LEPTOSPIROSIS IN DEER: MAF ANIMAL HEALTH LABORATORY AND DEER SLAUGHTER PREMISE SURVEYS

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Introduction

Attention was first drawn to leptospirosis in farmed deer in New Zealand in 1980[1] and evidence of Leptospiral infection of deer worldwide was reviewed in 1984 by Mackintosh[2]. There is serological evidence from farmed deer in New Zealand of *Leptospira interrogans* serovars *pomona, hardjo, copenhageni, ballum, bratislva, tarassovi* and *australis*, although some of these may represent serological cross-reactivity[3]. There is culture evidence from deer of serovars *pomona, hardjo* and *copenhageni*[4][5][6]. Wilson and Schollum[7] reported serological responses of farmed deer to a leptospiral *hardjo* and *pomona* vaccine and in reviewing the literature, concluded that ..... "Leptospirosis must be considered a potential threat to the health of deer herds...." Since that time there have been few publications describing leptospirosis in deer, although a number of cases have been reported briefly in Surveillance. Available reports indicate that the primary disease syndrome due to infection with some serovars appears to be a haemolytic crisis with resulting haemoglobinurea and jaundice which is often fatal.

As part of the broader study to establish the status of leptospirosis in New Zealand deer herds, two surveys have been undertaken by the authors. The first a survey of animal health laboratory submissions for leptospriosis between 1987 and 1992 is presented here in full. A second survey was conducted at the Feilding deer slaughter premises to determine the prevalence of leptospiral titres, kidney lesions and leptospiral cultures from deer at slaughter. Results of this survey are presented only in summary form. Full details will be published elsewhere.

1. MAF ANIMAL HEALTH LABORATORY SURVEY 1987-1992

1.1 Survey Method

Submissions were sought by disease surveillance staff of MAFQual from all diagnostic animal health laboratories dating from 1987 to early 1992. Data were presented to the survey personnel with reference to owner, veterinarian and location removed to return confidentiality. In total, 70 submissions were examined and dates, clinical histories, numbers of deer affected and numbers on farms, age, sex, gross pathology, histopathology, serological and culture results were tabulated. Case submissions included those with definitive and suspected diagnoses of leptospirosis, as well as routine investigations. Some submissions were follow-up of earlier submissions, but it was not always possible to identify these, so each submission was reviewed individually.

1.2 Distribution of Submissions: Region, Deer Species, Age, Sex and Season

Table 1 shows that the majority of submissions were from the Ruakura AHL and that few were from the South Island laboratories. The proportion of each species involved (Table 2) equates closely to the national herd structure, suggesting that there is no species pre-disposition to infection, although numbers involved are small.

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TABLE 1. **Number of submissions from each Animal Health Laboratory involving Leptospirosis, reviewed from 1987-1992**

Ruakura	46
Batchelar	16
Lincoln	5
Invermay	3
Total	**70**

TABLE 2. **Species of deer from which AHL submissions for Leptospirosis were made 1987-1992**

	Number	% of Total
Red	62	89
Red x Wapiti	5	7
Fallow	3	4

TABLE 3. **Number of AHL Submissions for Leptospirosis received each year from 1987-1992.**

Year	No. Submission
1987	3
1988	17
1989	18
1990	17
1991	6
1992*	3
Other+	6

* Only to May 1992
\+ No date given

Table 3 shows the greatest number of submissions were from 1988 to 1990. The reason for the smaller number in 1991 is not known, although changes in laboratory recording may have limited the ability to recover records. Alternatively, lower stock values may have reduced veterinary attendance to disease on deer farms. Only three cases were available from early 1992.

Figure 1 shows most of the submissions were made in autumn and early winter and the greatest number of submissions was from deer less than one year of age (Table 4). These findings suggest that the majority of leptospirosis cases occur in newly weaned deer during autumn. This time of year corresponds to the period when deer are often moved from farm to farm and mixed with other groups of deer. Indeed, many case histories made reference to these events. These management factors may allow introduction of the organism to new properties, or herds previously not affected, at a time when "stress factors" have increased the susceptibility of the animal to infection and at a time of the year when environmental and climatic factors favour survival and spread of the organism.

Data in Table 4 suggests that leptospirosis is more common in young male than in young female deer, but these figures must be regarded with caution, given that in some cases both sexes were involved and in others sex was not specified. The death of 50 2-year-old stags was on one

property. Fewer adult males were tested than adult females, but again, no conclusion about between sex susceptibility can be drawn from this data. In all, 309 deer were tested for evidence of leptospirosis and there were 345 deer reported dead in association with evidence of leptospirosis.

