SARS CoV-2 IN ANIMALS

*(Updated on **December, 7th 2020**)*

INIA
Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria

MediLabSecure

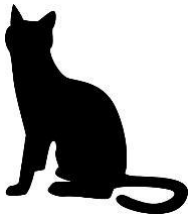
New information since last report (July) marked with **

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 and puma (zoo)

EXPERIMENTAL INFECTIONS *(by order of susceptibility)*


Ferrets

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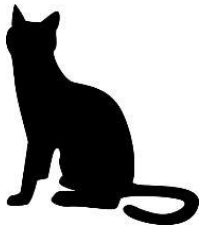
Raccoon dogs


Macaques


Fruit bats


Cats


Golden hamsters


Dogs

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Pigs


Tree shrew


Chicken & Ducks


Cows

(very low or non susceptible species)

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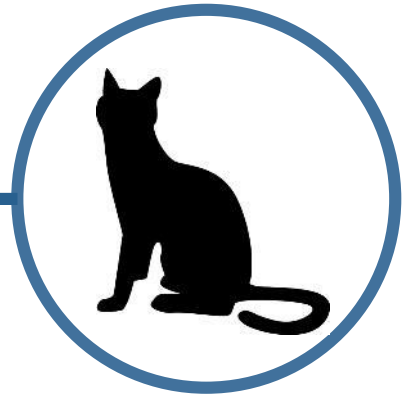
SARS CoV-2 & DOMESTIC ANIMALS

CATS (I)



43 PCR positive cats detected worldwide

All of them in close contact with COVID-19 positive humans

Variable clinical presentation: some were completely asymptomatic, others with respiratory and digestive 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.
**(August) 4 asymptomatic cats tested positive. More info here.

****USA:** 20 cases since April when the first case was detected. More info here.

FRANCE: First case (2nd May): 1 cat with mild repiratory and digestive symptoms. Detection by PCR in faecal swab (negative in oropharingeal swab). More info here and **Sailleau et al., 2020.
Second case (12th May): 1 cat with respiratory disoders tested positive in nasopharyngeal swab but negative in rectal swab. More info here.

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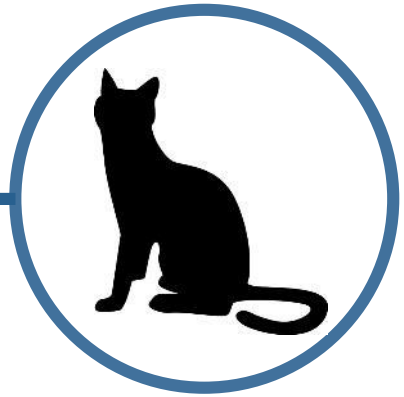
SARS CoV-2 & DOMESTIC ANIMALS

CATS (II)



SPAIN: First case (April) 1 cat PCR positive in oropharyngeal swab (negative in rectal swab). Asymptomatic. COVID-19 infected owner. More info here.
Second case (8th May) 1 cat died due to non-COVID-19 related cardiopathy. Samples were collected during necropsy and low RNA viral loads were detected in nose and mesenteric lymph node. More info **Segalés et al., 2020.

GERMANY: (29th April) 1 asymptomatic cat was PCR positive in throat swab. The owner of the animal died due to COVID-19 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 got 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.

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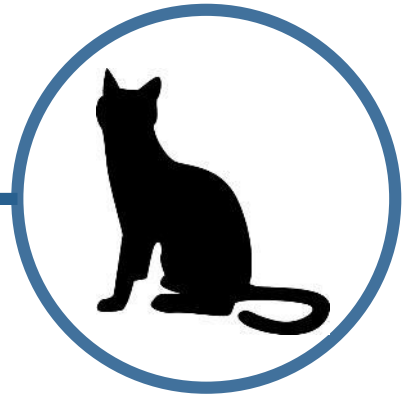
SARS CoV-2 & DOMESTIC ANIMALS

CATS (III)



**UK: (May) A cat with respiratory symptoms tested positive by PCR in May and was reconfirmed in July. The cat fully recovered after several days and developed neutralizing antibodies. More info here and here.

