The Effects of Parasitism on Weaner Deer : Parallel Studies with Red Deer Hinds and Wapiti Hybrid Hinds

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Abstract

This study was designed to compare the effects of parasitism on red and wapiti hybrid weaner hinds under conditions of moderate parasite challenge over their first autumn, winter and early spring. Two groups of 10 weaner wapiti hybrid (F1, red X elk) hinds, one with moderate parasitism and one strictly parasite controlled, were compared with 2 similar groups of 10 weaner red deer hinds for liveweight gain, serum biochemistry and lungworm faecal larval counts (FLC) for 91 days after weaning. At that time, five animals from each group were slaughtered, and total lungworm, abomasal worm and abomasal digest worm counts were performed. The remaining animals were monitored for a further 122 days and slaughtered at 213 days (average) after weaning. Stringent parasite control in wapiti hybrid hinds gave very significant increases in liveweight gains compared with moderately parasitized wapiti hybrids by 49 days post-weaning, and this difference was maintained for the remainder of the trial. A traditional parasite control strategy (21 day drench with albendazole) in weaner red deer hinds gave a slight increase in liveweight gains (not significant) over moderately parasitized red deer hinds but did not protect against a decrease in serum albumin. At both slaughters, the mean carcass weight of the minimally parasitzed wapiti hybrids was significantly increased over the moderately parasitzed wapiti hybrids. Ivermectin treament in wapiti hybrids over the autumn significantly reduced the decrease in serum albumin seen in other groups Both red deer groups exhibited increases in total serum protein which were not seen in the wapiti hybrid groups.

Introduction

Wapiti from North America (*Cervus elaphus nelsoni* or *C. e. manitobensis*, also called "elk") have been used since early in the history of deer farming in New Zealand, primarily to hybridize with red deer (1) While wapiti hybrids can demonstrate increased liveweight gains and greater velvet anter production over red deer, it has been noted that wapiti performance in New Zealand has not matched its genetic potential (2). Investigations into the aetiology of chronic illthrift in wapiti (or "fading elk" syndrome) have shown an association with gastro-intestinal parasitism, especially in stags (3,4). The present study was undertaken to compare the differences in the response to parasitism between wapiti hybrids and red deer and to compare the effects of long-term parasitism within each strain.

Methods and Materials

On 10 March 1993 (Day 0), 20 weaner wapiti hybrid (F1, red X Canadian wapiti) hinds and 20 weaner red deer hinds were assembled at Invermay Animals from each type were randomly divided into 2 groups of 10 which were planned to be either minimally parasitized or moderately parasitized. The minimally parasitized wapiti hybrid group (Group 1) was treated with topical ivermectin (Ivomec Pour-on for Cattle^{R}, Merck, Sharp and Dohme NZ Ltd) at the rate of 1500 µg/kg liveweight (triple the cattle dose) at 21 day intervals The minimally parasitized red deer

group (Group 3) was treated with albendazole (Albezol DC^R, SmithKline Beecham Animal Health) at the rate of 10 mg/kg liveweight at 21 day intervals.

To maintain animals with long-term, moderate levels of lungworm and abomasal parasites without considerable mortality, the moderately parasitized groups from both breeds were treated identically, being drenched with Albezol DC (at 10 mg/kg) at a 35 day interval rather than the standard 21 day interval for white drenches (Group 2 were wapiti hybrids and Group 4 were red deer). The animals within Groups 2 and 4 were divided into 5 pairs, and each pair was drenched on a rotating 5 weekly schedule. All animals in the trial were vaccinated with Yersiniavax^R and a multivalent clostridial vaccine and were given one 4 gram copper "bullet" (Copper Needles^R, Bayer New Zealand Ltd.) at the start of the trial.

