

How Is the COVID-19 Outbreak Affecting Wildlife around the World?

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Abstract

The COVID-19 is the infectious disease caused by the most recently discovered coronavirus at an animal market in Wuhan, China. Many wildlife species have been suggested as possible intermediate sources for the transmission of COVID-19 virus from bats to humans. The quick transmission of COVID-19 outbreak has imposed quarantine measures across the world, and as a result, most of the world's towns and cities fell silent under lockdowns. The current study comes to investigate the ways by which the COVID-19 outbreak affects wildlife globally. Hundreds of internet sites and scientific reports have been reviewed to satisfy the needs of the study. Stories of seeing wild animals roaming the quiet, deserted streets and cities during the COVID-19 outbreak have been posted in the media and social media. The strong link between wildlife markets and COVID-19 resulted in international calls asking countries to shut down wildlife markets forever. Poorer and vulnerable people around the world overexploit natural resources including wildlife. Roadkills became minimal because of the lockdown measures. The reduction in noise pollution level is expected to improve wildlife health and ecology including breeding success. The shortage of food items provided to zoo and park animals constituted a real threat to animals and the institution harboring them. The increase in fish biomass comes as a result of the sharp decline in fishing activities. The isolation of antibodies from certain wildlife species is promising in saving humankind against COVID-19. The infection of wild and pet animals with COVID-19 virus from humans and the interspecific transmission of the infection are disastrous to animal ecology. Finally, closures may enhance people to connect more and more with nature in order to acknowledge wildlife in their surrounding environments. In conclusion, the study asks the world's different parties to conserve wildlife in a sustainable fashion and to regulate exotic animal trade in wet markets in order to lower the incidence of zoonoses.

Keywords

COVID-19, Coronavirus, Outbreak, Wildlife, Wildlife Markets, China

1. Introduction

Coronaviruses are a large family (Coronaviridae) of single-stranded RNA (ribonucleic acid) viruses that have a lipid envelope studded with club-shaped projections, which may cause illnesses in wildlife and domestic animals (especially birds and mammals) or humans [1] [2] [3]. Some strains of coronaviruses are zoonotic; meaning they can be transmitted between animals and humans, but many strains are not zoonotic. In humans, several coronaviruses are known to cause severe respiratory diseases such as the Middle East respiratory syndrome (MERS) and the severe acute respiratory syndrome (SARS) [4] [5]. The coronavirus disease-19 (COVID-19) is an infectious disease caused by the most recently discovered coronavirus. The first transmissions of COVID-19 from animals to humans are said to have taken place at an animal market in Wuhan, China. COVID-19 was unknown before the outbreak began in Wuhan, China, in December 2019 [3] [6] [7].

Wildlife is a term that refers to all life forms of plants and animals that live in all ecosystems and do not depend directly on humans for their livelihood. Wildlife plays a vital role in human being life, providing cultural, medicinal, esthetic values and act as bioindicators [4]. Nowadays, the world is dealing with unprecedented threats to wildlife. The loss of habitat from farming, mining and new urban developments has dramatically decreased the natural space for wildlife. Climate change, pollution and introduction of invasive species are also threatening factors. Illegal wildlife trade continues to pose a real danger to biodiversity, ecosystems and human health, as a number of emerging diseases stem from animal products, both domestic and wild [8] [9].

Human interactions with wildlife can be a source of zoonoses or animal-based diseases [10] [11]. It is well known that people who have close contact with domestic or wild animals at home, zoo and nature can be subject to zoonotic diseases. Zoonoses account for an estimated 73% of all emerging infectious diseases affecting humans. Many wildlife species (especially wild mammals) were known to be associated with coronaviruses [1] [4] [12]. For example, the SARS coronavirus was associated with Civet Cats and the MERS coronavirus was transmitted by Dromedary Camels [5]. The COVID-19 virus isolated from humans shares 96% homology with beta coronaviruses isolated from multiple species of bats in the genus *Rhinolophus*. Bats belonging to this genus are widely distributed across Asia, the Middle East, Africa and Europe. How did the COVID-19 virus appear and spread from bat to human? This question still worries the scientists and researchers worldwide [3]. Although there is a wide dialogue that COVID-19 is thought to have originated in bats, the intermediate ani-

mal sources of the virus are completely unknown [2]. China is home for several farms that rear several animal species such as deer, snakes, porcupines, foxes, civets, bears, turtles, bamboo rats, mink, and birds. Such farms can be targeted to find the origin of COVID-19 [13]. Many wild animals have been strongly suggested by many scientific parties as possible intermediate sources for the transmission of COVID-19 virus from bats to humans (Table 1 and Figure 1).

