

UPDATE: Evidence for animal infections with SARS-CoV-2

Detection of SARS-CoV-2 in Mink in Netherlands

1. On April 26th, The Netherlands informed the European Commission of two outbreaks of SARS-CoV-2 in mink. On the first farm, three animals were tested which were showing gastro-intestinal and respiratory signs, while the farm generally had increased mortality. On the second farm, there were respiratory signs and increased mortality. People working at the farms had COVID-19-like symptoms.
2. Mink are part of the family Mustelidae, which also includes weasels, otters and ferrets. Ferrets are considered to be amongst the susceptible species for reverse zoonotic SARS-CoV-2 infections.
3. Although the Dutch human and veterinary expert group concluded negligible risk from any animal infections, in comparison to the human to human transmission driving the epidemic, the Dutch authorities have placed road closures around the farms which people are advised to avoid and are asking all mink farmers to report clinical signs.
4. The Netherlands has a large mink farming sector, one of the largest in the World after China, Poland and Denmark. Around 6 million animals are killed for their fur each year. This practice will be phased out by 2024 under a Supreme Court ruling.
5. The UK banned the farming of animals for fur in 2002 and there are no UK mink farms. Mink are present in the UK as they were illegally released from mink farms in the past, and they survive well as an invasive non-native species; they are a threat to our native bird and small mammal (eg water vole) populations, nevertheless they are protected under the Animal Welfare Act 2006.
6. The keeping of exotic animals as pets in the UK may include such mustelids, although ferrets are more common.

International Detections of SARS-CoV-2 to date

7. Several areas of investigation for animal infections are underway to determine the origin of SARS-CoV-2 and the risk to humans in contact with infected animals:
 - Investigating the role of animals through surveillance testing;
 - Testing report cases (suspect clinical signs such as respiratory signs) of in contact animals;
 - Investigating the role of animals through in silico predictions and comparing functional similarities to SARS-CoV;
 - Experimental infections.

8. Testing of animals from other surveillance programmes: domestic and stray cats in Wuhan, Javan pangolins (*Manis javanica*) and certain bat species (eg *Intermediate horseshoe bat*, *Rhinolophus affinus*). No confirmed contact with SARS-CoV-2 humans, some testing was carried out on samples collected before the start of the pandemic.
9. Positive animals in contact with infected humans: two dogs and one cat in Hong Kong; two cats in New York; two mink farms in the Netherlands and six big cats in Bronx zoo, New York. All except one NY cat, had contact with infected households / people. A cat in a household in Belgium tested positive but as samples were taken from an affected household, environmental contamination could not be ruled out.
10. Of these animals which tested positive, two big cats, one dog and two domestic cats showed mild respiratory signs.
11. Experimental infections: Likely susceptible animal species are domestic cats, ferrets, non-human primates, certain species of rodents (Cricetidae), certain species of bat (*Rhoseetus aegypticus*). These animals have tested positive by PCR for SARS-CoV-2 in experimental conditions but only ferrets and cats were capable of infecting other animals
12. Non-susceptible species are pigs and poultry where in experimental conditions, neither group became infected. These experiments used nasal inoculation and therefore the results only represent a single infection method. Aquatic farmed or wild stock have been ruled out as they do not appear to be susceptible to betacoronaviruses in general.
13. Predictions and functional similarities: There is an observed 3.8% difference between horseshoe bat and human SARS-CoV-2 isolates which suggests there is an intermediate (reservoir) host so far not identified. The sequence difference with the pangolin isolate was 2.6%. During SARS-CoV, when the masked palm civet (*Paguma larvata*) was identified as the intermediate host, the virus isolates showed high sequence similarity with human isolates from the start of the outbreak, less so from isolates collected several months later.
14. Experimental infections during 2002 SARS epidemic: of poultry and pigs with SARS-CoV did not lead to any clinical signs, nor were gross pathologic changes evident on postmortem examinations. Attempts at virus isolation were unsuccessful; however, viral RNA was detected by PCR in blood of both species during the first week after inoculation, and in chicken organs at 2 weeks after inoculation. Virus-neutralizing antibodies developed in the pigs. Results indicated that these animals did not play a role as amplifying hosts for SARS-CoV.

Defra Risk Assessments:

15. Defra carried out two risk assessments in February, which have been updated on 20th March and are due a refresh given the more recent information on the cats in

the USA and the mink farms. The level of uncertainty is high, but the overall risk for companion animals was considered to be low in terms of infecting other animals or humans, while for livestock the risk level is medium in terms of exposure for pigs, but it was not possible to assess the risk of infection and exposure. These assessments have been considered and agreed by HAIRS and ACDP.

Livestock

- **Risk question** – in a situation where a person has been exposed to the SARS-CoV-2 virus, what is the risk of any UK livestock animal being exposed to the virus?
- **Outcome** - In the event of sustained human-to-human transmission, the exposure of pigs on non-commercial farms from sub-clinically infected humans is HIGH and for commercial farms is MEDIUM. [Estimated 97% of GB pigs are kept on commercial farms.]
- **Key uncertainties** - the consequences of exposure is not known – whether pigs can become infected or infectious or if they are sub-clinically infected.
- **Level of uncertainty** - High for consequence of exposure; low for biological plausibility

Companion animals (cats, dogs and ferrets)

- **Risk question** - In a situation where a companion animal has had household contact with a test positive SARS-CoV-2 person, what is the risk of the animal being exposed to the virus and what is the risk of onward spread of infection from the animal to other people or companion animals?
- **Outcome** - Risk of exposure from infected humans HIGH (depending on the pathway); onward spread from animal to other animals or humans MEDIUM from fomite risk, VERY LOW from replicating virus in the companion animal (depending on the species); overall risk LOW from combining probabilities
- **Key uncertainties** - Infectious dose in people; Presence, possible length and duration of infection in companion animals and humans; Level of viral shedding in human asymptomatic cases and early stage symptomatic cases; duration and viral load of pet fur as fomite
- **Level of uncertainty** - mostly high

Research & future activities

16. APHA is currently undertaking transmission experiments in ferrets, collaborating with PHE Porton. This will inform the evidence base on length of infection, transmissibility and the risk of fomite transmission on fur. APHA has the ability to carry out PCR testing and immunopathology for SARS-CoV-2.

17. The Friedrich Loeffler Institute in Germany is starting transmission experiments on cattle. Other countries, including France, Spain, Italy and Netherlands are looking at targeted surveillance in cats and other animals.
18. We are considering working with Private Veterinary Surgeons and industry to develop a test protocol and case definition for companion animals (cats and ferrets) to enable us to fulfil our international obligations to report new and emerging infection in animals.
19. Continual monitoring and updating the risk assessments. Exotic animals including zoo species and wildlife will be risk assessed in light of the surveillance evidence in these sector.

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