Navigating Veterinary Borderlands:

'Heiferlumps', Epidemiological Boundaries and the Control of Animal Disease in New Zealand

Dr Gareth Enticott

School of Geography and Planning
Cardiff University
Glamorgan Building
King Edward VII Avenue
Cardiff
CF10 3WA
Email: enticottg@cardiff.ac.uk

Post-print. Accepted in Transactions of the Institute of British Geographers on 20th September, 2016.

Acknowledgements: This research was funded as part of the ESRC Centre for Business Relationships, Accountability, Sustainability and Society (RES-568-28-5001). I am grateful to comments from the Editors and three referees, as well as those of Chris Bear, Paul Livingstone, Jane Sinclair, Mike Davidson, Peter Jamieson, Alan White, the Animal Health Board and the staff of the New Zealand National Archives for their help and support with this research.

Navigating Veterinary Borderlands: 'Heiferlumps', Epidemiological Boundaries and the Control of Animal Disease in New Zealand

Abstract

This paper analyses the importance of boundaries in the control of animal disease. On the one hand, establishing geographical and disciplinary boundaries is seen to be vital to the control of disease. In practice, however, boundaries are unstable, disrupted and frequently transgressed. Disease and its diagnosis vary in space, whilst disciplinary boundaries between epidemiology, laboratory and clinical practices can collapse from the noncoherence of disease. Drawing on the concepts of 'disciplinary borderlands' and fluid space, the paper analyses how uncertainty over disease diagnosis establishes a veterinary borderland in which disciplines are merged and combined and difficult to tell apart. From archival research and interviews of key informants, the paper describes the history of the control of bovine Tuberculosis (bTB) in New Zealand. Focussing on disputes around the diagnosis of bTB in the West Coast region, the paper shows how the problem of non-specificity (locally referred to as 'heiferlumps') undermined attempts to impose a universal version of disease and control policy. In this new veterinary borderland, attempts to manage the noncoherence of disease shifted from denial to viewing disease as a moral problem in which farmers' own knowledges were central to the definition and management of disease. In doing so, boundaries between traditional disease disciplines were broken down, and new hybrid veterinary practices established to create geographically variable disease control rules and procedures. In conclusion, the paper considers the wider consequences for the management of animal disease arising from greater farmer involvement in animal disease management.

Introduction

> *"Infectious disease knows no boundaries, especially in today's increasingly mobile world" (Centres for Disease Control and Prevention, 2011)*

There is a paradox in disease control: if disease knows no boundary, why are boundaries required to control it? Boundaries are central to attempts to control disease. Geographical techniques map and define zones of disease and surveillance, whilst rules are created to control who and what can pass across them (Higgins & Dibden, 2011). Coherent boundaries are sought to define what disease is: in seeking to eliminate diseases like Tuberculosis, Fogel (2015: 527) argues that 'conceptual and clear understandings' of disease are pre-requisites for disease eradication. Meanwhile, different veterinary traditions not only invoke distinct ways of understanding disease, but are bounded by their own distinct physical and cultural geographies (Enticott, 2014b). Thus, when the concept of 'one-health' (Zinsstag et al., 2011) encourages disciplinary boundary crossings, there remains a tendency to seek singular, universal and coherent versions of disease by 'reduc[ing] diversity and to under-value the local, contingent and practical engagements that make health possible' (Hinchliffe, 2015: 28).

In this bounded world, the geography of disease and its dividing practices should be clear-cut. Yet, the purpose of this paper is to document how, in practice, these boundaries are unstable, disrupted and frequently transgressed. The paper concentrates on two ways in which the boundaries of animal disease control are challenged, blurred and remade. Firstly, the concept of 'non-specificity' frustrates attempts to define the presence and absence of disease. Non-specificity refers to interferences to diagnostic tests, causing false positive results that emerge from localised environmental, geological, climatic, and biological matter. The non-specific quality to these relations means that diagnostic tests are rarely perfect, working well in some places but not in others and requiring constant adaption to make health and disease control possible (Hinchliffe, 2015). In doing so, non-specificity directs

attention to the unpredictable relational mixes that come to define disease (Hinchliffe & Lavau, 2013) and the vibrant materialities (Bennett, 2010) that make defining and identifying disease open to constant change.

Secondly, if non-specificity makes the nature of animal disease elusive, it raises questions of how veterinary disciplines not only cope with non-specific relations, but the extent to which these disciplines are themselves discrete and bounded. For Law and Mol (2011: 2), different veterinary traditions – those of the clinic, epidemiology and the laboratory – enact 'their own specific ontological variant of 'the' disease', and mobilise different spatial relations and materials. Previous research suggests the boundaries between these disciplines and their version of disease are vigorously patrolled and disputed (Bickerstaff & Simmons, 2004). However, their accompanying claims of the singularity of disease belie tensions between different ways of knowing disease. Just as non-specificity challenges the boundaries of disease, so too are the boundaries of the disciplines of disease control unlikely to be so rigid. As Mol and Law (1994) suggest, different knowledge practices can find ways of living together and shift seamlessly between each other. Rather, in dealing with the challenge of non-specificity, different modes of resolving the 'noncoherence' of disease (Law et al., 2014) are likely to be found in the spaces between veterinary practices – what Kohler (2002) refers to as a 'disciplinary borderland'. The result is not just different versions of animal disease, but hybrid ways of knowing and controlling it.

In focussing on the challenge of non-specificity, this paper explores the fusing and folding together of different veterinary traditions in a veterinary disciplinary borderland. Specifically, it focuses on how different understandings of bovine Tuberculosis (bTB) became entangled in response to farmers' and vets' concerns about the problem of non-specificity – or what they referred to as 'heiferlumps' – in the West Coast of New Zealand. In doing so, it describes the emergence of a disciplinary 'borderland' (Kohler, 2002) in which different 'modes of noncoherence' (Law et al., 2014) contributed to the

development of new methods of disease control. The paper begins by setting these approaches in context by analysing the practices and spatial relations of different veterinary traditions, and the circumstances in which they combine and form 'fluid space' (Mol & Law, 1994). In describing this new geography of animal disease, the paper considers the wider importance for animal disease management as a whole.

Geographies of Veterinary Practices

Veterinary epidemiology studies the causes, distribution, and diffusion of disease within populations, and seeks to identify the biological, environmental, behavioural and socio-economic determinants of disease. Historically, however, the status of epidemiology has always been under pressure from other disciplines. Parascandola (1998) suggests that epidemiologists have always been concerned with their standards of proof compared to 'real' knowledge from the laboratory or clinical practices. Epidemiologists' resulting 'disciplinary status anxiety' (Amsterdamska, 2005: 44) has driven various forms of disciplinary 'boundary work' (Gieryn, 1999) that stress epidemiology's unique methodological combination of clinical and statistical expertise. Epidemiology's spatial discourse, techniques and practices are also part of this boundary work. Disease mapping is a central component of the epidemiologists armoury, whilst the spatialities of epidemiology are also evident in its attempts to define risk factors and provide a general overview of the conditions in which disease is transmitted.