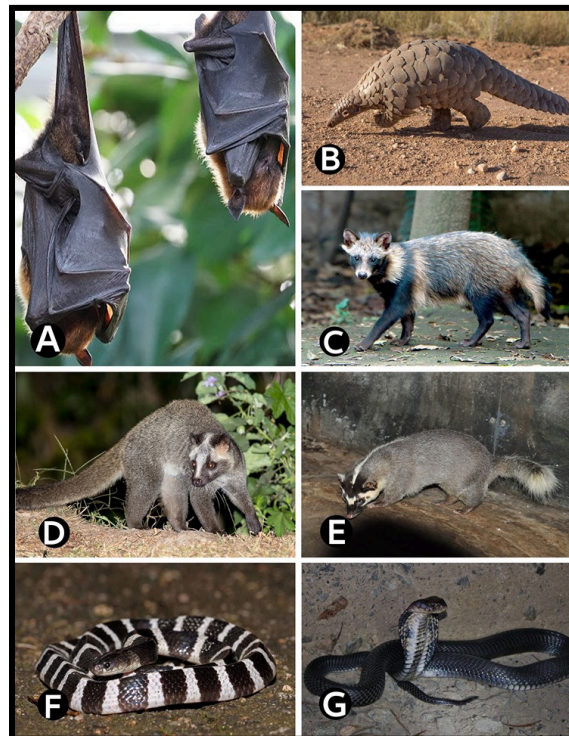


Figure 1. Wild mammals suggested as a missing link for transmission of COVID-19 virus from bats in the genus *Rhinolophus* to humans: (A) Horseshoe Bat (*Rhinolophus affinis*), (B) Malayan Pangolin or Scaly Anteater (*Manis javanica*), (C) Raccoon Dog (*Nyctereutes procyonoides*), (D) Masked Palm Civet (*Paguma larvata*), (E) Chinese Ferret-badger (*Melogale moschata*), (F) Chinese or Many-banded Krait (*Bungarus multicinctus*), and (G) Chinese Cobra (*Naja atra*) [The photos were taken from different internet sources including the Wikipedia, 2020].

Table 1. Wild animals considered as a missing link for transmission of COVID-19 virus from bats to humans.

Order	Family	Common Name	Scientific Name
Pholidota	Manidae	Malayan Pangolin	<i>Manis javanica</i>
	Canidae	Raccoon Dog	<i>Nyctereutes procyonoides</i>
Carnivora	Viverridae	Masked Palm Civet	<i>Paguma larvata</i>
	Mustelidae	Chinese Ferret-badger	<i>Melogale moschata</i>
Squamata	Elapidae	Chinese Krait	<i>Bungarus multicinctus</i>
		Chinese Cobra	<i>Naja atra</i>

Scientists think that the Malayan Pangolin or Scaly Anteater (*Manis javanica*), may be the missing link for transmission of COVID-19 from bats; especially the Horseshoe Bats (*Rhinolophus affinis*), to humans [14] [15]. Pangolins are the most illegally traded and most trafficked mammals in the world [16] [17]. They are prized for their meat and the claimed medicinal properties of their scales [18] [19] [20] [21]. There are many theories claiming the transmission of COVID-19 virus from the bats to the Raccoon Dog (*Nyctereutes procyonoides*), Masked Palm Civet (*Paguma larvata*) or the Chinese ferret-badger (*Melogale moschata*) and from them to humans. In addition to these mammalian species, snakes; notably the Chinese or Many-banded Krait (*Bungarus multicinctus*) and the Chinese or Taiwan Cobra (*Naja atra*), were also said as the original source of COVID-19 virus. The last conclusion was quickly ignored, partly because there was no previous evidence that coronaviruses can jump from a cold-blooded animal, such as snakes, to human beings [22].

As quarantine measures take hold across the world because of COVID-19 outbreak which started in December, 2019, the towns, cities and even the rural areas in most countries fell silent. The indoor situation of most people made these places calm. The wildlife harboring the various ecosystems like forests, jungles, coastal areas, ponds, agricultural fields usually aware of its surrounding environment; noticing and responding. In fact, COVID-19 outbreak affects wildlife around the world in several ways. Hence, the current study comes to investigate the different effects does the current COVID-19 outbreak impose on wildlife globally. The importance of the study comes from the fact that it is probably unique in its kind in times the current researches focus on the medical issues related to COVID-19.

2. Methods

This study depends mostly on media and posts of social media concerning wild animals that have been affected by COVID-19 outbreak and the associated quarantine measures. From the beginning of the COVID-19 outbreak, the author continued the follow up of all news and issues associated with the outbreak. Several Arabic and English news and scientific websites have been reviewed to meet the study needs.

3. Results & Discussion

The continual reviews of internet sites on how the current COVID-19 outbreak affects wildlife around the world were of great importance in giving a whole picture. The coming paragraphs, tables and photos point out much of the ecological effects of COVID-19 outbreak on wild animals around the world.

