Immunising the infected: do underlying parasitic infections impact the effectiveness of rabies vaccination in wild raccoons?

Liana Wait
lwait@princeton.edu

Introduction

Rabies is a deadly zoonotic disease of global importance. In the United States, raccoons are an important reservoir species for rabies, and a federal program (the National Rabies Management Program, in association with the USDA) aims to eliminate raccoon rabies by vaccinating them with an oral vaccine.

However, we know from other systems that the response to vaccination can vary between individuals – the same vaccine that provides protection against disease in one individual may be ineffective in another. One factor that can impact the way in which an individual responds to vaccination is the presence of an underlying infection. Individuals that are infected by parasitic worms, viruses, and protozoa are less likely to be immunized when they are vaccinated (Wait et al., Vaccine, 2020).

In this project, I investigated whether parasitic infections might be interfering with rabies vaccination in wild raccoons.

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Methods

Raccoons were trapped in July and October of 2018 and 2019. The ONRAB rabies vaccine was distributed in August of both years, so the July sampling represents pre-vaccination or baseline sampling, while the October sampling effort represents post-vaccination sampling. Individual raccoons were sedated, ear tagged, sampled as follows, and then re-released.

Basic demographic and morphometric details were obtained for each raccoon (sex, age class (i.e. juvenile vs adult), weight, body length.

Blood samples were collected and serology was performed for rabies (by the USDA) and for Toxoplasma gondii (ongoing, in collaboration with Dr Michael Grigg at the NIH) Blood smears were also collected and used to perform white blood cell differentials (labwork ongoing).

Faecal samples were collected when possible and were analysed using microscopy to detect and quantify gastrointestinal helminth eggs and protozoa. Faecal DNA was extracted in order to perform molecular parasitology and microbiome analyses (ongoing, in collaboration with Dr Michael Grigg at the NIH).

Results & Discussion

Nematode infections are associated with a lower likelihood of having rabies antibodies

In 2018, nematode infected raccoons tended to be less likely to be seropositive for rabies compared with uninfected raccoons (X-squared = 3.3662, df = 1, p-value = 0.06655). In 2019, significantly fewer raccoons were seropositive for rabies, which likely reduced our power to quantify the pattern in that year.

When I combined the 2018 and 2019 datasets and ran a logistic model, however, I found that year and nematode infection status were both predictive of rabies serostatus (Year: p-value = 0.00167; nematode infection status: p-value = 0.04352), while other variables (such as age, sex, and infection with gastrointestinal protozoa) were not predictive of rabies serostatus.

Presence of nematode infections seems to be more important than worm burden (the number of worms)

There was no association between the number of nematode eggs (a proxy for nematode burden) and the likelihood of having rabies antibodies, suggesting that it is the presence of nematodes and not the number of nematodes that matters.