The deer were weighed and faecal samples (for lungworm faecal larval counts) taken at 7 day intervals until the first slaughter in June and then at 14 day intervals until the second slaughter in October Blood samples were taken for serum from all animals at day 0 and then at 21 day intervals until June for analysis of total serum protein, serum albumin, serum pepsinogen and SGOT (serum glutamic oxalacetic transaminase). After June, all animals were bled monthly. Selenium supplementation was given monthly by oral solution at the rate of approximately 1 mg/10kg liveweight until June 2

After an average of 91 days, 5 animals from each group were randomly selected and slaughtered In Groups 2 and 4, one of each pair was randomly selected Due to a limited capacity to process all the samples, 9 were killed at day 90, 7 were killed at day 91 and 4 were killed on day 92 Groups 1 and 3 had been last treated with ivermectin and albendazole respectively on day 84 (each group having received 5 treatments in total). The last pair of animals in Groups 2 and 4 were treated on day 84 All animals in Groups 2 and 4 received 3 treatments, but the first pairs would have been treated 5 weeks prior. The remaining animals were maintained and monitored until slaughter in October. At slaughter, the abomasum was isolated, tied and removed, together with the respiratory tract, as quickly as possible post mortem Both were processed for adult and 5th stage larval nematodes (5) The abomasal mucosa was removed and processed (by acidic enzymatic digestion) for recovery of 4th stage *Ostertagia*-type larvae (5). The pH of the abomasal contents was measured with an electronic pH meter. Liver sections from each animal were analyzed for copper and selenium Statistical analysis was done by ANOVA and regression analysis using Genstat 5 (2.2). Statistical analysis of worms recovered was done with natural log transformation of one plus the actual number counted on the groups where at least some of the animals were parasitized In those situations where the mean group worm count was nil, a t test was used to compare means of the other groups.

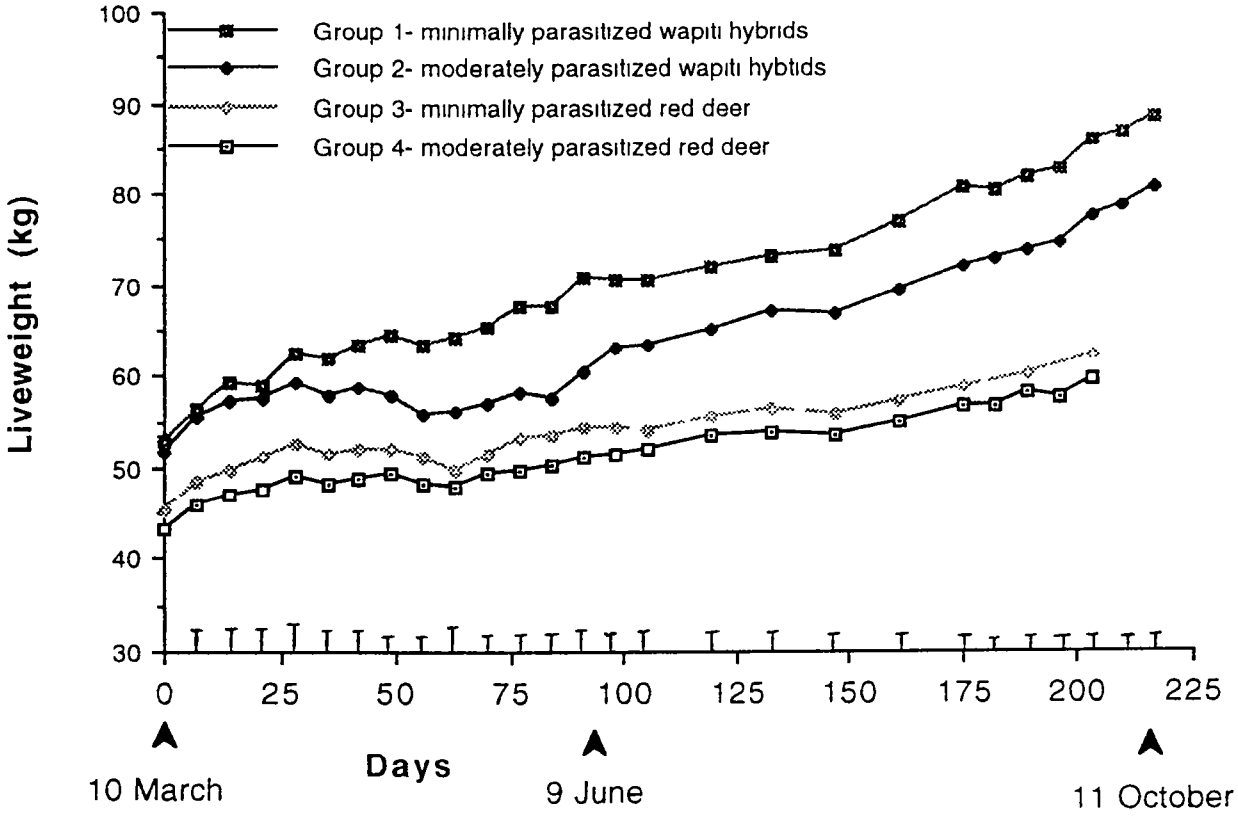
Beginning on day 210 after weaning, the remaining animals were slaughtered. Due to processing limitations, 3 were killed on day 210, 7 were killed on day 213 and 10 were killed on day 217. All samples were collected as above