Evident in disease outbreaks such as the 2001 Foot and Mouth Disease (FMD) outbreak in the United Kingdom, the spatiality underpinning epidemiology is different to other disciplines. For Law and Mol (2011: 13) epidemiology enacts a spatial pattern that is universal, drawing '*cartographic maps that allow it to depict relations between sites [and which] enacts space as a flat surface…Reality is spread out on the two dimensions of a sheet of paper or a whiteboard, or the screen of a computer*'. In seeking to create an

overview, epidemiology differs from laboratory work that seeks to connect identical places. Through identical protocols and procedures, laboratory work flattens space, drawing together places to make them similar, permitting laboratories to act at a distance (Latour, 1988). At the same time, the invariability of laboratory work results in a 'placeless' landscape in which the specificities of place are erased to provide scientific credibility (Kohler, 2002). A third way of knowing disease – clinical practice – has a different spatial perspective again. Clinical practice has an immediacy that fractures standards and works to establish a variable spatial plane. The identification of disease comes to rest on the situation at hand: disease can look, sound and feel different depending on context. What distinguishes clinical practice from epidemiology is its spatial attunement and adaptability that makes clinical practice highly mobile (Mather & Marshall, 2011).

Disease outbreaks such as FMD and bTB in the UK have highlighted how the spatial differences between epidemiology and other ways knowing disease appear vast enough as to be irreconcilable (Bickerstaff & Simmons, 2004; Enticott, 2001). However, the boundaries between them may not be so clear-cut after-all. Take the differences between clinical practice and epidemiology. Whilst the former may be lauded for its mutability and accommodation of difference, the temporality of epidemiology provides it with no closure. Instead, it is marked by an iterative process of 'continuously remaking the grounds and conditions of its own investigations' (Law & Mol, 2011: 12). Problems of distinguishing epidemiology from clinical practice are highlighted further when epidemiological techniques are examined in practice. Diagnosis is central to all three forms of veterinary practice but in use, diagnostic tools and materials turn out to be malleable, not universal (Mather, 2014). Controlling disease becomes less about boundaries and fixed objects and more about the 'intense entanglements' found in the 'borderlands' of biosecurity (Hinchliffe et al., 2013: 13; Hinchliffe & Lavau, 2013).

If the boundaries between veterinary disciplines are in fact blurred, then for Mol and Law (1994), they can be seen as movements between different forms of space. Laboratories and epidemiology seek to create regional topologies in which immutable veterinary tools and practices bring together far away places. Networks, though, have limits. Tools and practices can become mutable, but this does not mean disease control grinds to a halt. The failure of the laboratory or of epidemiology to impose uniform standards to get specific versions of disease to 'work' can open gaps for adaptable clinical practices (Enticott, 2012). These forms of animal disease 'local universality' (Timmermans & Berg, 1997) or 'interpretive flexibility' (Christley et al., 2013) may appear to be just another diagnostic network topology, but Mol and Law suggest an alternative: that different knowledge practices can live together and shift between each other seamlessly in a fluid space. Fluid space is marked by 'variation without boundaries and transformation without discontinuity' (Mol & Law, 1994: 658) in which 'it is not possible to determine identities nice and neatly, once and for all' (Mol & Law, 1994: 660). Boundaries between diseased and healthy, or between diagnosis and treatment are never fixed, the movement between them unpredictable. As a result, animal disease control will be marked by gradients, not boundaries. Distinguishing between different disease practices is difficult as different disease practices can comfortably sit alongside each other (Mol, 2002).

Thinking of disease control as a fluid space characterised by porous boundaries reflects broader thinking of the geography of scientific disciplines. Writing about the distinction between field and laboratory biology, Kohler (2002) notes that distinct disciplines do not live in isolation: they pay attention to each, meeting in a 'zone of active interaction and exchange' or what Galison (1996) refers to as a 'trading zone'. In these borderlands, spaces are created in which opposing practices combine and evolve into novel forms. For Kohler, the result is mixed practices and ambiguous identities that can be as much of the laboratory as of the field. By focussing on these disciplinary borderlands, Kohler directs attention to understanding how disciplinary

boundaries come to be blurred and the circumstances in which hybrid practices are formed. Kohler (2002) suggests that disciplinary borderlands are created from dissatisfaction and anxieties with old scientific regimes. As attempts at reform, they reflect the socio-political landscape of scientific life, made more or less important by institutions, social values and the deployment of scientific practices in new contexts (Sinding, 2004). Successful exchanges across borderlands can be dependent on who is attempting to mix disciplines: the social standing and experience of participants, the cultural proximity between disciplines and their history of borderland occupation. Importantly, navigating disciplinary borderlands requires geographical 'know-how' and judgement in order to identify when and where border practices are 'do-able' (Kohler, 2002: 131-133). In a similar way, Law et al. (2014) describe how modes and ecologies of syncretism – such as ignorance, denial and care – are central to ways of living with the noncoherence of opposing practices. Care, for example, allows noncoherence to be dealt with by striking imperfect, provisional and adaptable balances (Mol, 2008). Meanwhile, a strategies of ignorance and denial creation of 'zones of illegibility and ignorance' which help deny the existence of opposing practices (Mathews, 2005: 797) and ensure the smooth running of methods that struggle to adapt to local contexts (Singleton & Law, 2013).

Thus, the boundaries of disease control disciplines should not be thought of as 'homogenous and hermetically sealed conceptual entities, but rather dynamic configurations of practices and ideas which, under appropriate conditions, can be combined – more or less successfully – with other configurations' (Amsterdamska, 2004: 505). Like Kohler's (2002: 11) examination of field and laboratory biology, so too should we expect disciplinary exchanges where disease control practices are as much of one as the other, yet reflecting the specificities of place. We should therefore expect veterinary traditions to be both heterogeneous and fluid, be attentive to the specificities of place and reflective of institutional and social changes. The rest of this paper examines how in the course of dealing with non-specificity,

epidemiology started to flow with other veterinary disciplines to become as elusive as disease itself.

Geographies of Controlling Bovine Tuberculosis in New Zealand

Methodological Notes

In April 2013, the UK Government's Secretary of State for the Environment flew to New Zealand to see how the country's Animal Health Board (AHB) had dramatically reduced the number of herds infected with bovine Tuberculosis (bTB)[1]. The subsequent bTB eradication strategy for England (Defra, 2014) mentioned New Zealand 18 times and argued strongly for the need to follow their approach to disease eradication. In fact, both countries had attempted to learn from each other's approach to bTB from the 1950s, with scientists and policy makers sharing reciprocal visits and attending the same conferences. In this context of international policy mobility, the research on which this paper draws, set out to investigate the global mobility of disease control practices. In particular, the research focused on specific modalities of disease control within New Zealand, principally the use of the Caudal Fold Test (CFT) to detect bTB and the role of Risk Based Trading to reduce the translocation of disease (see Enticott, 2016).

Examining the status of the CFT as a Latourian obligatory passage point in New Zealand's control of disease, led to a typical Actor-Network Theory 'following the actors' style of inquiry and grounded theory approach to analysis. During trips to New Zealand between 2011 – 14, thirty interviews were conducted with the architects of New Zealand's bTB policy, Animal Health Board vets, scientists, and farming organisations, as well as ethnographic observation of veterinary technicians testing cattle for bTB. Whilst 'official' histories of bTB eradication in New Zealand failed to mention any 'messiness' to disease eradication (Animal Health Board., 2012;

[1] In 1995 there were 1462 infected cattle herds in New Zealand. By 2015 there were just 41 (OSPRI, 2015).

Nightingale, 1992), interviews with vets revealed the curiously named problem of 'heiferlumps' connected to non-specificity in New Zealand's West Coast region. Subsequent analysis of the archives of the Department of Agriculture provided greater insight to disputes over the bTB programme. Further interviews were conducted with vets who had worked in the West Coast during these disputes, former chief veterinary officers, and with colleagues and relatives of key figures in the dispute – Sam Jamieson and Peter Malone (both deceased). Finally, forty farmers were interviewed, 20 of whom lived in the farming community of Karamea in the West Coast, about the historical and contemporary use of the CFT and the challenge non-specificity presents to bTB testing in the area.

