Leptospirosis and the deer industry : Current knowledge and perspectives

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1. Introduction

Leptospirosis is becoming of increasing interest to the New Zealand deer industry from productivity, animal and human health, and food safety and animal welfare perception perspectives. There have been a number of reports of clinical disease due to leptospirosis in farmed deer in New Zealand (Anon, 1980; Fairley *et al.*, 1984; Fairley *et al.*, 1986; Wilson and Walker, 1988; Wilson *et al.*, 1993). Those cases were associated with serovars *pomona* and/or *hardjo*. There have been several other reports of various serovars, serological surveys, transmission studies and description of disease and abortion, particularly from overseas and in wild and captive white-tailed deer, reviewed by Mackintosh (1984).

As there is increasing concern expressed by the deer industry and veterinarians primarily regarding the occupational health and safety issues related to leptospirosis, and secondly, in relation to reproductive performance, it is considered timely to review the situation and to present preliminary results of recent survey work.

2. Knowledge and perceptions of leptospirosis in deer in New Zealand

2.1 Production

There is a growing belief that poor reproductive performance in some deer herds may be due to leptospiral infections. This is based on the presence of leptospiral titres in herds under investigation for low reproductive performance. It must be cautioned, however, that no direct evidence that leptospirosis causes abortion in farmed red or fallow deer in New Zealand has been published. One report of artificial infection of white-tailed deer in the USA with *Leptospira pomona* described abortion. Wilson and McGhie (1993) reported case records from animal health laboratories in New Zealand where a number of investigations into the leptospiral serological status of herds had been undertaken in response to low reproductive performance. No cause-and-effect relationships were established. No leptospires have been reported from aborted foetuses in New Zealand.

Data presented by Wilson *et al.*, (1997) shows that leptospiral infections are widespread in deer herds with between 82 and 100% herd prevalence being observed. Data from a Deer Herd Health and Production Profiling Study (Audigé *et al.*, 1993) indicated losses between pregnancy scanning and calving in adult hinds to be approximately 0.6% and in yearling hinds, 0.8%. Every herd under study was subsequently shown to have serological evidence (titres ≥ 1:24) of leptospiral infection. Perinatal mortalities averaged 9 and 17% for adult and yearling hinds, respectively. The potential rôle of leptospirosis in contributing to those losses requires investigation. Similarly the potential rôle of leptospirosis in serologically negative herds requires investigation, since the manifestation of infection is likely to be different between herds which are endemically infected *versus* those which were previously nàive. Thus, the presence of leptospiral titres, in conjunction with poor reproductive percentages alone, *cannot* be diagnostic of leptospirosis as a cause. A much more complete epidemiological and bacteriological investigation is required.

2.2 Animal health

According to practitioners, cases of haemoglobinuria, jaundice and deaths, either individually or in outbreaks, continue to occur. The report of Wilson *et al.,* (1993) describes laboratory data on leptospirosis from 1987-93. While no further laboratory survey has been conducted, reports in *Surveillance* and *Veterinary Cervus* from animal health laboratories indicate continuing diagnoses of leptospirosis as a cause of mortalities. A postal survey of farmers, whose deer were sampled by us at a deer slaughter premise (DSP), indicated that three of 36 farms with serological evidence of leptospirosis, had a veterinary diagnosis of the disease in a two-year period.

2.3 Human health

The human health concern is two-fold. Firstly, DSP workers, farmers, veterinarians, and others with close association with deer are at risk of leptospirosis. Leptospires have been found in the urine of deer (Fairley *et al.,* 1986; Flint *et al.,* 1986; Wilson *et al.,* 1993;), and leptospires have been cultured from kidneys collected at random at a DSP and can be observed in the renal tubules of these kidneys (Wilson *et al.,* 1997). Anecdotal reports confirm the risk of infection. In one case a farmer who was battered and urinated upon by a stag in the rut subsequently developed severe influenza-like symptoms which were eventually diagnosed medically as leptospirosis. Some DSP managers have noted absences of workers with a similar syndrome, diagnosed medically as leptospirosis.

