BATS, SARS COV VIRUSES, AND HUMANS

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A bushveld horseshoe bat emerging from its cave roost. Photo by Sherri and Brock Fenton

The ~1400 species of living bats are classified in 21 families. Wings and the ability to fly make bats distinctive among mammals. Bats are small (4 – 1500 g), but some live over 40 years in the wild. Most eat mainly insects and other animals, others many eat fruit, and some visit flowers. Bats provide valuable ecosystem services as important predators, and are vital to plants as pollinators and dispersers of seeds (Fenton and Simmons 2015).

Contrary to popular belief, bats are not exceptional hosts of viruses. A recent comparison of viral loads across birds and mammals shows that numbers of species of bats and birds is the best predictor of the numbers of kinds of viruses they host (Mollentze and Streicker 2020). But bats thwart some viruses that kill other mammals. Their antiviral immune system (the interferon pathway) is permanently turned on and protects them from inflammation (Brooke et al. 2020). This situation means that bats can harbor (= be a reservoir for) viruses such as coronaviruses, those that cause the common cold, Ebola, SARS (SARS CoV-1, and SARS CoV-2). But only some insectivorous bats (horseshoe bats and Old World leaf-nosed bats) have been associated with SARS CoV-1 and SARS CoV-2 (Zhou et al. 2020).

Humans do not share bats' abilities to thwart these viruses. Therefore, to really understand our vulnerability, we need to know how the viruses jumped from a wildlife host (perhaps a bat) to a human. The three species of blood-feeding vampire bats come to mind but they have not been associated with SARS-CoV and do not occur outside of the Neotropics. There are four obvious 'natural' routes: a) humans could handle or eat the meat of a wildlife host species; b) they could be exposed to the host's droppings; c) bodily fluids; or d) they could inhale contaminated exhalations of a host species.

All four routes have been suggested for the SARS CoV-2 situation in Wuhan, China. There, at a 'wet' market live bats were kept close to other wildlife species. Some people entered caves in the Wuhan area and came in direct contact with bats, or with their feces and urine, let alone the atmosphere of a cave, a rich source of bat exhalants. But talk is cheap, and none of these possibilities has been supported by scientific evidence gained from direct observation or experimentation.

Lurking in the background are the many impacts of an ever-expanding human population including destruction of natural habitats (Jones et al. 2013). These generate more interactions between humans and species we usually do not encounter. Consequently, it is a mistake to blame bats when humans set the stage for the virus to jump to people. In many parts of the world, wildlife (bush meat) has been a staple for hundreds of years. Caves used as roosts by bats, people, often tourists, visit caves that are bat roosts. Other people mine bat guano for fertilizer or, in the past, sodium nitrate (saltpetre) an ingredient in gunpowder. Despite all of these interactions, SARS CoV-1 and SARS CoV-2 rarely jump to humans. How do we know this?

Naturalists and biologists who study bats have worked in bat roosts for hundreds of years. But before SARS there was no evidence of them or others being infected with a coronavirus by exposure to bats. A survey of bat biologists confirmed this impression (Stockmann et al. 2008). In 2005, after the SARS outbreak, researchers collected 10mL samples of blood from 90 bat biologists. They tested the samples for antibodies against inactivated SARS-CoV. Eighty-nine of the biologists showed no antibodies against inactivated SARS-CoV. About 23% of the biologists had worked with horseshoe bats, including catching and handling them in the field. Since then Coronavirus RNA has been found in some North American bats but there are no medical cases associated with this occurrence.

Genetic evidence suggests that SARS CoV-2 diverged from SARS CoV-1 50 – 70 years ago (Boni et al. 2020). This could mean a time lag of 50 -70 years before the COVID-19 pandemic. Once it entered the human population and passed human to human, the rapidity of the COVID-19 pandemic spread is easier to understand. The spread reflects the mobility of people and the propensity of many of them to travel widely usually in close contact with others (Chinazzi et al. 2020).

The numbers of cases of Middle East Respiratory Syndrome (MERS) a respiratory disease associated with a coronavirus, put the COVID-19 data in perspective. About 1600 people were infected with MERS, 576 (36%) did not survive it, compared to COVID-19 (2,256,844 cases of COVID-19 and 154,350 deaths as of 18 April 2020). In MERS, transfer to humans was through close association with camels (Chu et al. 2014). Data from one bat were used to infer that bats were the reservoir, but there was no indication of how the virus jumped from bats to camels.

This raises the issue of intermediate hosts (Olival et al. 2017). In MERS, the route of infection could have been from camels directly to people. If bats were the reservoir, the trail would have been bats to camels to people. We do not know how the MERS virus could have moved from bats to camels. For SARS CoV-1 and SARS CoV-2, bats appear to be the reservoir. This means at least two possible routes to humans a)

bats to humans or b) bats to an intermediate host (e.g., palm civet or pangolin) and then to humans.

Blaming bats or some other reservoir will not improve the situation but it will lead to more persecutions of bats (e.g., Zhao 2020). To better prepare for future pandemics we need to invest in surveillance of wildlife populations for viruses as well as research to address the following questions. Where are coronaviruses? What animals are reservoirs for the viruses? How do viruses jump from the reservoir to humans (or their livestock and pets). What role do bats play in diseases such as COVID-19 or MERS?

Lack of data severely limits our ability to plan for a future pandemic. We need to invest in preventative surveillance. Where are coronaviruses? What animals are reservoirs for the viruses? How do viruses jump from the reservoir to humans (or their livestock and pets). What role do bats play in diseases such as COVID-19 or MERS? Blaming bats or some other reservoir will not improve the situation.

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