**CHILE: (May) 3 cats with positive PCR in nasal secretion and feaces. More info here.

**JAPAN: (July) 2 cats tested positive. More info here.

**ARGENTINA: (September) 2 cats were PCR positive in oral and rectal swabs. Both cats showed transient symptoms such as anorexia, sneezing and nasal secretions. More info here.

**BRAZIL: (October) 1 asymptomatic cat tested positive in oral and nasal swabs. More info here.

**SWITZERLAND: (November) 1 cat with sneezing, inappetence and apathy tested positive. The cat fully recovered. More info here.

SARS CoV-2 & DOMESTIC ANIMALS

DOGS (I)

28 PCR positive dogs detected worldwide

All in close contact with COVID-19 positive humans

No clinical signs except in one case

HONG KONG

- (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.
- (19th March): 2 dogs owned by a COVID-19 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 Sit et al., 2020.
- **(August): 2 asymptomatic dogs tested positive by PCR. More info here.

NETHERLANDS

(15th May): Specific SARS CoV-2 antibodies were found in a dog of a COVID-19 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.

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SARS CoV-2 & DOMESTIC ANIMALS

DOGS (II)

**USA

12 cases since June when the first case was detected. More info here.

**JAPAN

(July and August): 4 dogs gave PCR positive reuslts in oral and throat swabs, no clinical symptoms. More info here.

**ARGENTINA

(October): 4 dogs tested positive by PCR. Only one showed clinical symptoms (conjunctivitis, cough, dyspnea and weakening). More info here.

**CANADA

(October): 1 positive dog without any clinical manifestations. More info here.

SARS CoV-2 & WILDLIFE

FELINES

7 tigers, 3 lions and 1 puma

Close contact with a COVID-19 infected zoo employees

Mild respiratory signs

USA

- Bronx Zoo New York

A tiger (*Panthera tigris*) showed respiratory signs on March 27th. By April 3rd, three additional tigers and 3 lions (*Panthera leo krugeri*) living in the same enclosure were showing similar signs (dry cough and wheezing). The infection was confirmed in the 7 animals by PCR. Al of them recovered from infection. It is assumed that an asymptomatic zoo employee infected the animals. More info in **McAloose et al., 2020.

- **Knoxville Zoo, Tennessee

3 tigers showed mild coughing, lethargy and decrease in appetite in November. PCR analysis were positive. More info here.

**SOUTH AFRICA

Johannesburg Zoo

A puma (*Puma concolor*) tested PCR positive in July after contact with an infected worker. More info here.

SARS CoV-2 & WILDLIFE

MINKS (I)

Infected minks have been detected in farms in 10 countries (Netherlands, Denmark, Sweden, USA, Italy, Spain, Greece, Poland, France and Lithuania)

The virus is introduced into the farm by infected workers although other potencial routes could exist.

The minks are highly susceptible and can transmit the virus back into humans.

**NETHERLANDS

The first farms with outbreaks of SARS CoV-2 were detected in April. Since then, the infection has been confirmed in 70 farms. The virus is introduced into the farms by infected workers, then the virus spreads extremely fast among the animals and the virus can finally jump back to humans. This is the first confirmation of transmission of SARS CoV-2 from animals to humans.
More information can be found in Oude Munnik et al., 2020 and Oreshkova et al., 2020. Strong evidence suggests that the minks can also transmit the virus to cats and dogs (info).
The infection in minks has different clinical presentations: from completely asymptomatic to severe intersticial pneumonia and death. More information about clinical and pathological findings in farmed minks can be found in Molenaar et al., 2020.
Due to the risk that mink farms pose to Public Health in the context of the current pandemic, the Dutch Government has decided to finalize mink farming in the country by March 2021.

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SARS CoV-2 & WILDLIFE

MINKS (II)

**DENMARK

Since June, when the first outbreaks were reported, 289 farms have suffered COVID-19 outbreaks. First affected farms were located in North Jutland but now the infection has also been detected in farms from Central and Southern Denmark.

The reasons for this fast spread among farms despite the strong preventive and biosecurity measures are not well understood.

Specific mutations have been detected in the virus from infected minks. At least 4 of them affect to the spike protein. These mink-derived strains have also been detected in human population living in the vicinity of farms.

Although the potential impact of these mutations on vaccine development seems low, the Danish Government decided to kill the whole mink population of the country (around 15-17 millions of animals).

More information can be found in Hammer et al., 2020 and here.

