

Elaphostrongylus sp. (Nematoda, Protostrongylidae) and other helminths in faeces of moose (*Alces alces* (L.)) in North Norway

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Faecal samples collected from 103 moose (*Alces alces*) in Troms and Finnmark counties during the hunting season of September–October 1975 were examined. The faeces of all moose older than one year contained eggs or larvae of gastro-intestinal nematodes. In addition, gastro-intestinal nematodes were found in the faeces of one of the three moose calves examined. Digenean eggs, probably of *Paramphistomum cervi*, were found in 10 per cent of the faecal samples from moose older than one year. First stage larvae of *Elaphostrongylus* sp. were found in 26 (25%) of the faecal samples, but such larvae were not found in the 3 calves. Relatively more moose from Troms county than from Finnmark county had larvae of *Elaphostrongylus* in their faeces, but the opposite trend was observed for eggs of trematodes. Both the prevalence and mean l.p.g. of *Elaphostrongylus* larvae were lower in faecal samples from moose than in samples from reindeer occurring in the same area. Small intestines, livers, lungs and brains of a small number of moose collected in Troms during the 1976 hunting season were also examined. *Nematodirella alcidis* and *Trichostrongylus capricola* were found in all of the 8 small intestines examined. *Dictyocaulus viviparus* was found in 1 of 10 lungs examined, but none of 10 livers and 3 brains were infected with helminths.

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INTRODUCTION

Evidence from rock carvings (Hagen 1976) and excavated bone fragments (Olsen 1975) suggests that both reindeer (*Rangifer tarandus* L.) and moose (*Alces alces* (L.)) are old inhabitants of North Norway. Reindeer has been continuously present in significant numbers since the last ice age, but the abundance of moose has fluctuated markedly and the species may have been absent during some periods. According to Lykke (1960), the distribution of moose in Scandinavia was restricted to South- and Mid-Sweden around 1700 A.D., and it later reappeared in Mid-Norway around 1860. During the period from 1940 to 1970 the moose has increased its area dramatically in North Norway (Myrberget 1972, 1979), and reindeer and moose may now be found using the same habitats, particularly during winter and spring.

Elaphostrongylus rangiferi Mitskevich is a common parasite of reindeer in North Norway (Halvorsen 1979, 1981, Halvorsen et al. 1980,

and unpubl. obs. by O.H.), and epidemic outbreaks of elaphostrongylosis in reindeer herds have been recorded (Bakken and Sparboe 1973, Kummeneje 1974).

The first observation of *Elaphostrongylus* sp. in European moose was made in Sweden by Nilsson (1971).

In North America, the nematode *Parelaphostrongylus tenuis* Dougherty, which has White-tailed deer as its normal host, causes «moose sickness» in areas where the distribution of the two cervids overlap. This influences the overall distribution and abundance of moose (Anderson 1972).

It may, therefore, be pertinent to investigate the occurrence of *Elaphostrongylus* in moose, the possible effects of infection on the moose population, and the relationship between the infections in moose and reindeer. The results of a survey of parasites found in moose faeces collected in Troms and Finnmark counties, North Norway, are presented in this paper.

MATERIAL AND METHODS

Moose faeces were collected during September–October 1975 with the co-operation of a number of hunters. They were requested to take a small sample of faeces from the rectum of each moose shot and to store the sample either cooled or frozen in a polythene bag until it could be sent to the laboratory in Tromsø. In the laboratory the faecal samples were stored deep frozen until examined. Subsamples of approximately 1 g faecal material were subjected to baermannisation and flotation and then examined in a plankton counting chamber on an inverted microscope.

Faecal samples collected from 103 moose were received, of these 71 were collected in Troms and 32 in Finnmark. This material represented samples from 40% and 44% of the total number of moose reported shot during the season in Troms and Finnmark respectively.

Faecal material was obtained from 1 calf and 70 (48 males and 22 females) moose older than 1 year in the Troms district and from 2 calves and 30 (16 males, 13 females, and 1 unsexed) moose older than 1 year in Finnmark.

RESULTS

More males than females had *Elaphostrongylus* larvae in their faeces, but this difference was not statistically significant, neither within each county, nor when all observations were pooled (Fishers exact probability test and X^2 test).

More moose from Troms than from Finnmark had *Elaphostrongylus* larvae in their faeces (Table 1). This difference was statistically significant when sexes were treated together ($0.05 > P > 0.01$) and for females ($P < 0.05$), but not for males ($P \approx 0.12$).