3.1. Opportunistic Wildlife Occurring at Urban Places

In most countries of the world extending from the East to the West, people have been told to stay at home to try and stop the spread of COVID-19 outbreak. As a result of this lockdown and these quarantine measures, a lot of wild animal spe-

cies that live in cities or on their outskirts were seen by local people and stakeholders exploring or invading the empty streets, roads and parks in search of food or just to play [23] [24] [25]. The phenomenon is worldwide. People on lockdown have been posting on social media with stories of seeing wild animals roaming the quiet, deserted streets and cities during the COVID-19 outbreak. The examples are rich: The Kashmiri or Mountain Goats (*Capra falconeri*) roamed the streets and parks of Wales, Britain. Wild Boars (*Sus scrofa*) invaded the streets of many cities like Paris (France), Barcelona (Spain) and Haifa (Israel). The strange Small Indian Civet (*Viverricula indica*), which is a common carnivore in southeastern Asia [26], was seen roaming the streets of New Delhi (India). Agence France-Presse [23] has reported a Sika Deer (*Cervus nippon*) roaming through metro stations of Nara, Japan. Gangs of Wild Turkeys (*Meleagris gallopavo*) strut through Oakland in California, USA. The Puma or Cougar (*Puma concolor*) finds its way to the center of Santiago, Chile. In certain circumstances, these opportunistic invading wild animals may raid crops, attack livestock, and even kill people. **Table 2** and **Figure 2** illustrate a group of wildlife species (mammals, birds and reptiles) that were seen invading the empty, deserted cities and towns worldwide.

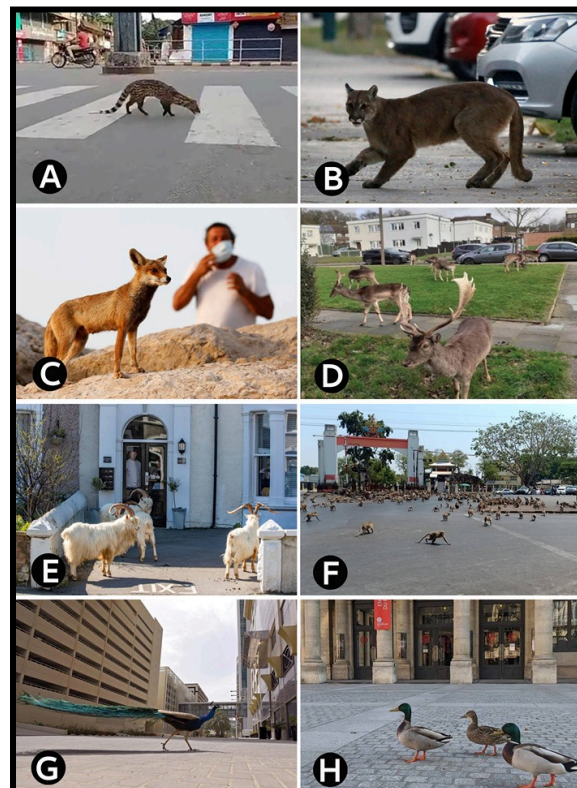


Figure 2. Examples of wildlife species taking over the streets and roads as an advantage of the deserted cities worldwide, imposed by the COVID-19 outbreak: (A) Small Indian Civet (*Viverricula indica*), (B) Puma (*Puma concolor*), (C) Red Fox (*Vulpes vulpes*), (D) Fallow Deer (*Dama dama*), (E) Kashmiri Goat (*Capra falconeri*), (F) Macaque (*Macaca sylvanus*), (G) Indian Peacock (*Pavo cristatus*), and (H) Mallard (*Anas platyrhynchos*) [The photos were taken from different internet sources].

Table 2. A selected list of wildlife species invading and roaming the empty cities worldwide during COVID-19 outbreak.

Class	Order	Common Name	Scientific Name	Location(s)
Mammalia (Mammals)	Carnivora	Coyote	<i>Canis latrans</i>	San Francisco, USA Los Angeles, USA
		Bear	<i>Ursus arctos californicus</i>	California, USA
		Small Indian Civet	<i>Viverricula indica</i>	Kerala, India
		Puma (<i>Cougar</i>)	<i>Puma concolor</i>	Santiago, Chile
		Sea Wolf	<i>Zalophus wollebaeki</i>	Galapagos Islands, Ecuador
		River Otter	<i>Lutrogale perspicillata</i>	Marina Bay, Singapore
		North American Raccoon	<i>Procyon lotor</i>	San Felipe, Panamá New York, USA
		Golden Jackal	<i>Canis aureus</i>	Tel Aviv, Israel
		Red Fox	<i>Vulpes vulpes</i>	West Bank, Palestine Ashkelon, Israel
		South American Sea Lion	<i>Otaria flavescens</i>	Buenos Aires, Argentina
	Rodentia	Capybara	<i>Hydrochoerus hydrochaeris</i>	Buenos Aires, Argentina
		Nutria (Coypu or Swamp Rat)	<i>Myocastor coypus</i>	Milano, Italy
		Eastern Gray Squirrel	<i>Sciurus carolinensis</i>	California, USA Milano, Italy
		European Rabbit	<i>Oryctolagus cuniculus</i>	Christchurch, New Zealand
	Lagomorpha	Water Buffalo	<i>Bubalus bubalis</i>	New Delhi, India
		Kashmiri or Mountain Goat	<i>Capra falconeri</i>	Wales, Britain
	Artiodactyla	Wild boar	<i>Sus scrofa</i>	Barcelona, Spain Paris, France Ajaccio, Corsica Haifa, Israel Sassari, Sardinia
		Sika Deer (Japanese Deer)	<i>Cervus nippon</i>	Nara, Japan
		Fallow Deer	<i>Dama dama</i>	London, Britain
		European Roe Deer	<i>Capreolus capreolus</i>	Zakopane, Poland
		Arabian Sand Gazelle	<i>Gazella marica</i>	Dubai, UAE
		Spotted Deer (Chital or Axis Deer)	<i>Axis axis</i>	Tirupati, India
		Blue Bull (Niglar)	<i>Boselaphus tragocamelus</i>	Noida, India
		Cow	<i>Bos taurus</i>	Delhi, India
		Arabian Camel (Dromedary)	<i>Camelus dromedarius</i>	Dubai, UAE
	Perissodactyla	Indian Rhinoceros	<i>Rhinoceros unicornis</i>	Sonapur, Guwahati
		Grey Langur (Hanuman <i>Langur</i>)	<i>Semnopithecus entellus</i>	Ahmadabad, India
	Primates	Macaque	<i>Macaca sylvanus</i>	Lopburi, Thailand

