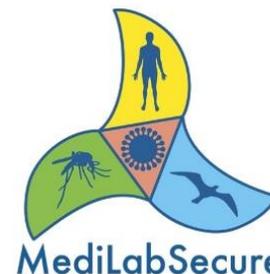




SARS CoV-2 IN ANIMALS

(Updated on July 13th 2020)

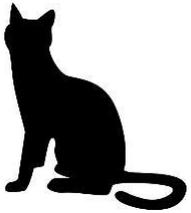


New information since last report (26th May) marked with **

*Document prepared by the Animal Virology Coordination team of MediLabSecure
Animal Health Research Center, INIA-CISA. Valdeolmos, Madrid SPAIN*

SUMMARY

NATURAL INFECTIONS



Cats



Dogs



Minks (farms)

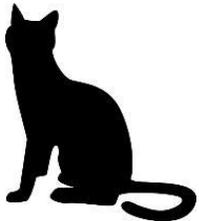


Lions & tigers (zoo)

EXPERIMENTAL INFECTIONS *(by order of susceptibility)*



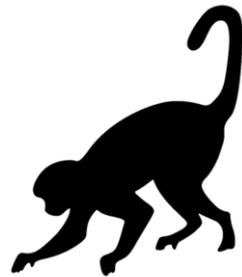
Ferrets



Cats



Golden
hamsters



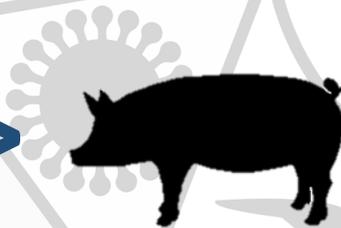
Macaques



Fruit bats



Dogs



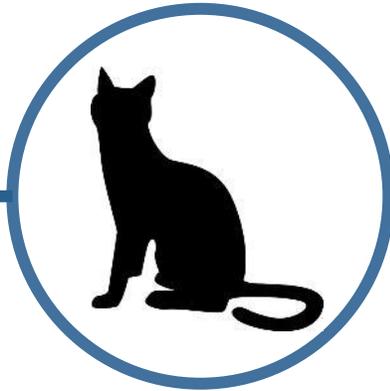
Pigs



Chicken
& Ducks

(non susceptible species)

CATS (I)



12 PCR positive cats detected worldwide

**All of them in close contact with
COVID19 positive humans**

**Most of them showed respiratory and
digestive clinical signs, although at least
2 without symptoms**

BELGIUM (27th March): 1 cat with respiratory and digestive symptoms tested positive by PCR in faeces and vomit. Recovery after 9 days. More info [here](#).

HONG KONG (31st March): 1 cat without clinical signs tested positive by PCR. More info [here](#).

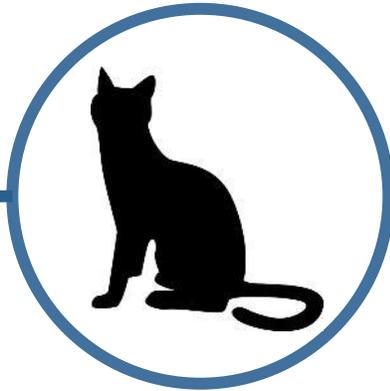
USA First case (18th April): 2 cats with respiratory symptoms. Detection of viral RNA by PCR and antibodies by VNT. More info [here](#).

****Second case (2nd June): 1cat with respiratory symptoms tested PCR positive. The cat fully recovered after 5 days. More info [here](#).**

FRANCE First case (2nd May): 1 cat with mild respiratory and digestive symptoms. Detection by PCR in faecal swab (negative in oropharyngeal swab). More info [here](#).

Second case (12th May): 1 cat with respiratory disorders tested positive in nasopharyngeal swab but negative in rectal swab. More info [here](#)

CATS (II)



12 PCR positive cats detected worldwide

All of them in close contact with
COVID19 positive humans

Most of them showed respiratory and
digestive clinical signs, although at least
2 without symptoms

SPAIN First case (April): 1 cat PCR positive in oropharyngeal swab (negative in rectal swab). Asymptomatic. COVID infected owner. More info [here](#).

