



Revista MVZ Córdoba  
ISSN: 0122-0268  
ISSN: 1909-0544  
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Universidad de Córdoba  
Colombia

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Revista MVZ Córdoba, vol. 22, no. 3, 2017

Universidad de Córdoba, Colombia

**Available in:** <http://www.redalyc.org/articulo.oa?id=69353287004>



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## The amazing bats: Friends, enemies or allies?

Los sorprendentes murciélagos: ¿Amigos, enemigos o aliados?

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Bats are a group of extraordinarily specialized vertebrates and are the only mammals capable of flying; their nocturnal habits have stigmatized them to such an extent that in the Hollywood film productions *Count Dracula of the Carpathian Mountains* was considered the first vampire man; even before Batman himself. In ecosystems, bats are actors with leading roles, 70% of them are insectivores, pollinators, or frugivorous and contribute to the regeneration of forests by disseminating seeds. Some are even fish hunters. Although their large population is mostly distributed in the tropics, they are cosmopolitan and are also found in the Northern Hemisphere. The population of these bats has been displaced in the South American tropics, due to, among many factors, illegal mining, pesticide spraying, indiscriminate deforestation to provide pasture for cattle, and the invasion of their habitats by humans (1).

Chiropterans (bats) cover over 1.200 species; they represent no less than 20% of all mammal species and are the second most numerically diverse mammalian (1). The number of zoonotic viruses is greater within rodents in comparison to bats. However, on a species-by-species basis, bats harbor more viruses (zoonotic and non-zoonotic) than rodents (1).

However, bats have a dark side because they are known as vectors involved in zoonoses such as the rabies, transmitted by the hematophagous bat, *Desmodus rotundus*, and the alphavirus's encephalitis (1). In addition, in some infections they participate as reservoirs or hosts of coronaviruses that cause severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), Nipah virus paramyxovirus, Hendravirus and filovirus like Ebola. A variety of pathogens such as Dengue, encephalitis's viruses, arenavirus, hantavirus, hepacivirus, *Leptospira*, *Bartonella*, *Leishmania* and *Trypanosome*, among others, have also been found in frugivorous and insectivorous chiroptera.

Bats evolved approximately 50 million years ago and therefore have adapted to these pathogens without suffering diseases. However, some of these microorganisms gave the intra-species jump as the H1N1 virus that used birds, pigs and finally reached humans. The questions that researchers ask are: Why do chiroptera not develop the diseases of the pathogenic microorganisms they carry or transmit? Is it the bats' immune system that allows them to survive these pathogens?

In humans, viruses attack the first line of defense of the immune response system allowing the spread of the virus. In bats, it is believed that the elevation of body temperature at 40 ° C that they obtain during flight generates a metabolic increase that produces active oxygen radicals that cause damage to cellular DNA (2). Apparently also the genes involved in antiviral responses are positively selected because of their role in DNA repair. Therefore, the chiroptera's ability to fly could cause the DNA repair genes to evolve for better functionality, which in turn may have led to the evolution of a stronger immune response in these mammals. It is believed that they are also prepared to resist viral infections due to an overactive antiviral response in

their cells (2). The viruses that are in the bats have also adapted and produce increasing amounts of proteins that can modulate the immune responses of the bat itself (2); which allows the viruses to spread through the chiroptera. In other words, viruses “do not want to defeat their means of replication, life and transport”.

That is why some scientists are investigating the immune system of bats since their understanding could help humans survive the next pandemic (2). Bats can be experimental models for the development of new vaccines or could serve as biological control allowing disseminating microorganisms to stop strains of pathogens in other environments.

In another recent study, researchers captured 12.300 bats, 3.400 rodents and 3.500 monkeys from Africa, Asia, South America and Central America. They found that 10% of bats carrying coronavirus, in contrast, with just 0.2% of other specimens (3). The diversity of the viruses was much greater in the Amazon where many of bats species live. However, biodiversity is not an indicator of risk, since only a small proportion of coronaviruses are pathogenic for humans (3). The researchers also observed that coronaviruses in Africa had spread among unrelated bat species, four times more frequent than viruses from Mexico, Brazil, Bolivia and Peru (3). This could be due to genetic differences in the coronaviruses of each region or to the social behavior of the various bats species that interact in different forest ecosystems. However, viruses in Latin America do not jump between bat species as much as their African counterparts (3).

To write about these amazing mammals in an editorial is to be too pretentious, because the literature that exists about these flying mammals is extensive, but we believe that this brief editorial allows us to share with the reader that bats are not our enemies, rather they are our allies and therefore we should “subscribe” a non-aggression agreement with them, accepting the agreements that are very fashionable these days both in the regional and global order and we can coexist in harmonious synergy between *Homo sapiens* and animals.

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