

PROJECT NATURE NEWSLETTER

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Coronavirus & Wildlife

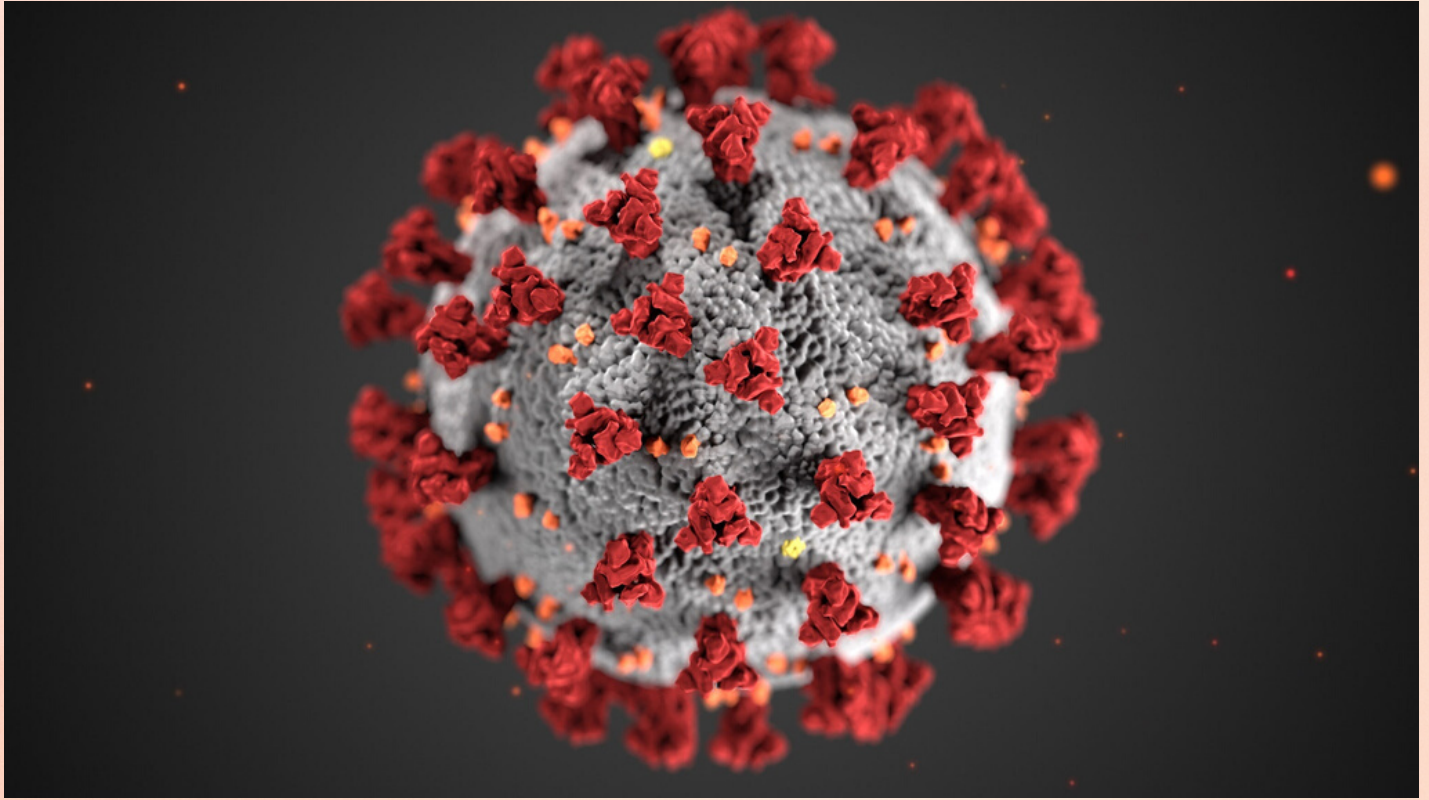
Coronavirus Disease 2019 or COVID-19 is a respiratory illness in humans caused by a coronavirus that originated from the live or wet animal markets in Asia. Diseases, such as COVID-19, that spread from animals to humans are called **zoonotic** diseases (or **zoonoses**). In more colloquial terms, it is known as a “**spillover**” event. Coronaviruses have caused two large-scale pandemics in the past within the twenty-first century — Severe Acute Respiratory Syndrome (or **SARS**) in 2003 and Middle East Respiratory Syndrome (or **MERS**) in 2012.