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SARS CoV-2 & WILDLIFE

MINKS (III)

SWEDEN The infection has been detected in 13 farms. More info here and here.

SPAIN An outbreak in a farm was detected in July. The 92.000 minks were euthanised. More info here.

ITALY Positive samples were detected in August in one farm and in November in another farm. More info here and here.

GREECE Outbreaks in 2 mink farms in Northern Greece. More info here.

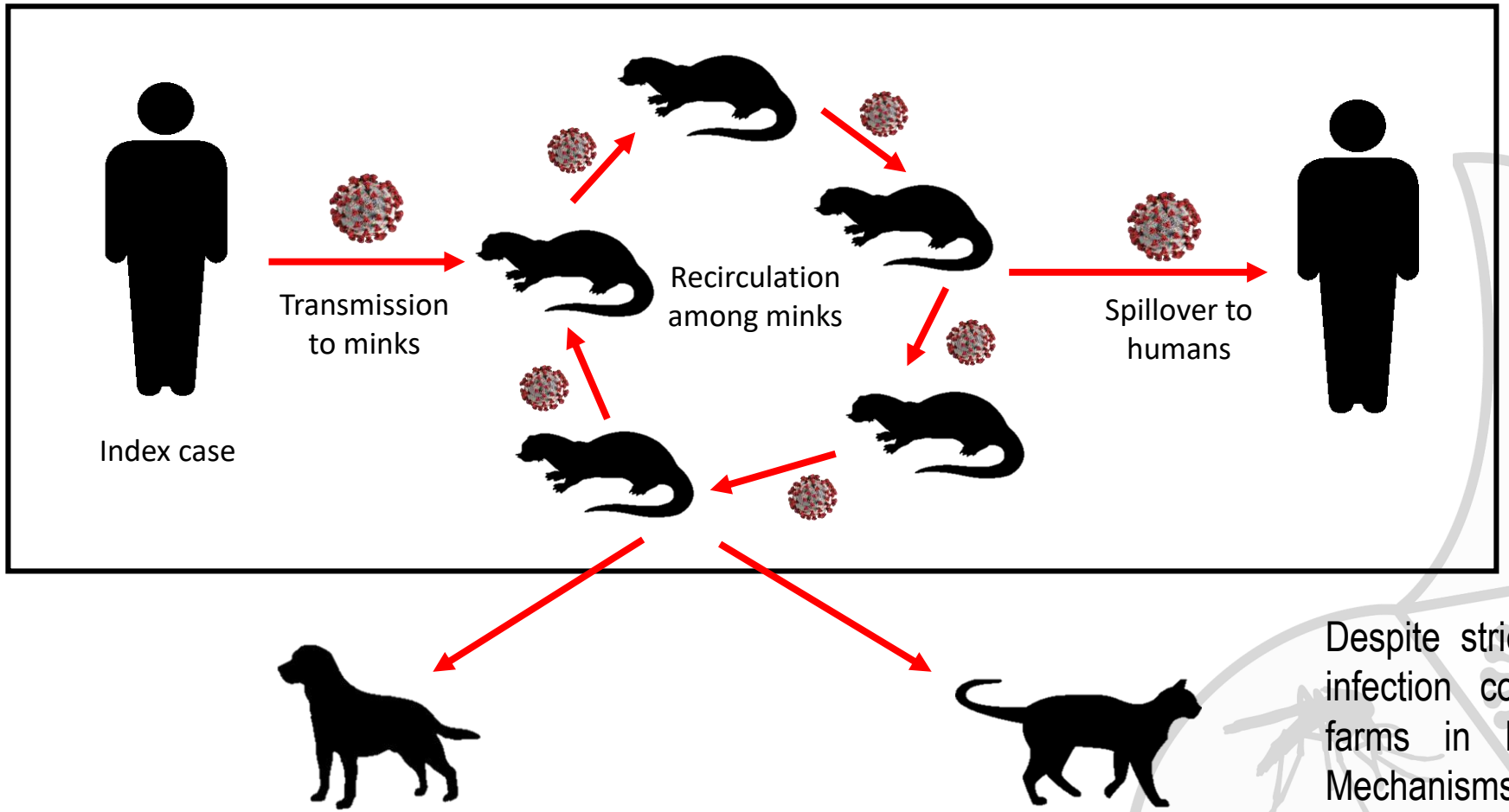
LITHUANIA Positive PCR results were found in a mink farm after the sudden death of 169 animals. More info here.

