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## THE ROLE OF WILD AND DOMESTICATED ANIMALS IN THE ORIGIN AND TRANSMISSION OF THE CORONAVIRUS SARS-CoV-2

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## РОЛЬ ДИКИХ И ОДОМАШЕННЫХ ЖИВОТНЫХ В ПРОИСХОЖДЕНИИ И РАСПРОСТРАНЕНИИ КОРОНАВИРУСА SARS-CoV-2

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*Abstract.* The review highlights animal coronaviruses, their pathogenicity, and the possible role of domestic and agricultural animals in the further spread of the COVID-19. Joint researches have been established amongst international team of scientists regarding a close phylogenetic relationship of the coronavirus SARS-CoV-2 with the coronaviruses of bats and carnivores, especially with the representatives of Felidae family (domestic cats). However, the case of Middle Eastern SARS transmitted by camels is required a special attention to biological safety measures in farms.

*Аннотация.* В статье приведены литературные данные по коронавирусам животных, степени их патогенности и возможной роли домашних и сельскохозяйственных животных в дальнейшем распространении вируса. Совместные исследования ученых по всему миру позволили установить, что коронавирус SARS-CoV-2 имеет тесную филогенетическую связь с коронавирусами летучих мышей и хищных животных, особенно с представителями семейства кошачьих. Однако случай ближневосточной атипичной пневмонии, передававшейся от верблюдов, требует особого внимания к мерам безопасности при содержании крупного и мелкого скота в фермах.

*Keywords:* coronaviruses, animal reservoir, origin, transmission.

*Ключевые слова:* коронавирусы, очаг заболевания в животном мире, происхождение, передача.

### Introduction

The world is experiencing anxious days. The borders are closed down, shopping centers and cultural institutions have ceased their operations. More than two hundred million people have already been infected [1], the number of infected people continues to grow rapidly. The reasons for all above-mentioned facts are the SARS-CoV-2 virus (Severe Acute Respiratory Syndrome

Coronavirus 2). The virus causes both common (fever, cough, shortness of breath, fatigue, loss of smell and taste) and specific symptoms in the affected organism. Although the majority of cases result in mild symptoms, rapid progress to multi-organ failure due to acute respiratory distress syndrome possibly precipitated by cytokine storm [2, 3].

In this short review, we will try to analyze the genesis of this pathogen, its connection with other coronaviruses and the ability to emergence and re-emergence in wild and domesticated animals.

### *CoVs in animals*

Coronaviruses (CoVs) are single-stranded RNA viruses that cause diseases in mammals and birds. They are belonging to the Coronaviridae family, Nidovirales order, Pisuviricota phylum [4]. Prominent club-shaped projections form a kind of solar corona in their surface, clearly visible under the electron microscope. Thereby, the systematic name of Coronaviridae family derives from these specific structures in virus surface [5, 6].

All human coronaviruses (HCoVs) are the typical zoonoses [7-9]. The primary hosts of HCoVs inhabits in wild and domestic animals. Since the 1930th, coronaviruses have been recognized as dangerous infectious agent [6]. The first dangerous representative of CoVs, Avian Coronavirus (IBV) was described in 1960 [10].

Then the human coronaviruses HCoV-229E and HCoV-OC43 were discovered [8]. Since the discovery of the first representative of the coronavirus family, many HCoVs have been described, including HCoVs from birds, even-toed ungulates (domestic pigs), ruminants, equines, bats, carnivores, rodents and insectivores [7].

There are relatively harmless and extremely dangerous coronavirus strains detected. For example, Murine Coronavirus (MCoV, MHV specifically) causes a high mortality, especially among colonies of laboratory mice. Another strain of Murine Coronavirus, SDAV (Sialodacryoadenitis virus) has high morbidity and tropism for the salivary, lachrymal and harderian glands [11].

Most Feline Coronavirus (FCoV)-infected cats are healthy or display only a mild enteritis. Up to 12% of infected animals may succumb to feline infectious peritonitis with high level of mortality. FCoV can survive for 7 weeks in a dry environment and may be transmitted indirectly [12].

Finally, we need to clarify the veterinary aspect of the origin of SARS-CoV-2. A study conducted by Chinese scientists demonstrated that the estimated primary reservoir for this coronavirus was the horseshoe bats [9, 13]. Apparently, new virus got to the man through intermediate hosts, pangolins, sold in the wet markets in Wuhan city. This mechanism of the new virus is very similar to the SARS-CoV epidemic in 2002 in Guangdong province, China. The intermediate host for SARS-CoV was the palm civets [14].

Since discovery coronaviruses in the early 1970s, a variety of pathological conditions in domestic animals were attributed to these virus infections. Some of the CoVs are already adapted in humans. They can cause mild diseases in patients with weak immune systems. However, in the case of the severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV), these CoVs are not adapted in humans and are found mainly in animal reservoirs [9]. Whereas the bat-to-human transmission of SARS-CoV was likely mediated by palm civets, humans probably acquired MERS-CoV from dromedary camels [15].