Secondly, the Occupational Safety and Health (OSH) implications of leptospiral infections in workers are significant. A recent case was brought against a dairy farmer for failing to vaccinate after a worker contracted the disease. Many farmers and veterinarians have expressed concern as to their liability in this respect. It is questionable as to whether a deer farmer could be held liable, given that we know so little about leptospirosis in deer, and there is certainly no widespread public knowledge of its prevalence or its risk. The efficacy of vaccination is unknown. There has been no industry scheme promoting vaccination as there has in cattle. However, the veterinarian asked the question by the farmer client is in a difficult situation. All veterinarians should recognise that there is a risk of transmission to humans, but whether vaccination is appropriate is not known given that vaccination efficacy has never been evaluated. Furthermore, appropriate vaccination regimes have not been evaluated, nor has the period of protection by vaccine been studied. The veterinarian's advice to a client may be different to that of the industry as a whole. The vet has a responsibility to fully inform the client, and give the best technical advice on the occasion, whatever that may be.

However, concern was sufficient to prompt the adoption of a remit at the 1997 Annual General Meeting of the New Zealand Deer Farmers' Association to encourage research to provide the industry with a full set of recommendations on this issue.

2.4 Food safety and animal welfare concerns

Venison is marketed as a quality assured, nutritious product, farmed in a clean, green and kind environment. The implication is freedom from disease. While it is highly unlikely that humans could be infected from meat other than kidneys, which are not normally used for human consumption, the potential negative impact of a zoonotic disease on the image of venison has not escaped the attention of the Game Industry Board marketing team. An effective industry-wide immunisation programme would help deflect concerns, real or imagined.

Animal welfare concerns aim to minimise the risk of ill health or disease to animals. It could be argued that all reasonable steps should be taken to protect the animal from disease. This entails assessment of risk to the animal *versus* the effectiveness and cost of the protection. These risks and relationships require further evaluation.

3. New knowledge of leptospirosis

Data from two surveys have recently been analysed and has been published elsewhere (Wilson *et al.*, 1997). A brief summary is presented.

3.1 DSP survey

3.1.1 Method

Ten or 12 blood samples collected from lines from a deer slaughter premise in Feilding from 622 deer from 53 farms in the lower half of the North Island, were analysed for serovars *pomona, copenhageni, hardjo* and *tarassovi*. A sub-sample of 72 samples from six farms was analysed for serovars *ballum, australis* and *balcanica*. Kidneys from each deer were collected, examined for gross lesions and sections fixed for histology. Samples of kidney from 202 deer, comprising 3-4 per farm of origin, were cultured for leptospiral organisms. Subsequent histological examination was undertaken from four groups of deer based on serological, gross lesion and culture status.

Subsequently a postal questionnaire was sent to herds of origin to ascertain whether or not leptospirosis had occurred in the two years prior to or after the DSP sample collections, and the vaccination status prior to the survey.

3.1.2 Results
A summary of serological data is presented in Tables 1 and 2.

Titres at a maximum dilution 1536 were observed for every serovar measured. The serovar *hardjo* were present in 81%, *pomona* in 60%, *copenhageni* in 66%, and *tarassovi* in 74% of 53 farms surveyed. Serovars *australis, ballum* and *balcanica* were present in a lower percentage. Overall, 82% of herds showed titres at dilution ≥ 24. There were, however, a wide range of titres observed depending on farms and serotype. The prevalence of titres to *hardjo* within herds was higher than the prevalence for other serovars. Many herds had combinations of two or more serovars. Twelve herds showed a high prevalence of titres to both *pomona* and *hardjo*.

The postal questionnaire achieved 36 replies (68%). Only one farmer had vaccinated prior to the survey. This suggests that the serological evidence was related to infection rather than vaccination for all but one, or, for all of the farms surveyed. It is significant, however, that three farmers responding to the survey noted that a veterinary diagnosis of leptospirosis had been made on their properties in the two years after the DSP samples were collected. All three had commenced vaccination.

Cultures for leptospires were positive in a total of 10 deer from six farms, with between 1 and 3 of the 4 samples cultured per farm being positive. Both *pomona* and *hardjo* were cultured. Five were from 1-year-old stags, 3 from 2-year-old stags and 2 from older stags, but the age prevalence of positive cultures was similar.