Results

Changes in Liveweight· Figure 1 shows the mean liveweights for each group throughout the entire trial. The weaning weights of the 2 breed types (red vs wapiti hybrid) were significantly different at the start, but there was no significant difference between the mean weights of each group within the two types. From 10 March through 9 June (the first slaughter), there was no significant difference among the mean liveweight gains in groups 2, 3 or 4 (8 50kg, 8 88kg and 7.92kg respectively, SED 1.314). The mean liveweight gain for Group 1 (17.90kg, SED 1.314)

during the same time was significantly greater ($p<0.01$). On a per sample day basis between groups 1 and 2, the mean liveweights were not significantly different until day 49 ($p<0.05$). This difference was highly significantly on day 84 ($p<0.01$). After day 84, the difference between mean liveweight of groups 1 and 2 remained significant ($p<0.05$) until the end of the trial However after day 91, the change in liveweight, that is, the rate of gain, between groups 1 and 2 was not significantly different. Neither the mean group liveweight nor the changes in liveweight between groups 3 and 4 were significantly different at any time during the trial

Figure 1. Liveweight changes in red deer hinds and wapiti hybrid hinds on different anthelmintic programs from weaning to 10 months of age



Serum Biochemistry: Figure 2 shows the change in total serum protein (TSP) among the 4 groups. In the time to the first slaughter, there was an increase in TSP in the red deer, Groups 3 (9.7 gm per litre) and 4 (7.6 gm per litre) and in the minimally parasitzed wapiti hybrid group (6.2 gm per litre). The moderately parasitized wapiti hybrid group increased by 3 4 gm per litre (SE 1.52). There was a significant difference ($p<0.01$) in the change in TSP between the moderately parasitized wapiti hybrids (Group 2) and the moderately parasitized red deer (Group 4, SED 2.149). The serum albumin levels of all four groups decreased (see Fig 3) for the initial 63 days of the trial, though the minimally parasitized wapiti hybrid group decreased the least. From the start of the trial to the first slaughter, there was no significant difference in the change in serum albumin between the two red deer groups (Groups 3 and 4) and the moderately parasitized wapiti hybrid group (-3.4 gm per litre, -4 0 gm per litre and -5.7 gm per litre, respectively, SED 1.437), but the change in serum albumin for minimally parasitized wapiti

hybrid group (0 7 gm per litre, SED 1.437) was significantly different ($p<0.01$) from the other groups The SGOT measurements from all animals remained within normal range (< 100 units/l) throughout the entire trial. Mean serum pepsinogen values were less than reference value (< 1 0 Units/l) in all groups throughout the trial with the exception of day 0 at which time Group 1 had 2 individuals giving very high values (14 4 and 27.9 units/l, SE 4.14) These had decreased to < 1 0 units/l by day 21.