Second case (8th May): 1 cat died due to non-COVID related cardiopathy. Samples were collected during necropsy and low RNA viral loads were detected in nose and mesenteric lymph node. More info [here](#).

GERMANY (29th April): 1 asymptomatic cat was PCR positive in throat swab. The owner of the animal died due to COVID infection. More info [here](#).

NETHERLANDS (May): Specific antibodies were detected in 7 cats (out of 24 that were tested) living in the proximity of the affected mink farms. In one of them the virus could be detected (low viral load). It is suspected that the cats could be infected from the minks. More info [here](#) and [here](#).

RUSSIA (22th May): Detection by PCR in one cat in Moscow (oropharyngeal swab). More info [here](#).

DOGS (I)



6 PCR positive dogs detected worldwide

All in close contact with COVID19 positive humans

No clinical signs

HONG KONG

- First case (26th Feb): Nasal and oral swabs from a dog whose owner was infected were positive by PCR. The dog did not show any clinical signs during the quarantine period. More info [here](#).
- Second case (19th March): 2 dogs owned by a COVID positive person were tested by PCR and only one was positive. The virus could be isolated from nasal and oral swabs. The dogs were asymptomatic. More info [here](#).

NETHERLANDS

(15th May) Specific SARS CoV-2 antibodies were found in a dog of a COVID patient. The dog had breathing problems but it is not clear if those were related to the infection. More info [here](#).

** DENMARK

(20th June): a family dog in the first mink farm affected by SARS CoV-2 in Denmark was found PCR positive. More info [here](#).

(Continues in the next page)

DOGS (II)



6 PCR positive dogs detected
worldwide

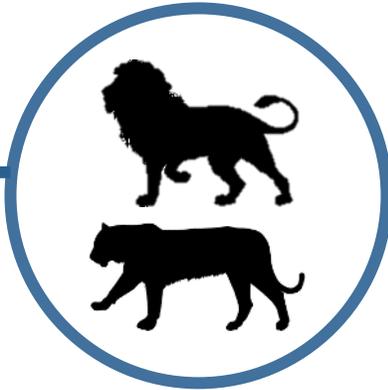
All in close contact with COVID19
positive humans

No clinical signs

** USA

- New York (2nd June): A dog whose owner was confirmed with COVID infection tested positive by PCR and by serology (neutralizing antibodies). The animal had hemolytic anemia. A second dog in the household (asymptomatic) also developed antibodies but the PCR was negative. More info [here](#).
- Georgia (1st July): 1 dog that died due to non-COVID related neurological disease, tested positive by PCR. More info [here](#).
- Texas (7th July): A dog whose owners were confirmed to have COVID, tested positive by PCR. More info [here](#).

FELINES



3 tigers and 3 lions with compatible symptoms. Infection confirmed by PCR in 1 tiger and 1 lion

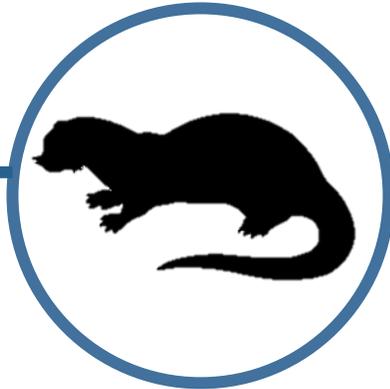
Close contact with a COVID19 positive zoo employee

Mild respiratory signs

NEW YORK (USA), Bronx Zoo

A tiger showed respiratory signs on March 27th. By April 3rd, three additional tigers and 3 lions living in the same enclosure were showing similar signs (dry cough and wheezing). Samples collected from the first affected tiger and one of the lions were SARS CoV-2 positive. The other animals with clinical signs were also presumed to be infected. All animals are stable and recovering. It is assumed that an asymptomatic zoo employee infected the animals (more info [here](#) and [here](#)).

