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A protostrongylid nematode (Strongylida: Protostrongylidae) in woodland caribou (*Rangifer tarandus caribou*)

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First-stage protostrongylid larvae found in faeces of woodland caribou (*Rangifer tarandus caribou*) in northwestern Ontario and Manitoba may be larvae of *Elaphostrongylus* sp., a well-known agent of neurologic disease in reindeer (*Rangifer tarandus tarandus*) of Eurasia.

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Les larves de premier stade de protostrongylidés trouvées dans les fèces du caribou (*Rangifer tarandus caribou*) dans le nord-ouest de l'Ontario et au Manitoba pourraient bien être des larves d'*Elaphostrongylus* sp., vecteur bien connu d'une maladie neurologique du renne (*Rangifer tarandus tarandus*) en Eurasie.

[Traduit par le journal]

Introduction

On April 2, 1975, a sample of faecal material from woodland caribou (*Rangifer tarandus caribou*) was collected on the Slate Islands 8 mi off the north shore of Lake Superior and examined for larval nematodes. The sample contained 200 first-stage protostrongylid larvae which were indistinguishable from those of *Parelaphostrongylus tenuis*, an ubiquitous parasite of white-tailed deer. This observation was particularly puzzling as *P. tenuis* is known to be highly pathogenic to cervids of the genus *Rangifer* (Anderson and Strelive 1968; Behrend and Witter 1968; Anderson 1971; Trainer 1973; and Dauphiné 1975) and it is doubtful whether the parasite could persist in a susceptible cervid population in the absence of its natural host, the white-tailed deer. Although white-tails infected with *P. tenuis* occur on the north shore of Lake Superior, they do not presently inhabit the Slate Islands, nor is there evidence suggesting they have ever been present in recent times. The islands have apparently been inhabited exclusively by woodland caribou from as early as 1907 (Euler *et al.*).[3]

Because our initial observation appeared to be inconsistent with published literature which implicates *P. tenuis* as a pathogen of caribou, an attempt was made to identify the nematode involved and to determine if the parasite is restricted to the long-isolated herd of the Slate Islands, or whether it occurs more widely in the range of woodland caribou.

Methods

Caribou faecal-pellet groups collected from the Slate Islands and other areas in northwestern Ontario and Manitoba were suspended over Kim-wipe tissue (Kimberly-Clark) in Baermann funnels and examined 5 h later for nematode larvae.

Faeces from caribou captured live at Sasaginnigak and Reed Lakes, Manitoba, were examined for larvae in the field while restrained animals were being measured and fitted with collars before being released. Faecal material was obtained from the rectum by gently inserting the index and adjacent finger smeared with surgical jelly into the rectum. In this way a sample of 10 to 30 pellets could be obtained. For field examination, 6 pellets were placed

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[3]Euler, D., J. B. Snider, and H. R. Timmermann. 1975. The Slate Islands: woodland caribou and plant communities. Unpublished report to the Ontario Ministry of Natural Resources, North Central Region, Thunder Bay, Ontario.

TABLE 1. Baermann examination of woodland caribou faeces for first-stage protostrongylid larvae

Site No.	Location	No. pellet groups examined	No. with larvae	%
1*	Slate Islands, Ontario	193	8	4
2	Pic Island, Ontario	11	0	0
3	Lake Nipigon Islands, Ontario	162	4	2
4	Armstrong, Ontario	44	0	0
5	Cliff Lake, Ontario	35	0	0
6	Flinstone Lake, Manitoba	23	5	22
7	Sasaginnigak Lake, Manitoba	40	5	13
7	Sasaginnigak Lake, Manitoba	14†	4	29
8	Reed Lake, Manitoba	6†	4	67

*Site number corresponds to location indicated in Fig. 1.
†Pellets removed from the rectum of live animals.

in an Erlenmeyer flask and gently agitated in 5 ml of water for 2 min. The water was then poured off into Syracuse glasses and examined at 25 × using a Wild M5 field dissecting microscope. The remaining pellets obtained from animals on Sasaginnigak Lake were later placed in Baermann funnels and examined in the laboratory. Nematode larvae recovered were heat-relaxed in water and measured.

Results and Discussion

Eight of 193 caribou-pellet groups collected from the Slate Islands contained first-stage protostrongylid larvae (Fig. 1, Table 1). Pellets from three other locations in northwestern Ontario were negative, but similar larvae were found in caribou faeces from Russell Island, Ontario, and Flintstone, Reed, and Sasaginnigak Lakes in Manitoba (Fig. 1). It was not possible to estimate accurately the age of the pellets collected from the ground, but each positive sample yielded fewer than 20 larvae.

