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CORONAVIRUS DISEASE 2019 UPDATE (448): ANIMAL, RACCOON DOG, RESEARCH, EXPERIMENTAL INFECTION
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Date: Sun 23 Aug 2020 [accessed Wed 21 Oct 2020]
Source: News-Medical.net [abridged, edited]
https://www.news-medical.net/news/20200823/Raccoon-dogs-potential-intermediate-host-for-SARS-CoV-2.aspx

Researchers at the Friedrich Loeffler Institute in Germany have conducted a study demonstrating that raccoon dogs were a potential intermediate host in the transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the agent that causes coronavirus disease 2019 (COVID-19).

The study [see ref below] showed that the animals, which are kept in their millions on commercial farms across China, are susceptible to infection and readily transmit the virus to other raccoon dogs in close proximity. Animals that were intranasally inoculated with SARS-CoV-2 quickly became infected and went on to transmit the virus to direct contact animals. A pre-print version of the paper is available on the server bioRxiv, while the article undergoes peer review.

Since the 1st cases of COVID-19 were identified in Wuhan, China, in late [2019], SARS-CoV-2 has swept the globe and was declared a pandemic by the World Health Organization on 11 Mar 2020.

Viruses closely related to SARS-CoV-2 have been identified in bats, but whether the virus was directly transmitted from bats to humans or whether transmission involved an intermediate host such as the pangolin remains unclear. In the cases of SARS-CoV-1 and the Middle East respiratory syndrome (MERS), intermediate hosts were eventually found to be involved, but no such intermediary has yet been confirmed for SARS-CoV-2.

Although the pandemic has been driven by transmission between humans, cases of human-to-animal transmission through contact with companion animals and on mink farms have been reported.

Natural SARS-CoV-1 infection of raccoon dogs has been documented, suggesting the animals' potential involvement in the 2002-2003 outbreak [ref 1 in commentary]. Furthermore, some studies have shown that in raccoon dogs, the host cell protein angiotensin-converting enzyme 2 (ACE2) serves as an efficient receptor of both SARS-CoV-1 and SARS-CoV-2. However, to date,

there are no known studies that have investigated the infection of raccoon dogs with SARS-CoV-1 or SARS-CoV-2 under controlled conditions and with serologic surveillance.

Now, Mettenleiter and colleagues have tested susceptibility to SARS-CoV-2 in raccoon dogs by infecting 9 animals with the virus and then evaluating viral transmission by introducing 3 further animals 24 hours post-infection.

Prior to the experiment, all animals tested negative for the virus by a reverse transcription-quantitative polymerase chain reaction and antibody tests. 9 raccoon dogs (3 males, 6 females) were inoculated intranasally with 10^5 TCID50 [50% tissue culture infective dose] SARS-CoV-2 2019_nCoV Muc-IMB-1.

Nasal, oropharyngeal, and rectal swabs were taken on days 2, 4, 8, 12, 16, 21, and 28 following infection, and blood samples were taken on days 4, 8, 12, 16, 21, and 28.

Of the original 9 animals, 6 became infected with SARS-CoV-2. The animals had already started to shed viral RNA in nasal and oropharyngeal swabs at 2 days post-infection, and infectious virus was isolated from individual animals up to 4 days post-infection. Viral RNA was present in the nasal swabs up to 16 days following infection, with the highest viral genome loads found in nasal swabs, followed by oropharyngeal swabs and then rectal swabs.

The virus was transmitted to 2 of the 3 contact raccoon dogs that were introduced; one dog tested negative due to its cage neighbors not shedding the virus following infection.

None of the animals exhibited any apparent signs of infection, and at autopsy, no gross lesions that could be attributed to SARS-CoV-2 were observed. However, histopathology analysis revealed mild rhinitis in 3 animals by day 4, in one animal by day 8, and in another animal by day 12.

The serological analysis showed that by day 8 following infection, all animals had antibodies specific for SARS-CoV-2, and 2 of the inoculated animals had neutralizing antibodies.

To test whether any viral adaptations had occurred during infection, the team performed high-throughput sequencing of SARS-CoV-2 re-isolated from nasal swabs of one inoculated dog and one infected contact dog. The re-isolated virus was identical to the inoculum, showing that no mutations had occurred and suggesting that the virus is already sufficiently adapted to this potential host.

The researchers say affected fur farms may serve as reservoirs for SARS-CoV-2 and that this risk should be mitigated by efficient and continuous surveillance.

They also say that while it may be possible to control the virus in holdings, a spill-over into susceptible wildlife species and particularly free-living raccoon dogs would be an even greater challenge for elimination.

