WEST KITIKMEOT / SLAVE STUDY SOCIETY

**Re: Prevalence and Intensity of Gastro-Intestinal Nematode Parasitism in the Bathurst Caribou Herd 1998-99**

## Disclaimer

This Report is the result of a project conducted under the West Kitikmeot / Slave Study. The Report has not been peer reviewed or approved by the Board, and the contents and opinions are considered the sole responsibility of the authors.

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# Prevalence and intensity of gastro-intestinal nematode parasitism in the Bathurst caribou herd 1998-99

**Final Report to the**

**West Kitikmeot Slave Study Society**

Submitted By

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## SUMMARY

Ecologists are starting to investigate how parasite infections have subtle effects on foraging behavior as animals trade-off the risk of infection against selecting nutritious forage. We suggested that parasite infection may be a contributing factor influencing caribou calving ground ecology. We found that the prevalence of nematode eggs (*Ostertagia* spp) peaked in mid-summer but was also relatively high during pre-calving migration. The parasite eggs that were shed at the beginning of calving on the calving grounds hatched and larvae left the fecal pellets within 2 weeks. The cows and their newborn calves leave the calving grounds about the time that infectivity by the parasitic larvae increases from the relatively high but patchy density of fecal pellets on the calving grounds.

**ACKNOWLEDGEMENTS**

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**1.0 OBJECTIVES:**

Our objectives were to:

1) Estimate nematode parasite load for calving caribou (parasite prevalence).
2) Estimate the larval emergence during calving and evaluate overwinter larval survival in experimentally placed fecal pellets on the calving ground.
3) Evaluate the potential effect of climatic trends and variation on nematode larval survival.

## 2.0 DESCRIPTION

### 2.1 Background

Caribou are present on the Bathurst calving grounds at high densities for a brief time during May and June.  Caribou at the peak of calving reach estimated densities of 111 caribou/$km^2$ which means that densities of their fecal pellets will be correspondingly high.  Fecal pellets often harbor eggs from parasitic nematode worms and this is especially likely on the calving grounds.  During the caribou host's calving and lactation, hormonal changes temporarily relax immuno-suppression allowing a surge in the parasitic nematode worm's egg production. This surge is a well-known phenomenon in domestic stock and leads to increased infections as the eggs hatch into larvae – the infective stage.

Potentially then the calving grounds with high densities of caribou and their fecal pellets may also have high densities of larval parasitic nematodes.  Folstad *et al*. (1991)

commented that calving grounds "may develop into transmission foci for parasites, where females and their susceptible calves would experience intense parasitic transmission." We have hypothesized that if caribou respond to the high fecal and parasite densities by foraging away from those areas, that avoidance may be a contributing factor to progressive shifts in the annual locations of calving grounds (Sutherland and Gunn 1996, Gunn and Sutherland 1997). Fecal avoidance in domestic sheep is strongest with fresh dung (Hutchings *et* al. 1998). However, if foraging caribou respond to fresh fecal pellet concentration, then avoidance of high fecal and parasite densities may also be a factor in timing of postcalving migration away from the calving grounds and local movements within the calving grounds.

Among the nematode worms that parasitise the stomach of caribou and other hoofed animals is *Ostertagia*. *Ostertagia* is a major cause of parasitic gastritis in domestic cattle and sheep and infection leads to changes in protein metabolism and weight loss or even death. The adult worm is a reddish-brown worm up to 1 cm long but finer than the average human hair. The worms are found inside the abomasum (true stomach). The nematode eggs pass through the caribou's stomach and intestines and are shed in the fecal pellets. Within the fecal pellets, the eggs hatch, pass through two growth (larval) stages ($L_1$ and $L_2$). The third growth stage $L_3$ larvae move from the fecal pellets onto the vegetation where a grazing caribou may accidentally eat them. The $L_3$ growth stage infection depends on the weather being relatively warm and humid which is why the predicted effects of global warming could include changes in parasitic infection (Kutz 2000). The $L_3$ larvae can also probably over winter and infect caribou the next calving season but this has not been confirmed for *Ostertagia* infecting caribou. Almost no specific information is available on *Ostertagia* nematode worms in barren-ground caribou.