POLAND Outbreak in one mink farm. More info here.

FRANCE Positive cases in one farm in Eure-et-Loire region. More info here.

USA Several outbreaks in mink farms in the 4 states with the largest fur industry in the country: Utah, Wisconsin, Michigan and Oregon. More info here and here.

SARS CoV-2 IN MINK FARMS



Despite strict biosecurity measures, the infection continues to spread to new farms in Netherlands and Denmark. Mechanisms of transmission between farms are still unknown.

Diagram produced based on data from Oreshkova et al., 2020, this ProMed report and this OIE report

SARS CoV-2 IN MINK FARMS

WHO RECOMMENDATIONS

These events highlight the **important role that farmed mink populations can play in the transmission of SARS CoV-2** and the critical importance of **robust surveillance, sampling and sequencing of these viruses using a One Health approach**.

Countries need to **increase surveillance for COVID-19 at the animal-human interface** where susceptible animal reservoirs are identified, including on mink and other fur farms.
Biosafety and biosecurity measures in the farms have to be strenghten, including farm workers, visitors and those involved in animal husbandry or culling.

WHO recognizes the importance of **prompt sharing of epidemiological, virological, and full genome sequence information** with other countries and research team.

ACTIVE SURVEILLANCE IN FARMS + INCREASED BIOSECURITY + INFORMATION SHARING

OIE guidance on working with farm animals suceptible to SARS CoV-2

Rapid risk assessment for SARS CoV-2 in mink farms by ECDC

EXPERIMENTAL INFECTIONS IN ANIMALS

INIA Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria

MediLabSecure

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

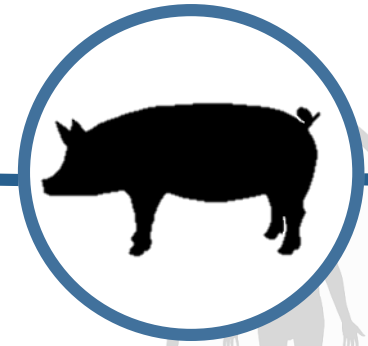
DOGS

- **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

*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), **Vergara-Alert et al., 2020 (pigs), **Kutter et al., 2020 (ferrets), **Gaudreault et al., 2020 (cats)*

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EXPERIMENTAL INFECTIONS IN ANIMALS

GOLDEN HAMSTERS

- **Efficient viral replication in the nasal mucosa and lower respiratory tract**
- Weight loss in infected animals
- Transmission by direct contact and via aerosols
- Good animal model

MACAQUES

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

**RACCOON DOGS

- **Efficient viral replication in the respiratory tract**
- Subtle clinical signs
- Transmission to contact animals

**CATLLE

- **Low susceptibility**
- Low viral replication only in 2/6 cows
- No clinical signs
- No transmission to contact animals

**TREE SHREW

- **Low susceptibility**
- Low viral shedding and replication
- No clinical signs
- Different shedding patterns depending on the age
- Not suitable animal model

*Sia et al., 2020 (Golden Syrian hamsters), Rockx et al., 2020 (Cynomolgus macaques), Chandrashekar et al., 2020 (Rhesus macaques), **Zheng et al., 2020 (Rhesus macaques), **Freuling et al., 2020 (raccoon dogs), **Ulrich et al., 2020 (cattle), **Zhao et al., 2020 (tree shrew)*

OTHER SARS CoV-2 STUDIES IN ANIMALS

USA

Serological testing of domestic animals

- **SARS CoV-2 antibodies have been detected in 23 dogs and 29 cats from USA. 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.

SPAIN

Molecular testing of domestic animals living with COVID-19 infected humans

23 pets with COVID-19 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 oropgharyngeal swab. The animal was asymptomatic. More info in **Ruiz-Arrondo et al., 2020.

OTHER SARS CoV-2 STUDIES IN ANIMALS

CHINA

Molecular and serological testing of cats from Wuhan

Out of 102 analysed cats, 15% were found serpositive 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 in **Zhang et al., 2020.

Molecular testing of fur farm animals

Negative results in minks, foxes and raccoon dogs. More info here.

