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Humans, wildlife, and our environment: One Health is the common link

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At the time this commentary was written (March 18, 2020), >100 countries had confirmed cases of COVID-19, the disease caused by the novel coronavirus (Figure 1). In China, where the outbreak was first reported, >81,000 people have been infected and more than 3,100 have died. Outside of China, >50,000 people have been infected with the virus, and >1,300 have perished. In the United States, there were >6,000 cases reported, 90 deaths, with 53 states and territories reporting cases.

By April 28, 2020, the number of confirmed COVID-19 cases reported globally has now exceeded 3 million. Over 200,000 people have died and 900,000 recovered (Figure 2). The 2020 COVID-19 pandemic has served to highlight how humans globally are connected socially and economically, for better or for worse.

Since the coronavirus outbreak was first reported, media reports have traced the cause of the outbreak to horseshoe bats (*Rhinolophus* spp.; Figure 3). There are literally hundreds of genetically diverse bat-borne coronaviruses in the wild. Most of them are harmless, except for a group responsible for the 2002–2003 severe acute respiratory syndrome (SARS) outbreak (Ge et al. 2016). Because of the global distribution of bats, their rich diversity, and the importance of bats as natural reservoirs of coronaviruses, the number of bat coronaviruses with the potential for transmission to humans will likely increase.

But bats are not the problem. Bats help promote biodiversity and the health of their ecosystems by eating insects and pollinating plants. The problems surface when humans come into contact with infected bats.

COVID-19 is a zoonosis. A zoonosis is a disease that can be transmitted to humans from animals. Zoonoses have affected human health throughout history, and wildlife have played a central role. Wildlife are normally defined as free-roaming animals (mammals, birds, fish, reptiles, and amphibians). Prior to COVID-19, the bubonic plague, or Black Death, a bacterial disease transmitted by rats and fleas, was probably the best known example of a zoonosis. Bubonic plague still causes global illness and human death (Newman 2019).

The total number of zoonoses is unknown. Taylor et al. (2001) cataloged 1,415 known human pathogens, of which 62% were of zoonotic origin. Most of the emerging infectious diseases (i.e., SARS, N1H1 influenza, West Nile Virus, hantavirus, Lyme disease) in humans are zoonoses. More wild animals are increasingly being linked in their epidemiology as major reservoirs for their transmission to domestic animals and humans (Chomel et al. 2007, Conover 2019). Arguably, the recent COVID-19 pandemic is one of the worst zoonoses in decades because of its uncertain effects on global society and economies (Karesh et al. 2012). However, scientists have long warned that the rate of emergence of new infectious diseases is accelerating (Jones et al. 2008).

Microbial changes influence the epidemiology of zoonoses that have wildlife reservoirs. These changes include mutations, such as genetic drift and recombination in viruses, and transformations in bacteria that increase their resistance to vaccines. The risk of transmission of adaptive or genetically changed microorganisms from wildlife to humans, either directly or indirectly through domestic animals, is also increasing because of human-caused ecological changes. The ecological changes that are influencing the epidemiology of wildlife-reservoir zoonoses include human population expansion and encroachment, reforestation and other habitat changes, pollution, and climatic change (Wobeser 2006, Vaske et al. 2009). The changes in land use that accompany human population growth, the increased global transportation of wildlife and livestock and

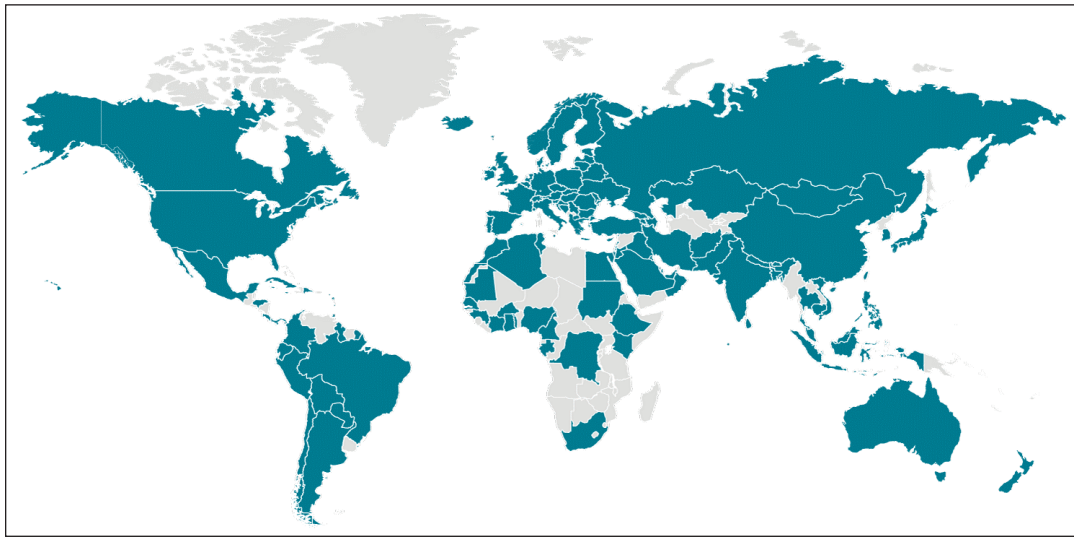

Figure 1. Over 100 countries had confirmed cases of COVID-19, as of March 18, 2020. Map courtesy of the U.S. Centers for Disease Control and Prevention (2020*a*).