Most ruminants are infected with intestinal parasites (summarized for North American ruminants by Hoberg et al. 2001). Wildlife mangers have conventionally rated parasites as unimportant (benign) unless they cause pathological disease (clinical parastism). By contrast, subclinical parasitism (no apparent signs of illness) is well documented in domestic stock to cause complex and subtle effects on the host's physiology. Relatively little is known about the effects of sub-clinical parasitism in caribou. Infection with *Osteragia* have been shown to reduced the appetite of reindeer (Arneberg *et al.* 1996).

Our interest in sub-clinical parasitism in caribou is the effect that parasitic infections have on forage selection. A recent paper concluded that domestic sheep could balance between the risks of being infected (avoiding fecal contaminated vegetation) against selecting for nutritious forage (Hutchings *et al.* 1999). The sheep's decisions were influenced by whether the sheep were already infected and whether they were particularly hungry. The sheep's select to avoid fecal contamination was stronger than their attraction for nutritious forage. Wild reindeer are also influenced by dung as to how they select foraging sites (van der Wal et al. 2000*a*). On Svalbard, reindeer grazed a lower proportion of grasses in plots experimentally treated with dung (similar to naturally occurring levels) compared to untreated plots. Nematode development was highest in the wetter habitats while dung deposition was higher on the drier sites suggesting that dung density was an unreliable predictor for the risk of infection. As the reindeer selectively foraged in the wetter sites, which have greater forage quality and quantity, they may have traded off parasitism risk and forage quality (van der Wal et al. 2000*b* ). Factors that affect diet selection and forage intake are often regarded as pivotal to describing foraging ecology and distribution of ungulates (Trudell and White 1981, Spalinger et al. 1988, Bailey et al. 1996).

### 2.1.1 Project history and changes to objectives.

The project was originally proposed as part of the WKSS calving ground ecology project. However, we reported as a separate project because of the logistics of the sample handling and analyses were in Canada rather than Alaska as was the case for the other data collected under that project. Resources and field time available did not permit us to collect data for the third objective (Evaluate the potential effect of climatic trends and variation on nematode larval survival), however in the Discussion, we describe some possible effects and their mechanisms

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## 2.2 Study Area

The Bathurst herd's seasonal range overlaps the Slave Geological Province (Figure 1) which is described in WKSS State of Knowledge Report (Sly *et al.* 1999). The