The subsequent analysis describes the geography of three different approaches to resolving non-specific reactions to bTB testing in New Zealand. These are presented in turn: firstly, a variable clinical approach used by private vets is described; secondly, epidemiological and laboratory based approaches which sought to deny the presence of non-specificity and discipline farmers into accepting a universal version of bTB; and finally, a hybrid approach combining different perspectives to resolve the problem of non-specificity, in which different spatial relations merge and are difficult to separate. As such, the analysis reveals how different approaches to disease control have evolved and clashed over time, and the circumstances that contributed to a veterinary borderland in which practices merged. As the analysis shows, transitions between these practices were not in any way easy or expected. Indeed, as the analysis shows, these approaches are inter-related and the transitions between them are not clearly defined. It is also interesting to note that this account of the realities of disease control is absent from other historical narratives of disease control in New Zealand, and appears to be one that some participants may have deliberately sought to forget.

Non-specific Beginnings: Heiferlumps and 'Reading Light' in Clinical Space

In 1945, legislation was enacted in New Zealand that required compulsory bTB testing for all dairy herds, commonly known as town milk supply herds[2]. Negotiations between farmers organisations and the Department of Agriculture[3] meant its implementation was delayed until 1961 (Davidson, 2002). In the meantime, town milk supply herds were tested on a voluntary basis with worrying results: 10% of cattle were testing positive, and farmers' confidence in the bTB test had been "shattered". Few were visibly sick or wasting away: '*some of them were [the farmer's] best cows. Lively as crickets. Producing milk at every milking to capacity. [Farmers] made no secret of their anger and despair. Who could blame them?*'[4].

In 1961, the Department gradually began to introduce the eradication programme across New Zealand. As it did so, the programme began to encounter resistance from farmers, particularly in the South Island's West Coast region. On 5th August 1963, the Tadmor-Matariki branch of Federated Farmers wrote to the Minister of Agriculture Brian Talboys expressing their *"grave concern…at the slaughter of animals, which were reacting to the Tuberculin Test, and at slaughter no evidence of TB could be found"*[5]. The letter set out farmers' concerns over the reliability of the Caudal Fold Test used to diagnose bTB, arguing that, *"it fails to differentiate in a positive re-action between bovine Tb and non-specific sources. This being the case, needless slaughter of animals will continue"*[6].

---

[2] AAFB 632 W4914/188 246/62/1 Tuberculosis – Bovine TB – Testing for disease in dairy herds 1939 – 1967. "The history and progress of the Town Milk Supply Tuberculin Testing Scheme' ADMG Laing, New Zealand Veterinary Conference, 4th February 1955.
[3] The Department of Agriculture was renamed several times. For the sake of consistency, the paper referred to 'the Department' throughout.
[4] ACCR 7837 W5124/1 Unpublished manuscript on the History of the Animal Health Division of the Ministry of Agriculture. Chapter 3: Control of Indigenous Infectious Diseases, unpublished manuscript, p.24. (Authors S. Jamieson and C. Ensor) 1985.
[5] AAFZ 7174 W5705/227 21207A/1 Tuberculin Testing TTO [Technical Training Officer] – Appointments – Disciplinary Action – PH Malone 1963-64. "'Strike Action' By Famers In Tadmor-Matariki" Nelson Evening Mail, 16th August, 1963.
[6] AAFZ 7174 W1634/33 21136/3 Tuberculosis Advisory Committee 1963-65. 'TB Testing in Tadmor Area Halted', Nelson Evening Mail 23rd October, 1963.

In concluding their letter, the Tadmor-Matariki farmers presented a 99-name petition asking the Department to investigate. Not soon after, farmers decided to take matters into their own hands. On 16th August, the Nelson Evening Mail announced that farmers in Tadmor-Matariki were to strike and refuse to test their cattle[7]. By 17th October, 1963, the Minister of Agriculture wrote to the Tadmor-Matariki farmers acceding to their requests and formally announcing that bTB tests would be suspended throughout the area whilst investigations were undertaken[8]. The farmers' vet – Peter Malone – also expressed his support for the decision saying: "*the Department has failed to accept the field evidence which shows that the great preponderance of reactors are young animals. Few of these animals on slaughter have been found to have tuberculosis…Gross differences in results …have highlighted our ignorance of causes of sensitivity and work will have to be done on this*"[9].

In fact, Peter Malone had supported and encouraged protests from these and other farmers that he served on the West Coast. Flying into the remote settlement of Karamea in his plane every week, Malone adopted a pragmatic view to veterinary practice, his style of thought far removed from that in the Department. Charismatic and eloquent if not eccentric, he was trusted by the farmers who experienced his work at first hand. Farmers in Karamea were reported to be in 'panic' because of what they referred to as the 'heifer reactor problem' or 'heiferlumps' – a disproportionate number of heifers reacting to

---

[7] AAFZ 7174 W5705/227 21207A/1 Tuberculin Testing TTO [Technical Training Officer] – Appointments – Disciplinary Action – PH Malone 1963-64. "'Strike Action' By Famers In Tadmor-Matariki" Nelson Evening Mail, 16th August, 1963. 'Farmers Refuse to Comply with Tb Test Direction' Nelson Evening Mail, 27th September 1963.

[8] AAFZ 7174 W5705/227 21207A/1 Tuberculin Testing TTO [Technical Training Officer] – Appointments – Disciplinary Action – PH Malone 1963-64. "'Strike Action' Decision. Minister Asks Tadmor Farmers to Reconsider' Nelson Evening Mail, 6th September 1963. ' TB Testing in Tadmor Area Halted' Nelson Evening Mail, 23rd October, 1963.

[9] AAFZ 7174 W1634/33 21136/3 Tuberculosis Advisory Committee 1963-65. 'TB Testing in Tadmor Area Halted', Nelson Evening Mail 23rd October, 1963.

the bTB test[10]. Malone raised these concerns at a meeting of vets in February 1963, pointing out that heifers were reacting but failing to display lesions at slaughter and requested that these heifers be retested 6 months later[11].

Although bTB appeared to be rising in Karamea, at a meeting in Murchison in April 1963[12], Malone suggested that this was down to a change in the bTB testing regulations that had left little room for interpretating lumps found at the bTB test. Prior to this, Malone argued, vets throughout the region had taken a view on whether the cattle were infected or displaying non-specific reactions caused by biological or local environmental conditions. This was contrary to the Department's regulations that ruled any swelling must be defined as a reactor. Instead, Malone argued that '*it depends on the size of the swelling before he decides whether it is a reactor or not*', a method he called '*reading light*'[13]. Malone's version of bTB testing is a clear reflection of the thinking of the clinic and the practical creation and application of veterinary knowledge, similar to the forms of local universality that Enticott (2012) would later identify amongst bTB testers in the UK. Malone described 'reading light' as requiring sensitivity to local conditions, experience and knowledge of the area[14]. It was no wonder, Malone argued, that his newly employed vet had found so many

---

[10] AAFZ 7174 W5705/227 21207A/1 Tuberculin Testing TTO [Technical Training Officer] – Appointments – Disciplinary Action – PH Malone 1963-64. 'Young Stock Problem In Tuberculosis Herds' Westport News, 4th April 1963.

[11] AAFZ 7174 W5705/227 21207A/1 Tuberculin Testing TTO [Technical Training Officer] – Appointments – Disciplinary Action – PH Malone 1963-64. Letter to the Director of the Animal Health Division, MC Armstrong (Livestock Superintendent, Christchurch) March 4th, 1963. "Report on Tuberculosis Control – February 1963".