Faeces from the rectum of four (4 ♀♀) of six (1 ♂, 5 ♀♀) animals examined live at Reed Lake contained up to 152 protostrongylid larvae. At Sasaginnigak Lake, similar larvae were recovered from 4 (1 ♂, 3 ♀♀) of 11 (3 ♂♂, 8 ♀♀) adult caribou examined live. Three calves examined were not infected. The four infected animals, one prime bull and three cows, each with a nursing calf, were considered indispensable to the herd and were not sacrificed. Each infected animal was passing one to four larvae in about 20 pellets. Only one of these infections was detected upon examination of pellets in the field.

Larvae recovered from faeces were typical of several metastrongyloid nematodes within the Protostrongylidae (namely, Elaphostrongylinae, Muelleriinae, Capreocaulinae, and Neostrongylinae). Larvae of this group have a dorsal spine on the tail and prominent lateral alae which likely determine the characteristic C-shape assumed by such larvae when heat-relaxed in water. Also, they are similar in size and appearance and cannot be identified reliably even to genus. Larvae recovered in this study cannot be distinguished from those of *P. tenuis* (after Anderson 1963) or larvae of other members of the genus *Parelaphostrongylus*. The larvae are also similar to those described by Mitskevich (1958) for *Elaphostrongylus cervi rangiferi* (in the sense of

FIG. 1. Locations in northwestern Ontario and Manitoba where faeces of woodland caribou contained protostrongylid nematode larvae (●) and where faeces examined were negative (○).

TABLE 2. Comparative measurements (μm) of first-stage protostrongylid larvae from woodland caribou and those of *Parelaphostrongylus* and *Elaphostrongylus*

Measurement	Woodland caribou		*Parelaphostrongylus tenuis* (after Anderson 1963)	*Elaphostrongylus cervi* (=*rangiferi*) (after Mitskevich 1958)
	Slate Islands, Ontario	Reed Lake, Manitoba		
Number	20	20	20	?
Length	354 (319–380)	350 (291–390)	348 (310–380)	349
Width	16 (14–20)	18 (16–19)	18 (16–19)	16
Nerve ring	94 (81–104)	93 (80–101)	94 (80–112)	—
%*	27 (23–28)	27 (23–29)	27 (21–32)	—
Excretory pore	94 (85–105)	93 (81–101)	94 (80–112)	95
%	27 (24–29)	27 (24–29)	27 (21–31)	27
Oesophagus	166 (155–175)	165 (150–176)	165 (132–181)	169
%	47 (44–51)	47 (43–53)	48 (41–52)	48
Genital primordium	234 (214–248)	232 (195–249)	224 (210–246)	—
%	66 (63–69)	67 (61–72)	64 (60–71)	—
Anus	32 (24–38)	32 (25–40)	32 (29–41)	31
%	91 (89–93)	91 (89–92)	90 (89–92)	92

*% = percentage of total body length measured from anterior extremity.

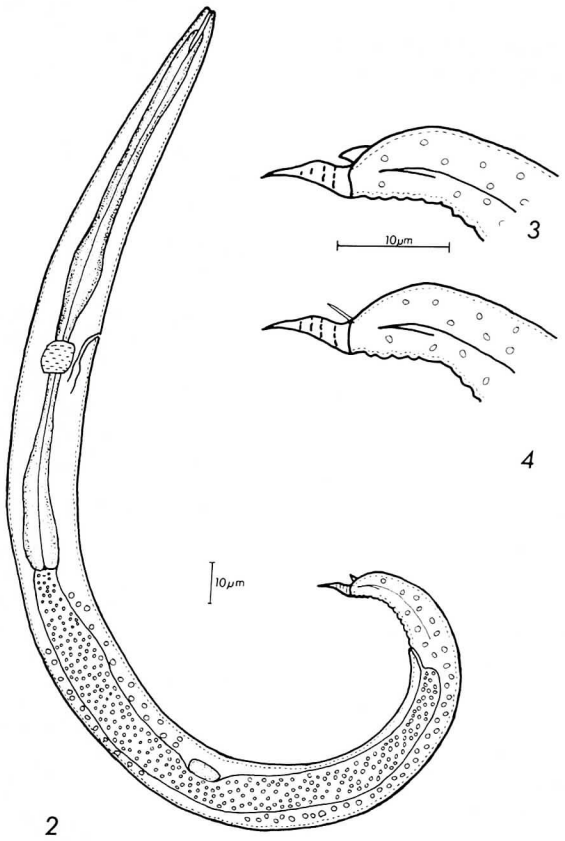
Pryadko and Boev 1971) in European reindeer (*Rangifer tarandus tarandus*) (Table 2). Most larvae from caribou had a prominent dorsal caudal spine (Figs. 2, 3), but the caudal spine on a few larvae from the Manitoba locations was slender and often difficult to observe (Fig. 4). Two larvae from infected animals at Sasaginnigak Lake had no detectable spine on the tail, yet otherwise in size and appearance were identical to larvae with a dorsal spine from the same animal. This variation may be expected, yet the possibility exists that more than one species of protostrongylid is involved.