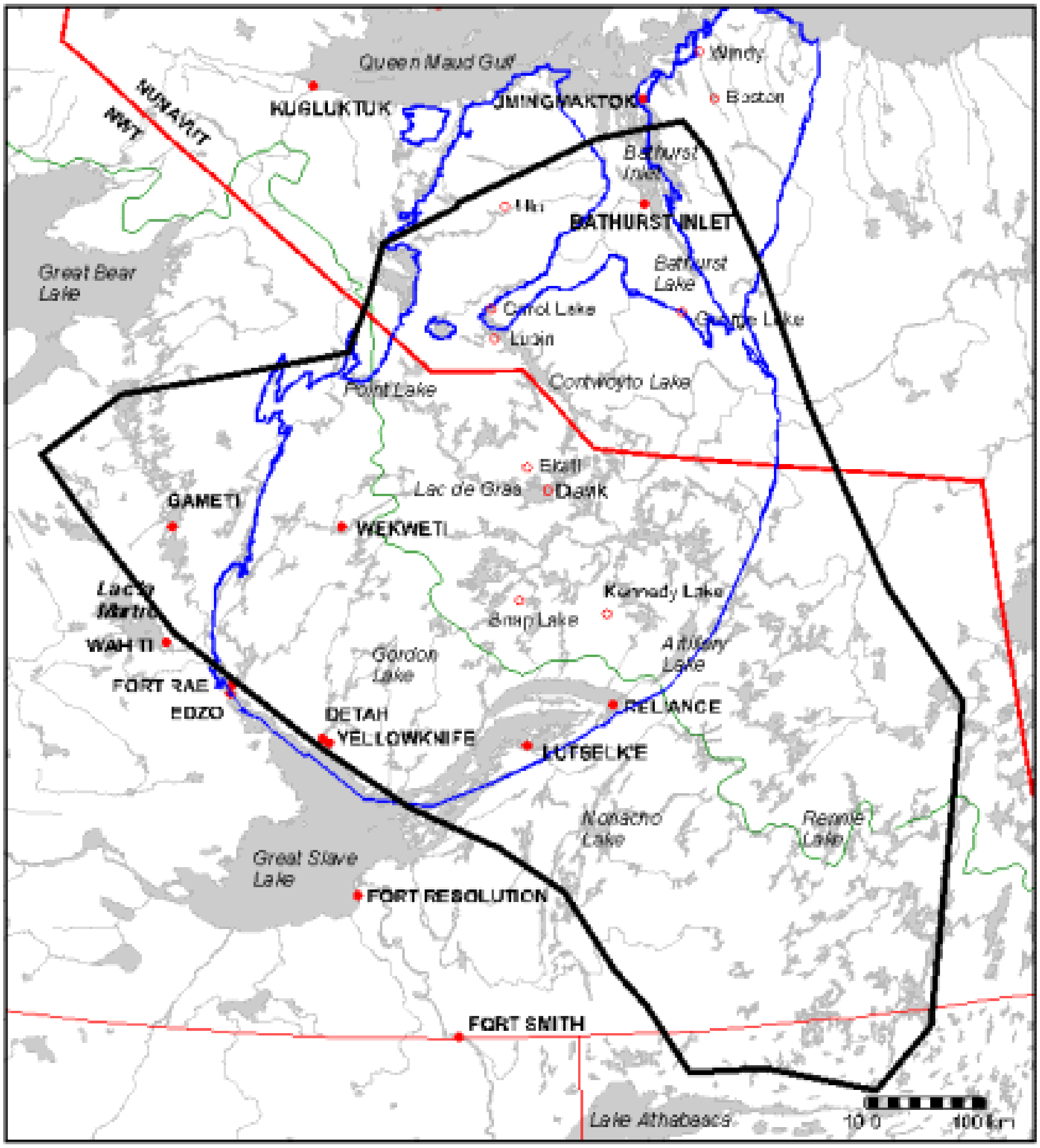


Figure 1. Study area of the West Kitikmeot / Slave Study Society (in blue) the Bathurst caribou herd's seasonal range (in black).

vegetation of the calving ground is described in the WKSS calving ground project final report (Griffith *et al*. 2001). To record the weather on the calving ground, we had a remote weather station but damage by a grizzly bear prevented us from obtaining weather data for the site.

## 2.3 Project design

### Nematode prevalence

We defined the nematode parasite load for calving caribou as the proportion of caribou infected (prevalence) and as we could not directly sample individual caribou, we sampled fecal pellet groups as an indicator for the proportion of the caribou on the calving ground infected. We measured intensity of infection as the number of eggs or larvae per 5 grams of fecal pellets.

In June 1998, we collected pellet groups during the estimation of pellet density as an indicator to habitat selection which was part of the WKSS calving ground ecology project (Griffith *et al*. 2001). We collected enough fresh pellets in the immediate vicinity of the density estimation transects to ensure several samples of at least 10 g (wet weight) pellets each day. We kept the samples cool in the field camp, until we shipped them to Yellowknife where we divided them into paired samples. We froze the samples before sending one set of the paired samples to the Department of Parasitology, Western College of Veterinary Medicine, Saskatoon (the second set were a contingency for samples that might be lost in shipping). The lab used the Wisconsin flotation technique to count numbers of *Ostertagia* eggs/5 g of fecal pellets for one of each pair of samples and Baermann's technique to count hatched larvae in the other sample of each pair. We counted both eggs and larvae as the eggs were hatching during the sampling period. We analyzed the data using SigmaStat® (Version 1.0, 1993) to obtain descriptive statistics (mean and standard error).

We also took advantage of other opportunities during the WKSS Seasonal Movements of the Bathurst caribou herd project (Gunn *et al.* 2001) to collect fecal samples during July and November 1999 to determine the seasonal output of *Ostertagia* eggs.