Figure 2. Changes in total serum protein between weaner wapiti hybrid hinds and weaner red deer on different anthelmintic regimes

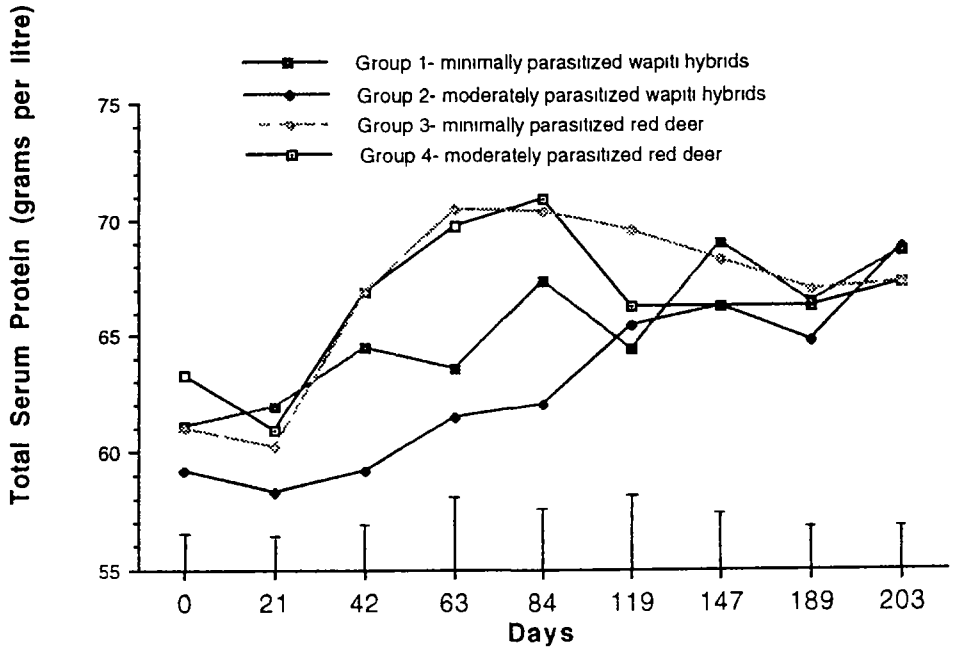
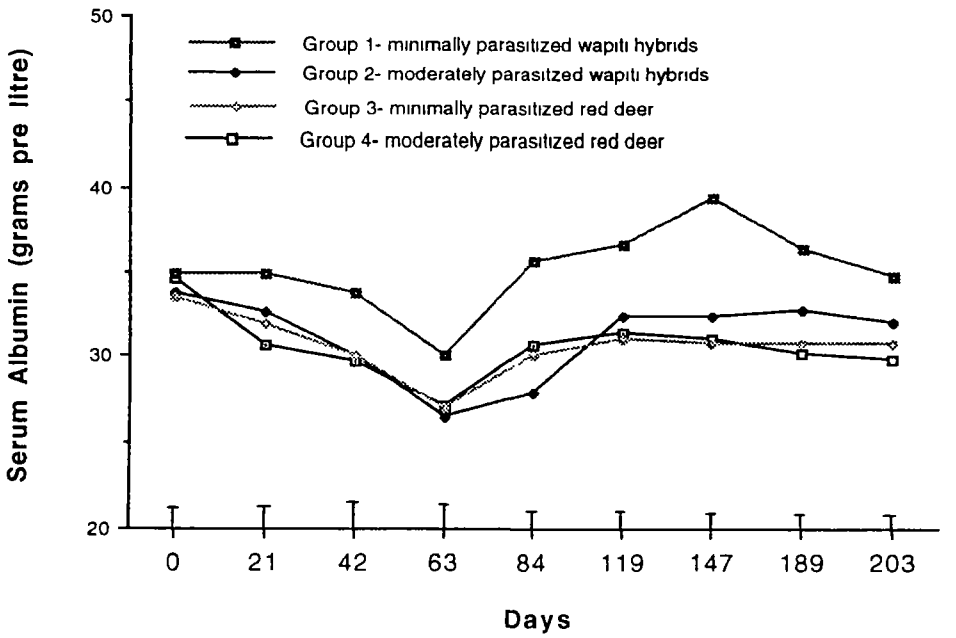


Figure 3. Changes in serum albumin among weaner wapiti hybrid hinds and weaner red deer hinds on different anthelmintic regimes