In Troms, moose infected with *Elaphostrongylus* sp. were found in 11 of the 13 local council

areas (kommuner) from which samples were obtained, and these positive samples were collected from widely different regions of the county including the islands, the fjord areas, and inland areas (Fig. 1). The faecal samples from Finnmark were collected in 6 different council areas covering the same regional range as those in Troms, but positive samples were found only in moose shot in Karasjok and Sør-Varanger (Fig. 1). Both these council areas fall partly within the area of the North-Western extension of the coniferous forest.

Larvae or eggs of gastro-intestinal nematodes were found in all the faecal samples with the exception of those collected from two of the calves. *Nematodirella alcidis* (Dikmans) and *Trichostrongylus capricola* Ransom were found in all the 8 small intestines obtained from moose shot in Tromsø kommune during 1976. One of 10 lungs contained *Dictyocaulus viviparus* (Bloch), but helminths were not found in the 10 livers and the 3 brains examined.

Digenean eggs, assumed to be those of *Paramphistomum cervi* (Schränk) were found in the faeces of 3 of 70 (4.3%) moose from Troms and 7 of 30 (23.3%) moose from Finnmark. This difference is statistically significant ($P = 0.01$).

DISCUSSION

The results of the present investigation suggest that moose in North Norway are commonly infected with gastro-intestinal nematodes. Similar findings have been reported for moose from Sweden in which *N. alcidis* and *T. capricola* were the most prevalent intestinal nematodes (Nilsson 1971).

Nilsson (1971) found both *Fasciola hepatica* L. and *P. cervi* in the Swedish moose, but there are very few verified observations of *F. hepatica* in Troms and Finnmark, so the digenean eggs in the faeces of moose from this region are most probably those of *P. cervi*.

Several genera of the family Protostrongylidae, including *Elaphostrongylus*, have first stage larvae which have a caudal dorsal spine, and at present these larvae can not be identified solely on morphological characters.

In addition to *Elaphostrongylus* sp., Nilsson (1971) included *Muellerius capillaris* (Mueller) and *Bicaulus* (= *Varestrongylus*) *alces* (Demidova et Naumitscheva) in his check-list of moose parasites. The record of *M. capillaris* stems from Wetzel and Enigk (1936), and the larvae in moose faeces which they identified as

Table 1. The prevalence of *Elaphostrongylus* sp. first stage larvae in faeces from male og female moose from Troms and Finnmark counties.

Male	Troms	Finnmark
Samples (n_1)	48	16
Positive	17 (35.4%)	3 (18.8%)
Female		
Samples (n_2)	22	13
Positive	6 (27.3%)	0 (—)
$n_1 + n_2$	70	29
Positive	23 (32.9%)	3 (10.3%)

