Laying in Wait:
How One Parasite has Adapted to a Migratory Host in the Arctic

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Migratory 'Escape' Hypothesis[1]

Long-distance migration of host populations separates susceptible hosts from infective parasites in space and time. Migration allows 'escape' from parasitism unless the parasite adapts to a migratory host. Adaptations of the host and parasite will be examined within this framework using the barrenground caribou/ *Ostertagia gruehneri* system as an example.

Barrenground Caribou

- A subspecies of *Rangifer tarandus* found across the Canadian Arctic
- Keystone species of the tundra
- Traditional and economic importance to Northern communities
- Annual mass migrations spanning 100s of kilometers across the tundra

Ostertagia gruehneri

- Family Haemonchidae
- Most common gastrointestinal nematode in caribou
- Adult size: ~10 mm; infective larval size: ~1 mm
- Causes decreased appetite, weight loss, and reduced pregnancy rates in reindeer[2-4]
- Development from egg to infective larva requires 3-4 weeks during the arctic summer[5]

Host Adaptation: Long-Distance Migration

Five phases of the Bathurst caribou migration:
Spring – migration north to the calving grounds along the Arctic coast (May)
Calving - congregation of females (and newborn calves) on the calving grounds (June)
Post-Calving – large aggregations of all caribou and southward migration (July)
Fall Dispersal – fragmentation into small groups spread across tundra (August-October)
Winter – low density groups south of the treeline (November-April)

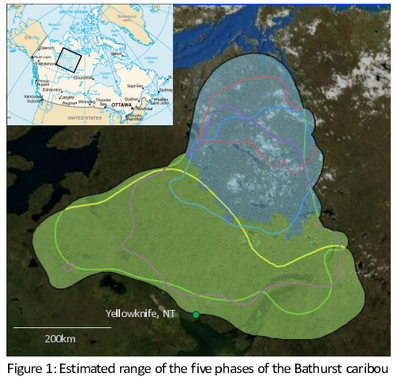

Figure 1: Estimated range of the five phases of the Bathurst caribou migration - spring, calving, post-calving, fall dispersal, and winter. Based on satellite-collar data from adult female caribou only. Courtesy of Don Russell, Yukon College[6].

Table 1: Overview of barrenground caribou migration and potential for infection based on overlap with infective larvae.

Phase	Movement Rate	Host Density[7]	Parasite Development	Potential for Infection
Spring (May)	High and directional	Low	Minimal – end of May only when > 0ºC	Minimal – restricted by < 0ºC temperatures
Calving (June)	Minimal	High	Yes – overnight freezing events possible	Low – restricted by parasite development
Post-Calving (July)	High and directional	Moderate	Yes – temperatures above 30ºC likely limit development[5]	Minimal – restricted by parasite development and caribou migration
Fall Dispersal (Aug-Oct)	Low and overlapping	Low	Variable – Aug generally > 0ºC ; overnight freezing events Aug to Sept, < 0ºC in Oct	Moderate – restricted by host density and overlap with heavily contaminated areas
Winter (Nov-Apr)	Low and overlapping	Low	No	Minimal – restricted by < 0ºC temperatures

Long-distance migration of barrenground caribou limits infection risk by:
1. Leaving heavily contaminated areas (calving and post-calving) prior to larval development to L3
2. Minimizing host densities during periods of highest infection risk (fall dispersal)

Parasite Adaptations: Hypobiosis and Overwintering Larvae

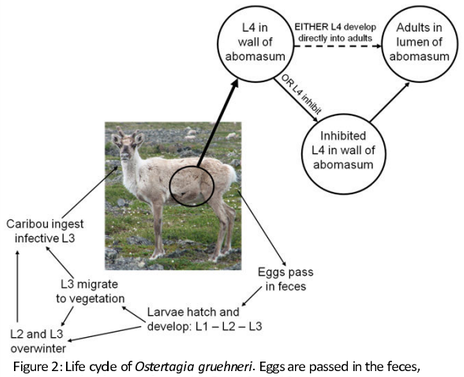

Figure 2: Life cycle of *Ostertagia gruehneri*. Eggs are passed in the feces, hatch, and develop to infective L3. Both L2 and L3 can overwinter in the environment. Nearly 100% of ingested L3 enter hypobiosis.

- Development and survival of free-living stages temperature dependent
- Passive transmission when caribou graze
- Transmission limited by length of growing season and spatio-temporal overlap between infective larvae and susceptible hosts
- *Ostertagia gruehneri* life history adapted to a short growing season and a migratory host
  - nearly 100% hypobiosis[8]
  - high rates of overwinter survival for both L2 and L3[5]

Table 2: Overview of *O. gruehneri* larval adaptations to increase transmission potential

Adaptation	Features	Growing Season	Host Migration	Potential for Infection
Hypobiosis	Development of ingested L3 is arrested until the spring following infection	Concentrates egg production during the growing season	Eggs shed across entire summer range of caribou (June-Sept)	Increases reproductive output of adult *O. gruehneri* by ensuring at least one full season of egg production
Overwintering Larvae	L2 and L3 overwinter in the environment and are available to infect caribou in following summer	Extends life cycle across two growing seasons	L3 overlap with caribou across entire summer range	Maximizes temporal (extends transmission to two seasons) and spatial (entire summer range) overlap between caribou and L3

Larval adaptations of *O. gruehneri* increase transmission potential by:
1. Focussing egg production during the short growing season (hypobiosis)
2. Maximizing the amount of overlap between L3 and susceptible hosts (overwintering larvae)

References:
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