First Slaughter: The mean liveweight of the minimally parasitized wapiti hybrids (Group 1) was significantly different ($p<0.01$) from that of the other 3 groups, and correspondingly the carcass weights for group 1 were significantly higher as well ($p<0.01$) (see Table 1). The dressing percentages were significantly different between Groups 1 and 2 ($p<0.05$) but not Groups 3 and 4. There was no significant difference between Groups 2 and 4 or Groups 1 and 3. Table 2 shows the parasitological data from the first slaughter Group 2 had a significantly ($p<0.05$) higher number (log plus 1) of adult lungworms compared to Groups 1, 3, and 4 Group 1 had significantly fewer immature lungworms ($p<0.05$) than the other groups. There was no significant difference in the numbers of abomasal worms or abomasal pH due to the variation and small group sizes The mean liver copper values were not significantly different among the groups (372 umol/kg, 284 umol/kg, 354 umol/kg and 284 umol/kg respectively, s.e.d. 88 0) Among the mean liver selenium values, Group 4 was significantly decreased (462 nmol/kg, $p<0.05$) compared with Groups 1, 2 and 3 (1166 nmol/kg, 1148 nmol/kg, 902 nmol/kg respectively, s.e.d. 129 6).

Second Slaughter: There was a significant difference ($p<0.05$) in the mean liveweight between groups 1 and 2 (88.5kg and 80.6kg respectively, s.e.d. 2.91). There was no significant difference between groups 3 and 4 (62.2kg and 62.0kg respectively) There was a highly significant difference between the mean liveweight between types ($p<0.01$) As with the first slaughter, the differences in mean group carcass weight were similar to mean liveweight with the wapiti hybrid groups significantly different than the red deer groups ($p<0.01$). There was a significant difference ($p<0.05$) in the mean carcass weight between groups 1 and 2 (52 3kg and 46.9kg respectively, s.e.d. 1.774), but there was no significant difference between groups 3 and 4 (35.7kg and 35.3kg respectively) There was a significant difference ($p<0.05$) in the carcass dressing % between groups 1 and 4 (59.0 and 57.0 respectively, s e.d. 0.547). Table 3 shows the mean liveweight, mean change in liveweight (since 91 days post weaning), mean carcass weight and mean carcass dressing % at 213 days post weaning.

Table 1: Liveweight, liveweight gains, carcass weights and dressing percentages of red deer and wapiti hybrid weaner hinds on different anthelmintic regimes from weaning to 91 days later.

Group	Mean liveweight (kg) at weaning (n=10 per group)	Mean liveweight gain (kg) at 91 days post weaning (n=10 per group)	Mean liveweight at 91 days post weaning (kg) (n=5 per group)	Mean carcass weight at 91 days post weaning (kg) (n=5 per group)	Mean Carcass dressing % at 91 days post weaning (n=5 per group)
1 (minimally parasitized wapiti hybrids)	52 75^{a}	17 90^{a} (P<0 01)	70 65^{a} (p<0 01)	37 06^{a} (p<0 01)	51 88^{a}
2 (moderately parasitized wapiti hybrids)	51 75^{a}	8 50^{b}	60 25^{b}	28 60^{b}	49 18^{b}
3 (minimally parasitized red deer)	45 35^{b}	8 88^{b}	54 23^{c}	28 14^{b}	52 32^{a}
4 (moderately parasitized red deer)	43 30^{b}	7 92^{b}	51 22^{c}	26 06^{b}	50 98^{ab}
SED	1 903	1 314	2 438	2 413	1 051

In columns, similar superscripts indicate no significant difference Different superscripts indicate a significant difference of $p<0.05$.