Other zoonotic diseases that have occurred in the past, include the 1918 Spanish flu and more recently, the 2009 swine flu and the Ebola virus disease (EVD). HIV (or human immunodeficiency virus), which causes AIDS, was originally a zoonotic disease transmitted from non-human primates (chimpanzees and sooty mangabeys) in the early twentieth century. HIV has now mutated to a separate human-only disease. It is estimated that about 1 billion cases of human illness worldwide are due to zoonoses, which result in millions of deaths. About 60 percent of emerging infectious diseases (**EID**) that are reported globally are zoonoses. Of the over 30 human pathogens detected in the last three decades, 75 percent have originated from animals.

Wet markets

“Wet markets” are markets selling fresh meat and produce, and are named so for the melting ice used to preserve the food, as well as for the constant washing of the market floors when they are covered in blood from the animals. Animals in wet markets are often slaughtered on-site to ensure freshness.

Coronavirus



*Illustration by Alissa Eckert and Dan Higgins
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Source: Center for Disease Prevention and Control (cdc.gov)*

Named for the crown-like spikes on its surface, coronaviruses are a large family of viruses. There are numerous coronaviruses that animals carry, but mostly none of those infect humans. Rarely, animal coronaviruses that infect animals have emerged to infect humans. Animal viruses mutate and most of the time, the mutations do not have a significant impact on humans. Sometimes they mutate and allow a single “dead-end” transmission to a human, which means it transmits from an animal to a human, but does not transmit further from human to human. Hence, such events result in individual infections and not outbreaks. For example, the H5N1 and H7N9 influenza viruses (avian flu) jumped from chickens to humans but did not spread from human to human. Even more rarely, animal viruses mutate which not only allows them to jump species, i.e. transmit from animal to human, but also effectively spread from human to human. This was the case with MERS, SARS, and now with COVID-19.

SARS-CoV-2, formerly known as the Novel Coronavirus or 2019-nCoV, is a new coronavirus that has not been previously identified, and causes the COVID-19 disease.

Human coronaviruses were first detected in the 1960s. There are seven coronaviruses that can infect humans. Some coronaviruses commonly circulate among humans and cause mild illness, such as common cold. The four types of coronaviruses that commonly infect people around the world are **229E**, **NL63**, **OC43**, and **HKU1**. The other three human coronaviruses are the ones that have been responsible for causing a pandemic. They are the **MERS-CoV**, **SARS-CoV**, and **SARS-CoV-2** (formerly 2019-nCoV) that is currently causing the COVID-19 disease.

Mutation

Mutations are alterations of DNA sequence. Deoxyribonucleic acid, or DNA, is a molecule that contains the instructions an organism needs to develop, live and reproduce. These instructions are found inside every cell, and are passed down from parents to children. Mutations are random errors or unexpected changes in the instructions, which result in the cells acting differently. Mutations happen all the time. They can happen spontaneously when the DNA is being replicated during cell division, but can also be induced by external factors, such as chemicals or ionizing radiation (e.g. UV rays). Sometimes mutations are inconsequential, while other times, they might have significant ramifications. The evolution of all modern species of plants and animals from their primitive ancestors happened through a series of random mutations over thousands or millions of years.

It must be pointed out that viruses such as coronaviruses, flu viruses and HIV viruses, are RNA-based (and not DNA-based) genomes. RNA or ribonucleic acid also carry genetic information, like the DNA, but there are few differences, including the mutation mechanisms. For one, RNA viruses are much more mutation-prone than DNA viruses, and this high rate of mutation helps them rapidly evolve resistance to drugs, making it difficult for the scientists to make vaccines.

Pathogen

A pathogen is any organism that causes disease. Virus is a type of pathogen. Pathogens need a live host to survive. Once established, a pathogen is able to successfully avoid the host's immune system and uses the resources from the host's body to replicate before exiting and spreading to a new host. There are five types of pathogens - **viruses**, **bacteria**, **fungi**, **protozoa** (or single-celled organisms) and **helminths** (or worms that live inside a host's body). Protozoa and helminths are usually grouped together as **parasites**, and hence fall under the discipline of **parasitology**, while viruses, bacteria, and fungi are the subject of **microbiology**.

A human body is a complex and thriving ecosystem containing about 10^{13} human cells and about 10^{14} cells of thousands of microbial species of bacteria, fungi and protozoa. These microbes are called **normal** (microbial) **flora**, and are usually confined to certain areas of the body. Humans are always infected by viruses, but very rarely such viruses become symptomatic. Pathogens are distinct from the normal flora. Our normal microbial inhabitants only cause a problem when our immune systems are weakened or if they gain access to an otherwise sterile part of the body. Pathogens are not a part of the normal flora of our body, and they have developed specialized mechanisms to cross cellular and biochemical barriers that help the organism to thrive and multiply at the expense of the host. In many cases, however, the induction of disease has no apparent advantage for the pathogen. Many of the symptoms and signs that are associated with a disease are merely the immune responses of the host. For example, fever is a defensive response of our body's immune system, as the increase in body temperature can inhibit the growth of some microorganisms.

