Predictors for SARS-CoV-2 Seropositivity in Owned and Feral Cats in North Georgia

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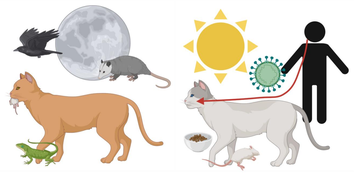
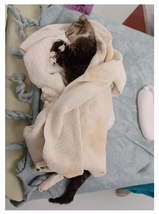
Introduction

- Little is known about dynamics of SARS-CoV-2 in animal populations. Cats interact with many other species and could drive interspecies transmission.
- Feral cats are mostly nocturnal; owned cats are mostly active outside during the day, reducing contact between these populations.



- Higher seropositivity (presence of pathogen-specific antibody) rates found in cats living with positive humans as opposed to unknown humans. Cat-to-cat transmission demonstrated in lab settings.
- **Goal: Evaluate predictors for SARS-CoV-2 seropositivity in feral and owned cats.**
- **Hypothesis:** Increased contact with humans predicts higher SARS-CoV-2 seropositivity rates.
- **Prediction:** Owned cats will have higher seropositivity rates than feral cats. Cats in areas with higher human population densities and human case loads will have higher seropositivity rates.

Methods

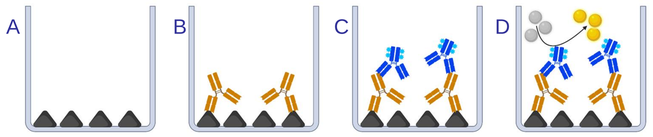


Cat anesthetized at local shelter.

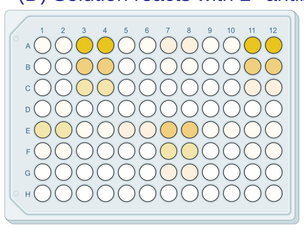
Collection of feline blood samples

- Owned cats brought to the veterinary teaching hospital at the University of Georgia 08/2021-06/2022.
- Feral cats captured and sampled at shelters 01/2022-06/2022.

Lab analysis of serum using ELISAs



(A) SARS-CoV-2 protein bound to plate well.
(B) Cat anti-SARS-CoV-2 antibody bound to SARS-CoV-2 protein.
(C) Goat anti-cat secondary antibody with reactive conjugate bound to cat anti-SARS-CoV-2 antibodies.
(D) Solution reacts with 2° antibody to produce absorbent color.



ELISA plate showing difference in absorbance between samples.

- Detection of anti-SARS-CoV-2 antibodies with indirect Enzyme-Linked Immunosorbent Assays (ELISAs).
- Absorbance of samples compared to positive control using Normalized Absorbance Ratio.

Methods cont.

Other data used

- COVID-19 data: county-level government human COVID-19 case numbers.
- 2020 census population data for counties & zip code tabulation areas.

Data analysis & modeling

- For owned cats, binary logistic regression model in R for seropositivity predictors: sex, metro area, total human cases to date, days since 1st Georgia COVID-19 case.
- Feral cats excluded from model due to lack of positive samples.
- Human cases to date: average human case load to date for each county the cat's zip code of origin is in, weighted by the proportion of the zip code in each county.

Results

1. Total Seropositivity Rates - 0% for ferals, 5.2% for owned cats.

- For feral cats with n=33, none of the samples were positive.
- For owned cats with n=193, 10 samples were positive (5.2%).

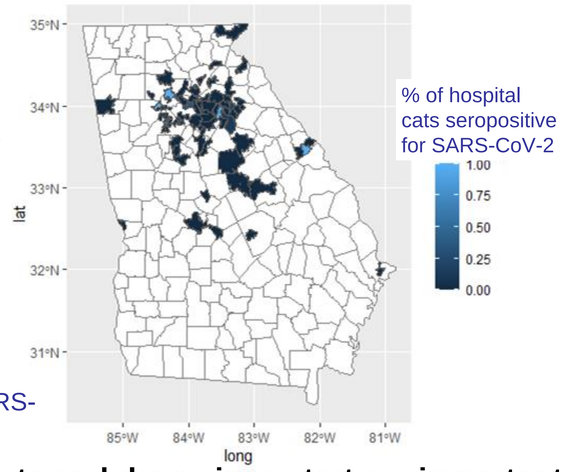


Figure 1: Geographic distribution of owned cats brought to the UGA Veterinary Teaching Hospital with SARS-CoV-2 seropositivity shown.

2. Models: Human cases to date and days since start are important.

- Best fit logistic regression models determined through multi-model inference and Akaike information Criterion (AIC). **Cumulative human cases by county** and **days since the pandemic started** were the only terms in the 3 top models.

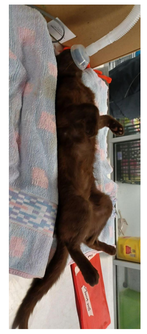
Model rank	DF	logLik	AICc	delta	weight	Intercept	Days since start	Human cases	Days:Human cases
1	2	-29.948	64.0	***0.74***	0.228	-3.193e+00	–	***8.433e-06***	–
2	2	-30.155	64.4	***1.16***	0.186	-5.156e-01	***-3.575e-03***	–	–
3	3	-29.371	64.9	***1.68***	0.143	-6.542e-01	***-4.100e-03***	***9.889e-06***	–
4	4	-29.215	66.7	3.49	0.058	-2.300e+00	-1.621e-03	3.806e-05	-4.171e-08

Table 1: Best models developed using the dredge function from the MuMIn R package. Models 1, 2, and 3 are equivalent. Model 4 is shown for comparison. Model rank, delta values, and terms from these three equivalent models are bolded.

3. Antibody duration and repeat positives.

- One cat was positive twice 3 months apart showing lasting antibodies.
- One cat had a low positive (25% NAR value) on 11/3/21 and a high positive on 11/12/21.
- All negative cats present multiple times in the dataset remained negative.

Conclusions



Cat anesthetized at local shelter.

1. Evidence that cats acquire SARS-CoV-2 from people rather than cats or wildlife.

- Importance of human case loads to likelihood of cats being infected.
- Potentially reduced risk to ferals due to lower human contact.
- Consistent with findings of higher positivity rates in cats from positive households.

2. The spread of SARS-CoV-2 in humans has a rippling effect on the ecosystem.

- As human infection spikes, cat infections also spike, increasing the potential for transmission between cats and transmission from cats to other species, such as pets or wildlife.
- Hotspots for human transmission are also hotspots for human-to-cat transmission.

3. Preliminary evidence for duration of anti-SARS-CoV-2 antibodies in feline sera.

- Antibody titers increase as infection starts and may last for three months or more.

4. The general population should be aware that cats from positive households can become infected with SARS-CoV-2 and may be contagious to other cats or wildlife.

Future Research

- Additional collection and analysis of feral samples to obtain larger sample size.
- Analysis of feral nasal swabs for active infection.
- Impact of owned cat health status on seropositivity.
- Longitudinal study to assess feline antibody duration and potential lasting immunity.
- Coinfection dynamics with immunosuppressive pathogens such as feline immunodeficiency virus (FIV).

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