Reference

Freuling CM, Breithaupt A, Mueller T, et al. Susceptibility of raccoon dogs for experimental SARS-CoV-2 infection. bioRxiv 2020; doi: https://doi.org/10.1101/2020.08.19.256800 [Corresponding authors: Beer M & Mettenleiter TC; preprint not certified by peer review].

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[The report above, initially published 23 Aug 2020, is being posted due to its preserved actuality and in view of the striking spread of SARS-CoV-2 in farmed mink observed in the Netherlands and Denmark, leading to mass cullings. So far, no information from China's fur animal farms has become available. China and Denmark are the world's leading mink-farming countries.

Raccoon dogs (_Nyctereutes procyonoides_) are kept in their millions on commercial farms across China. Other wild species, namely (American) minks, silver foxes, and blue foxes, are similarly farmed in China for fur production.

Natural SARS-CoV-1 infection of raccoon dogs has been documented in China (ref 1). However, in spite of this industry's very large size, there is no report/evidence so far from farms in China on field cases affecting any fur animals due to SARS-CoV-2, nor of a relevant surveillance. This, while minks have been reportedly been infected afield by SARS-CoV-2 in several other countries (Netherlands, Denmark, Spain, USA).

The need to check the possible role of raccoon dogs in the epidemiology of COVID-19 was mentioned in a published interview with Germany's expert, Prof Drosten, who told The Guardian in late April 2020 that "the [SARS-CoV-1] virus was found in civet cats, but also in raccoon dogs -- something the media overlooked. Raccoon dogs are a massive industry in China, where they are bred on farms and caught in the wild for their fur. If somebody gave me a few hundred thousand bucks and free access to China to find the source of the virus, I would look in places where raccoon dogs are bred" (https://www.theguardian.com/world/2020/apr/26/virologist-christian-drosten-germany-coronavirus-expert-interview).

In May 2020, it was reported (item 2 in ProMED-mail archive no. 20200512.7328587) that China's agriculture ministry was proposing to reclassify mink, raccoon dogs, silver foxes, and blue foxes as domestic livestock, rather than wild animals, their traditional status. It was stated that such a move "would entrench China's vast fur industry further into the country's economy" in view of raised worries over the spread of coronavirus among animals crowded together in small spaces. Animal-welfare lobbyists said the change was due to protect China's fur industry from the global pressure to end the farming of wild species because of the coronavirus pandemic.

It will be interesting to note how far the implementation of this initiative has progressed; such change may also encourage the Chinese authorities to apply the long due surveillance in the country's fur animal farms or, alternatively, to report the results of such surveillance in case already applied, in particular on mink and raccoon dog farms. - Mod.AS

Although they resemble raccoons, raccoon dogs (_Nyctereutes procyonoides_) belong to the family Canidae (as dogs, foxes, wolves); raccoons are procyonids. A photo of raccoon dogs can be seen at https://grapee.jp/en/wp-content/uploads/yy-2.jpg. Dogs have been shown to be susceptible to SARS-CoV-2 infection, although experimental evidence showed they are poor replicators. This study is suggesting that this is not the case for all canids, as inoculated raccoon dogs not only became infected and shed the virus, but also infected sentinel animals. - Mod.PMB]

Reference
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1. Guan Y, Zheng BJ, He YQ, et al. Isolation and characterization of viruses related to the SARS coronavirus from animals in southern China. Science. 2003; 302(5643): 276-278. doi: 10.1126/science.1087139; https://science.sciencemag.org/content/302/5643/276/tab-article-info.

HealthMap/ProMED map of China: https://promedmail.org/promed-post?place=7880283,155]