Table 2: Means of the log count (plus 1) of the numbers of worms recovered and arithmetic means of the abomasal pH at necropsy from red deer and wapiti hybrid weaner hinds on different anthelmintic programmes 91 days from weaning

Group	Adult lungworm	Immature lungworm	Adult *Ostertagia*	Early L4 *Ostertagia*	Late L4 *Ostertagia*	Abomasal pH
1	0^{b}	0 14^{a}	0^{a}	3 40^{a}	6 84^{a}	3 96^{a}
2	2 32^{a}	5 06^{b}	2 87^{a}	3 50^{a}	6 37^{a}	4 06^{a}
3	0^{b}	2 50^{b}	0^{a}	3 36^{a}	6 03^{a}	3 82^{a}
4	0 66^{b}	3 50^{b}	3 45^{a}	4 68^{a}	6 51^{a}	4 36^{a}
SED	0 615	0 981	1 627	1 920	1 724	0 393

In columns, similar superscripts indicate no significant difference Different superscripts indicate a significant difference of $p<0\ 05$

Table : Liveweight, liveweight gains, carcass weights and dressing percentages of red deer and wapiti hybrid weaner hinds on different anthelmintic regimes from 91 days to 213 days post weaning.

Group	Mean liveweight (kg) at 91 days post weaning (n=5 per group)	Mean liveweight gain (kg) from 91 days to 213 days post weaning (n=5 per group)	Mean liveweight (kg) at 213 days post weaning (n=5 per group)	Mean carcass weight (kg) at 213 days post weaning (n=5 per group)	Mean Carcass dressing % at 213 days post weaning (n=5 per group)
1	70.65[a]	18 50[a]	88 49[a] (p<0 01 against °)	52 30[a]	59 0[a]
2	60 25[b]	18 20[a]	80 60[b] (p<0 01 against °)	46 90[b]	58 1[ab]
3	54 13[c]	8 94[b]	62 30[c]	35 70[c]	57 4[b]
4	51 22[c]	10 48[b]	62 00[c]	35 30[c]	57 0[b]
SED	2 438	2 746	2 054	1 774	0 547

In columns, similar superscripts indicate no significant difference. Different superscripts indicate a significant difference of $p<0.05$

Table 4: Means of the natural log count (plus 1) of the numbers of worms recovered and arithmetic means of the abomasal pH at necropsy from red deer and wapiti hybrid weaner hinds on different anthelmintic programmes 213 days from weaning

Group	Adult lungworm	Immature lungworm	Adult *Ostertagia*	Early L4 *Ostertagia*	Late L4 *Ostertagia*	Abomasal pH
1	0 77[b]	1 20[b]	6 76[ab]	5 58[a]	9 26[ab]	3 76[b]
2	2 29[a]	3 19[a]	7 84[a]	4 19[a]	9 10[ab]	4 24[ab]
3	1 56[ab]	1 77[b]	7 01[ab]	4 47[a]	8 67[b]	4 64[ab]
4	2 07[a]	2 29[ab]	6 37[b]	6 28[a]	9 38[a]	4 80[a]
SED	0 489	0 590	0 558	1 233	0 295	0 465

In columns, similar superscripts indicate no significant difference Different superscripts indicate a significant difference of $p<0.05$.

Table 4 shows the parasitological data from the second slaughter. The last scheduled treatment for any group had been 7 days before the first slaughter. One animal in Group 2 was treated with albendazole on 19 July as its FLC had exceeded 100 lpg, but no other animal was treated prior to the second slaughter. There was no significant difference in the logs of the numbers of adult lungworms recovered from Groups 1 and 3, though Group 3 was not significantly different that Groups 2 and 4. Group 2 had significantly ($p<0.05$) higher numbers of immature lungworms than

Group 1 but not Groups 2 or 4, and Group 2 had significantly higher numbers of adult *Ostertagia* than the other groups. There was a significant difference ($p<0.05$) in the numbers of late 4th stage larvae recovered between Groups 3 and 4, but there was no significant difference among the groups for early 4th stage larvae. The mean abomasal pH of Group 1 was significantly lower ($p<0.05$) than Group 4