FIGURE 1. **Number of AHL submissions for leptospirosis investigation each month from 1987-92.**

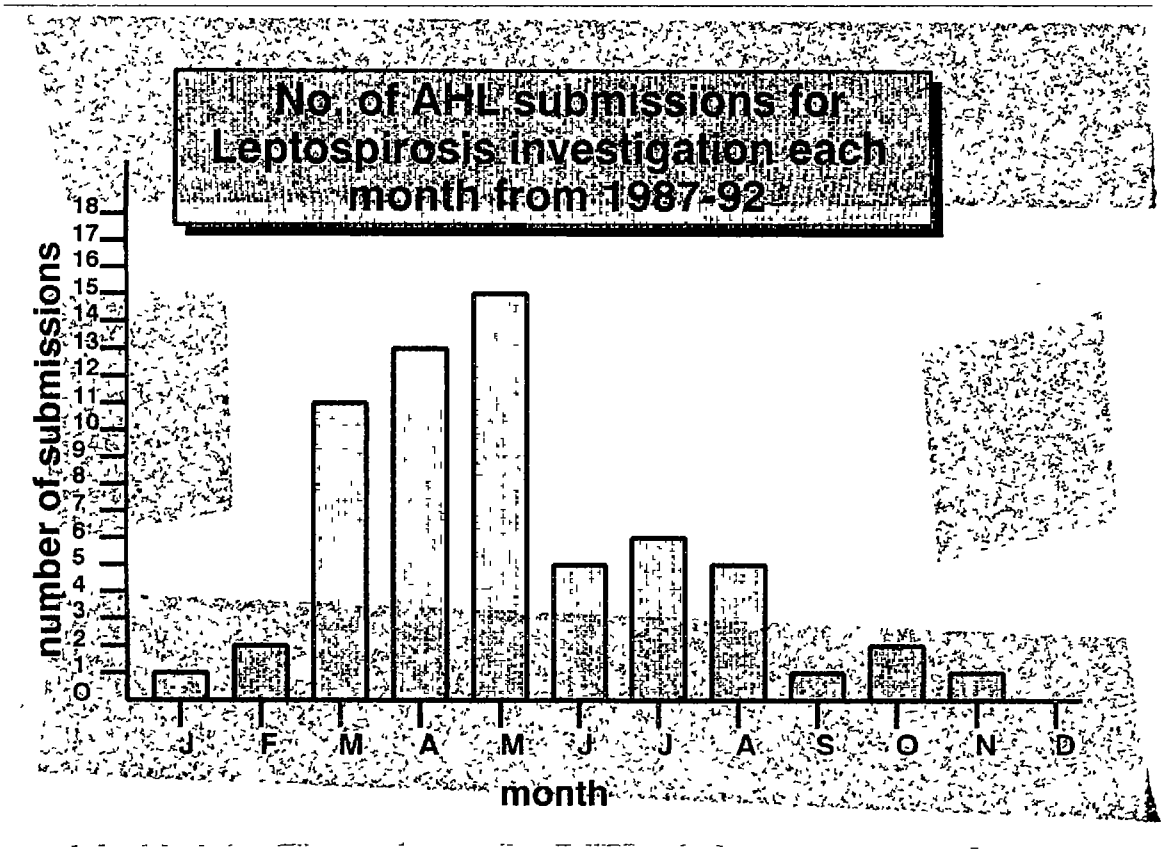

TABLE 4. **Numbers of deer undergoing serological, bacteriological and histological tests, and fatalities reported in submissions for leptospirosis investigation, in deer of different ages and of each sex: AHL submissions 1987-92.**

	FEMALE		MALE		BOTH		Not Specified		
AGE	Tested	Dead	Tested	Dead	Tested	Dead	Tested	Dead	Total
MA (>3yo)	73	13	2						88
2 - 3yo			8	50					58
1 - 3yo							8		8
0 - <12 mth	37	34	62	81	52	47	27	45	385
Not specified	7		2	55	5	12	26	8	115
TOTAL	117	47	74	186	57	59	61	53	

It has not always been possible from the submissions to distinguish the precise cause of death. In a number of cases, serological evidence of leptospirosis may have been incidental to the cause of death, since some submissions were not correlated with pathological or culture confirmation or such confirmation was not requested. For example, some submissions which requested serology only, were from deer that had been in contact with others that had died; the cause of death was therefore presumptive.