### *Transmission SARS-CoV-2 from animal to human: New Facts*

Since the beginning of the COVID-19 epidemic, infection of domestic and farm animals with SARS-CoV-2 virus has been assessed as unlikely [16, 17]. Meanwhile, in November 2019, Connor Reed, a teacher in Wuhan, gave the first information about the infection of a kitten with a fatal outcome [18]. Unfortunately, this message was not taken seriously. Finally, in March 2020, the fact of the transmission of SARS-CoV-2 from man to animal was confirmed. A Pomeranian dog died in Hong Kong, being infected by its owners [19, 20].

The last update in the site of World Organization for Animal Health shows that the cats (101 cases), dogs (85 cases), mink (346 cases) and other pets (1 case), pet ferrets (1 case), lions (4 cases), tigers (8 cases), pumas (3 cases), snow leopard (1 case), and gorillas (1 case) has already infected by SARS-CoV-2 in all inhabited continents. Most of registered outbreaks have been reported from Americas and Europe. Perhaps this is due to the fact that people in these continents keep more pets in zoos and at home. Also, the prevalence of infection with feline and mink virus is quite enough relevant [21].

Soon, Chinese scientists investigated the susceptibility of ferrets and other animals in close contact with humans to SARS CoV-2. They found that this coronavirus replicates poorly in dogs, pigs, chickens, and ducks. Unfortunately, ferrets and cats are permissive to infection. Also, cats are susceptible to airborne transmission [22].

Information about the infection of domestic cats was confirmed experimentally as a result of the joint work of American and Japanese scientists [23].

No one farm animal (excluding minks) case has been reported to date, which would have significant implications in food safety and biohazard. Nevertheless, the S protein nucleotide sequence of the SARS-CoV-2 virus isolated in domestic animals and humans is identical [24, 25]. However, a high rate of variation within SARS-CoV-2 mink isolates implies that these animals were infected before human populations [26]. Coronaviruses infecting humans and carnivores are phylogenetically closely related [27].

At the same time, information on a possible leakage of coronavirus infection from the Institute of Virology in Wuhan is gradually accumulating. On May 14, 2021, leading scientists signed a letter in which they called for a thorough investigation of both versions of the origin of the coronavirus: "We must take hypotheses about both natural and laboratory spillovers seriously until we have sufficient data" [28]. Also, it is turned out that neither bats nor pangolins, which were almost unanimously dubbed as the most likely intermediate hosts of the virus, were not sold on the market at all [29]. The tone of the statements of WHO has also changed; previously this organization took an extremely restrained position to the hypothesis of a coronavirus leakage from the Wuhan laboratory [30].

In this regard, one incident that took place in April 2012 in the southern prefecture of Yunnan is particularly interesting. Then six miners worked in an abandoned mine in the district of Mojiang and cleaned it of the feces of the horseshoe bats. After a few weeks, everyone developed symptoms of an unknown disease that resembled SARS. Three of them died. For three years, they scientists collected nearly 300 samples of various coronaviruses from these bats. One of them, RatG13, turned out to be on the genetically related SARS-CoV-2 [31].

Thus, we have to admit: SARS-CoV-2, in principle, can pass from humans to animals. The reverse transmission has not yet been registered — but not excluded [32, 33, 34]. And this can lead to even greater growth of the epidemic.

Since the start of the pandemic more than a year and a half has passed. Unfortunately for the time being the international scientific community does not have a proven theory of the origin of

SARS CoV-2. If a leakage of infection from the laboratory is indeed to blame, a careful investigation can improve safety in virology laboratories, and avoid a repeat of this in the future. If it is found that the virus has overcome the interspecies barrier in a natural way, the scientific community must develop an international system for early warning of new and potentially dangerous pathogens.

### Conclusion

The presented short review allows us to draw the following conclusions. The appearance of SARS CoV 2 was predictable: it already had many strains similar in structure and life cycle among other CoVs. Failure in veterinary regulations in wet Chinese markets has led to a spontaneous mutation of the ancestor virus and generated a new and aggressive HCoV.

Thus, it is very important to observe biohazard rules in research laboratories, not to keep animals clumped, and not to allow direct contact with them by service personnel.

Despite the fact that no cases of infection with the virus of cattle and other farm animals have been detected, possibility for this undesirable scenario still persists. Farm workers must wear personal protective facilities and observe safety measures. Owners of infected pets should not contact their companions to prevent infection and possible transmission to other people.

The outbreak of the coronavirus epidemic has taken on a large scale. But it can be stopped only with the joint efforts of medical workers and veterinary services.

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