MINKS (I)



20 affected farms in Netherlands
and **3** in Denmark

Contact with COVID19 infected workers

In some cases they show digestive and respiratory signs that can cause the death of the minks but the animals can suffer also asymptomatic infection

NETHERLANDS

At the end of April, SARS CoV-2 was detected in 2 minks. On May 7th, two additional mink farms in the country were affected by the virus. It is suspected that SARS CoV-2 was transmitted to the animals by infected workers and then the disease spread between minks. The virus has been detected in dust particles inside the farm.

The infection can cause pneumonia and death of minks, but the morbidity and mortality rates are low. Some animals do not show any clinical signs. More info [here](#) and [here](#). Information from 2 affected farms has been published as a preprint [here](#).

In May it was published that 2 employees of the mink farms could have acquired the infection from the minks. If confirmed these would be the first transmissions of SARS CoV-2 from animal to human (apart from the first one that originated the pandemic in Wuhan). More info [here](#) and [here](#).

MINKS (II)



20 affected farms in Netherlands
and **3** in Denmark

Contact with COVID19 infected workers

In some cases they show digestive and respiratory signs that can cause the death of the minks but the animals can suffer also asymptomatic infection

NETHERLANDS

******The number of affected farms has increased up to 20. The Government of Netherlands has proceeded to the culling of all the animals in affected farms. It is now mandatory to test by serological assays the animals in all the mink farms in the country, as well as to notify any disease suspicion and to submit weekly the early warning survey (number of dead animals). More info [here](#) and [here](#).

Strong evidence suggests that apart from transmission among the minks, also transmission from minks to cats and dogs occurred in the farms ([info](#)).

**** DENMARK**

Three mink farms have suffered COVID outbreaks in North Jutland since June. The origin of the outbreaks is related to infected workers. All the animals in the affected farms will be culled. Strong preventive measures have been established in all mink farms in Denmark. More info [here](#) and [here](#).

