

Final grant report form: Student Grants

Project title:	Deciphering the microbiome of infectious lameness causing lesions in dairy cattle
Researcher:	Bethany Griffiths and George Oikonomou
Year awarded:	2017

Provide a lay summary outlining the project, focusing on the project's achievements and potential impact to animal welfare.

Lameness is one of the greatest challenges facing the dairy industry. It has been associated with a wide range of negative effects, such as pain, infertility, reduced milk yield and altered behavior of affected cows, and has shown to be prevalent within the UK dairy industry.

The aim of this study was to characterize the community of microbes (the microbiome) found within both infectious lameness causing lesions and lesions of a non-infectious cause which have become complicated by secondary infection.

As part of this study, foot trimmers from the North West and West Midlands were shadowed as they visited their clients' farms. When specific lesions were identified as being targeted within this study a swab sample of the lesion was obtained. A second control swab sample of healthy skin was taken at a nearby standardized location on the same foot as the lesion. This control sample allowed us to explore the differences in the microbiome for these targeted lesions and the microbiome of the healthy unaffected cow. The lesions targeted were; secondarily infected (complicated) sole ulcers, secondarily infected (complicated) white line disease, foul in the foot, toe necrosis, interdigital hyperplasia, secondarily infected interdigital hyperplasia and axial wall fissures.

Once the lesions were sampled the genetic content of the bacteria present on each swab was analysed allowing the assessment of bacterial diversity and the relative abundance for each bacterial type present.

This project yielded a large and complex set of results. In total samples were obtained from ten farms. The type of samples obtained are detailed within the table below.

Lesion Type	No. of Samples obtained
Complicated sole ulcer	21
Complicated white line disease	11
Interdigital hyperplasia	11
Infected interdigital hyperplasia	4
Foul in the foot	4
Toe necrosis	3
Axial wall fissure	2
Toe ulcer	1
Interdigital dermatitis	1

We were able to show that the microbiome of healthy skin was not significantly different between farms, with all control samples (healthy skin) displaying very similar microbiomes. Complicated white line disease and complicated sole ulcers exhibited different microbiomes to their corresponding control sample; showing reduced microbial diversity, with several bacterial families dominating. Furthermore the bacteria that dominated varied between lesions; in complicated sole ulcers, *Treponema* spp. and *Fusobacterium necrophorum* were both found to dominate. In complicated white line disease, *Treponema* spp. were found to be less important, but *Porphyromonas levii* was found to dominate. Further results will be detailed within the scientific paper that is currently in development, once this large and complex data set has been fully analysed, however as I have now returned to my veterinary studies this process has slowed.

Detailed below are some of the results for complicated white line disease. Figure 1. Is the proportion of each bacterial species found in each individual sample of complicated white line disease compared to the control samples. Figure 1a. details *Treponema* spp. and Figure 1b. details *Porphyromonas* spp.

Figure 1a.

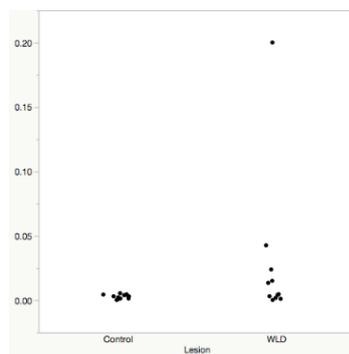
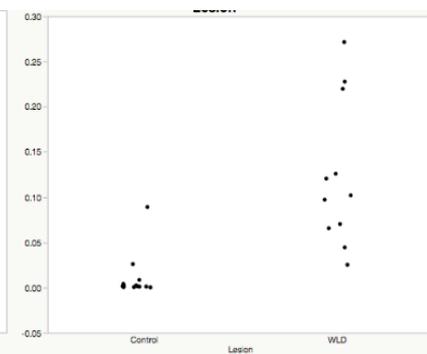


Figure 1b.



These results agree with previous findings, no novel bacteria have been found to dominate these lesions, however the difference in microbiomes for complicated sole ulcers and white line diseases, has proven to be an interesting finding. Complicated sole ulcers and white line disease have previously been described as non-healing lesions with studies implicating *Treponema* spp. within their development (Evans *et al.*, 2011), these findings have confirmed that *Treponema* spp. are found to dominate in complicated sole ulcer lesions, however other anaerobic bacterial species have also been found. These *Treponema* spp. have been shown to play an important role in the development of digital dermatitis, a significant infectious cause of lameness worldwide.

The results of this study may allow us to design better approaches towards the treatment and prevention of these lesions. The relatively consistent polymicrobial nature with previously known bacteria, in complicated sole ulcer lesions and white line disease lesions, could lend itself to the development of a multivalent vaccine, intended to target those bacteria found to dominate. Furthermore these results suggest antimicrobials that target anaerobic bacteria should be favored when treating complicated sole ulcers and white line disease. It has previously been shown that bandaging sole ulcers that aren't secondarily infected had a negative effect on healing (Klawitter *et al.*, 2017), perhaps due to the promotion of an environment conducive to the growth of these anaerobic bacteria.

The unequal distribution of the different lesion types is a potential challenge, with some lesions being underrepresented, however due to the nature of the study we were restricted to the lesions found on these farms within the sampling period.

Provide a short description of your personal experience in undertaking this project

I have thoroughly enjoyed this project. I have previously been involved in epidemiological studies and prospective cohort studies examining lameness in dairy cattle, with limited experience in the laboratory. Therefore this project has allowed me to broaden my horizons and experience a wider range of research, whilst still staying within an area of research that I am passionate about. I have enjoyed taking on more responsibility when organising research, whilst also benefitting from the significant research experience of my supervisor (George Oikonomou) and his PhD student (Veysel Bay). I feel much more enthusiastic about undertaking further research into dairy cattle lameness and hope that I can play a part (however small) in reducing lameness within the dairy industry.

Use the space below for any other relevant information you wish to report on. This could include details of knowledge transfer activities and any future plans/actions.

Further data analysis will be completed on this large and complex data set and a scientific paper is currently in development.