**Larval emergence during calving 1998**

In 1998, we looked for fecal pellet groups from caribou cows as they arrived on the calving ground and were moving through the Wright River area. We marked 31 pellet groups with wooden numbered stakes on May 30. On 11 June, we either collected the whole pellet group if there were only a few pellets, or otherwise we collected half the pellets and clipped the vegetation to ground level in a 10 cm circle around the pellets to collect larvae that may have migrated from the pellets. The collected pellets were kept cool and sent for both egg and larval counts.

**Larval emergence during calving 1999**

On 30-31 May 1999, we collected 50 groups of pellets and divided each in half – one half was sent for egg counts and the other half was placed on moist tussock tundra marked with a wooden stake to determine the timing of larval hatching and migration. We collected the staked groups on 13-14 June 1999.

**Over-winter larval survival**

We used two approaches to determine over-winter survival of larvae. Firstly, we used paired samples from individual fecal pellet groups to estimate larval abundance and compare it to abundance a year later after the pellets had over-wintered on the calving ground. In 1998, we used pellet groups that were had just been deposited (May 1998) from caribou cows as they arrived on the calving ground. As described above we sampled half the 31 groups in June 1998 and left 14 groups to be re-sampled in June 1999.

Our second approach was to use plastic buckets to restrict the migration of the nematode larvae (Kutz 2000). We collected fresh whole pellets group from different sites on the Bathurst calving ground, 6-9 June 1998 and half each group was held for analysis. We did not have enough samples to pair them between wet and dry sites. The other half was placed on the vegetation either within a plastic tub (to prevent emerging larvae from escape or outside the tub) as a control for any microclimatic changes within the tub. The tubs were approximately 30 cm in diameter and the bottoms had been cut out. We cut a plug of vegetation down to mineral soil, placed the tub in the hole and the vegetation plug into the tub before placing the lid (with holes) on the numbered tub.

## 3.0 RESULTS

**Prevalence:** The prevalence of fecal pellets containing *Osteragia* eggs was 72% for the 89 groups of fecal pellets collected 6-8 June 1998 (Table 1); egg intensity was low

(9.3 ± 1.6 SE eggs/5g) and no larvae were found. However, our results on larval emergence (see next section) suggested that the low results in 1998 were because the eggs had hatched by 6-8 June and the larvae migrated onto the vegetation. In 1999, we collected and analyzed 50 pellet groups earlier (30-31 May 1999) and recorded a prevalence of 78% for 50 groups and the egg count was 44.7 ± 10.45 SE eggs/5 g. By mid-July caribou were again shedding Ostertagia eggs but the shedding of eggs had ceased by early winter (Table 1).

Table 1. Seasonal prevalence (% pellet groups with *Ostertagia* eggs) and intensity (Mean ± Standard Error counts eggs/5g of fecal pellet) on the range of the Bathurst caribou herd, NWT and Nunavut, 1998-99.

| | **Prevalence (eggs)** | | **Intensity (eggs/5 g )** | |
|---|---|---|---|---|
| | No. pellet groups | % | Mean | Standard Error |
| 6-8 June 1998 | 89 | 72 | 9.3 | 1.6 |
| 11 June 1998 | 31 | 6 | | |
| 30-31 May 1999 | 50 | 78 | 44.7 | 10.45 |
| 13-14 June 1999 | 50 | 4 | <0.1 | |
| 24 July 1999 | 40 | 98 | 120.4 | 16.49 |
| November 1999 | 50 | 0 | 0 | -- |

**Larval emergence 1998**

We found that only 3 of 31 samples deposited by cows in late May 1998 and collected by us on 11 June contained eggs (1, 1, 1 eggs) and no larvae suggesting that the eggs had hatched and the larvae migrated onto the vegetation.

**Larval emergence 1999**

Prevalence of *Ostertagia* eggs in half of each fecal pellet group collected 30-31 May 1999 was 78% and the count of eggs/5 g was 44.7± 10.45 (Table 1). However, by 13-14 June 1999, when we re-sampled the other half of the fecal pellets, egg prevalence in the other half of the pellet groups had dropped to 4% with intensity <0.1 egg/5 g and the eggs were larvated. The counts from the Baermann's for larvae was low: 16% prevalence and intensity <0.1 larvae/5 g suggesting that the eggs had hatched and rain had washed the larvae onto the vegetation.