SARS CoV-2 IN MINK FARMS

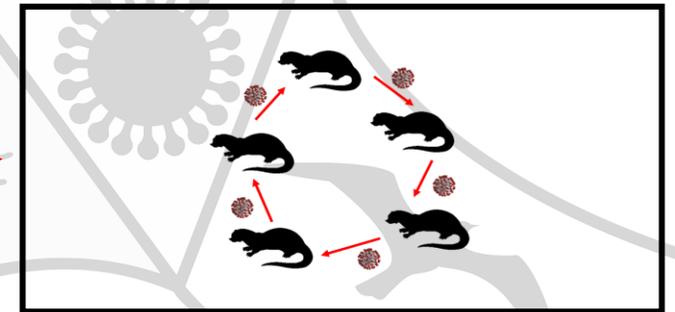
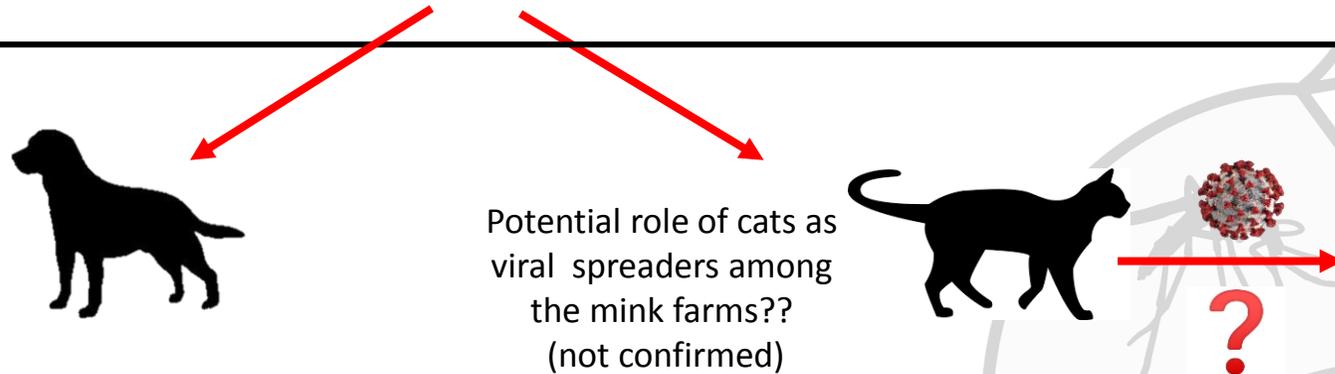
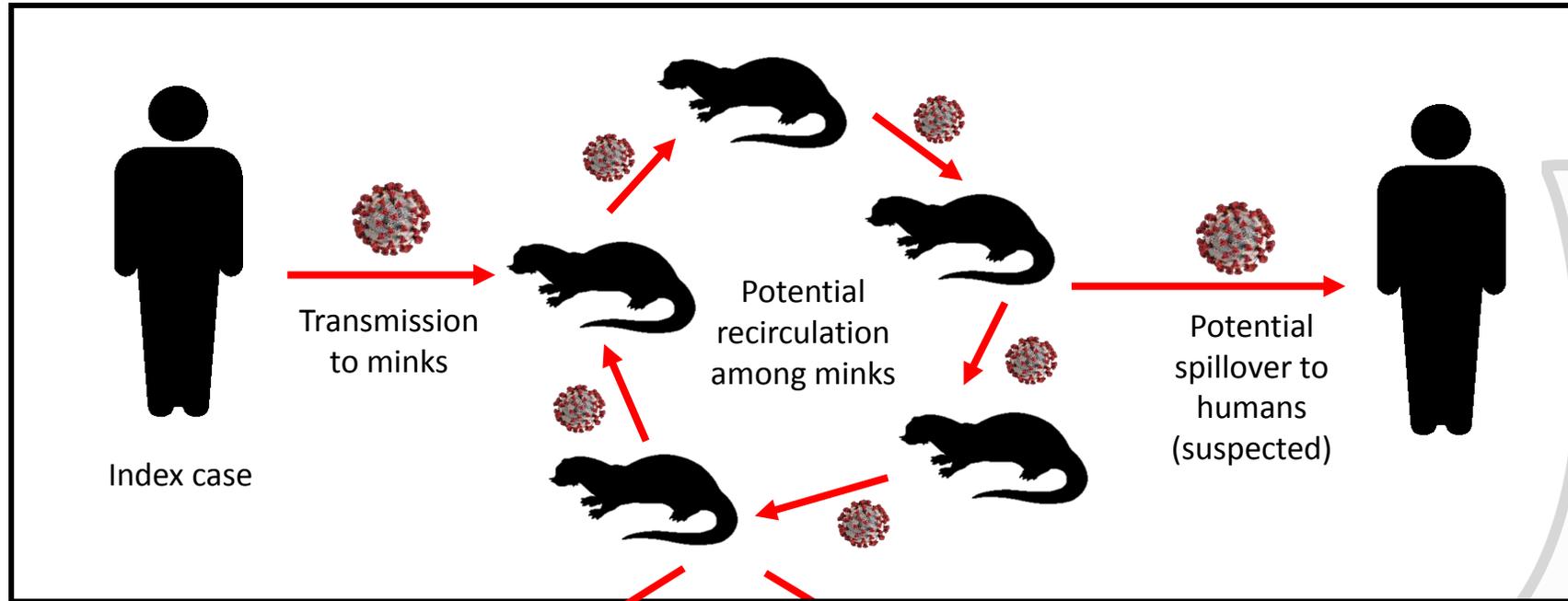


Diagram produced based on data from [Oreshkova et al., 2020](#), [this ProMed report](#) and this [OIE report](#)

EXPERIMENTAL INFECTIONS IN ANIMALS

CATS



- **Efficient viral replication**
- Severe disease in juveniles. Adults mostly asymptomatic
- Abundant virus in respiratory and gut epithelium
- Transmission of virus among cats via droplets

FERRETS



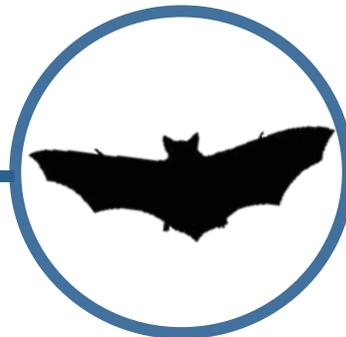
- **Very efficient replication** with high viral loads in upper respiratory tract
- No signs of severe disease or death
- ****Contact and air borne transmission**
- Seroconversion in all inoculated ferrets

