# Factors Affecting the Presentation of Footrot and Interdigital Dermatitis in a UK Sheep Flock.

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## Introduction

Footrot is a disease of sheep presenting as lameness caused by foot lesions, the most severe of which cause extreme under-running of the hoof horn. It is caused by a bacterium, *Dichelobacter nodosus* (Beveridge 1941), and it is believed that pre-infection with other bacteria, particularly *Fusobacterium necrophorum* (Egerton, Roberts and Parsonson (1969); Roberts and Egerton (1969)), are required for footrot to develop. Footrot is an economically important disease, costing an estimated £24.4 million per year in the UK (Nieuwhof and Bishop (2005)) and coming second only to sheep scab as the disease which, according to UK sheep farmers, poses the greatest "threat to animal health and welfare" (Moredun Research Institute (1997) cited in Nieuwhof and Bishop (2005)). Interdigital dermatitis (ID) is a bacterial infection which also presents as foot lesions and lameness. ID lesions are less severe than footrot and ID is be a precursor to footrot. This study aims to investigate and quantify factors affecting presentation of footrot and ID in an intensively monitored flock of ewes and their offspring, including both environmental and family effects.

## Material and methods

**Data collection.** During 2005 and 2006 a study into footrot was conducted on an Oxfordshire farm (Wassink, Hawker and Grogono-Thomas (2010)). Using a scoring scale where '0' indicates healthy and increasing score represents increasing severity, three clinical signs were recorded for lambs and ewes during the study; locomotion (loco) score (0-6), footrot (FR) lesion score (0-4) and interdigital dermatitis (ID) lesion score (0-4). Records of age (date of birth for lambs), breed (mules, Hartlines, Roussin & Suffolk cross (the latter two grouped together as 'other')), body condition score (ewes only), birth weight (lambs only) and treatment group were also kept. The ewes were stratified into four groups, two of which started as treatment groups and two as control groups. In September 2005 one control group and one treatment group were swapped over. Sheep locomotion was scored 2 – 5 times per week. Lame sheep in the treatment group were given parenteral and topical antibiotics, while sheep in the the control group were treated as the farmer normally approached his treatments, with foot trimming and antibiotic foot spray. Sheep in the the control groups tended to be left lame for a longer period of time until the lameness was more severe (approximately score four) before they were treated while in the treatment groups they were treated as soon as a locomotion score of two was observed. To maintain as much similarity in the conditions of the two groups, when the control group was foot-bathed the treatment group was also foot-

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bathed and the type of pasture was matched. An overview of the study population and mean scores for each of the clinical signs used as traits in these analyses are given in table 1.

**Statistical analyses.** Variance components analysis was performed using ASReml (VSN International ). Three outcome variables were analysed, which correspond to the three clinical signs measured. Maximum values for each clinical sign for each animal in each year were used and clinical signs were also converted to binary outcomes (occurred / did not occur), whereupon they were analysed using logit transformations. These variables were also paired and analysed using bivariate analysis to calculate between-trait correlations. Factors included in the ewe analyses were treatment group, body condition score at the start of the year, age, breed, litter size (per year) and year of study, with ewe identification included as a random effect to obtain repeatability estimates. For lambs the factors were maternal details listed above plus birthday (day in year), birth weight, sex and an interaction of birth day by year, with the dam included as a random effect to obtain estimates of maternal effects for each trait. Using the obtained residual and ewe and/or maternal variance components, outputs from the analyses are summarised as repeatabilities for ewe traits and maternal effects for lamb traits. Sire of lamb was not recorded, but lower and upper-bound heritabilities were estimated from the maternal effects.

**Table 1: Summary of study population**

| | Ewes | Lambs 2005 | Lambs 2006 |
|---|---|---|---|
| No. of animals | 957 | 1356 | 1077 |
| Mean of maximum FR | 0.367 | 0.0435 | 0.0325 |
| Mean of maximum ID | 0.646 | 0.529 | 0.242 |
| Mean of maximum loco | 1.290 | 0.841 | 0.444 |

## Results and discussion

The clinical sign with the highest average maximum score was locomotion. Footrot lesions and interdigital dermatitis lesions had lower average maximum scores but this may be an underestimate because animals were examined for lesions only once lameness was observed, other than at the start of the study and at lambing when all animals were examined for lesions. Scores for all clinical signs were much lower in lambs than ewes, and lower scores were seen in the second year of the study than in the first year of the study.

Estimates of repeatabilities and maternal components for ewe and lamb traits respectively are summarised in table 2, along with approximate lower and upper-bound heritability estimates for lambs. Bivariate and binomial outcomes were not significantly different from using maximum observed values as single outcomes and so are not presented here. The (across-year) ewe repeatability is an upper-bound heritability estimate for the trait, biased upwards by possible across-year environmental covariances. The lower and upper bound heritabilities for lambs were simply estimated as twice and four times the maternal component, assuming a small common environment component; the true multiplier is unknown, it depends on the unknown sire mating design. Interdigital dermatitis lesions had the highest repeatability in ewes, at 20%, and highest maternal component in lambs, at 8%. Locomotion scores had the

lowest repeatability whilst footrot lesions had the lowest maternal component. The magnitude of maternal components for lamb traits cannot be compared with the repeatabilities of the ewe traits, because they contain only a proportion of the additive genetic component; a better comparison is with the approximate heritabilities. Approximate upper bound heritabilities for ID and loco were moderately high, at 0.32 and 0.28, respectively, whilst that for FR was much lower.