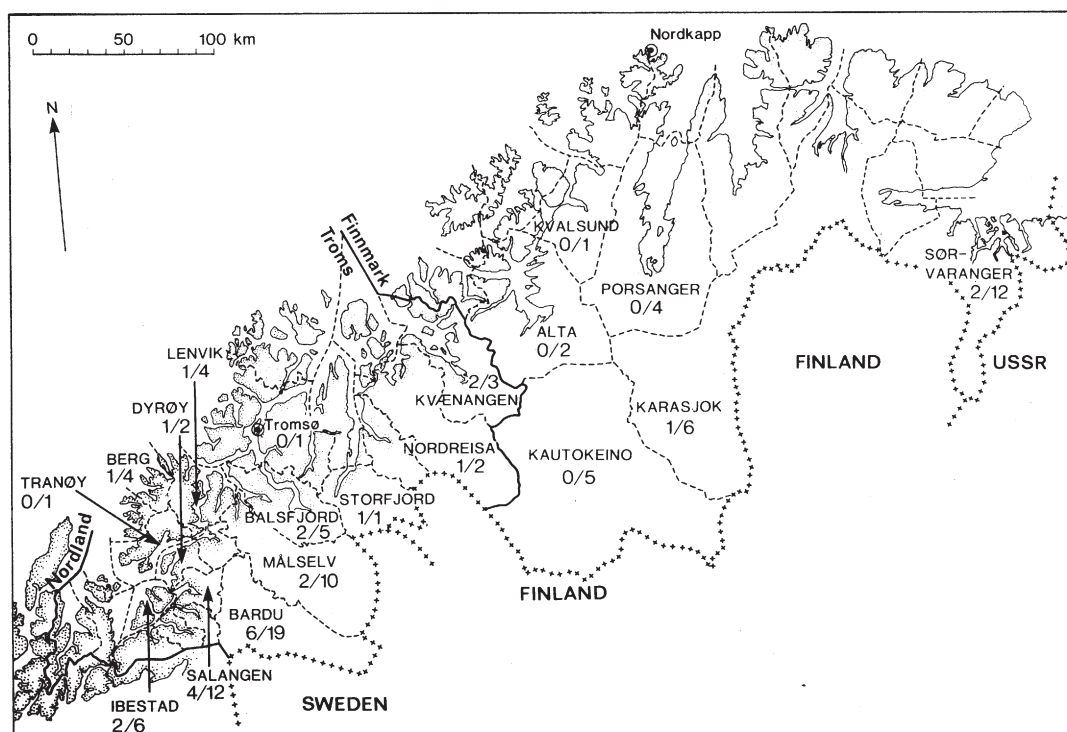


Fig. 1. The positions of local council areas (kommuner) in Troms and Finnmark counties from which faecal samples from moose were obtained in September–October 1975.

The fraction of samples containing first stage larvae of *Elaphostrongylus* sp. relative to the total number collected is shown for each area.

M. capillaris may have been those of *Elaphostrongylus* sp. Drozd (1966) found *V. alces* in 2 out of 5 moose examined in Poland, and gave USSR and Poland as the geographical distribution of this nematode.

Elaphostrongylus sp. is the only protostrongylid known to occur in moose in Scandinavia. It has been found by dissection in moose from Sweden (Nilsson 1971) and from South and

North Norway (Holt 1982, K. Kummeneje pers. comm.). It is, therefore, most likely that the protostrongylid first stage larvae found in moose faeces in the current study were larvae of *Elaphostrongylus* sp.

Lankester and Northcott (1979) concluded that all Eurasian cervids were infected with the same *Elaphostrongylus* species, that is, *E. cervi* Cameron, which was originally described from red deer. Material from European moose has not been studied taxonomically, so the use of *Elaphostrongylus* sp. may be preferable for worms infecting this host. The name *E. rangiferi* has been used for worms from reindeer.

Wissler and Halvorsen (1976) reported that there were seasonal variations in the density of first stage larvae of *E. rangiferi* in the faeces of infected reindeer, and that the minimum density was reached in September/October. If the output of first stage larvae of *Elaphostrongylus* sp. from moose follows the same kind of seasonal pattern as that of reindeer, samples examined in the current study were obtained at a time when

Table 2. The prevalence and density (mean l.p.g. of positive samples) of *Elaphostrongylus* first stage larvae in faeces from reindeer and moose in Porsanger and Karasjok in September 1975.

	Reindeer 1.5 years old	Reindeer 2.5 years and older	Moose
Examined	22	12	10
Positive	7 (31.8%)	9 (75.0%)	1 (10.0%)
Mean l.p.g.	16.6	39.6	2.0
Max l.p.g.	40	112	2

the output of larvae would be expected to be close to minimum. The overall prevalence of infection may, therefore, be considerably higher than recorded in the current study, and it may be concluded that *Elaphostrongylus* sp. is a common parasite of moose in Troms and parts of Finnmark. Available information (Nilsson 1971, Holt 1982, and this paper) would suggest that *Elaphostrongylus* sp. is a relatively common parasite of moose throughout its entire distribution area on the Scandinavian peninsula.

The population density of moose is much lower in Finnmark than in Troms (Myrberget 1972), and the difference in prevalence of infection may, therefore, be a consequence of the difference in host population density. If, however, this was the case one would expect to find the same trend for trematode infection, but trematode eggs were more prevalent in Finnmark than in Troms.

Although *Elaphostrongylus* sp. was rather prevalent in moose, the number of larvae per gram faeces was low compared to that observed in reindeer herds at the same time of the year. Anderson and May (1978) concluded from a theoretical study that when overdispersed burdens of parasites per host, with small mean, were observed in the field, parasite induced host death rate was likely to be relatively high. Moose deaths from elaphostrongylosis have been recorded both in South and North Norway (Holt 1982, K. Kummeneje pers. comm.) indicating that the pathogenicity of the parasite is considerable.

E. rangiferi is very prevalent in reindeer from Finnmark (Halvorsen 1979, Halvorsen et al. 1980, Halvorsen 1981). During September 1975 faecal samples were obtained from a reindeer herd (The Munkovarre herd) which has its summer range in Porsanger council area and winter range in Karasjok council area (Table 2). Of 22 samples obtained from 1.5 years old deer, 7 contained larvae of *E. rangiferi*, and of 12 faecal samples from deer 2.5 years or older, 9 were positive. Of the faeces collected from 10 moose killed in these two areas during autumn 1975 larvae of *Elaphostrongylus* sp. were found in only one sample. It appears therefore that infection with *Elaphostrongylus* may be quite different in reindeer and moose even when they occur in the same area with considerable overlap in habitat during large parts of the year.

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