[12] AAFZ 7174 W5705/227 21207A/1 Tuberculin Testing TTO [Technical Training Officer] – Appointments – Disciplinary Action – PH Malone 1963-64. Minutes of Federated Farmers Meeting, Murchison, 29th April, 1963.

[13] AAFZ 7174 W5705/227 21207A/1 Tuberculin Testing TTO [Technical Training Officer] – Appointments – Disciplinary Action – PH Malone 1963-64. Nelson Evening Mail 30th, April, 1964. Minutes of Federated Farmers Meeting, Murchison, 29th April, 1963. Copy of a report on Tb Matters recently prepared by Mr P. Malone, Veterinary Surgeon, Nelson, and submitted to the Tb Technical Committee on 3 June 1964 by Secretary, Tadmor Matariki Special Tb Committee.

[14] AAFZ W1634 7174 Box 3 / 21136 / 2 Tuberculosis Advisory Committee 1962-3. Letter to DNR Webb Chairman, TB Advisory Committee from Peter Malone, 7th August, 1963.

reactors in Karamea without having time to develop the experience Malone had.

When the Department found out about Malone's methods, he was suspended from bTB testing, but farmers continued to trust and support him. The Department subsequently sent its Assistant Director – George Adlam – to investigate the heiferlump problem in Karamea. Reporting back that farmers' concerns revolved around '*the same story about the large number of reactors in the two-year old class*', Adlam suggested that farmers in Karamea '*feel they have been neglected, exploited and forgotten over the years. They are convinced that they cannot expect help and understanding from the central government, and this persecution complex has been strengthened further by the knowledge that the one man who has helped them, and tried to bring their difficulties over high losses from TB testing to the attention of Wellington, has been penalised by having his licence cancelled'*[15]. Adlam concluded his report by suggesting that the Department needed to show concern for the fate of farmers and investigate the problem of high reactor rates among young adult cattle. For the moment, at least, it was clear that the clinical style of thought was a long way from any approach the Department could entertain. There was considerable physical, practical and cultural distance between Malone's approach, and that of the Department.

Denying Non-Specificity: The Laboratory and the Universal Spaces of Disease

The Department recognised that complaints about bTB testing had become a serious drain on resources. At the meeting of the National TB Advisory Committee in April 1964, the Department complained that '*troublemakers*' and '*dissident farmers*' were disrupting meetings about bTB and that '*farmers were*

[15] AAFZ 7174 W5705/227 21207A/1 Tuberculin Testing TTO [Technical Training Officer] – Appointments – Disciplinary Action – PH Malone 1963-64. Report by Dr G.H. Adlam. Observations on the problems arising out of Tb testing in the areas of Karamea, Murchison and Westport. May 24-26. p.2.

not prepared to listen to logical arguments'[16]. Eradication had always been based on maintaining New Zealand's beef and dairy exports: with those framed as threatened, the chairman of the Dairy Board, Sir Linton Andrews, was drafted in to convince farmers of the value of the eradication scheme, warning them that '*if they continued to 'agitate' about the tests the entire scheme could be broken down…[and] we shall no longer be able to compete and the economic situation will be grave*'[17].

The Department's response reflected two key elements in their style of thought: the unshakeable belief in the power of laboratory science; and their status as a paternalistic leader in disease control. Farmers needed to be disciplined into accepting bTB science and would need to educate themselves about the value of bTB eradication, but they would not interfere with the Department's scientific approach to bTB. In this view, disease was disease: it would be the same everywhere, and non-specific reactions would not interfere with this universal geography. A reliance on laboratory science as a form of establishing universal disease and discipline farmers had always been a cornerstone of the Department's approach to bTB. In 1952, the first formal plan for bTB eradication in New Zealand (known as the 'Leslie Plan') stressed that *'education of the farming community [is] the first step in any scheme of the elimination of bovine Tuberculosis'*[18]. To begin with, the Department relied upon a public demonstration of the CFT. At the 1953 Veterinary Services Council, two Department vets publicly interpreted the results of a bTB test on 52 cattle before submitting the cattle for a post-mortem. Both vets independently identified the same 18 cows that reacted to the test and the post-mortem found each contained bTB lesions. Whilst agricultural field demonstrations are often considered compelling evidence (Latour, 1988;

---

[16] AAFZ 7174 W1634/33 21136/3 Tuberculosis Advisory Committee 1963-1965. "Tb Advisory Committee: Minutes of Meeting of 27 April at 10.30am, 1964".

[17] AAFZ 7174 W2138/19 21207A/2 Tuberculin Testing- Disciplinary Action – PH Malone 1964 – 1976. "Nelson Farmers May Lift Tb Testing Ban", Nelson Evening Mail, 13th May 1964.

[18] ACCR 7837 W5124/1 Unpublished manuscript on the History of the Animal Health Division of the Ministry of Agriculture. Chapter 3: Control of Indigenous Infectious Diseases, unpublished manuscript, p.22. (Authors S. Jamieson and C. Ensor) 1985.

Henke, 2000), in this case '*they did little to calm the dairy industry on the reliability of the tuberculin test*'[19]. Continued farmers' strikes and veterinarians' clinical interpretation of the test results led the Department to return to the laboratory to prove that the test was immutable and the disease universal. In 1963 the Department commissioned a large-scale trial of the bTB test at Flock House, an agricultural college near Bulls on the North Island. The experiment railroaded 550 cattle to Flock House where they were subjected to a range of different diagnostic tests, before being slaughtered and examined for bTB lesions.

The Flock House experiment concluded in 1964 and the results made public. For the Department, the experiment confirmed their view: bTB was identical throughout New Zealand and the caudal fold test was the best available to detect it. Farmers, however, took a different view. Concentrating on the rate of false positives, newspapers reported their despair at the number of 'wasted' cattle that were slaughtered following a false positive test[20]. If the laboratory was supposed to establish the immutability of disease diagnosis and provide power to the Department, it failed. Rejecting the 'placelessness of laboratory knowledge' (Kohler, 2002) and the need to situate animal disease knowledge in place, Peter Malone was unimpressed, arguing the experiment failed to reflect the reality of field diagnosis: '*as experiments using only cull cows, they could in NO way demonstrate the picture likely to be met in the field…the conclusions must have been doubted by every veterinarian who was actually testing under field conditions*'[21]. Instead, those responsible for analysing the

[19] ACCR 7837 W5124/1 Unpublished manuscript on the History of the Animal Health Division of the Ministry of Agriculture. Chapter 3: Control of Indigenous Infectious Diseases, unpublished manuscript, p.27. (Authors S. Jamieson and C. Ensor) 1985.
[20] AAFZ 7174 W2138/10 20467A/1 Tuberculin testing publicity – Newspaper Cuttings 1965 – 1969 'Farmers Doubtful of the Reliability of the Bovine TB Test' Otorohanga Times, 16th June 1965; '85000 cows may have died through inaccurate tests' Hawkes Bay Herald Tribune, 30th March, 1966; 'Doubts "proved" by TB trial' Waikato Times, 11th April, 1966; 'Tb Test Method Justified Says Committee' New Zealand Herald, 8th October, 1965.
[21] AAFZ 7174 W5705/227 21207A/1 Tuberculin Testing TTO [Technical Training Officer] – Appointments – Disciplinary Action – PH Malone 1963-64. Copy of a report on Tb Matters recently prepared by Mr P. Malone, Veterinary Surgeon, Nelson, and

Flock House experiment realised that it '*didn't change anybody's positions: those who were against the scheme used the evidence of the non-specificity of the caudal fold test as an argument against it*'[22]. Instead, the Department simply tried to '*wear the bastards down*'[23].