Continued

Aves (Birds)	Charadriiformes	Black-headed Gull	<i>Chroicocephalus ridibundus</i>	Paris, France
	Pelecaniformes	White Pelican	<i>Pelecanus erythrorhynchos</i>	Paris, France
	Galliformes	Indian or Blue Peacock	<i>Pavo cristatus</i>	Ronda, Spain Dubai, UAE
		Swan	<i>Cygnus olor</i>	Milano, Italy
	Anseriformes	Egyptian Goose	<i>Alopochen aegyptiaca</i>	Tel Aviv, Israel
		Mallard	<i>Anas platyrhynchos</i>	Paris, France
	Galliformes	Turkey	<i>Meleagris gallopavo</i>	California, USA
	Columbiformes	Rock Dove or Pigeon	<i>Columba livia</i>	San Juan, Puerto Rico
	Accipitriformes	Black Kite	<i>Milvus migrans</i>	Gaza Strip, Palestine Kathmandu, Nepal
	Cathartiformes	American Black Vulture	<i>Coragyps atratus</i>	Quito, Ecuador
Reptilia (Reptiles)	Procellariiformes	Scopoli's shearwater	<i>Calonectris diomedea</i>	Bouches-du-Rhône, France
	Testudines	Olive Ridley Turtle	<i>Lepidochelys olivacea</i>	Odisha, India
	Crocodylia	American Alligator	<i>Alligator mississippiensis</i>	South Carolina, USA

3.2. Preventing and Stopping Illegal Trade in Wildlife

China is one of the largest consumers of wild animals for food and traditional Chinese medicine in the world. A large volume of illegal trade has been recorded in the various cities of the country [27] [28]. In a modest study, Chow *et al.* [29] revealed the selling of 97 animal species distributed among reptiles, birds and mammals. Reptiles; particularly turtles, were the most commonly traded wild animals in China's wildlife markets. The Wuhan Market, for example, had a wild animal section where live and slaughtered species were for sale: snakes, beavers, porcupines, and baby crocodiles, among other animals. The sold animals originated not only from China but also Southeast Asia. **Table 3** and **Figure 3** illustrate a list of wildlife species sold at different wildlife markets in China; particularly the Wuhan Market. The COVID-19 outbreak, which likely originated at Wuhan Market selling wild animals in China, is a watershed moment for curbing the global wildlife trade, which can drive extinction and spread disease. Chinese farmers used to collect wild animals such as rats, civets, snakes, bats and others, and breed them for home consumption.

The overexploitation of wildlife through hunting and trade had led to an increase in infectious animal diseases that could spread between humans. Moreover, as natural habitats of wildlife diminish because of anthropogenic factors, wildlife closely approaches people, and this, in turn, accelerates the outbreak of diseases in wildlife and puts humans at risk of epidemics. Accordingly, many international calls have asked China and other countries to shut down wild animal markets forever, because of the strong link between those markets and the spread of zoonotic diseases. It was believed that the COVID-19 virus killed hun-

dreds of thousands and infected millions of people till now. Humane Society International recommends that all countries with wildlife markets (including those selling live wild animals or their parts for food, pets, or other purposes) permanently ban, or severely limit, wildlife trade, transport and consumption. This ban should also apply to import, export and internal transport of live wildlife or wildlife meat intended for sale in wildlife markets [30]. The ban is encouraging in helping to address the fact that massive Chinese demand is driving some species to extinction. In this regard, the Chinese authorities have excluded cats and dogs from an official list of edible animals, in preparation for enacting legislation to reduce wild animal husbandry for the purpose of preventing the transmission of viruses to humans, as was most likely the case with the new COVID-19 virus. Moreover, eating and selling bat and pangolin meat has been banned by officials in Gabon. The decision was made over fears related to the global COVID-19 outbreak, which is thought to stem from wild animal meat sold at a market in Wuhan, China [31].



