Modelling faecal egg count reduction test data from a large population of equidae

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Introduction and Objectives

- Reduced efficacy to the anthelmintic moxidectin is of severe concern in populations of equidae such as that housed at The Donkey Sanctuary
- The use of moxidectin and ivermectin has been minimised as part of a parasite control programme introduced progressively from 2010-2015
- **Does reducing drug use lead to changes in drug efficacy over time?**
- **What group and/or animal-level factors are associated with efficacy?**

Data Collection

- **Faecal Egg Count Reduction Test (FECRT) data** were obtained from a total of **1614 equidae** (primarily donkeys) kept in **68 co-grazed groups** on 8 sanctuaries within The Donkey Sanctuary, Devon
- One or two pre-treatment samples from each individual animal were examined using the standard McMaster method in conjunction with **moxidectin dosing during winter housing in 2010, 2013, 2018 and 2019**
- Up to four post-treatment samples were obtained 10-14 days later
- In total, over **4500 faecal egg counts** were available for analysis

Modelling Methods

- A **multi-level generalised linear mixed model** with over-dispersed Poisson distributions describing the pre- and post-treatment egg counts
- The log link effectively results in a model of geometric mean efficacy
- Pre-treatment group mean counts were allowed to be independent
- **Additive fixed effect interactions of year, sanctuary, group-level factors, and animal-level factors were used to assess associations with efficacy**
- Random intercepts were used to describe between-animal variation, within-animal pre-treatment and within-animal post-treatment variation
- **Random slopes were used to describe variation in efficacy between groups and individual animals**
- The model was implemented using Markov chain Monte Carlo and fit using JAGS interfaced using the runjags package in R

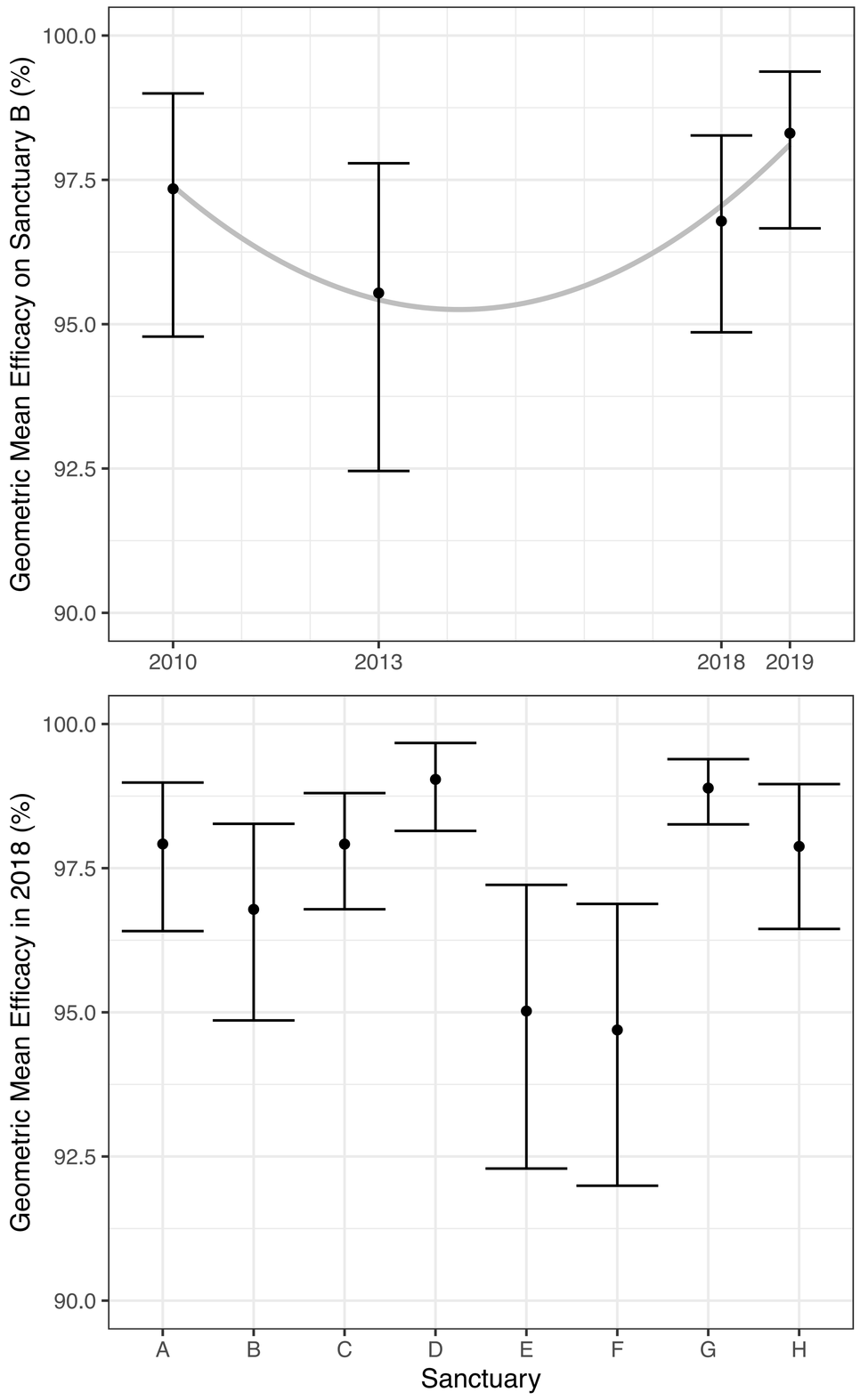

Figure 1: Estimated geometric mean efficacy by year (top) and sanctuary (bottom) obtained from a multi-level generalised linear mixed model fit to FECRT data following dosing with moxidectin in 1614 equidae kept in 68 co-grazed groups. Median estimates are shown as dots and 95% credible intervals as error bars.

Table 1: Estimates and 95% credible intervals corresponding to fixed effect interactions of selected group- & animal-level factors with efficacy following dosing with moxidectin in 1614 equidae kept in 68 co-grazed groups. Positive estimates correspond to a higher post-treatment expected log count, i.e. reduced efficacy.

Interaction	Comparison	Estimate (95% CI)
Pasture Hygiene	Pasture sweeper vs no removal	0.1 (-0.4; 0.5)
	Manual hygiene vs no removal	-1.8 (-3.1; -0.6)
	Sweeper vs manual hygiene	1.9 (0.7; 3.2)
Sex/Species of Animal	Female vs male donkey	-0.1 (-0.4; 0.1)
	Female donkey vs pony / hybrid	1.7 (0.6; 2.9)
	Male donkey vs pony / hybrid	1.9 (0.7; 3.0)

Results

- Non-overlapping CI confirm **variation in efficacy between sanctuaries**
- Estimates for overall mean efficacy suggest an initially deteriorating efficacy between 2010-2013 followed by an **increase in efficacy between 2013-2019**, although the 95% CI are relatively wide
- Estimates for group-level factors indicate that **manually removing faeces from pasture is associated with increased anthelmintic efficacy**
- **Donkeys are associated with reduced efficacy relative to ponies/hybrids**

- **Reducing anthelmintic use minimizes the development of resistance and may lead to moderate improvements in efficacy over time**
- **Group- and animal-level factors such as species / hybrid and pasture hygiene strongly influence anthelmintic efficacy**

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