A wide range of kidney gross lesions was observed as published earlier (Wilson *et al.*, 1993). A high proportion of kidneys with white spots, red spots or white and red mottling were seen in deer with titres to *pomona* and/or *hardjo*. Histologically, lesions in white spotted kidneys consisted of mild lymphocyte and plasma cell infiltrations which had both a focal and diffuse interstitial location in cortex and medulla similar to Leptospirosis in other species. Kidneys without gross lesions had no histological lesions. Spirochetes were observed in the tubules of three of the 10 culture-positive kidneys.

3.2 On-farm survey

3.2.1 Method
Serum samples from weaners, yearlings and adults of both sexes were selected from a serum bank collected as part of the Deer Herd Health and Production Profiling study reported elsewhere (Audigé *et al.*, 1993) from March and November samplings. Serum was tested against *Leptospira* serovars *pomona* and *hardjo*.

3.2.2 Results
In March, seven and six of 14 herds had titres to *pomona* and *hardjo*, respectively. The highest prevalence was 3 of 10 deer. By November, when those deer were 11

months of age, 14 and 6 of 15 farms sampled had serological evidence of *pomona* and *hardjo*, respectively. Titres in 1-year-old deer showed 1 of 12 farms was sero-negative to *pomona* and/or *hardjo* in March, whereas by November, all farms in November were sero-positive to one or other serovar. Serological evidence to *pomona* and/or *hardjo* was found in all adults on all farms.

3.3 General discussion

This paper presents only summary data. Full data is to be published elsewhere (Wilson *et al.*, 1997).

These results have shown conclusively that leptospiral infections are highly prevalent on deer farms in the lower North Island. Data has shown that deer may possess one or more of a range of serovars. Histological and cultural data provide evidence that deer may be maintenance hosts. Fairley *et al* (1986) and Flint *et al* (1986) observed leptospires in urine of infected deer. Thus, any person handling deer and a high prevalence of these same animals were infected by 11 months of age, and given that most farms were deer only, suggests that the source of infection to weaners is from adult stock. However, infection from neighbouring properties cannot be totally excluded

While there was widespread infection on the 15 herd health and production survey farms, there was no evidence of clinical leptospirosis during the 2 years of study. Furthermore, there were no clinical signs of leptospirosis on any of the 622 deer sampled at the slaughterhouse.

The gross kidney lesions observed correlated well with histological lesions. It is proposed that many of the gross lesions are indicative of previous leptospiral infections, since histologically they resembled lesions in known infected deer. None of the histological lesions observed would be classified as severe. This suggests that deer can be clinically asymptomatic carriers of the organism. However, no work has been done to look at subclinical growth patterns of young deer which have become infected with leptospirosis.

The reason that clinical outbreaks of leptospirosis occur is not clear. However, previous reports (Wilson and McGhie, 1993) suggest that mixing of deer from a number of different herds is a risk factor. Thus, mixing infected and uninfected deer in times of stress, ie, after transport and during introduction to a new property soon after weaning, may be factors predisposing to the onset of clinical disease. That no disease was observed in weaners in the on-farm survey described in this paper may be due to avoidance of this risk, and/or feeding and management practices that maintain a high level of health and therefore disease resistance.

Data presented here relate only to the lower half of the North Island. However, anecdotal and laboratory reports (Wilson and McGhie, 1993) suggest that infection is widespread. Veterinarians in parts of the country that were believed to be leptospirosis-free did have recently collected samples and observed serological evidence of infection.

4. Conclusion

The above evidence suggests the industry should have significant concern from animal and human health perspectives. There is a growing belief, possibly erroneous, that leptospirosis is the cause of poor reproductive performance in many situations. Occupational health and safety issues are clearly of concern to all sectors of the industry.

The survey data presented in this paper asks more questions than it answers. It is clear that if deer farmers are to adopt an industry-wide strategy, or if veterinarians are to advise technically sound leptospirosis control and prevention programmes, significantly more information is needed. It is hoped that research into leptospirosis will continue over the next three years to provide many of the answers required by the industry.