Figure 3. Examples of vertebrate wildlife species traded in China markets: (A) The marsupial Koala (*Phascolarctos cinereus*), (B) American Mink (*Neovison vison*), (C) Chinese Francolin (*Francolinus pintadeanus*), (D) Emerald Dove (*Chalcophaps indica*), (E) Burmese Python (*Python molurus*), (F) Chinese or Yellow-margined Box Turtle (*Cuora flavomarginata*), (G) Chinese Edible Frog (*Hoplobatrachus rugulosus*), and (H) Chinese Giant Salamander (*Andrias davidianus*) [The photos were taken from different internet sources including the Wikipedia, 2020].

Table 3. A collected list of wildlife species traded in China markets, particularly Wuhan Market, which is believed to be the source of COVID-19.

Order	Family	Common Name	Scientific Name
Class Mammalia			
Diprotodontia	Phascolarctidae	Koala	<i>Phascolarctos cinereus</i>
Lagomorpha	Leporidae	Chinese Hare	<i>Lepus sinensis</i>
Pholidota	Manidae	Malayan Pangolin	<i>Manis javanica</i>
		Raccoon Dog	<i>Nyctereutes procyonoides</i>
		Himalayan wolf	<i>Canis lupus chanco</i>
	Canidae	Arctic or Polar Fox	<i>Vulpes lagopus</i>
		Masked Palm Civet	<i>Paguma larvata</i>
		Asian Palm Civet	<i>Paradoxurus hermaphroditus</i>
	Viverridae	Chinese Ferret-badger	<i>Melogale moschata</i>
		American Mink	<i>Neovison vison</i>
		Hog Badger	<i>Arctonyx collaris</i>
	Mustelidae	Eurasian or European Otter	<i>Lutra lutra</i>
		Asian Small-clawed Otter	<i>Aonyx cinereus</i>
		Smooth-coated Otter	<i>Lutrogale perspicillata</i>
Carnivora	Ursidae	Giant Panda	<i>Ailuropoda melanoleuca</i>
	Sciuridae	Tarbagan Marmot	<i>Marmota sibirica</i>
	Hystriidae	Himalayan Porcupine	<i>Hystrix brachyura</i>
	Spalacidae	Chinese Bamboo Rat	<i>Rhizomys sinensis</i>
	Cervidae	Spotted or Chital Deer	<i>Axis axis</i>
Artiodactyla	Bovidae	Sika Deer	<i>Cervus nippon</i>
		Tibetan antelope	<i>Pantholops hodgsoni</i>
	Suidae	Wild Boar	<i>Sus scrofa</i>
Chiroptera	Pteropodidae	Mariana Fruit Bat	<i>Pteropus mariannus</i>
		Small Mauritian Flying Fox	<i>Pteropus subniger</i>
		Guam Flying Fox	<i>Pteropus tokudae</i>
	Rhinolophidae	Chinese Horseshoe Bat	<i>Rhinolophus sinicus</i>
		Greater Horseshoe Bat	<i>Rhinolophus ferrumequinum</i>
Eulipotyphla	Erinaceidae	Amur Hedgehog	<i>Erinaceus amurensis</i>
Class Aves			
Struthioniformes	Struthionidae	Common Ostrich	<i>Struthio camelus</i>
Falconiformes	Falconidae	Saker Falcon	<i>Falco cherrug</i>
		Golden Pheasant	<i>Chrysolophus pictus</i>
Galliformes	Phasianidae	Common Pheasant	<i>Phasianus colchicus</i>
		Hainan Peacock Pheasant	<i>Polyplectron katsumatae</i>

Continued

		Silver Pheasant	<i>Lophura nycthemera</i>
		Indian or Blue Peacock	<i>Pavo cristatus</i>
		Hainan Partridge	<i>Arborophila ardens</i>
		Red Junglefowl	<i>Gallus gallus</i>
		Chinese Francolin	<i>Francolinus pintadeanus</i>
		Spotted Dove	<i>Streptopelia chinensis</i>
		Emerald Dove	<i>Chalcophaps indica</i>
Columbiformes	Columbidae	Barred Cuckoo Dove	<i>Macropygia unchall</i>
		White-bellied Green Pigeon	<i>Treron sieboldii</i>
		Green Imperial Pigeon	<i>Ducula aenea</i>
		Mountain Imperial Pigeon	<i>Ducula badia</i>
	Emberizidae	Yellow-breasted Buntings	<i>Emberiza aureola</i>
Passeriformes	Motacillidae	White Wagtail	<i>Motacilla alba</i>
	Turdidae	Common Blackbird	<i>Turdus merula</i>
	Sturnidae	Crested Myna	<i>Acridotheres cristatellus</i>
Piciformes	Megalaimidae	Black-browed Barbet	<i>Megalaima oorti</i>
Class Reptilia			
Crocodylia	Alligatoridae	Chinese or Yangtze Alligator	<i>Alligator sinensis</i>
	Pythonidae	Burmese Python	<i>Python molurus</i>
	Elapidae	Chinese Krait	<i>Bungarus multicinctus</i>
		Chinese Cobra	<i>Naja atra</i>
Squamata		Chinese Ratsnake	<i>Ptyas korros</i>
	Colubridae	Radiated Ratsnake (Tri-rope Beauty Snake)	<i>Coelognathus radiatus (Elaphe radiata)</i>
		King Ratsnake (Taiwan Stink Snake)	<i>Elaphe carinata</i>
		Taiwan Beauty Snake	<i>Elaphe taeniura</i>
	Testudinidae	Impressed Tortoise	<i>Manouria impressa</i>
		Elongated Tortoise	<i>Indotestudo elongata</i>
		Black Marsh Turtle	<i>Siebenrockiella crassicolis</i>
		Amboina or Southeast Asian Box Turtle	<i>Cuora amboinensis</i>
		Chinese or Yellow-margined Box Turtle	<i>Cuora flavomarginata</i>
		Indochinese or Vietnamese Box Turtle	<i>Cuora galbinifrons</i>
Testudines	Geoemydidae	Asian Leaf Turtle	<i>Cyclemys dentata</i>
		Black or Spotted Pond Turtle	<i>Geoclemys hamiltonii</i>
		black-breasted or Vietnamese Leaf Turtle	<i>Geoemyda spengleri</i>
		Mekong Snail-eating Turtle	<i>Malayemys subtrijuga</i>
		Chinese Three-keeled Pond Turtle	<i>Mauremys reevesii or Chinemys reevesii</i>
		Yellow Pond Turtle	<i>Mauremys mutica</i>