An initial suspicion that the long-isolated caribou of the Slate Islands may be resistant to the pathogenic effects of *P. tenuis* now seems unlikely. Firstly, published literature indicates that *Rangifer tarandus* is particularly susceptible to *P. tenuis*; apparently more so than any cervid studied (Anderson and Strelive 1968). The prevalence of worms and lesions in the dorsal and lateral funiculi, as well as the suddenness of the onset of clinical signs, distinguished experimentally infected caribou from other susceptible animals such as moose, wapiti, and mule deer. Also, reindeer and caribou introduced on range inhabited by infected white-tails succumb rapidly to parelaphostrongylosis (Behrend and Witter 1968; Anderson 1971; Trainer 1973; and Dauphiné 1975). Finally, this study establishes the presence of similar protostrongylid larvae in faeces of caribou far removed from the Slate Islands, suggesting that it may be a common parasite of woodland caribou and likely to occur widely in this host.

In Eurasia, *Elaphostrongylus cervi rangiferi* is a common parasite of wild and domestic reindeer. Adult worms are apparently found in the cranial cavity, skeletal musculature, and middle ear (see a review of the extensive Soviet literature in Anderson 1968). Neurologic signs in infected reindeer, including weakness, paresis, and ataxia of hind limbs, have been reported in Swedish animals usually less than 1 year old (Ronéus and Nordkvist 1962). The occasional onset of such severe clinical signs in reindeer, a host frequently infected, is as yet unexplained. Anderson (1968) suggested that *E. cervi*, like *P. tenuis* may require a developmental period in the central nervous system. If so, the worm may be potentially hazardous if transmitted to other cervids.

Elaphostrongylus cervi is the only protostrongylid reported from *Rangifer* in Eurasia, where the parasite fauna of this host is best known (Pryadko and Boev 1971). On the basis of the present study, it seems reasonable to suggest that the same or related species of nematode may be widespread in woodland caribou of Ontario and Manitoba.

Elaphostrongylus sp. and *Pneumostrongylus* sp. (the latter genus referring presumably to the meningeal worm, formerly *Pneumostrongylus tenuis*, but presently regarded as *Parelaphostrongylus tenuis*) were reported by Bergerud (1971) in caribou of Newfoundland. To the best of our knowledge, specimens are no longer avail-



FIGS. 2–4. Protostrongylid larvae from woodland caribou faeces. Fig. 2. Lateral view. Fig. 3. Caudal extremity showing prominent dorsal spine. Fig. 4. Caudal extremity showing slender dorsal spine occasionally observed on recovered larvae.

able for study. This is particularly disappointing because at the time of Bergerud's publication *Elaphostrongylus* and *Pneumostrongylus* were not distinguished particularly well and a correct diagnosis may have been difficult. It is unlikely that *Parelaphostrongylus tenuis* occurs in Newfoundland, as white-tailed deer have never been present. Although the anatomical location of worms recovered was not mentioned by Bergerud (1971), subsequent enquiries establish that nematodes from caribou were collected from within the cranium (Bergerud, personal communication). An attempt is presently being made to collect and study new material from Newfoundland.

In view of our findings, a reconsideration of other works reporting unidentified protostrongylid larvae in cervids of North America may be possible. Karns and Jordan (1969) found larvae (1 in each of 2 samples of 240 examined) indistinguishable from those of *P. tenuis* in moose faeces on Isle Royale. Considering the known pathogenicity of *P. tenuis* to moose (Anderson 1964, 1965), it seems highly unlikely that this parasite could persist in a moose population for 30 years, since deer were last known on the island. If the presence of some metastrongyloid in moose on Isle Royale is confirmed, it is not likely to be *P. tenuis*. Caribou, however, were present on Isle Royale until as late as 1925 (Mech 1966). If a protostrongylid nematode is present in moose of Isle Royale, it may have originated from caribou and its persistence would suggest that the nematode is not pathogenic to moose, at least to the same degree as *P. tenuis*.

Bindernagel and Anderson (1972) found larvae indistinguishable from those of *P. tenuis* in faeces (9%) of white-tailed deer in eastern and central Saskatchewan, but were unable to recover adult nematodes in the cranium of 60 deer heads examined from the same area. Samuel and

Holmes (1974) also reported similar larvae in faeces collected from mule deer habitat in western Alberta, yet were unable to find adult *P. tenuis* in a large number of deer heads from throughout the province. It is interesting to note that parts of these areas in Saskatchewan and western Alberta where protostrongylid larvae were recovered are presently inhabited by woodland caribou (Banfield 1974). The possibility that a protostrongylid in deer in central and western Canada may have originated from caribou should be considered. The apparent absence of neurologic disease in white-tailed and mule deer in these areas may indicate that they are tolerant hosts of such a worm.

Further studies are presently underway to determine the specific identity of the protostrongylid in caribou and pathogenic effects it may produce when transmitted to other native cervids.

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