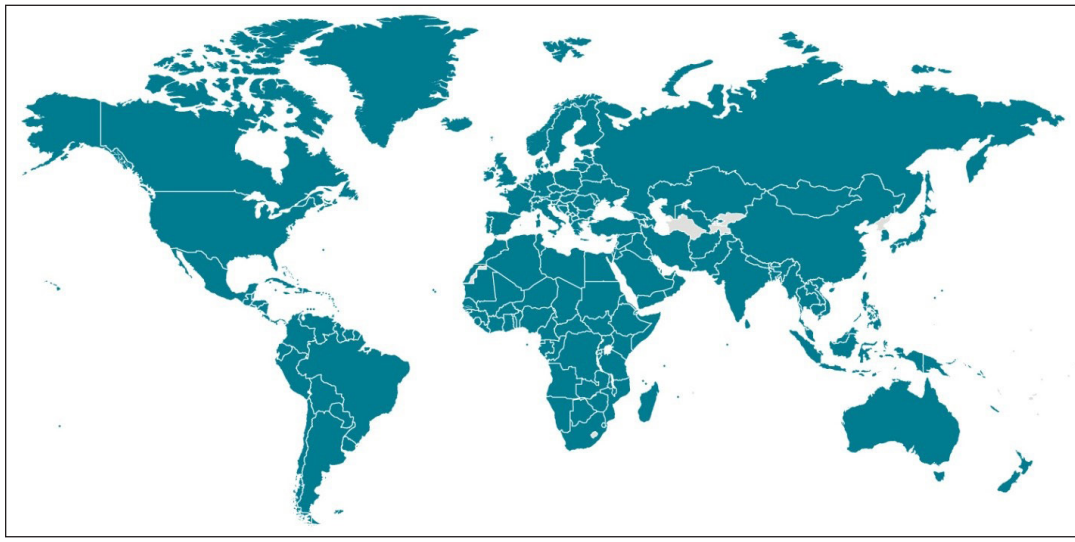

Figure 2. By April 28, 2020, the number of confirmed COVID-19 cases reported globally has now exceeded 3 million. Over 200,000 people have died and 900,000 recovered. Map courtesy of the U.S. Centers for Disease Control and Prevention (2020*b*).

their products, and increases in both domestic and international travel increase the risk of new disease outbreaks of pandemic scale (Jones et al. 2008, Liu et al. 2014). Infectious agents harbored within insects, animals, or humans can travel halfway around the globe in <24 hours in airplanes. Thus, infectious agents can be transported to the farthest reaches of the globe in less time than it takes most diseases to incubate. In this respect, the international wildlife trade, often illegal, where wild animals end up in live-animal markets, restaurants, and farms, increases the proximity between wildlife, domestic animals, and humans and the risk of zoonosis transmissions (Liu et al. 2014).

In 2012, Utah State University's Berryman Institute (https://www.berrymaninstitute.org/) published a special issue of the journal Human–Wildlife Interactions (HWI 2012) dedicated to the concept of One Health and its role in

Figure 3. The COVID-19 outbreak was traced back to the horseshoe bat family (*Rhinolophus* spp.).

mitigating the zoonosis outbreaks. One Health is a worldwide approach that recognizes that the health of people is closely connected to the health of animals and our shared environment (Jack 2012). One Health has become more important in recent years because interactions between people, animals, plants, and our environment have dramatically changed.

One Health seeks to engage experts in human, animal, environmental health, and other relevant disciplines and sectors to develop surveillance systems that increase international integration and sharing of information to better understand the epidemiology and pathogenesis of zoonosis (Jack 2012). Enhanced diagnostic methods can detect changes in the epidemiology of a zoonosis and its potential human impacts, expediting the development of cost-effective vaccines and drugs. One Health also recognizes that cost-effective prevention and control of zoonosis in humans must include risk communication and acknowledge the importance of wildlife as a reservoir.

Public education and behavioral change are critical to successful disease intervention. Implementing restrictions on human movement of animals is another important preventive measure. For example, on February 24, 2020, China implemented a permanent ban on wildlife consumption and trade except for research or medicinal or display purposes (https://www.businessinsider.com/china-bans-wildlife-trade-consumption-coronavirus-2020-2). The animal trade industry in China was estimated to be worth $76 billion and employ >14 million people (Chinese Academy of Engineering 2017). Although some welcomed this action, others worry it could create a new underground market that may make disease detection more difficult.

Wildlife professionals working at the interface where conflicts arise between people and wild animals have a responsibility in the long-term interest of sustaining society's support for wildlife and its conservation by resolving human–wildlife conflicts so that humans continue to view wildlife as a valued resource (Decker et al. 2012). The questions yet to be addressed include: (1) how will people react to the message that human health and wildlife health are linked? and (2) will wildlife-associated disease foster negative attitudes about wildlife as reservoirs, vectors, or carriers of disease harmful to humans? The answers to these questions will depend on whether One Health professionals can successfully manage wildlife zoonosis and communicate the associated risks to society in a way that promotes for healthy wildlife rather than calls for eliminating wildlife because they are viewed as disease-carrying pests (Decker et al. 2012).

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