1.3 Principal Presenting Histories

The principal presenting history and signs are summarised in Table 5. The most common presenting sign was sudden death of one or more deer. The few affected deer presented alive generally suffered malaise and occasionally haemoglobinurea. Some submissions were made as a routine investigation, a follow-up to another outbreak, or in response to a diagnosis on a neighbouring property. It was not possible to collate the numbers per herd because some numbers were not stated and others were follow-up of previous cases which were not always identifiable.

TABLE 5. **Numbers of submissions for Leptospirosis with each principal presenting sign. AHL submissions 1987-92.**

Principal Presenting Sign	Number(%) of Submissions
Sudden death	28 (40)
Routine	13 (18.6)
Poor reproductive %	4 (5.7)
Redwater	3 (4.2)
Low weight gain	3 (4.2)
Sick	2 (2.8)
Abortion	2 (2.8)
Export	1 (1.4)
Anaemia	1 (1.4)
Fading	1 (1.4)
Not stated/incidental	12 (17.5)
Total	70

1.4 Serological Tests

Table 6 shows the number of submissions, number of serological titres for the three major serovars and the range of titres reported. Titres varied considerably in magnitude and the percentage of animals from each submission that were positive ranged from 0-100%.

TABLE 6. **Number of deer reported with serological titres for the three major Leptospiral serovars: AHL submissions 1987-92**

Serovar	No of Submissions* with titres	Suspicious Negative	Number of Deer within Each Titre range			Total#
			200 -400	400 -800	>800	
Pomona	35	5	40	11	50	106
Hardjo	12	2	26	4	5	37
Copenhageni	3	0	13	0	0	13
Total	47	7	79	15	55	124

* 1 submission reported both *pomona* and *hardjo* titres
2 submissions reported both *hardjo* and *copenhageni* titres

\# The total number of deer testing negative was 124

Caution must be exercised in interpreting the number of serovars involved, since many submissions only requested *pomona* titres and very few requested *copenhageni* titres. Thus no conclusion as to the prevalence of each serovar can be drawn from this survey. Caution must also be exercised since the vaccination status of deer was rarely reported.

The relationship between serotype and primary presenting sign showed that 18 submissions for investigation of sudden deaths yielded *pomona* titres whereas only 2 submissions investigating sudden death yielded *hardjo* titres. The direct conclusion could be that sudden death is usually associated with *L.pomona*, but this is not entirely valid since in many instances *hardjo* titres were not requested, so were not performed, thus possibly obscuring the real cause of death.

Of four deer herds with poor reproductive performance, serological evidence existed only for *hardjo* and not *pomona*. One also had serological evidence of *copenhageni*. Of two submissions where abortions were reported, there was serological evidence only for *hardjo*. For routine and other submissions, serological evidence was present for both *pomona* and *hardjo*.

1.5 Gross and Histopathology

Table 7 presents the number of submissions with a range of gross and histopathological lesions. Jaundice was clearly the most common gross pathological sign. A range of histological descriptions were reported. A number of kidneys contained leptospires in sections stained with the Warthin-Starry or other silver stains. Leptospires were observed in urine from seven cases submitted. A number of liver lesions were reported and leptospires were seen in one liver histological section. In one case leptospires were observed by dark-field microscopy in blood.

TABLE 7. **Principal gross, histopathological and microscopic observations. AHL submissions 1987-92.**

	Description	No. Submissions	(% of Total)
Gross lesions (33 submissions)	Jaundice	24	73
	Redwater	11	33
	Kidney lesions	11	33
	Liver lesions	2	6
	Decreased fat reserves	2	6
Kidney Histological lesions (34 submissions)	Haemoglobinuric nephrosis	9	26
	Neprosis	6	18
	Leptospires	14	41
	Haemoglobin casts	8	24
	Protein casts	5	15
	Interstitial nephritis	8	24
	Nephritis	2	6
	Other	7	21
Liver Histological lesions (22 submissions)	Centralobular necrosis/ degeneration	16	73
	Bile stasis	10	45
	Siderosis	1	5
	Inflammatory cells	3	14
	Leptospires	1	5
	Damaged hepatocytes	4	18
	Accumulation of Bilirubin	1	5
Urine microscopy	Leptospires observed	7	

1.6 Leptospiral Cultures

There were few requests for culture so few were cultured. Only two samples yielded leptospires; both were typed as *pomona*. However, in a number of cases leptospires were observed in kidneys and urine. One hind which aborted had a high *hardjo* titre (1:3200) but culture of foetus and membranes was negative for leptospirosis, but positive for *Campylobacter foetus*.