Continued

		Chinese Stripe-necked Turtle	<i>Mauremys sinensis</i>
		Indian Eyed Turtle	<i>Morenia petersi</i>
		Beale's Eyed Turtle	<i>Sacalia bealei</i>
		Four-eyed Turtle	<i>Sacalia quadriocellata</i>
Carettochelyidae		Pig-nosed Turtle (Fly River Turtle)	<i>Carettochelys insculpta</i>
Chelidae		Common Snapping Turtle	<i>Chelydra serpentina</i>
		Painted Turtle	<i>Chrysemys picta</i>
		Yellow-blotched Map Turtle or Yellow-blotched Sawback	<i>Graptemys flavimaculata</i>
Emydidae		Ringed Map Turtle or Ringed Sawback	<i>Graptemys oculifera</i>
		River Cooter	<i>Pseudemys concinna</i>
		American Red-bellied Turtle	<i>Pseudemys rubriventris</i>
		Red-eared Slider or Turtle (Red-eared Terrapin)	<i>Trachemys scripta elegans</i>
Pelomedusidae		Yellow-spotted River Turtle	<i>Podocnemis unifilis</i>
Platysternidae		Big-headed Turtle	<i>Platysternon megacephalum</i>
		Asian Forest Tortoise	<i>Manouria emys</i>
		Impressed Tortoise	<i>Manouria impressa</i>
Testudinidae		African Spurred Tortoise (Sulcata Tortoise)	<i>Geochelone sulcata</i>
		Elongated Tortoise	<i>Indotestudo elongata</i>
Class Amphibia			
		Chinese Edible Frog (East Asian Bullfrog)	<i>Hoplobatrachus rugulosus</i>
Anura	Dicroglossidae	Tiger Frog	<i>Hoplobatrachus tigerinus</i>
	Ranidae	Chinese Brown Frog	<i>Rana chensinensis</i>
		South China Giant Salamander	<i>Andrias sligoi</i>
Urodela	Cryptobranchidae	Chinese Giant Salamander	<i>Andrias davidianus</i>

3.3. Exploitation of Wildlife Resources

During the COVID-19 outbreak and the accompanied quarantine measures, a lot of people have lost their livelihood. Social safety nets are a widespread feature of many industrialized economies, keeping the poor and vulnerable people from destitution. In many low-income countries, people simply do not have such back-up from their governments, leaving them incredibly vulnerable. Exploiting natural resources is often the only option for the destitute. The longer the COVID-19 outbreak lasts, many more people will be finding themselves poorer, hungrier, and much closer to exploitable wildlife than they were in the nearest past time. In a few words, when people are left with nothing, they can always find something to eat or sell in the wild; either being forests or oceans. In the Gaza Strip of Palestine, which has been under siege imposed by the Israeli occu-

pation for more than a decade, the operations of poaching and hunting of wildlife, especially wild birds, by poor Gazans have increased. Wildlife hunting was not limited to food purposes, but rather to raising them as pets or to selling them to zoos that abounded in recent years in the Gaza Strip as a way to entertain the Gazans suffering from siege and repeated Israeli wars and invasions [32] [33] [34] [35] [36]. In the same context, the Palestinians of the West Bank of Palestine have been found, during the COVID-19 outbreak, to threaten the breeding success of the Chukar Partridge (*Alectoris chukar*) (Figure 4) and other breeding bird fauna. They search for nests and confiscate eggs, either for trade or food [33] [34] [35] [36] [37]. Such practices lead to reducing the numbers of these birds in the wild and constituting an obstacle to the ecological balance, as these birds contribute to reducing the number of insect pests harmful to agricultural crops.