DOGS



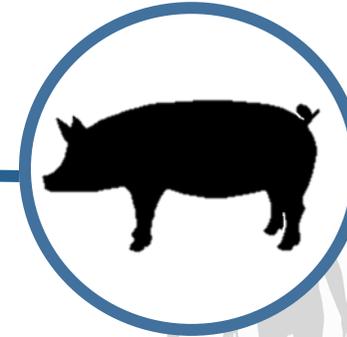
- **Low susceptibility** to the infection
- No infectious virus in swabs
- Asymptomatic infection
- Seroconversion in inoculated animals

FRUIT BATS



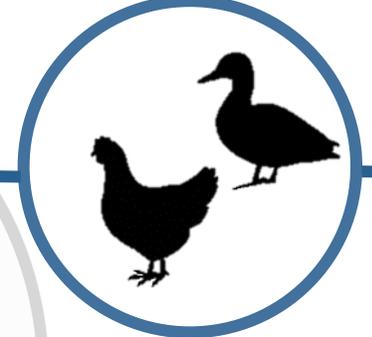
- **Transient infection of the respiratory tract**
- Contact transmission in 1 out of 3 bats

PIGS



- **Not susceptible** to intranasal inoculation
- No contact transmission

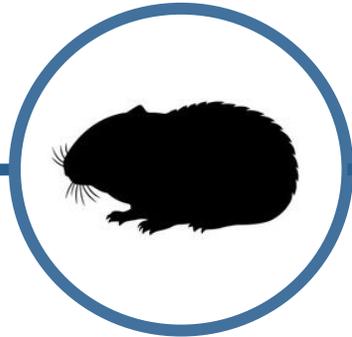
CHICKEN & DUCKS



- **Not susceptible** to intranasal inoculation
- No contact transmission

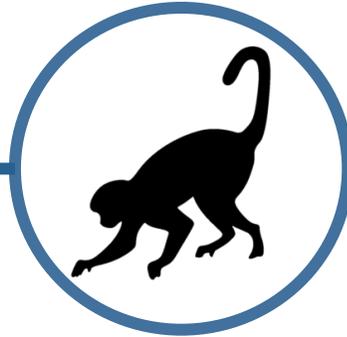
Data obtained from [Shi et al., 2020](#) (cats, dogs, ferrets, pigs, duck & chicken), [Schlottau et al., 2020](#) (ferrets, pigs, fruit bats and chicken), [Halfmann et al., 2020](#) (cats), [**Bosco-Lauth et al., 2020](#) (cats & dogs), [**Kim et al., 2020](#) (ferrets), [**Richard et al., 2020](#) (ferrets)