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Table 1. **Number of deer serologically positive (titres ≥ 1:24) and range of titre for serovars *pomona, copenhageni, hardjo* and *tarassovi*, from the slaughterhouse survey.**

Farm No.	No. of samples	*Pomona*		*Copenhageni*		*Hardjo*		*Tarassovi*	
		No (+)	Titre Range	No (+)	Titre Range	No (+)	Titre Range	No (+)	Titre Range
1	12	3	24-1531	12	24-1536	9	24-192	2	48-92
2	12	2	48	12	24-1536	7	24-192	1	96
3	12	-		10	24-96	11	24-384	2	24
4	12	12	192-1536	3	24-96	11	24-384	-	
5	12	-		4	24-96	-		-	
6	12	4	24-1536	-		8	24-384	8	24-192
7	10	5	48-192	-		-		5	24-192
8	12	1	768	-		8	24-384	6	24-192
9	10	-		-		6	48-384	1	24
10	12	1	24	-		-		-	
11	12	1	96	-		1	48	-	
12	10	1	192	4	24-48	6	48-1536	-	
13	12	1	192	1	24	-		-	
14	12	-		-		-		-	
15	12	-		-		-		-	
16	12	-		-		-		-	
17	12	-		-		12	48-192	-	
18	12	-		-		11	24-768	-	
19	12	2	24-48	-		12	48-1536	-	
20	12		48-3536	-		11	24-1536	3	24-48
21	12	-		-		-		-	
22	10	2	192	-		10	24-768	-	
23	12	-		-		-		-	
24	12	1	96	-		2	48	-	
25	12	11	192-1536	-		12	48-768	2	24-48
26	12	1	24	5	24-48	9	24-192	-	
27	12	-		1	24	12	48-768	-	
28	12	6	24-1536	2	24	12	48-768	-	
29	12	10	24-92	2	24	10	24-1536	5	24-48

Farm No.	No. of samples	*Pomona*		*Copenhageni*		*Hardjo*		*Tarassovi*	
		No (+)	Titre Range	No (+)	Titre Range	No (+)	Titre Range	No (+)	Titre Range
30	12	1	24	1	24	12	96-1536	-	
31	12	-		-		12	48-1536	6	24-192
32	12	-		-		12	48-1536	1	24
33	12	-		-		2	48	-	
34	12	-		-		12	48-1536	-	
35	12	1	24	-		12	24-1536	-	
36	12	8	48-192	5	24-96	9	24-384	-	
37	12	9	24-96	1	48	12	48-1536	-	
38	12	5	48-1536	3	24	8	24-192	2	24
39	12	10	24	1	24	6	24-28	-	
40	12	-		-		12	96	-	
41	12	7	24-96	2	24	12	48-1536	10	24-96
42	12	10	24-192	-		12	48-1536	4	24
43	12	2	24-48	1	48	12	48-1536	-	
44	10	7	24-192	3	24	10	96-1536	10	24-96
45	12	-		1	24	12	48-1536	1	48
46	12	-		-		10	48-768	-	
47	10	-		1	24	9	24-1536	-	
48	12	5	24-1536	5	24-48	2	384-768	-	
49	10	-		-		-		-	
50	12	-		-		11	96-769	-	
51	12	-		-		6	24-384	-	
52	12	-		-		1	48-1536	-	
53	12	2	24	-					
% farms with titres		57		42		83		34	
% farms with >1 sample positive		40		28		77		24	

Table 2. **Number of deer serologically positive (titre ≥ 24) and range of titres for serovars for *australis, ballum* and *balcanica*, from the slaughterhouse survey.**

Farm	No. of samples	Serovar					
		Australis		*Ballum*		*Balcanica*	
		No (+)	Titre Range	No (+)	Titre Range	No (+)	Titre Range
1	12	5	24-48	-		5	24-48
2	12	4	24	-		8	24-96
3	12	2	24	-		8	24-96
4	12	12	24-1536	11	24-1536	9	24-1536
5	12	3	24-48	-		-	
6	12	11	24-96	1	24	9	96-384