3.4. Reduction of Noise Pollution Benefits Wildlife

Worldwide, human development introduces anthropogenic noise sources into the environment across many elements of the modern terrestrial landscape, including roads, airports, military bases, and cities. Cities and towns are very noisy places, with their transportation systems seem to be the most pervasive sources of noise across all landscapes. According to Blickley and Patricelli [38], noise can impact wildlife species at both the individual and population levels. The types of impacts include damage to auditory system, masking of sounds important to survival and reproduction, imposition of chronic stress and associated physiological responses, startling, interference with mating, and population declines. Noise is well-known to affect how different species communicate with each other [39]. Francis and Barber [40] pointed out that chronic and frequent noise interferes with animals' abilities to detect important sounds, whereas intermittent and unpredictable noise is often perceived as a threat. During the COVID-19 outbreak and the accompanied quarantine measures, there is a reduced traffic noise. Such reduction in noise may lower the impact of noise on wildlife health and ecology and offer better communication and mating opportunities among the wild biota.

3.5. Breeding Success of Wildlife

Wildlife species, particularly birds, usually carefully chose their breeding spots that are rarely disturbed by humans and predators. Such safe breeding places can be available during lockdowns associated with COVID-19 outbreak. As an example of breeding wildlife, the Little Tern (*Sternula albifrons*), a rarer seabird in the UK (Great Britain), is a vulnerable species that usually attempt to breed in the UK (Figure 5) in areas under public pressure, particularly holiday beaches [41] [42]. It is the smallest of the five tern species that breed in the UK. It lays camouflaged eggs on the beach, often close to the high water line. Human disturbance, primarily as an unintentional result of recreation activity, is thought to

have been a major cause of reduced breeding success. The predation from foxes, kestrels, carrion crows and magpies is widely reported to cause colony failure or at least severe reduction to breeding success [41]. The breeding success (nest and hatching success) of the Little Tern could be threatened as dog walkers and other people flock to beaches once restrictions of COVID-19 outbreak are lifted, potentially trampling and disturbing breeding pairs and their young.



Figure 4. Poaching of the Chukar Partridge (*Alectoris chukar*) and the collection of its eggs increased during the COVID-19 outbreak in the West Bank of Palestine.



Figure 5. The breeding of the Little Tern (*Sternula albifrons*) on UK beaches.

Another example showing the increase in bird populations during the COVID-19 outbreak and lockdown is the Albania's Pink Flamingo or what is known scientifically as the Greater Flamingo (*Phoenicopterus roseus*). These birds are recently flourishing at Narta Lagoon, an important waterfowl habitat in Albania, coinciding with the complete isolation witnessing Albania like the rest of the countries during the COVID-19 outbreak. The numbers have increased by nearly a third up to some 3000 since January of 2020. Albanian researchers plan to study flamingos to see if the coronavirus-induced calm is conducive to establishing the Narta Lagoon as a place where they can nest and breed. With less human interference and light pollution during COVID-19 outbreak, sea turtles, as endangered species, across the world are daring to lay their eggs on beaches they once avoided. For the first time in around a decade, Olive Ridley Turtles (*Lepidochelys olivacea*) can nest off the coast of the Bay of Bengal, India [43].

3.6. Reduction of Wildlife Roadkills

The development of roads and highways was known to affect wildlife by altering and isolating ecological habitats and populations, deterring and restricting the movement of wildlife, and resulting in extensive wildlife mortalities. Road traffic affects the natural environment in numerous ways. The most striking of these is the death of wild animals, including mammals, birds, reptiles, amphibians and invertebrates as a result of collisions with moving cars and other transportation motor vehicles [44] [45] [46]. The term "roadkills" means the animals struck and killed by cars and other transportation vehicles on roads and highways. Very large numbers of wild animals are killed on the world's roads every day [47]. About 350,000 to 27 million birds are estimated to be killed on European roads each year [48]. In Sweden, ungulates (mammals having hooves) were of primary concern, as they accounted for more than 60% of the accidents registered by the police [49]. In fact, wildlife mortality on roads is a problematic with profound deleterious effects, including reductions in population sizes, increases in local extinction, and loss of ecosystemic functionality. These numbers of wildlife-vehicle collisions are highly expected to diminish because of the lockdown of cities and towns during COVID-19 outbreak. In simple words, fewer cars on the road mean less roadkills. This may explain the encroachment of many wildlife species, as stated before, into the deserted cities and towns during the current COVID-19 outbreak. The fewer transportation vehicles and people promote such a wildlife safety from collisions and traffic accidents.