GOLDEN HAMSTERS

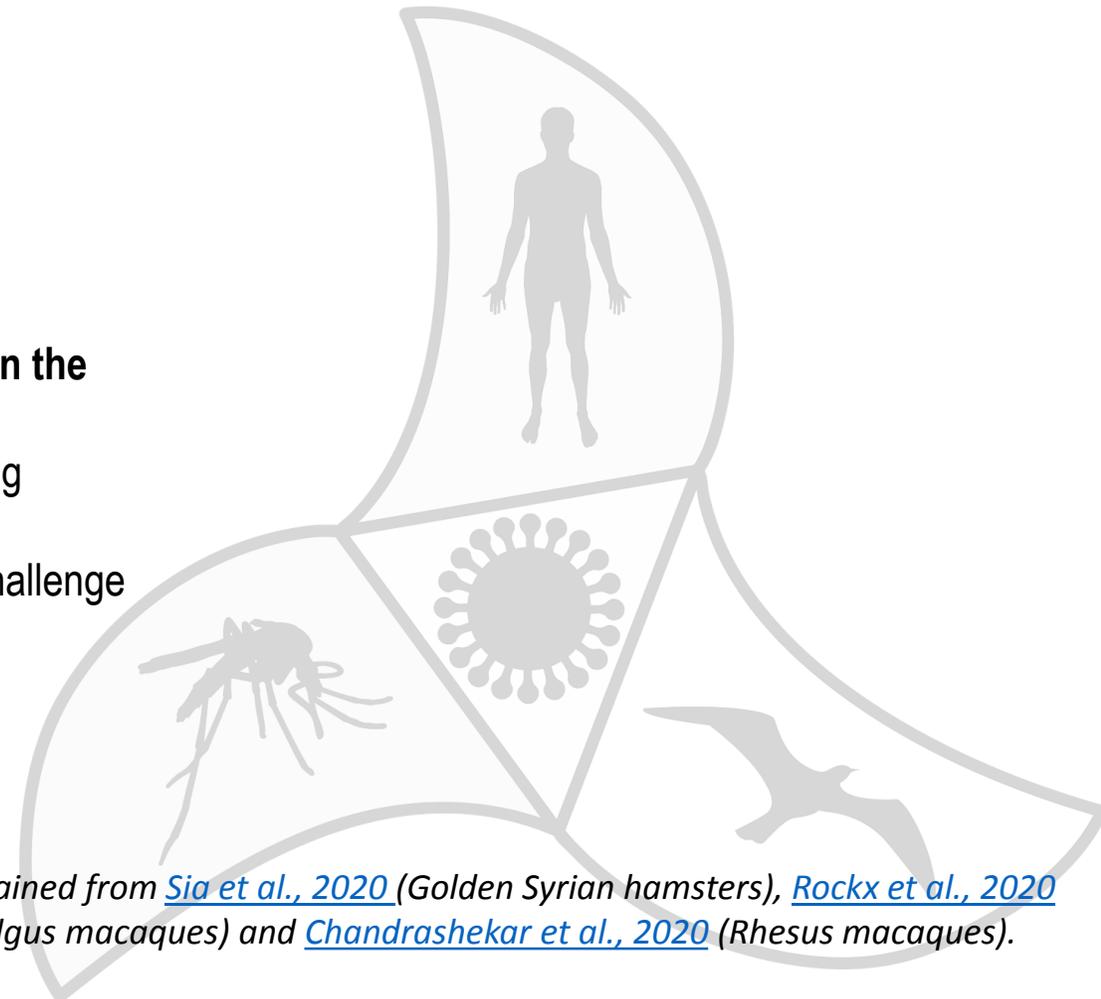


- **Efficient viral replication in the nasal mucosa and lower respiratory tract**
- Weight loss in infected animals
- Transmission of virus among hamsters by direct contact and via aerosols
- Good animal model for SARS CoV-2 studies

MACAQUES



- **Efficient viral replication in the respiratory tract**
- Prolonged viral shedding
- No clinical signs
- Infection protects against rechallenge with SARS CoV-2



Data obtained from [Sia et al., 2020](#) (Golden Syrian hamsters), [Rockx et al., 2020](#) (Cynomolgus macaques) and [Chandrashekar et al., 2020](#) (Rhesus macaques).

OTHER SARS CoV-2 STUDIES IN ANIMALS

USA and SOUTH KOREA

Molecular testing of domestic animals

IDEXX Company tested by PCR 3500 dog, cat and horse samples collected in February and March 2020. No positive cases were found. There is no information about potential contact of the animals with infected humans. More info [here](#).