The reliance on the laboratory as a disciplinary tool reflected the belief in the Department that their role was to eradicate bTB. Referring to farmers and vets as bastards might have been a turn of phrase, but the atmosphere between the Department in Wellington, and farmers and vets on the distant and independently minded West Coast was '*toxic*'[24]. It underlined the extent to which the Department believed farmers' understandings and disease control practices were aberrant and in need of control. This attitude came right from the top of the bTB programme. Led by Dr Sam Jamieson, any approach that was not backed up in science was wrong. Clinical interpretations of the meaning of test results, variation, flexibility and accommodation of difference were not Jamieson's way of doing things. Jamieson had completed a PhD in microbiology at Aberdeen University before falling into bTB after emigrating to New Zealand, and this laboratory training was central to his dismissal of clinical interpretations of bTB test results: '*Sam being a scientist he went the scientific way – [he'd say] "its either a bloody reactor or its not! It doesn't matter if you get 95% prevalence or not, zilch per cent prevalence, the test is the same!"*'[25]. This meant that the universal immutable standards of the laboratory applied everywhere. For Departmental vets, claims of non-specific reactions were treated speciously: *'it wasn't a major problem… there was never anything to it as far as I was concerned it was a bloody myth that local farmers had convinced themselves was the truth'*[26].

---

submitted to the Tb Technical Committee on 3 June 1964 by Secretary, Tadmor Matariki Special Tb Committee.

[22] Interview, former Departmental vet.

[23] Interview, former Departmental vet.

[24] Interview, former Departmental vet.

[25] Interview, former Departmental vet.

[26] Interview, former Departmental vet.

This did not mean that Jamieson was blind to the concept of non-specificity. Indeed, the Department used an alternative test – the short thermal test – in cases where they suspected non-specificity. However, its use was rigorously controlled reflecting the Department's desire to control what counted as disease. Jamieson believed non-specificity was just '*what you made it*': of value to the academic '*perfectionist*' but not a national eradication scheme[27]. Non-specificity might become apparent in some areas in the later stages of eradication, he thought, but that time had not arrived. Instead, Jamieson argued that non-specificity was only of '*temporary persistence*' and told farmers that it would not happen in a '*big way*' so there was little point establishing investigation areas[28]. Thus, a mode of denial was central to the Department's attempt to deal with the noncoherence of its scheme. If non-specificity did exist, it was simply collateral damage that farmers needed to put up with for the good of the programme. As one former chief vet put it, "*the Department took the line that a bit of pain upfront was a hell of a lot better than dragging things out…we knew that we were forcing farmers to slaughter animals that probably weren't infected, we also knew that we were taking out the ones that were*"[29]. Jamieson's view of bTB control therefore revolved around an '*objective uniform system of interpretation of the tuberculin test*'. Failure to establish objective standards would be '*a major factor in bringing a national eradication programme into disrepute*'[30]. Denying non-specificity therefore reflected the way the disease programme was thought of at the time: it was a job for Government who expected farmers and vets to do as they were told. This paternalistic style of governance both reflected and was informed by the scientific, laboratory reliant form of disease control.

---

[27] Transcript of "Bovine Tuberculosis: Progress Towards Eradication in New Zealand", Guest Lecture by Sam Jamieson at the JD Stewart Course held by the Post-Graduate Committee in Veterinary Science University of Sydney, February 15-19, 1971. Provided by Mike Davidson.

[28] AAFZ 7174 W5705/227 21207A/1 Tuberculin Testing TTO [Technical Training Officer] – Appointments – Disciplinary Action – PH Malone 1963-64. "Talk of Tb Upsurge in Nelson Herds 'Completely Untrue"', Nelson Evening Mail, 20th April, 1963.

[29] Interview, former Chief Veterinary Officer for New Zealand.

[30] Transcript of "Initial Problems of Tuberculosis Control in New Zealand", *MAF Tuberculosis Seminar by Sam Jamieson,* August 1976. Provided by Mike Davidson.

If fluid geographies are related to skills and technologies, then Jamieson's vision of a universal disease and denial of non-specificity was much to do with his scientific and personal leadership. In an interview shortly before retirement, Jamieson admitted that, '*I don't make any bones about how I feel toward people who have a half-knowledge [about my field]*'[31]. Jamieson's obituary described him as an 'autocrat' whose meetings with farmers '*generated heat as well as light*' (Davidson, 1987). For colleagues, he '*took a no-nonsense stand to the whole issue of TB control…If colleagues came and put some clearly unscientific proposition, he gave them both barrels… he expected more of them, and when they didn't, when they put up fallacious arguments, he gave it to them. He wasn't a politician in that sense*'[32]. So, when it when it came to dealing with Peter Malone's clinical approach to testing, Jamieson was forthright, suspending him from duty, condemning his unscientific approach and restating a universal geography of disease with the Department at its centre:

> *'I look with some dismay – quite a bit more than dismay really – on statements which imply that the facts, which are true facts, do not actually exist because they can cause interminable confusion in the minds of farmers. The departmental veterinarian in the district is the only person in a position to know the overall picture and this kind of statement sets us back all the time in getting rid of bovine TB as fast as we can*'[33]

Yet Jamieson's suspension of Malone, his denial of non-specificity, and his universal geography of disease was fundamental in pushing farmers towards a strike. When he toured the South Island to address farmers' concerns, his determination to deny that there was no problem with the test shone through. At a meeting in the Rai Valley in April 1964, Jamieson confronted a farmer who dared to suggest that the bTB test was wrong:

---

31 "A troubleshooter Who Saves Us From Ruin", New Zealand Weekly News, February 23rd, 1970 p.3-5. Provided by Peter Jamieson.

32 Interview, former colleague. Interviews with other colleagues provided similar accounts.

33 AAFZ 7174 W5705/227 21207A/1 Tuberculin Testing TTO [Technical Training Officer] – Appointments – Disciplinary Action – PH Malone 1963-64. "Talk of Tb Upsurge in Nelson Herds 'Completely Untrue"', Nelson Evening Mail, 20th April, 1963.

Dr Jamieson: *Well please tell us what is wrong with it?*
Mr Hislop: *Well to start with I think young cows should not be tested – it upsets them.*
Dr Jamieson: *You mean to tell me that too many of your young cows are reactors?*
Mr Hislop: *Yes*
Dr Jamieson: *Well the reason why there are more young cows among the reactors is that tuberculosis is a disease of the young. Tell me where it is wrong.*[34]

If the purpose of the meeting was to convince farmers that the test was without problems, it failed: soon after farmers in the Rai Valley began petitioning for a halt in the TB testing scheme[35].

The West Coast Rules! Resolving Heiferlumps in the Veterinary Borderland

Until the 1970s, bTB diagnostics struggled to move seamlessly from the Department's laboratories to the fields of the West Coast. However, during the 1970s seemingly opposing veterinary practices coalesced to create new hybrid styles of disease control such that the existence of heiferlumps came to be accepted. In this sense, the geography of disease became fluid and variable. Within this veterinary borderland, approaches to disease flowed into each other making them inseparable, but the degree of this flow varied throughout New Zealand. Whilst non-specificity was central to the opening up of this veterinary borderland, it also owed much to the skills of veterinary epidemiologists who began working on the West Coast in the 1970s, as well as the involvement of farmers in the production of veterinary knowledge to manage bTB. By 1970, Jamieson had retired and replaced by new staff with epidemiological training. For people like Paul Livingstone, the Regional Veterinary Officer posted to the West Coast in 1974, the problems of non-

---

[34] AAFZ 7174 W5705/227 21207A/1 Tuberculin Testing TTO [Technical Training Officer] – Appointments – Disciplinary Action – PH Malone 1963-64. "Departments' Duty to Eradicate Tb" Marlborough Express, 18th April, 1964.
[35] AAFZ 7174 W5705/227 21207A/1 Tuberculin Testing TTO [Technical Training Officer] – Appointments – Disciplinary Action – PH Malone 1963-64. "Halt to Bovine Tb tests Urged" Marlborough Express, 20th April, 1964.

specificity were undeniable and the effects of the heiferlump problem were still being felt by farmers struggling to manage their businesses (Animal Health Board., 2012). Farmers had proposed various theories about non-specificity on the West Coast. Some believed that heiferlumps were the result of age-related biological changes and stress brought on by a wet climate. A common theory was that environmental factors on the West Coast caused some cattle to react and not others. Specifically, farmers thought heiferlumps were down to the presence of sphagnum moss on the West Coast that supported mycobacteria and sensitised cattle to the bTB test. These lay epidemiologies suggested a more complex geography of disease, but in seeking to get the bTB programme to work across New Zealand, different styles of veterinary practice merged to form a new approach.