See Also

COVID-19 update (445): animal, Netherlands, Denmark, mink, spread, epidemiology 20201019.7873326
COVID-19 update (439): animal, Denmark, mink, spread, control 20201014.7861560
COVID-19 update (437): animal, Netherlands, Denmark, mink, spread, control 20201013.7858915
COVID-19 update (433): animal, Denmark (ND, MJ) farmed mink, spread, control 20201010.7851707
COVID-19 update (430): animal, USA (UT) mink 20201009.7847704
COVID-19 update (425): animal, Denmark (ND) farmed mink, spread, control 20201004.7835635
COVID-19 update (414): animal, Netherlands (LI), Denmark (ND), farm mink, spread 20200925.7813579
COVID-19 update (406): animal, Netherlands (LI), Denmark (ND), farm mink, spread 20200918.7794239
COVID-19 update (401): Netherlands (NB), Denmark, farmed mink, spread 20200914.7777661
COVID-19 update (394): Netherlands (NB) animal, farmed mink, spread 20200908.7759382
COVID-19 update (387): Netherlands, mink, animal & public health, research 20200902.7740793
COVID-19 update (382): Netherlands, animal, farmed mink, spread, control 20200830.7730463
COVID-19 update (376): animal, ferret, mink, comment 20200827.7721923
COVID-19 update (366): animal, USA (UT) mink 20200818.7692815
COVID-19 update (363): animal, Denmark (ND) Netherlands (NB,LI) mink, spread 20200817.7687830
COVID-19 update (340): animal, China, envir monitoring, Netherlands (NB), mink 20200801.7635820
COVID-19 update (334): animal, Netherlands, mink, spread, UK, cat, 1st rep, OIE 20200727.7617582
COVID-19 update (324): Netherlands (NB) animal, farmed mink, spread 20200719.7591013
COVID-19 update (317): Netherlands (NB) animal, farmed mink, spread 20200716.7578453
COVID-19 update (307): Netherlands (NB), Denmark (ND) farmed mink, spread, control 20200708.7553067
COVID-19 update (301): Denmark (ND) Netherlands (NB) farmed mink, spread, control 20200703.7536980
COVID-19 update (284): Denmark (ND) animal, farmed mink, spread, dog 20200624.7506728
COVID-19 update (281): Netherlands (NB, LI) farmed mink, spread, animal, global 20200623.7502849
COVID-19 update (266): Denmark (ND) animal, farmed mink, 1st rep 20200617.7479510
COVID-19 update (251): Netherlands (NB, LI) animal, farmed mink, spread, culling 20200610.7453845
COVID-19 update (248): Netherlands (NB, LI) animal, mink, spread, culling, cat 20200609.7446478
COVID-19 update (236): Netherlands (NB, LI) animal, farmed mink, spread, culling 20200604.7427849
COVID-19 update (230): Netherlands (NB, LI) animal, farmed mink, spread, control 20200602.7420433
COVID-19 update (215): Netherlands (NB) animal, mink-to-human, epidem., control 20200527.7385049
COVID-19 update (209): Netherlands (NB) farmed mink, animal-to-human, cat, epid 20200525.7375359
COVID-19 update (198): Netherlands (NB) farmed mink, animal-to-human infect susp 20200520.7359976
COVID-19 update (189): Netherlands (NB) animal, farmed mink, research, cat, dog 20200517.7344274
COVID-19 update (177): Netherlands (NB) animal, farmed mink, Spain (CT) cat susp 20200512.7328587
COVID-19 update (174): Netherlands (NB) animal, farmed mink, comment 20200511.7323845
COVID-19 update (169): Netherlands (NB) animal, farmed mink, spread, rabbit susp 20200509.7316646
COVID-19 update (154): Netherlands (NB) animal, farmed mink, research 20200503.7294846
COVID-19 update (146): Netherlands (NB) animal, farmed mink, epidemiology 20200501.7286113
COVID-19 update (135): Netherlands (NB) animal, farmed mink 20200427.7272289
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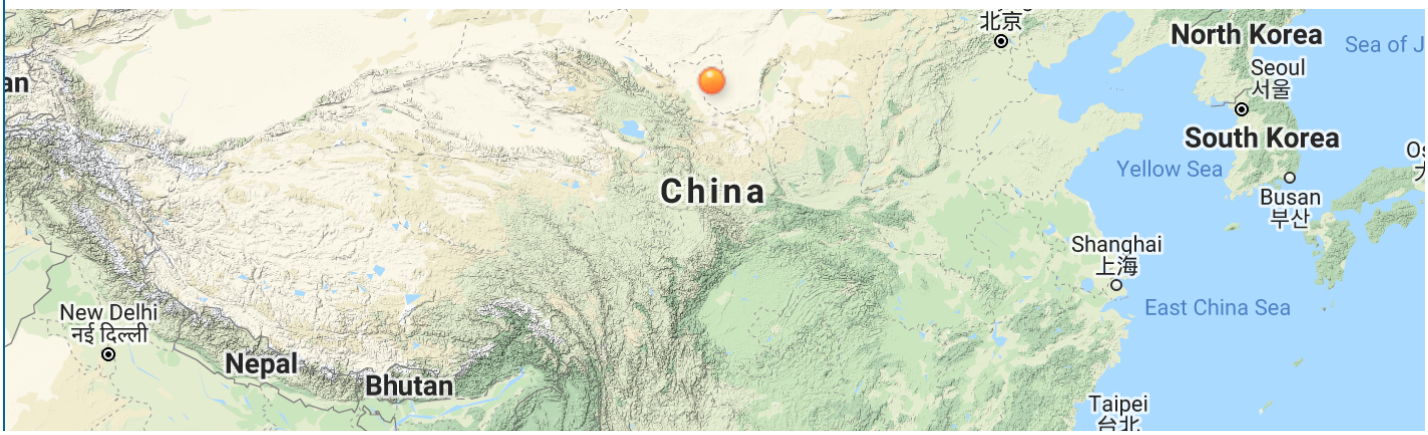

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