1.7 AHL Survey Conclusions

Analysis of laboratory records from 1987-1992 has shown evidence that leptospirosis was a significant cause of death in deer, particularly those less than 12 months of age and particularly during the autumn season. The principal disease entity appears to be one of acute haemolytic crisis, followed by haemoglobinurea and jaundice with renal lesions in which leptospires were commonly seen and in which leptospires were commonly shed in urine. Ninety per cent of such cases possessed serological evidence of *pomona* and 10% *hardjo*. The only two positive cultures yielded *pomona*.

Six submissions reporting poor reproductive performance or abortion yielded serological evidence of *hardjo*, with one showing *copenhageni* titres. The latter may be a cross-reaction with *hardjo*.

While it is tempting to speculate that there are two syndromes associated with leptospirosis in deer - haemolytic crisis associated with *pomona* and reproductive failure due to *hardjo*, data from a survey such as this must be interpreted with caution. Analyses were confined largely to requests, so complete confirmatory diagnostic procedures were not common. Numbers of cases were small,

histories were often incomplete and cross-referencing was very difficult.

It is apparent however, that leptospirosis can have severe consequences in some affected herds and that the organism is shed in the urine. That leptospirosis can manifest itself in this way and that it is a zoonosis must be of concern and warrants further research and epidemiological investigation.

2. DEER SLAUGHTER PREMISE SURVEY

2.1 Survey Method

During December 1992 and January 1993 the Feilding deer slaughter premises was visited 11 times and samples and data collected from different farms from various locations in the southern part of the North Island, as detailed in Table 8.

Table 8 Samples and data collected from DSP

No. of Farms	53
No. samples/farm	10-12
Total animals sampled	622
Samples collected from each deer:	
Serum	
Kidneys - fixed section	
Records:	
Age of Deer	
Sex of Deer	
Carcass weight	
Kidney Gross Lesions	

2.2 Analyses

Analyses performed are summarised in Table 9. An initial seven farms were surveyed for seven serovars, thereafter the four major serovars were analysed.

Table 9 **Analyses performed on samples collected from DSP**

Serology:

pomona)
hardjo) All farms (622 samples)
copenhageni)
tarassovi)

australis)
ballum) 7 farms only
balcanica)

Culture : 200 at random (3-4/farm)

Histology: Selection based on:

Gross lesion + Serology +
Gross lesion - Serology +
Gross lesion + Serology -
Gross lesion - Serology -

for major serovars

Within a line from each farm generally four kidney samples were macerated and presented for culture. These were selected randomly to include kidneys with lesions and without lesions and farms and animals with and without serological evidence of leptospirosis.

A section from each kidney from all deer was fixed in formulin and later, depending on serological and cultural results, together with gross lesion status, samples were selected for histological examination, such that all lesion, culture and serological combinations were included.

Kidneys were examined for gross lesions and these were classified and scored according to descriptions presented in Table 10.

Table 10 **Gross kidney lesions observed, and their frequency**

Code	Lesion	Number of Deer	% of Total Lesions
1	< 6 small white spots	56	27
2	6-12 small white spots	24	11
3	> 12 small white spots	31	15
4	< 6 small red spots	20	10
5	6-12 small red spots	2	1
6	>12 small red spots	4	2
7	Mottled white	36	17
8	Mottled red	20	10
9	Scarring/fibrous tissue	2	1
10	Cysts - Single or multiple	14	7

Note: * some deer had more than one lesion type
* 207 of 622 (33%) deer had kidney lesions

2.3 Preliminary Results

At the time of writing not all analyses had been completed, thus results presented here are summary of raw data only.

2.3.1 Serology

There was serological evidence of leptospiral infection of a range of serovars in 82% of farms (See Table 11). Seventy nine percent of herds had evidence of *hardjo* infection, while 47% had *pomona* infection. A number of herds had evidence of dual infection. Many lines of deer had a 100% prevalence of serologically positive animals and this occurred for all 4 major serovars tested. Many other herds had a lower percentage of animals with serological titres and the titres varied considerably. Some farms had consistently high titires, whereas others had consistently low titres. Herds with evidence of *hardjo* infection generally had a high prevalence of titres.

Note: The vaccination status of these herds was unknown.

Table 11 **Percent of farms surveyed which had serological evidence of Leptospiral infection (Titres 1:24 or greater without cross-reactivity)**

Serovar	%
pomona	47
hardjo	79
copenhageni	30
tarassovi	24
Total	**82**

Note: Many lines had evidence of more than one serovar.