**1998-99 Overwinter larval survival**

We did not re-sample the 31 groups staked and sampled in June 1998 again in June 1999 (as originally planned) because the June 1998 results from half those groups suggested the eggs had already hatched and the larvae migrated. We also had problems using the buckets to sample over-winter survival. Only 7 of 17 pellet groups inside the buckets and 5 of 20 pellet groups outside the buckets had *Ostertagia* eggs and intensity was low (12 ± 8.2 SE eggs/5 g). We did not find larvae but we suspect, in hindsight the lack of larvae was the result of freezing the sample which may have killed the third stage larvae. Given those 1998 results we did not resample the pellet groups or vegetation in June 1999 although we did remove the buckets.

## 4.0 DISCUSSION

Our results demonstrate that caribou cows and their newborn calves on the Bathurst calving grounds are potentially exposed to re-infection by a common gastro-intestinal nematode parasite (*Ostertagia* spp.).  The cows and calves migrate away from the calving grounds within the timing of Ostertagia larval emergence. The timing of the emergence of the 3rd stage larvae (the infective stage) is the end of the second week of June and the initiation of postcalving migration annually varies but is as early as 6 June in 1998 (a warm calving season with early plant green-up, Gunn et al. 2001) and extends toward late June in other years.

Parasitic nematode emergence and survival are influenced by temperature and humidity (for example, Armour 1980 Kutz 2000). Predictions for global climate change include warmer summers with more precipitation and cloud cover (Maxwell 1992) which are those conditions which would favour nematode larval survival and an extended or more intense period of infectivity.  Already, a likely signal for global climate change is detectable on the Bathurst caribou's calving grounds as the effect of a trend in warming temperatures and green-up of the vegetation (Griffith et al. al 2001).

Our results are a preliminary step toward understanding how parasitism may be a factor in caribou ecology especially the timing of postcalving migration away from the calving grounds and shifts in calving grounds.  We recognize that this is a preliminary result in a field that is only just beginning to be recognized – the role of sub-clinical parasitism and host foraging ecology (reviewed in Gunn and Irvine submitted).  However, we suggest that demonstrating that the *Ostertagia* third stage larval emergence within the time when the caribou cows and their newborn calves are on the calving grounds is a significant result.

We were unable to determine if eggs or the earlier larval stage were able to over-winter  although we suspect that it is possible based on research from wild reindeer (*Rangifer tarandus platyrhynchus*) on Svalbard (Irvine *et al. 2000*). The intensity of infection that we recorded was relatively low, but Halvorsen *et al*  (1999) suggested that on Svalbard, reindeer parasites are longer-lived than in domestic stock and they estimated that only 26 larvae/day are necessary to reached observed levels of infection. Therefore it is possible that arctic ungulates, can pick up and tolerate persistently high levels of infection which would not be observed in the domestic situations. We have also only reported on Ostertagia but caribou are infected with other parasites and the timing of their like-histories and timing of infection varies between even related nematode species (Irvine *et al.* 2000).

Theoretical models have revealed how parasites can affect population dynamics (Anderson and May 1978) and a recent empirical study of wild Svalbard reindeer is beginning to confirm that parasites may be sufficient to cause these patterns (Albon et al., In press). The significance of this for wildlife is that firstly, sub-clinical parasitism has both explanatory and predictive power in the complexities that drive population dynamics. And secondly, parasitism is a factor to be accounted for in the experimental design especially in studies of diet and foraging behavior.

## 5. 0 LINKS WITH PARALLEL STUDIES

The project was a sub-project for the WKSS project - the Bathurst Caribou Calving Ground Studies: Influence of Nutrition and Human Activity on Calving Ground Location, (Griffith *et al.* 2001).

## 6.0 TRAINING ACTIVITIES AND RESULTS

Opportunities for training were limited to demonstrations in the field on what the eggs and larvae looked like and techniques used to detect them.

## 7.0 EXPENDITURES AND SOURCES OF FUNDS

As per terms of the annual contribution agreements, financial statements were provided to WKSS during the study.

## 8.0 SCHEDULE AND CHANGES

Resources and time available did not permit us to collect data for the third objective (Evaluate the potential effect of climatic trends and variation on nematode larval survival).

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