**Table 2: Trait repeatabilities ($\sigma^2$ewe), maternal components ($\sigma^2$dam) and heritabilities[α]**

| | $\sigma^2$ ewe ± s.e. | $\sigma^2$ dam ± s.e. | $h^2$ lamb (lower bound) | $h^2$ lamb (upper bound) |
|---|---|---|---|---|
| FR | 0.10±0.03 | 0.02±0.02 | 0.04 | 0.08 |
| ID | 0.20±0.03 | 0.08±0.02 | 0.16 | 0.32 |
| Loco | 0.07±0.03 | 0.07±0.02 | 0.14 | 0.28 |

[α]FR = max. footrot lesion score. ID = maximum interdigital dermatitis score. Loco = maximum locomotion score.

Tables 3 and 4 show the phenotypic correlations and correlations of repeatability and maternal effects, respectively, for the three clinical signs measured; the latter correlations being approximated genetic correlations. In ewes the repeatability correlations are high (>0.8) between all pairs of traits. However, phenotypic correlations are all below 0.5, with that between FR and Loco being the lowest at 0.28. In lambs the maternal effect correlation between FR and ID, and Loco and ID are high, but the genetic correlation between FR and loco is much lower, although it should be noted that standard errors for these estimates are high. Phenotypic correlations in lambs are again lower than genetic correlations, with that between FR and Loco being particularly low at just 0.18.

**Table 3: Phenotypic and repeatability effect correlations between ewes traits ± s. e.[α]**

| Traits | FR | ID | Loco |
|---|---|---|---|
| FR | - | 0.89±0.16 | 0.87±0.24 |
| ID | 0.34±0.02 | - | 1.00±0.18 |
| Loco | 0.28±0.02 | 0.41±0.02 | - |

[α] Repeatability effect and phenotypic correlations above and below the diagonal, respectively.

**Table 4: Phenotypic and maternal effect correlations between lamb traits ± s. e.[α]**

| Traits | FR | ID | Loco |
|---|---|---|---|
| FR | - | 1.00±0.48 | 0.57±0.40 |
| ID | 0.27±0.02 | - | 0.82±0.17 |
| Loco | 0.18±0.02 | 0.45±0.02 | - |

[α] Maternal effect and phenotypic correlations above and below the diagonal, respectively.

Table 5 gives predictions for the average maximum scores seen for each clinical trait in each breed and treatment group. Hartlines showed the highest average maximum scores across all clinical signs in ewes, while no significant differences between breeds were seen in lambs. In ewes, the TT group showed the highest average maximum scores for FR and ID. In lambs it

was also the TT group which showed the highest maximum ID score. The CC group showed lower scores in lambs for ID and loco scores, and was not significantly different from the other groups for FR scores.

**Table 5: Predicted average maximum values of FR, ID and loco for different breeds and treatment groups for ewes and lambs [α]**

| | | Breed | | | Treatment group | | | |
|---|---|---|---|---|---|---|---|---|
| | | Mule | Hartline | Other | TC | TT | CT | CC |
| Ewe | FR | 0.20±0.05 | 0.49±0.06 | 0.30±0.08 | 0.28±0.05 | 0.43±0.05 | 0.30±0.05 | 0.33±0.05 |
| | ID | 0.57±0.07 | 0.85±0.10 | 0.47±0.12 | 0.25±0.08 | 1.10±0.07 | 0.69±0.07 | 0.24±0.07 |
| | Loco | 1.12±0.07 | 1.35±0.08 | 0.87±0.11 | 1.05±0.07 | 1.23±0.06 | 1.23±0.07 | 1.25±0.07 |
| Lamb | FR | 0.17±0.06 | 0.18±0.06 | 0.20±0.06 | 0.17±0.06 | 0.19±0.06 | 0.16±0.06 | 0.19±0.06 |
| | ID | 0.68±0.19 | 0.68±0.20 | 0.65±0.21 | 0.47±0.20 | 1.29±0.20 | 0.43±0.20 | 0.39±0.20 |
| | Loco | 0.68±0.21 | 0.76±0.21 | 0.64±0.22 | 0.60±0.22 | 0.80±0.21 | 0.84±0.21 | 0.58±0.22 |

[α]FR = maximum footrot lesion score. ID = maximum interdigital dermatitis score. Loco = maximum locomotion score. Treatment groups represented the following treatment categories for the two periods of the study: TC = treatment/control; TT = treatment/treatment; CT = control/treatment; CC = control/control.

## Conclusions

These results suggest that the three disease traits are genetically correlated in both lambs and ewes, despite lower phenotypic correlations. The maternal effects seen in lamb disease phenotypes are quite low and this suggests it may be difficult to make an impact on disease in lambs through genetic intervention in the mothers. However, moderate heritability estimates in lambs for ID lesions and locomotion scores (14-32%) suggest it may be possible to use these in breeding schemes to reduce the amount of disease seen in lambs. Low repeatability in ewe disease traits suggests that it would be beneficial to take repeated measurements over time as presentation of clinical signs may be significantly different over time. Further repeated measurements would significantly increase the level of information on individual animals' susceptibilities to footrot and help improve the design and implementation of treatment/prevention programmes.

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