FRANCE

Molecular testing of cats and dogs living in close contact with COVID-19 infected people

- The virus could not be detected in any of the 9 cats and 12 dogs living in close contact with infected veterinary students. More info in Temmam et al., 2020.
- **One cat out of 22 and 0 dogs out of 11 tested PCR positive in another study carried out in Paris, Grand Est area and Alfort Vet school. More info in Sailleau et al., 2020.

****Serological testing of pets living in COVID-19 positive households**

Antibodies were found in 23.5% of cats (8/34) and 15.4% of dogs (2/13). More info in Fritz et al., 2020.

OTHER SARS CoV-2 STUDIES IN ANIMALS

THE NETHERLANDS

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

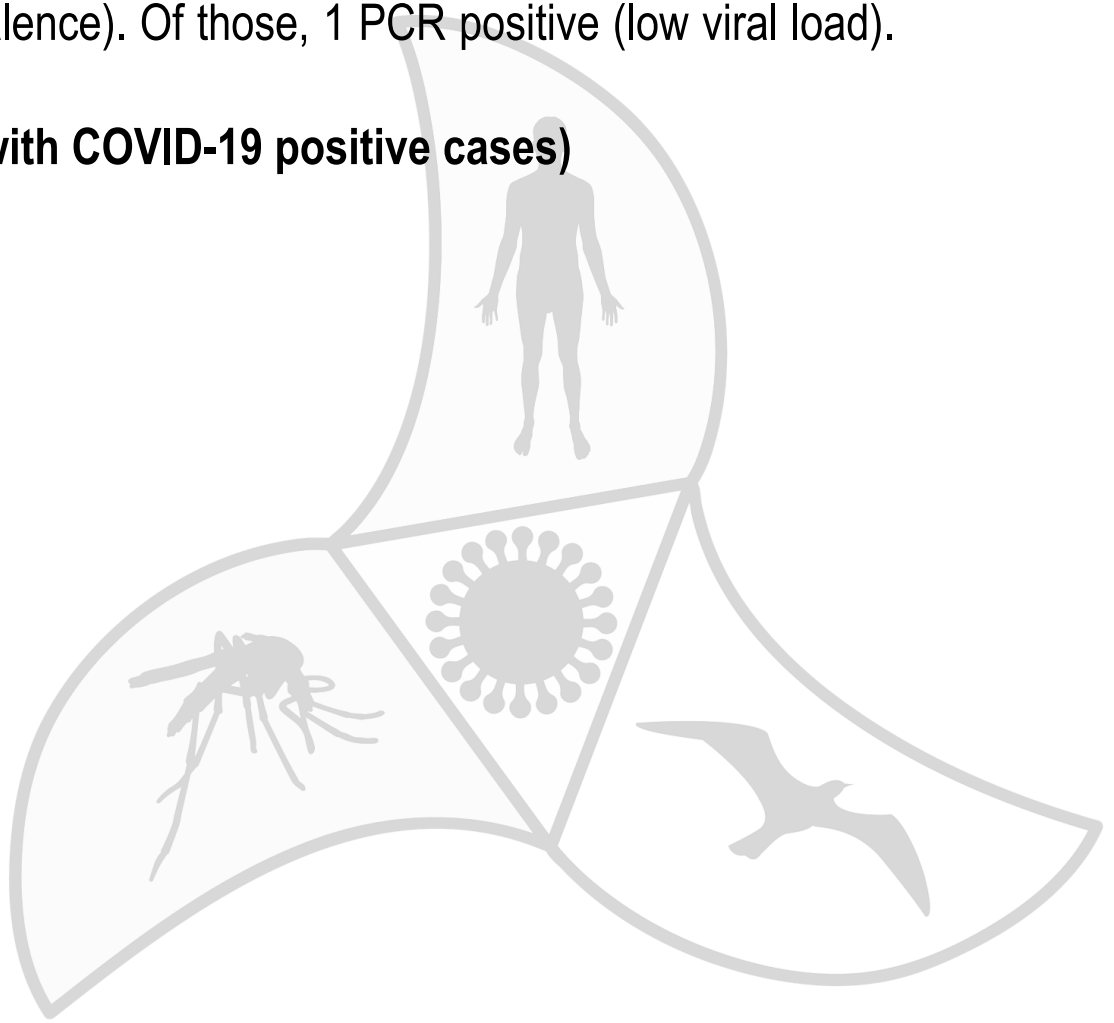
24 cats analyzed by serological assays, 7 positive (29.2% seroprevalence). Of those, 1 PCR positive (low viral load). More info here.