According to the **Center for Disease Control and Prevention** (CDC), zoonotic pathogens can transmit between animals and humans in five different ways:

Direct Contact through touching and petting or by coming in contact with body fluids of an infected animal, such as saliva, blood, etc.

Indirect Contact by coming in contact with surfaces contaminated by an infected animal

Vectorborne by being bitten by disease-carrying vectors, such as ticks, mosquitoes or fleas

Foodborne by consuming contaminated food

Waterborne by drinking or coming in contact with water that has been contaminated by feces from an infected animal

A wide variety of vertebrates are carriers of zoonotic pathogens, among which, rodents — the most abundant mammals — carry at least 180 unique zoonotic pathogens. Bats are also a major virus reservoir, although they carry only about a third of zoonotic pathogens that rodents do. **PREDICT**, a project of USAID's **Emerging Pandemic Threats** (EPT) program, estimates that there are more than 1.6 million unknown viral species in mammals and birds, of which 700,000 could pose a risk to human health.

Wildlife Trade

Wild animals are traded around the world for their skin, meat, traditional medicine, pets or private collections. The international wildlife trade — both legal and illegal — is a thriving market, with the demand driving the supply. Millions of wild animals are commercially traded every year across the world, either through extraction from the wild or by captive breeding, sometimes in poorly regulated facilities. The wildlife supply chain, from source to market, creates conditions for the emergence and transmission of zoonotic diseases. Mixing of wild with domestic animals further exacerbates the problem and increases the likelihood of a spillover. *[To learn about the differences between domestic and wild animal- and plant-life, read the December 2019 issue of Project Nature newsletter].* In addition to the risk to human health, wildlife trade has driven several animal species to the brink of extinction. Pangolins are one such animal. Native to Africa, they have been widely traded for their scales, which are used in some traditional medicines in certain communities of the world and their meat is considered a delicacy. Pangolins are considered to be the most trafficked animals in the world.

But wildlife trade is not restricted to only some parts of the world; it's a global trade. It is estimated that wildlife imports in the US make up almost 20 percent of the global wildlife market. The 2003 **monkeypox** virus outbreak in the US was traced to small mammals that were imported to Texas from Ghana in Africa. The imported wild animals were kept in close proximity to prairie dogs, who caught the infection from the imported animals. The infected prairie dogs were sold as pets (unknown of the virus at the time), transmitting the disease to humans.

Some trades, such as international trade in threatened and potentially threatened species is regulated by **Convention on International Trade in Endangered Species of Wild Fauna and Flora** (CITES). However, CITES does not address the impact of the animals after they have been traded.

The risk of a spillover is independent of whether or not the traded animals are a threatened species, whether the trade is legal or illegal and whether or not the extraction of the animals from the wild was sustainable.

Pandemic vs Epidemic

There is no hard definition or a strict distinction between the two terms. Generally, an epidemic refers to a rise in the number of cases of a disease beyond what is normally expected in a geographical area. However, that increase in cases doesn't spread among other countries and continents. It may not even spread across an entire state. Epidemics happen frequently, but since they are localized, we don't hear as much about them. Zika virus outbreak and Ebola virus outbreak are examples of epidemics. A pandemic, on the other hand, is used to describe a global outbreak of disease that has spread across many countries and affects a large number of people. On March 11, 2020, COVID-19 was declared a global pandemic by the **World Health Organization** (WHO). However, neither the WHO nor the CDC define the threshold at which an epidemic is called a pandemic.

Origin Source of COVID-19

Bats are the natural reservoirs for coronaviruses. However, in the past, the spillover did not happen directly from bats, and there was an intermediate species. For example, SARS, which also originated from live animal markets in 2002, was linked to palm civets, who got it from one of the horseshoe species of bats. MERS, another outbreak originating from Arabia in 2012, was linked to camels, who got the virus through bats. Initially, SARS-CoV-2 – the virus responsible for COVID-19 disease – was traced to pangolins, which along with bats and other wild animals, are traded in the live animal markets in Asia. Pangolins do carry a virus similar to the new virus, and hence they were thought to be the intermediate species. However, most studies have now concluded that the spillover did not happen from pangolins. Since the last two coronavirus pandemics were transmitted through an intermediate species between bats and humans, scientists have been trying to find that species for COVID-19. The jury is still out on the verdict.