2.3.2 Kidney Lesions

In all, 33% of deer had gross kidney lesions (see Table 10). While a detailed analysis has not yet been done, visual appraisal of the data suggests that kidney lesions were more frequent in herds which had serological evidence of leptospirosis, although some herds with no serological evidence of leptospirosis did present with kidney lesions. No conclusion can yet be drawn as to a causal or relationship between leptospirosis and renal lesions.

2.3.3 Culture

Eight kidney samples cultured positive for leptospira. At the time of writing 4 samples had returned a positive *hardjo* typing, two were mixed and are undergoing further testing and two cultures did not persist in order to allow typing.

2.3.4 Further Analyses

Once histological examinations have been completed, data will be correlated in an attempt to examine whether there is an association between lesion positive animals, serological evidence, culture evidence and histological findings. Thus an attempt will be made to establish whether or not the lesions observed are indeed due to leptospirosis.

3. CONCLUSION AND COMMENTS

Preliminary analysis of data from this survey indicates that infection of farmed deer with leptospirosis appeared to be widespread. Given the small number of cases reported to Animal Health Laboratories summarised in the first part of this paper, it would appear that deer may be asymptomatically infected with leptospires, but that under certain conditions clinical disease can occur

The widespread nature of infection and the number of culture positive animals observed in this survey, coupled with the observation of leptospiras in urine of a number of AHL submissions, suggestes that workers at deer slaughter premises are at risk of contracting leptospirosis. Indeed some workers at the Feilding DSP reported medical diagnoses of leptospirosis in conjunction with clinical signs. It is therefore likely that leptospirosis is a significant public health risk to deer slaughter premise workers. While this risk should not be over-stated, precautionary measures and advice should be given to workers at risk. More work needs to be done at the DSP to investigate the precise areas of risk and methods of reduction for that risk.

These surveys have shown that leptospiral infections in deer may be at a higher prevalence than previously thought. Given that leptospirosis is a zoonosis, it has potential for disruption of the "Cervena" strategy and quality assurance programme within the deer industry. As veterinarians we need to be extremely careful not to over-state the risks concerned, but all must be aware of the risks.

The primary outcome of these surveys is the conclusion that considerably more work needs to be done to define precisely the leptospirosis status of the national deer herd. Practitioners need to undertake investigations more diligently and seek a wider range of information (e.g. serology) from laboratories to be more precise in reaching a clinical or post mortem diagnosis. More research work is needed to evaluate the epidemiology of infection in deer herds, in particular whether deer can be maintenance hosts, and some of the risk factors which pre-dispose deer to infection and clinical disease.

Lastly, leptospiral vaccination programmes have been effective in reducing the risk to the animal and humans in other livestock enterprises. Once more research work is done to establish the risk and to evaluate these risks in relation to the quality assurance programme, it may be necessary for the industry to evaluate the justification or otherwise of a nationally promoted campaign to vaccinate deer against these organisms.

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References

(1) Anon (1980). *Pomona* redwater in deer. Surveillance 7: No. 3 p11.

(2) Mackintosh, C.G. (1984). Leptospirosis in deer. Proc. Deer Course for Veterinarians No. 1. Deer Branch NZVA 100-106.

(3) Flint, S.H., Corner, R.J., Marshall, R.B. (1988). A serological study of Leptospirosis in domestic deer in New Zealand. N.Z.vet.J. 36: 151-152.

(4) Fairley, R.A., Schollum, L.M., Blackmore, D.K. (1984). Leptospirosis associated with serovars *hardjo* and *pomona* in red deer calves (*Cervus elaphus*). N.Z.vet.J. 32: 76-78.

(5) Fairley, R.A., Cooper, D.R., Guilford, W.G., Schollum, L.M. (1986). Haemolytic disease associated with *Leptospira interrogans* serovar *pomona* in red deer calves *(Cervus elaphus)*. N.Z.vet.J. 34: 116-117.

(6) Flint, S.H., Marshall, R.B., Winter, P.T. (1986). Dual infections of red deer (*Cervus elaphus*) by *Leptospira interrogans* serovars *copenhageni* and *hardjo*. N.Z.vet.J. 34: 70-71.

(7) Wilson, P.R., Schollum, L.M. (1984). Serological responses of farmed red deer to a vaccine against *Leptospira interrogans* serovars *hardjo* and *pomona*. N.Z.vet.J. 32: 117-119.