One solution to the problem of heiferlumps and non-specificity was the development of the 'West Coast Rules'. Livingstone had arrived on the West Coast to be confronted by the problem of non-specificity that the Department had denied for so long. Collating statistics of breakdowns and the ages of cattle infected, he returned to the Department in Wellington to show how their approach was '*wiping farmers out*'[36]. To resolve the heiferlump problem, a new set of procedures – the West Coast Rules – were proposed, based on the epidemiological analysis of cattle ages testing positive for bTB in the region. The rules meant that cattle under 3 years old displaying heiferlumps would be retested after 6 months. The approach saved the slaughter of around 70% of heifers reacting to the bTB test. Ironically, the West Coast rules were largely what Peter Malone had been calling for ten years earlier, but they didn't reflect a wholesale shift to his local and situated understanding of bTB. If Malone's interpretation of non-specificity was a form of 'local universality' (Enticott, 2012), the West Coast rules were situated at a larger spatial scale. Set against the rest of New Zealand, the West Coast was seen as an exceptional environment in which accommodations needed to be made. In the West Coast rules, the accommodations of the clinic were married with

[36] Interview, Dr Paul Livingstone.

the wider ambitions of epidemiology. In this veterinary borderland, disease practices sat comfortably within each other making their distinctions irrelevant.

The marriage of different disease practices reflected a changing relationship between Departmental vets and farmers. There was a growing feeling in the Department that disease control could only be successful if it was based on social as well as technical decisions. Rather, the recognition of non-specific environmental and biological factors went hand in hand with reframing bTB as a social problem requiring social work. Unlike Jamieson, Livingstone's approach *'was not to go out and bang the table and frighten people. He would try and find a way to satisfy as many people as possible'*[37]. The relationship between farmers and the Department had deteriorated to such an extent that any approach to managing the disease would need to address farmers' concerns. In forging a relationship with farmers to understand bTB, Livingstone himself recognised a moral duty of care in getting disease control to work for farmers as much as the Department:

> *'with me, I was with those guys and you get affected by that – you can see what they were going through and how it was affecting them…To me it was just morally wrong to be taking [that amount of] cows away from them – it was just wrong! In those circumstances you have to do something different and so we had to develop our rules'*[38].

During his time on the West Coast, Livingstone attended many '*very uncomfortable*' meetings with farmers. Until his arrival, the Department had denied farmers' knowledge as unscientific, whilst Jamieson had expressed his own discomfort with the possibility that farmers could influence the bTB testing regime[39]. Yet for Livingstone their knowledge was crucial in redefining how bTB could be recognised and dealt with:

> *'[farmers] knew a lot about TB and TB testing. They had lived with it for years and they were able to just throw all the stuff at you and you had no real answer to them… I mean you'd go along to their meetings and they would have those folders full of information which because it*

---

[37] Interview, former Departmental vet.
[38] Interview, Dr Paul Livingstone.
[39] AAFZ 7174 W1340 32/21220/2 Tuberculin Testing – Research Projects 1964-1967. Eradication of Bovine Tuberculosis – Research. Letter from Sam Jamieson to The Director of Agricultural Research, Ruakura Research Centre, 7th May 1964.

affected them they had collected information anything they could and combined it into their own experiences…They were gumboot epidemiologists. They were seeing within the field'.[40]

In this veterinary borderland, listening to and accepting farmers' 'gumboot epidemiology' was central to the development of the West Coast rules. It also contributed to the development and use of new diagnostic tools. On April 27 1977, Livingstone wrote to Bawa Singh, the Chief Advisory Officer in the Animal Health Division describing a number of West Coast farms with on-going bTB problems but whose slaughtered cattle continually failed to show lesions at post mortem[41]. Colleagues also offered support: John Muir, another Regional Veterinary Officer, wrote to Singh arguing that non-specificity was resulting in cases where it was '*quite unrealistic to slaughter [Caudal Fold test] +ves*' because of the cost to farmer confidence. In calling for diagnostics that would result in the slaughter of '*an acceptable number of animals*', Muir suggested a 'longish scale' trial of the comparative tuberculin test because '*it is accepted by farmers*'[42]. Despite complaining of Livingstone's 'incomplete' data, Singh was persuaded and wrote to the Director of the Animal Health Division arguing, '*the only conclusion that can be reached is that most of the reactors were non-specifically sensitised*'. Singh concluded that, '*whilst at one time I shared the doubts of many others on the possibility of non specific sensitisation in an infected herd, it now appears that this in fact is occurring in the country*'. Soon after, the Department began experimenting with the use of alternative forms of ancillary testing[43].

As the emphasis on farmer 'acceptance' and 'confidence' in Muir's letter suggests, the new style of disease control therefore reflected a shift from a

---

[40] Interview, Dr Paul Livingstone.
[41] ABMF 515 W4882/107 6/14/1/1/3 Tb [Tuberculosis Testing] – Policy and Instruction 1977. 'Through Regional Veterinary Officer, Christchurch' Letter from Paul Livingstone to Bawa Singh, 27th April 1977.
[42] ABMF 515 W4882/107 6/14/1/1/3 Tb [Tuberculosis Testing] – Policy and Instruction 1977. 'Tuberculin Testing' Letter from John Muir (Regional Veterinary Officer, Christchurch) to Bawa Singh, 31st March, 1977.
[43] ABMF 515 W4882/107 6/14/1/1/3 Tb [Tuberculosis Testing] – Policy and Instruction 1977. 'Non specific sensitization to Bovine Tuberculin' Letter from Bawa Singh to the Director, Animal Health Division, May 23rd, 1977.

disciplinary style of disease control to one in which the Department was a 'moral manager' (cf. Sinding, 2004) where care acted as a mode of syncretism (Law et al., 2014) and the social became as important as the scientific. Thus, moral care for the plight of the West Coast farmers led to the recognition of farmers' 'gumboot epidemiology' and its incorporation into more traditional epidemiological analysis. The resulting hybrid approach recognised different forms of expertise, styles of thinking and geographical variations in the way bTB could be made visible. Central to this style was a balance between different techniques and between different social groups. In this balanced approach to disease control, no single view of bTB dominated but its definition remained a matter of contingencies:

> *'We try to look at everything. We accept once upon a time we used to think there was a golden bullet, a silver bullet somewhere. If we could only find that silver bullet we would be right. I now accept that is no such thing as a silver bullet and therefore you are trying to maximise what you can do with the data that you have got and but also aware that if you go too stringent you might last for a period of time and then you will lose it big time with the farming community. We have to therefore be aware that there is a certain level that you can be tough on but if you overstep that too much you are going to lose it…we walk that fine line*[44].