Discussion

Despite the small numbers of animals per group, it is evident that wapiti hybrids gained a significant mean liveweight benefit from a stringent topical ivermectin programme compared with wapiti hybrids which were on a less stringent albendazole regime. Both groups 1 and 3 were planned to be on a similar 21 day albendazole schedule, but because of questionable efficacy of white drenches in wapiti-type animals (C G Mackintosh, pers. comm.), it was decided to use the topical ivermectin in the animals in Group 1. It was further decided to use the triple dose regime in an effort to reduce *Ostertagia*-type larvae based on previous experience at Invermay (C G Mackintosh, unpublished data) This mean liveweight gain occurred in spite of the fact that the Ivomec-treated (triple dosed) wapiti hybrids did not have significantly lower mean populations of *Ostertagia*-type larvae present in the abomasum after 91 days (5 treatments), though it did significantly reduce adult *Ostertagia.* Previous reports of "fading" in mature wapiti have been associated with abomasal parasitism with particular reference to inhibited larvae (4). This suggests that there is a different parasite mechanism involved in young wapiti-type animals. The ivermectin treatment did substantially reduce lungworm infections although it did not eliminate them.

The mean liveweight advantage of the Ivomec-treated wapiti hybrids remained significant until slaughter at 7 months post weaning, though the moderately parasitized wapiti hybrids had a similar rate of gain over the second part of the trial While the red deer which were drenched with the standard (21 day) white-drench programme had a liveweight advantage over the moderately parasitized red deer, it was not significant. That the standard white-drenched red deer group had similar biochemical responses, serum albumin loss and total serum protein increase, to the moderately parasitized red deer was unexpected and indicates that 21 day treatment with albendazole does not prevent pathophysiological changes which appeared to be lessened with the ivermectin treatment. Cattle treated with a 21-day pulse release oxfendazole ruminal bolus developed pathophysiological changes associated with parasitism between the pulse doses (6) The nature of these pathophysiological changes is not yet entirely defined in deer. Of particular interest is the difference in the serum proteins between types that occurred presumably in response to parasitism. The Ivomec-treated wapiti hybrids did not show the degree of serum albumin loss as seen in the moderately parasitized wapiti hybrids or, to a lesser extent, in the red deer groups, and yet the moderately parasitized wapiti hybrids did not exhibit the increase in total serum protein as seen in the red deer groups.

It has long been held that wapiti-type deer are more susceptible to parasitism than red deer in New Zealand (7,8) This study shows that moderately parasitized wapiti hybrids show the same serum albumin decrease but do not exhibit a total serum protein increase as seen in parasitized red deer. The exact composition of protein in the parasitized red deer response was not explored within the parameters of this study, but there may be some response factor(s) present in the young red deer which contributes to resistance of parasitic disease and is either not present or is less responsive in wapiti hybrids Since it is well known that weaner red deer can succumb to lungworm infections, this resistance would obviously not be absolute In spite of the influence of parasitism on the liveweight gains of the wapiti hybrid hinds in Group 2, serum pepsinogen

evaluations were not of diagnostic value. As seen with Group 3 at the first slaughter which was 7 days after treatment, albendazole is efficacious at removing adult lungworms and adult *Ostertagia*-type nematodes. Neither ivermectin or albendazole were completely effective at removing immature lungworms or abomasal worms. This trial was designed to provide a high degree of challenge to these animals. The persistent activity of ivermectin (28 day claim for deer against lungworm when applied at 500 µg/kg) may give an advantage over albendazole which has no claim for persistent activity in the oral form The use of albendazole in a sustained release ruminal bolus has been shown to provide a liveweight gain advantage against 21 day albendazole treatment for the expected life of the bolus (9). While persistent activity has been associated with anthelmintic resistance, it appears to offer a production benefit to weaner wapiti hybrid deer during the autumn.

Conclusions

1) Parasitism had a greater effect on liveweight gains in wapiti hybrid weaner hinds than in red deer weaner hinds for 3 months post weaning.
2) Twenty-one day treatment with triple dose (1500 µg/kg) Ivomec pour-on prevented significant serum albumin loss in wapiti hybrid weaner hinds as compared with 21 or 35 day treatment with albendazole in wapiti hybrid or red deer weaner hinds.
3) Five previous treatments with triple dose Ivomec pour-on did not significantly reduce larval Ostertagia infections as compared with 35 day albendazole treatment
4) The parasitized, albendazole-treated red deer exhibited a total serum protein increase which was not observed in the parasitized, albendazole treated wapiti hybrids.

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