It is also possible that there was no intermediate species and the new virus (SARS-CoV-2) was transmitted to humans directly from bats. Finding the exact species of animal from which the spillover of this new coronavirus happened that caused COVID-19 will not affect the course of the current pandemic, but it will certainly help prevent future outbreaks.

Bats and Viruses

Bats are the natural reservoirs for coronavirus, and many other viruses, such as **Marburg** virus, **Nipah** virus and **Hendra** virus. They are also thought to be hosts for the **Ebola** virus. But bats are themselves mostly immune to these viruses they carry. As a matter of fact, their tolerance to these viruses, which surpasses that of other mammals, is one of their many distinctive qualities. The only flying mammals, bats are very diverse, such that they make up almost a quarter of all mammalian species. There is evidence that bats have adapted to the energetic demands of flight and are better at repairing DNA damage. This perhaps helps them from getting sick from the virus. A more recent study [11] has shown that bats handle something called “DNA sensing” a bit differently from other animals, including humans. The energy demands of flight for bats are so high that cells in their body break down and release

bits of DNA, which then float around in the body where they shouldn't be. The immune system of mammals, including bats, would usually perceive such bits of DNA as an indication of an invasion by a foreign organism, such as a virus, and initiate a response. Mostly, it's the response of the immune system that makes an animal sick. Typically, the immune system would respond by causing inflammation as it fought the foreign invasion. It was found that in bats, evolution has significantly weakened that system. Bats have lost some genes that are responsible for responding to such events, thus minimizing any inflammation, which could be very damaging to the body. This weakened response system in bats perhaps allows them to optimize their response, and not over-respond to the virus.

An Unexpected Event?

One might say that no one could have expected such a global pandemic. Except that the epidemiologists and scientists working in infectious diseases had already predicted it! In 2008, a study published in the journal *Nature* [12], reported that the frequency of viral spillover from wildlife was increasing significantly in the past decades. The researchers warned the international community of a massive spillover event and a subsequent pandemic. A 2019 paper published in the journal *Viruses* [13], had warned that a batborne coronavirus will re-emerge to cause the next disease outbreak. In 2018, the World Health Organization added '**Disease X**' to its list of priority diseases, stating '*Disease X represents the knowledge that a serious international epidemic could be caused by a pathogen currently unknown to cause human disease*'. In less than two years from that announcement, Disease X has arrived and has resulted in the COVID-19 pandemic!

Countries where wild animals are traded in wet markets have ordered a temporary ban on the wildlife trade. However, the same action was taken in response to the SARS outbreak, but the markets quickly sprang back up. And eighteen years later, yet another – and much worse – pandemic broke out. But it's not just the wet markets from where outbreaks can happen. For example, the 2003 monkeypox virus outbreak in the US did not originate from wet markets.

There needs to be a complete and permanent legal ban on wildlife trade, and a strict and rigorous enforcement of the laws and international treaties is imperative to reduce the number of zoonoses as well as for protecting the threatened wildlife.

Epilogue!

While most scientists now agree that pangolins are not responsible for the spread of COVID-19, they still have potential to sicken people. Additionally, the fact that pangolins have been driven to the brink of extinction, should be reasons enough to permanently stop the animal trade in the world markets. Last year, the **Intergovernmental Panel on Climate Change (IPCC)** reported that up to a million species of wildlife were at the risk of extinction in the next few years due to human activity, including deforestation, poaching, and overhunting. Loss of species and impacts on biodiversity were noted as one of the major drivers of climate change in the report. *[To learn more about IPCC Report on Climate Change, read the January 2020 issue of Project Nature newsletter.]*

It is important that animals not be vilified for such outbreaks. Animals are not to be blamed for causing pandemics. Such viruses exist in animals regularly, such as bats that host several coronaviruses, but very rarely are those transmitted to humans. Bats are extremely crucial to the ecosystem. Insectivorous bats are responsible for keeping insect population in check and act as nature's pest control. Fruit bats are important pollinators. Bats, like all other wildlife, are extremely important to the ecosystem goods and services upon which our own lives depend. Similarly, birds were not responsible for the avian flu. The Ebola virus infected humans when we infringed upon the pristine primate habitat to capture gorillas and chimpanzees for wildlife trade.

Animals do not cause the transmission of viruses to humans. The capturing, slaughtering, consumption and trade of wild animals is the cause of transmission. The outbreaks are caused when we interfere with the wildlife by encroaching and destroying their natural habitats. We bring together and mix animals from different parts of the world and from different habitats, and in doing so, create a perfect recipe for a disaster.

A long-term lesson to be learned here is to always practice “social distancing” with the wildlife!

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