Importantly, this social and technical balance to disease control was only able to evolve in relation to Jamieson's paternalistic approach to governing bTB. In the 1950s, Jamieson had established Regional Animal Health Advisory Committees (RAHACs) as a way of educating farmers about bTB. Ironically, as bTB became viewed as an issue of moral management, the RAHACs increasingly provided opportunities for farmers to influence bTB testing procedures. It was through these committees on the West Coast that Livingstone was exposed to farmers' plight and their knowledge and experiences of bTB so central to the West Coast rules. Nevertheless, there were also times when RAHACs could upset the balance. For example, RAHACs could sometimes pressure the Department into using ancillary

[44] Interview, Dr Paul Livingstone.

diagnostics reserved for areas with problems of non-specificity meaning that disease management required constant work and adaption.

Throughout the 1970s and 1980s farmers became increasingly involved in the management of bTB, replacing the Department's paternalistic scheme with one in which it acted as an advisor to help farmers find solutions to problems. The 1980's financial crisis in New Zealand accelerated this approach as the Government withdrew from funding disease control leading to the creation of a new organisation, the Animal Health Board in 1994, to replace the work of the Department (Enticott, 2014a). Funded by farmers and Government, with a farmer as its chairman, it governed by the maxim "farmer pays, farmer says". Jamieson's RAHACs became formalised as regional committees providing farmers with elected representation and a voice in the national governance of bTB in New Zealand. Moreover, as interpretations of disease and styles of management became the responsibility of the AHB, so a style of combining different veterinary traditions with farmer experiences of disease was cemented reflecting the relationship between disease control and the social environment in which it was situated:

> *'The difference is in the funding mechanisms: we have to work for farmers, so if its not working then we've got to do something different*[45]*.*

Conclusion

In 1985 Sam Jamieson returned to the Department he once ran, this time to write its history on its 100th anniversary. His time away had not diminished his view of universal bTB and his denial of non-specificity. The unpublished manuscript revealed he held no regrets about his handling of the controversy surrounding non-specificity. '*After the storm is over*', he wrote, '*is there value*

[45] Interview, Animal Health Board official.

in looking for the wind that caused it?"[46]. Whilst the answer for Jamieson was no, this paper has shown the answer is likely to be different for geographers.

Firstly, in tracing the practices of animal disease control in New Zealand, the paper has sought to explore the paradox of boundaries within animal disease control. In focussing on the effects of non-specificity to disease control, the paper has shown how the boundaries of disease are not stable but subject to unpredictable biological and environmental interferences to disease diagnosis. Environmental interferences, such as sphagnum moss on the West Coast, disrupt universal geographies of disease. These interferences have not been confined to the West Coast: adaptions to testing have been made elsewhere, for example, in areas with volcanic soils. In this sense, disease is not universal, proves difficult to know in some places and contexts, and its definition fluid and changeable. Rather than universal, disease should be thought of as comprising of an ever-changing set of social, biological and environmental relations highlighting the difficulty of predicting what disease is and how it is shaped.

Secondly, exploring veterinary borderlands should also challenge how the boundaries of disease control practices are thought of. One legacy of disease outbreaks such as FMD has been to fix in the mind the differences between different disciplines of disease control and their consequences for farmers and their animals. Whereas epidemiology is frequently presented as seeking to present a flat undifferentiated landscape of universal rules and fixed ideas of disease, the clinic provides an antidote to epidemiology's excesses of universalism. Yet, in veterinary borderlands, these distinctions fail to last. The non-specificity of disease prompts thinking about how disciplines themselves might be thought of as non-specific and lacking in fixed boundaries. By themselves, the practices of the laboratory, epidemiology and the clinic produce their own spatial topologies. But there are times when the distinctions

[46] ACCR 7837 W5124/1 Unpublished manuscript on the History of the Animal Health Division of the Ministry of Agriculture. Chapter 3: Control of Indigenous Infectious Diseases, unpublished manuscript, p.32. (Authors S. Jamieson and C. Ensor) 1985.

between these disciplines rapidly fade, and spaces into which disease can flow because of these mutations. These conditions of exchange and interaction transform epidemiology into a variable practice to accommodate different biological, environmental and social conditions. In this view, it is difficult to maintain distinct veterinary traditions or consider them in tension with each other. There are no simplistic, binary shifts from the practical clinical approach to computer based epidemiological modelling or veterinary practices that can be specifically isolated. Neither is it the case that people working in disease control find themselves belonging to any of these categories. Rather, examining the geographies of disease shows how veterinary practices overlap and evolve. The significance of these overlaps suggests that it is perhaps best to talk less of specific veterinary traditions and more of the ways and places in which disease control practices evolve and are transformed in order for disease control to work (Hinchliffe, 2015). This is a continuing task: as Mol and Law (1994) suggest, mutations in what counts as disease are continuous, varying in time and space. Indeed, in New Zealand, the West Coast Rules did not apply everywhere and neither have they lasted forever. Currently in New Zealand, there are signs of fluidity in new blood tests developed to combat non-specificity (thresholds and boundaries still require interpretation in relation to place), but also signs of a managerial approach to disease control in which methods have become more formal and universal.

Thirdly, in writing about the borderlands of field and laboratory biology, Kohler (2002: 308) concludes that 'the art…will always be to borrow, adapt and blend – and to know the limits of cultural borrowing'. In the veterinary borderlands of New Zealand's West Coast, negotiating the borderlands of bTB disease control required the same skills and sensitivities. In particular, the paper has shown how different strategies and modes of noncoherence are vital to the navigation of veterinary borderlands and the creation of new hybrid veterinary practices. For Sam Jamieson, a strategy of denial held opposing veterinary practices apart to ensure disease remained universal. By contrast, Paul Livingstone was able to combine traditional epidemiology with farmers'

gumboot own knowledges and a clinical sensibility, through a 'moral duty' of care. Acting as a kind of veterinary entrepreneur, and aided by farmers' records, files and numerical inscriptions, Livingstone's mode of care was essential to dissolving the distinctions between disciplines. Analysis of the navigation of veterinary borderlands for other animal diseases may also reveal the existence of other modes of noncoherence, how these modes themselves combine, and the reasons for transitions between them. Moreover, what is perhaps of significance for disease control more broadly, is an understanding how the skills and sensitivities required to navigate veterinary borderlands such as those in the West Coast can be fostered so that future challenges of disease control can avoid the binary traps of the past.

Finally, analysing veterinary borderlands raises broader questions about the transitions and mobility of the modalities of disease control. In short, what can be learned from New Zealand by other countries seeking to control animal disease? Can the kinds of rapproachments made in the veterinary borderland offer solutions to other disease outbreaks? In the case of bTB, the evolution of veterinary practices raises questions about the roles played by different social actors in agricultural, veterinary and policy communities. The co-production of solutions to the problem of heiferlumps in the West Coast can be seen as an early form of what Catley et al. (2012) call 'participatory epidemiology': an approach to disease control that recognises the value of different forms of knowledge. It might be tempting to conclude that co-productive styles of disease control could be applied to the problems of bTB in the UK, helping to resolve tensions in disease management by ensuring farmers' voices are fully incorporated into disease management practices (Enticott, 2008). This, however, is no easy challenge: the evolution of New Zealand's bTB control strategy is embedded and reflective of its own social and environmental context. Such an approach is demanding: it calls for reflexivity and humility amongst disease control experts (Leach & Scoones, 2013) and raises wider questions over which farmers and kinds of farming are able to reshape

disease and for what purpose. Indeed, the solutions developed to non-specificity in New Zealand were not accepted uncritically: not all farmers believed in it, and some have blamed the new rules for the continued high incidence of bTB in the West Coast. More generally, as productivist and post-productivist styles of agriculture increasingly represent divergent agricultural futures (Marsden & Morley, 2014), so might it be increasingly difficult to reconcile the aims of animal disease policy, making challenges to universal approaches to animal disease – of the kind witnessed in New Zealand – harder to orchestrate. In a context of agricultural change and the spread of new animal diseases as a consequence of climate change (Godfray et al., 2010), accounting for heiferlumps in veterinary borderlands therefore has broader relevance to the future of agriculture and the control of animal disease.

