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The epidemiology of Johne's disease in New Zealand farmed deer, including validation of abattoir-based surveillance

A thesis presented
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Abstract

Johne's disease (JD), a fatal granulomatous enteritis predominately affecting ruminants, is caused by *Mycobacterium avium* subspecies *paratuberculosis* (MAP) and has become a potentially serious economic risk to New Zealand deer farmers. This research investigates the incidence of clinical JD on affected deer farms, along with potential risk factors that may be adopted by farmers for its control. Additionally, research was undertaken to establish a national abattoir surveillance mechanism for MAP, and to validate criteria used for that purpose.

Personal interview of 174 farmers in a 2005/2006 national case-control study, followed by a 2007 longitudinal postal questionnaire, allowed characterization of clinical JD at the herd- and age-class levels and identification of risk factors significantly associated with herd-level MAP infection and farmer-diagnosed clinical JD in young deer. The mean within-herd clinical JD annual incidence rate was 1%, with age-class incidence rates highest (2.0%) in yearling hinds and stags. The proportion of herds affected with clinical JD increased from 2005 to 2007, showed a seasonal trend, and was higher in the South versus North Island. Species other than deer, specifically beef cattle and sheep, were variably associated with herd-level MAP infection and clinical JD in young deer. As the first investigation of herd-level MAP and clinical JD in farmed deer, this research considerably increased our knowledge specific to this species. This information may inform control measures and direct further research aimed at reducing the prevalence and transmission of MAP and development of clinical JD in farmed deer.

Another research aim was to validate abattoir MAP surveillance in deer through meat inspector identification of 'abnormal' lymph nodes (LN). A pilot cross-sectional study found 94.6% of 'abnormal' LN were MAP-positive through culture or histopathological examination. A 55 mm circumference cut-point defining an 'abnormal' LN was then established and the sensitivity, specificity and level of agreement of inspector detection were estimated at 13.3%, 99.9% and 'fair' ($\kappa = 0.32$), respectively. As an adjunct to this validation, the prevalence of and risk factors associated with seven histopathological features of grossly 'normal' LN from herds classified at 'low' and 'high' MAP risk were described. This research allows confident and informed use of

conclusions drawn from the national abattoir-based surveillance scheme. However, animal-level prevalence is currently underestimated with use of 'abnormal' LN as the sole criterion and further inspector training is required.

The research presented in this thesis provides the foundation for future examination of MAP and clinical JD in farmed deer, its control and surveillance.

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Declaration

Each chapter in this thesis was formatted in the style required of the journal to which it was submitted at the date of thesis submission. As a result, there is some repetition, particularly in the methods, and there are some small inconsistencies with style and format between chapters.

Chapter 7 has been published as a Short Communication:

Hunnam JC, Wilson PR, Heuer C, Mackintosh CG, West DM, Clark RG. Histopathology of Grossly Normal Mesenteric Lymph Nodes of New Zealand Farmed Red Deer (*Cervus elaphus*) Including Identification of Lipopigment. *Veterinary Pathology*. 48(2): 525-529, 2011.

The full, published article is reproduced in Appendix 1.

All work contained herein is original and has not been used for the award of any other degree. All co-authors to all papers have been acknowledged.

Nomenclature

AHB	Animal Health Board
bTb	Bovine tuberculosis
CCT	Comparative cervical test
CFU	Colony Forming Units
CI	Confidence interval
DFA	Deer fenced area
DINZ	Deer Industry New Zealand
DSP	Deer slaughter premise
ELISA	Enzyme-linked immunosorbent assay
H & E	Haematoxylin & Eosin
HSe	Herd-level sensitivity
HSp	Herd-level specificity
IFC	Individual faecal culture
JD	Johne's disease
JML	Johne's Management Limited
JRG	Johne's Research Group
LN	Lymph node
LRP	Lateral retropharyngeal
MAP	<i>Mycobacterium avium</i> subsp. <i>paratuberculosis</i>
MCF	Malignant Catarrhal Fever
MCT	Mid-cervical test
MLN	Mesenteric lymph node
MRP	Medial retropharyngeal
OR	Odds Ratio
PAS	Periodic Acid-Shift
PCR	Polymerase chain reaction
PFC	Pooled faecal culture
RR	Risk ratio
Se	Sensitivity
SOTD	Species Other Than Deer
Sp	Specificity
SU	Stock Units
TC	Tissue culture
ZN	Ziehl-Neelsen

List of Publications

2005:

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“If” – Rudyard Kipling

If you can keep your head when all about you
Are losing theirs and blaming it on you;
If you can trust yourself when all men doubt you,
But make allowance for their doubting too;
If you can wait and not be tired by waiting,
Or, being lied about, don't deal in lies,
Or, being hated, don't give way to hating,
And yet don't look too good, nor talk too wise;

If you can dream - and not make dreams your master;
If you can think - and not make thoughts your aim;
If you can meet with triumph and disaster
And treat those two imposters just the same;
If you can bear to hear the truth you've spoken
Twisted by knaves to make a trap for fools,
Or watch the things you gave your life to broken,
And stoop and build 'em up with wornout tools;

If you can make one heap of all your winnings
And risk it on one turn of pitch-and-toss,
And lose, and start again at your beginnings
And never breathe a word about your loss;
If you can force your heart and nerve and sinew
To serve your turn long after they are gone,
And so hold on when there is nothing in you
Except the Will which says to them: "Hold on";

If you can talk with crowds and keep your virtue,
Or walk with kings - nor lose the common touch;
If neither foes nor loving friends can hurt you;
If all men count with you, but none too much;
If you can fill the unforgiving minute
With sixty seconds' worth of distance run -
Yours is the Earth and everything that's in it,
And - which is more - you'll be a Man my son!