HONG KONG

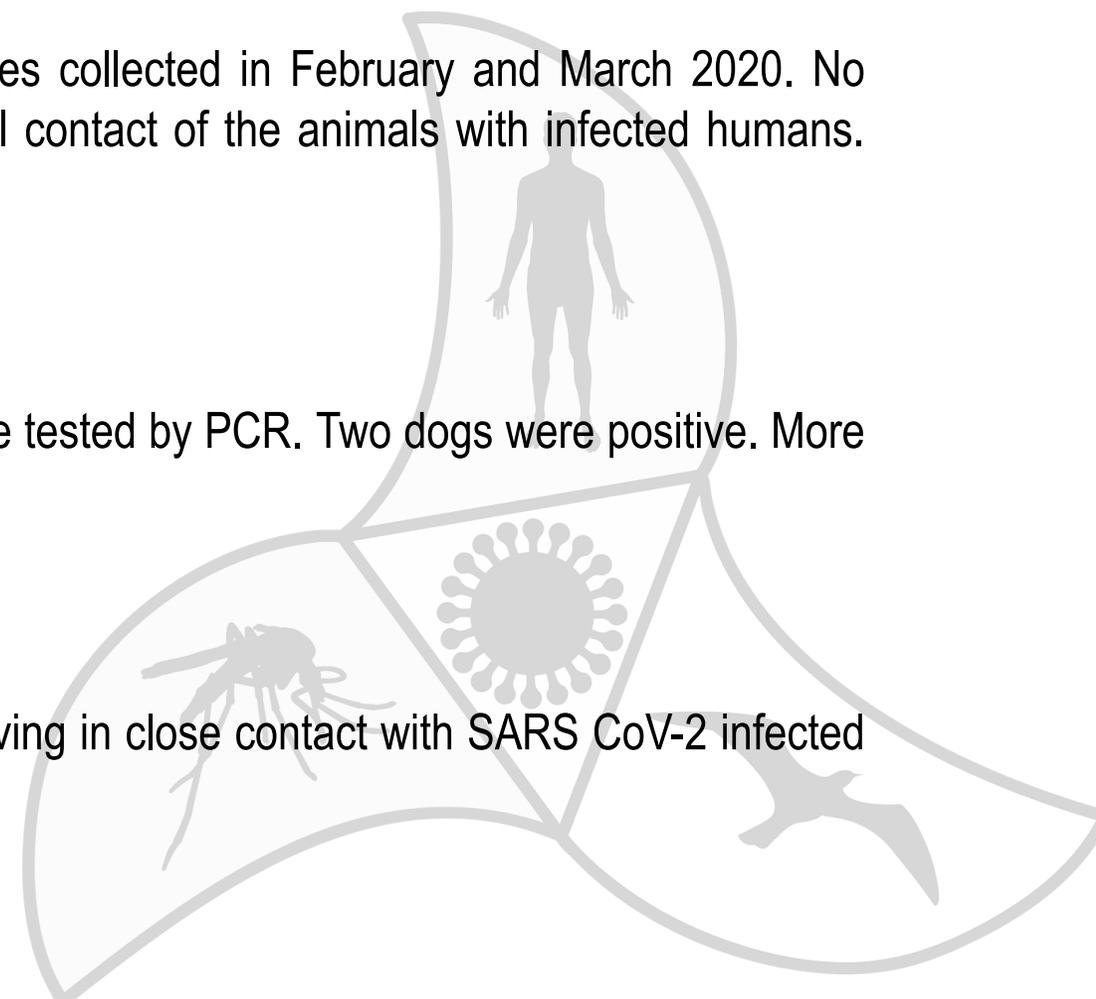
Molecular testing of cats and dogs

17 dogs and 8 cats living in close contact with infected owners were tested by PCR. Two dogs were positive. More info [here](#).

FRANCE

Molecular testing of cats and dogs

The virus could not be detected in any of the 9 cats and 12 dogs living in close contact with SARS CoV-2 infected veterinary students. More info [here](#).



OTHER SARS CoV-2 STUDIES IN ANIMALS

CHINA

Molecular and serological testing of cats from Wuhan

Out of 102 analysed cats, 15% were found seropositive by indirect ELISA and 10.8% by VNT. The virus could not be detected in oropharyngeal or rectal swabs in any of the cats. More info [here](#).

Molecular testing of fur farm animals

Negative results in minks, foxes and raccoon dogs. More info [here](#).

