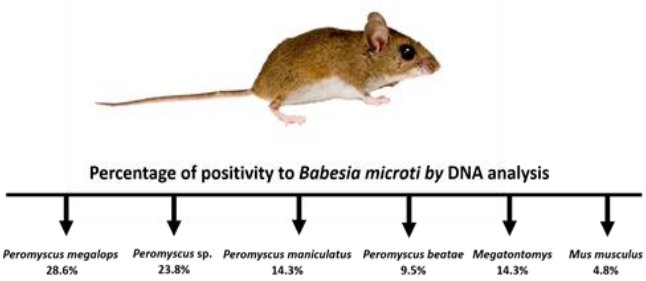

Fig. 4: Percentage of positivity of *B. microti* in wild rodents from three Mexican States.

DISCUSSION

The knowledge on *B. microti* has been increasing in recent years (Gray et al. 2010; Al Zoubi et al. 2016; Arsuaga et al. 2016; Primus et al. 2018; Strizova et al. 2020; Puri et al. 2021; Telford et al. 2021). It also indicates that this parasite may infect small mammals belonging to different families (Gao et al. 2017), which suggests that the problem of babesiosis is complex.

On the other hand, further research on *B. microti* infections needed in Mexico because the only published study on *B. microti* in the country is that carried out in humans in Yucatán (Peniche-Lara et al. 2018). In this context, it must keep in mind that a serious risk for human health is the fact that *B. microti* can be transmitted by blood transfusion (Kumar et al. 2021; O´Brien et al. 2021). Additionally, in a recent study researchers demonstrated that wild rodents from México, such as those of the *Peromyscus* genus, are also infected with *Borrelia burgdorferi*, the causative agent of Lyme disease (Rodríguez-Rojas et al. 2020).

With reference to alternatives for controlling babesiosis, Bautista-Garfias et al. (2005) demonstrated experimentally that using the acid lactic bacteria *Lactobacillus casei* in mice controls infection by *B. microti*, but further research is needed.

Conclusion

The results demonstrated that *B. microti* is present in wild rodents, mainly in animals of the *Peromyscus* genus, which live in natural parks of three states of México. There is a risk that the human population living in these areas, not aware of the problem, and chances are there that they may already exposed to infection by this pathogenic protozoan. At the same time, the population of wild mice infected with *B. microti* and the ticks involved in its transmission is unclear which represent a major threat for human health. It is urgent to carry out epidemiologic studies of *B. microti* and its vectors using One Health approach so that appropriate control measures may be applied (Hopkins et al. 2022).

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