References

Amsterdamska O 2004 Achieving disbelief: thought styles, microbial variation, and American and British epidemiology, 1900–1940 *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences* **35** 483-507

Amsterdamska O 2005 Demarcating Epidemiology *Science, Technology & Human Values* **30** 17-51

Animal Health Board. 2012 *Making TB History* Animal Health Board Wellington, New Zealand

Bennett J 2010 *Vibrant matter: A political ecology of things* Duke University Press London

Bickerstaff K and Simmons P 2004 The right tool for the job? Modeling, spatial relationships, and styles of scientific practice in the UK foot and mouth crisis *Environment and Planning D: Society and Space* **22** 393-412

Catley A, Alders RG and Wood JLN 2012 Participatory epidemiology: Approaches, methods, experiences *The Veterinary Journal* **191** 151-160

Centres for Disease Control and Prevention 2011 Global Health - Global Immunization. Why CDC is Commited to Global Immunization in Editor ed^eds *Book Global Health - Global Immunization. Why CDC is Commited to Global Immunization,* Volume 2016, City

Christley RM, Mort M, Wynne B, Wastling JM, Heathwaite AL, Pickup R, Austin Z and Latham SM 2013 "Wrong, but Useful": Negotiating Uncertainty in Infectious Disease Modelling *PLoS ONE* **8** e76277

Davidson D 1987 Obituary: Dr Sam Jamieson *New Zealand Veterinary Journal* **35** 95

Davidson RM 1965a A Comparison of the Efficacy of Canadian and Australian Tuberculins. Part I *New Zealand Veterinary Journal* **13** 109-115

Davidson RM 1965b A comparison of the efficacy of Canadian and Australian Tuberculins. Part II *New Zealand Veterinary Journal* **13** 154-158

Davidson RM 1965c A comparison of the efficacy of Canadian and Australian Tuberculins. Part III *New Zealand Veterinary Journal* **13** 159-162

Davidson RM 2002 Control and eradication of animal diseases in New Zealand *New Zealand Veterinary Journal* **50** 6-12

Defra 2014 *The Strategy for Achieving Officially Bovine Tuberculosis Free Status for England* Defra London

Enticott G 2001 Calculating nature: The case of badgers, bovine tuberculosis and cattle *Journal of Rural Studies* **17** 149-164

Enticott G 2008 The ecological paradox: Social and natural consequences of the geographies of animal health promotion *Transactions of the Institute of British Geographers* **33** 433-446

Enticott G 2012 The local universality of veterinary expertise and the geography of animal disease *Transactions of the Institute of British Geographers* **37** 75-88

Enticott G 2014a Biosecurity and the Bioeconomy: The case of disease regulation in the UK & New Zealand in Marsden T and Morley A eds *Researching Sustainable Food: Building The New Sustainability Paradigm,* Earthscan, London 122-142

Enticott G 2014b Relational distance, neoliberalism and the regulation of animal health *Geoforum* **52** 42-50

Enticott G 2016 Market instruments, biosecurity and place-based understandings of animal disease *Journal of Rural Studies* **45** 312-319

Fogel N 2015 Tuberculosis: A disease without boundaries *Tuberculosis* **95** 527-531

Galison P 1996 Computer Simulations and the Trading Zone in Galison P and Strump DJ eds *The Disunity of Science: Boundaries, Contexts and Power,* Stanford University Press, Stanford 118-157

Gieryn TF 1999 *Cultural Boundaries of Science: Credibility on the Line* University of Chicago Press Chicago

Godfray HCJ, Beddington JR, Crute IR, Haddad L, Lawrence D, Muir JF, Pretty J, Robinson S, Thomas SM and Toulmin C 2010 Food Security: The Challenge of Feeding 9 Billion People *Science* **327** 812-818

Henke CR 2000 Making a place for science: The field trial *Social Studies of Science* **30** 483-511

Higgins V and Dibden J 2011 Biosecurity, trade liberalisation, and the (anti)politics of risk analysis: the Australia - New Zealand apples dispute *Environment and Planning A* **43** 393-409

Hinchliffe S 2015 More than one world, more than one health: Re-configuring interspecies health *Social Science & Medicine* **129** 28-35

Hinchliffe S, Allen J, Lavau S, Bingham N and Carter S 2013 Biosecurity and the topologies of infected life: from borderlines to borderlands *Transactions of the Institute of British Geographers* **38** 531-543

Hinchliffe S and Lavau S 2013 Differentiated circuits: the ecologies of knowing and securing life *Environment and Planning D: Society and Space* **31** 259-274

Kohler RE 2002 *Landscapes and Labscapes. Exploring the Lab-Field Border in Biology* Chicago University Press London

Latour B 1988 *The Pasteurization of France* Havard University Press Cambridge, Mass.

Law J, Afdal G, Asdal K, Lin W-y, Moser I and Singleton V 2014 Modes of Syncretism: Notes on Noncoherence *Common Knowledge* **20** 172-192

Law J and Mol A 2011 Veterinary Realities: What is Foot and Mouth Disease? *Sociologia Ruralis* **51** 1-16

Leach M and Scoones I 2013 The social and political lives of zoonotic disease models: Narratives, science and policy *Social Science & Medicine* **88** 10-17

Marsden T and Morley A 2014 Researching Sustainable Food: Building The New Sustainability Paradigm in Editor ed^eds *Book Researching Sustainable Food: Building The New Sustainability Paradigm,* Volume Earthscan, City

Mather C 2014 Avian influenza multiple: Enacting realities and dealing with policies in South Africa's farmed ostrich sector *Journal of Rural Studies* **33** 99-106

Mather C and Marshall A 2011 Living with disease? Biosecurity and avian influenza in ostriches *Agriculture and Human Values* **28** 153-165

Mathews A 2005 Power/Knowledge, Power/Ignorance: Forest Fires and the State in Mexico *Human Ecology* **33** 795-820

Mol A 2002 *The Body Multiple: Ontology in Medical Practice* Duke University Press London

Mol A 2008 *The Logic of Care* Routledge London

Mol A and Law J 1994 Regions, networks and fluids: Anaemia and social topology *Social Studies of Science* **24** 641-671

Nightingale T 1992 *White collars & gumboots: A history of the Ministry of Agriculture & Fisheries, 1892-1992.* Dunmore Press Auckland

OSPRI. 2015 *Annual Report. 2014/2015* OSPRI Wellington

Parascandola M 1998 Epidemiology: Second-rate science? *Public Health Reports* **113** 312-320

Sinding C 2004 The specificity of medical facts: the case of diabetology *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences* **35** 545-559

Singleton V and Law J 2013 Devices as Rituals *Journal of Cultural Economy* **6** 259-277

Timmermans S and Berg M 1997 Standardization in Action: Achieving Local Universality through Medical Protocols *Social Studies of Science* **27** 273-305

Zinsstag J, Schelling E, Waltner-Toews D and Tanner M 2011 From "one medicine" to "one health" and systemic approaches to health and well-being *Preventive Veterinary Medicine* **101** 148-156