3.7. Shortage of Food Provided to Wild and Zoo Animals

Many wildlife species in local zoos and parks like primates, ducks and geese rely on foods provided by humans including tourists. The current close of zoos and parks and other similar places to the public during COVID-19 outbreak may make many animals to seeking new sources of food. Many news websites claimed that the German zoos are in struggle for survival because of closures re-

sulted from COVID-19 outbreak and its quarantine measures. Because of zoo's financial crisis, the directors pointed out that the zoos may have to feed some of their animals to the flesh of other animals from its inmates, and there was a screening for animals to be slaughtered before others. The directors added that seals and penguins and many other zoo animals need large quantities of fresh fish and food every day and they may have to kill the animals for mercy with them, instead of letting them die of hunger. From another point of view, the current COVID-19 crisis has had emotional repercussions for some animals like monkeys, gorillas, otters, seals, Giant Pandas and parrots that yearn for the attention they receive from the public (**Figure 6**). It is worth mentioning that visitors can have either negative, neutral or positive impacts on zoo animal behavior and welfare. Sherwen and Hemsworth [50] pointed out that the variation of zoo animal's responses to visitors may be associated with several factors including the species-specific differences, the nature and intensity of the visitor interactions, differences in the physical features of enclosures, and individual animal characteristics.

Because of the worldwide COVID-19 outbreak, city-dwelling rodents find themselves unable to dine out on restaurant waste, street garbage and other food sources. There was an increase in rodent activity as rodents search for new sources of food. According to Helmore [51], complaints in Chicago, USA, have included reports of infestations in housing blocks as rodents seek new sources of food. Many rat species have been observed resorting to eating their young in the wake of urban shutdowns in the USA.

3.8. Fish Biomass Increase as a Consequence of COVID-19

In most coastal countries of the world, safety rules designed to stop the spread of COVID-19 virus, coupled with reduced demand because of unemployment and closed restaurants, have forced fishing fleets and vessels to stay in ports and harbors [52]. As a result, fish biomass was expected to increase because of the sharp decline in fishing activities [53]. It is well known that overfishing is an escalating environmental issue threatening fisheries resources all over the world, even in the Gaza Strip of Palestine in spite of its small marine area [54]. Overfishing has reduced the stocks of many predator fishes in the Mediterranean Sea by high percentages compared to their pre-industrial fishing populations. As a consequence of COVID-19 lockdowns, some fish species are expected to double their biomass.

3.9. Wildlife Saves Humankind from COVID-19

Current research reports announced that there is a success in isolating an antibody from a four-year-old female Llama (*Lama glama*) living in a Belgian farm, suggesting that it would form a barrier against COVID-19. It was claimed that this antibody can make the COVID-19 virus harmless. The antibody molecule was said to be found in camels and alpacas in addition to sharks. It is worth mentioning that the Llama (**Figure 7**) are very social animal belonging to Came-

lidae family and Artiodactyla order of mammals. In this context, it was found that cats—though they are domestic—are more susceptible to infection with coronaviruses, making them ideal for testing against COVID-19 vaccines.

3.10. Infection of Wild and Pet Animals with COVID-19

There is a possibility for some pet or wild animals to become infected with COVID-19 virus through close contact with infected humans. Several dogs, ferrets, cats (including tigers and domestic cats) and even Egyptian Fruit-bats have tested positive to COVID-19 virus following close contact with infected humans. According to a recent study, the media of Aljazeera pointed out that cats can easily get infected with COVID-19 virus and even transmit the infection between them. In New York State of USA, current tests on two pet cats confirmed they were infected with COVID-19, in what were the first two cases of pets in the USA [55]. Tests have previously shown the infection of seven lions and tigers (feline family) with COVID-19 in the Bronx Zoo in New York. It is worth mentioning that infection of animals with COVID-19 virus may have implications for animal health and welfare, and for wildlife conservation.



Figure 6. Zoo animals, like the Giant Panda (*Ailuropoda melanoleuca*), are missing human attention because of closures imposed by COVID-19 outbreak.



Figure 7. The Llama (*Lama glama*) may save humankind from COVID-19.

In a strange event that occurred in India, a troop of monkeys attacked a lab technician at a government hospital in the Meerut district of the north Indian state of Uttar Pradesh and stole sample boxes containing blood samples of patients who were found to be infected with COVID-19. The monkeys climbed the trees with the samples and threw them after chewing the packets. It was said that the sample boxes were recovered at a later time without any damage or any risk of contamination or spread of infection. The hospital authorities have sanitized the area and disposed of the samples snatched by the monkeys. The district administration has ordered an inquiry against the hospital authorities for alleged mishandling of the samples [56]. The question here, which needs a scientific interpretation, is what would happen if monkeys messed with blood samples or consumed them orally?

3.11. Connection with Nature and Wildlife

School and university closures during the lockdown of cities and towns because of COVID-19 outbreak were a common phenomenon in most countries worldwide. Such closures may enhance many people to use their time and own skills to connect with nature in their own backyards and surrounding environments. Activities done by people and even children in gardens and parks like making bird feeders or birding (bird watching) could help encourage nature close to home. The connection with wildlife may contribute to important scientific research.

4. Concluding Remarks

In conclusion, the regulation of native and exotic animal trade in wildlife or wet markets is of utmost priority in order to lower the incidence of COVID-19 and other zoonoses. Such regulations should be accompanied with public education and awareness campaigns focusing on the need to prevent new diseases by reducing demand for wildlife and its products.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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