** **Serological testing of 500 cats and 500 dogs (no connection with COVID-19 positive cases)**

0.4% seroprevalence in cats and 0.1% in dogs. More info here.

** **Serosurveillance in rabbit farms**

No positive cases in any of the farms of the country. More info here.



THE MEDILABSECURE PROJECT

Visit our website for more useful information about prevention and control of zoonotic diseases with a One Health approach

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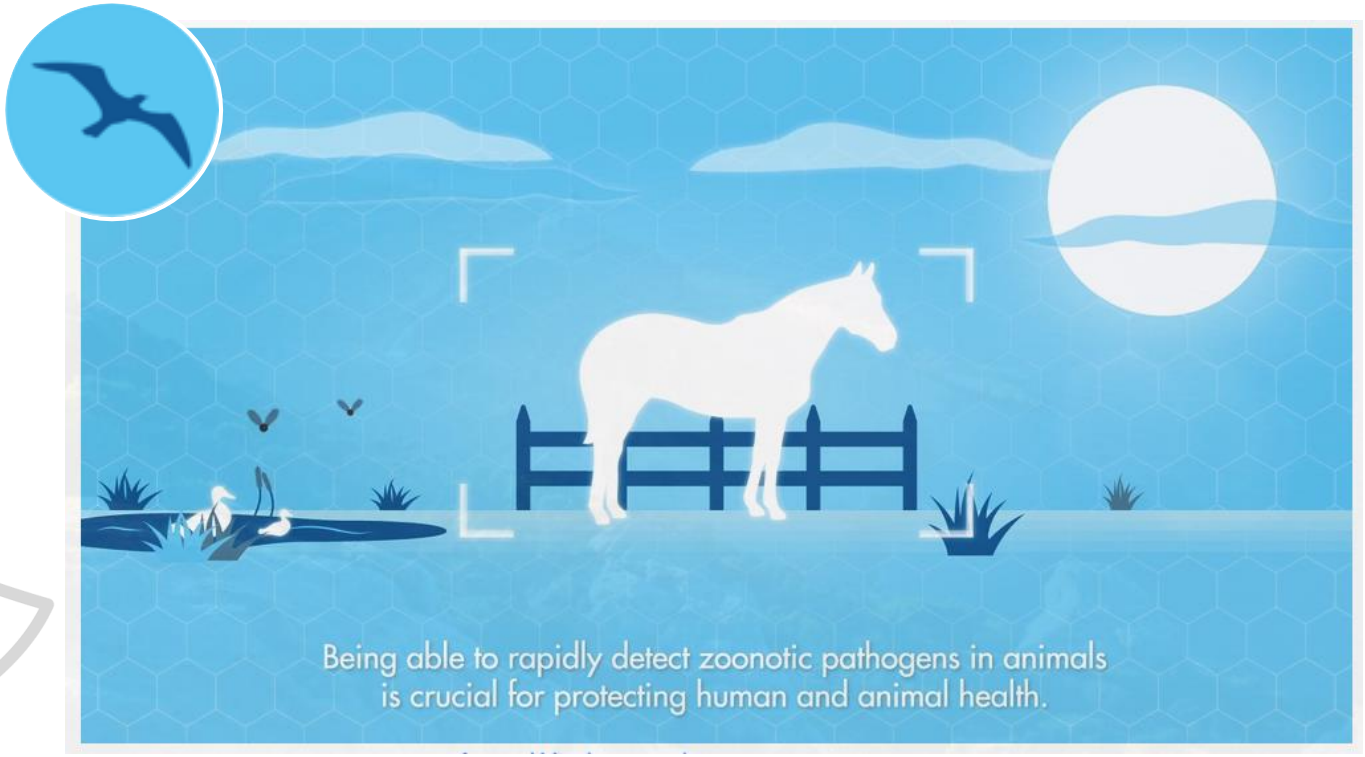
And do not miss our motion design video!!

The role of animal virology in the fight against zoonotic diseases



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