SPAIN

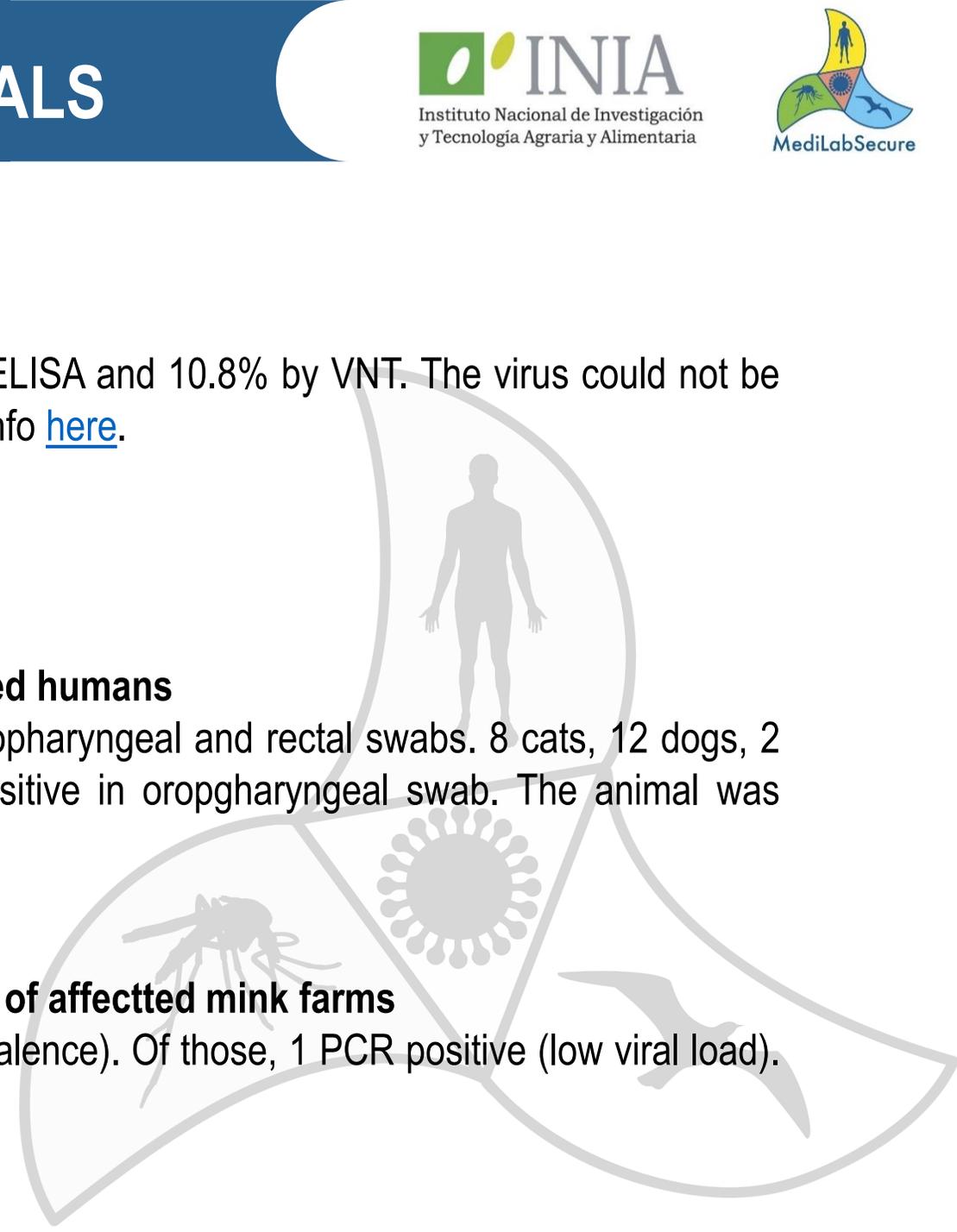
Molecular testing of domestic animals living with COVID infected humans

23 pets with COVID positive owners were tested by PCR using oropharyngeal and rectal swabs. 8 cats, 12 dogs, 2 rabbits and 1 guinea pig were analysed. Only one cat tested positive in oropharyngeal swab. The animal was asymptomatic. More info [here](#).

NETHERLANDS

Molecular and serological testing of cats living in the proximity of affected mink farms

24 cats analyzed by serological assays, 7 positive (29.2% seroprevalence). Of those, 1 PCR positive (low viral load). More info [here](#).



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