On the efficacy of ivermectin against the reindeer sinus worm *Linguatula arctica* (Pentastomida), with a review on ivermectin treatment in reindeer

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Abstract: This field study compared the infection level of *Linguatula arctica* in 14 treated and 19 control calves of the reindeer host *Rangifer tarandus.* Eighty calves were each treated subcutaneously with 1 ml (200-250 µg/kg) ivermectin primo December, to ensure that a sufficient number of treated animals later would be selected by the herders for slaughtering. The target parasite *L. arctica* was then in the reproductive stage of its life cycle. The reindeer were slaughtered in ultimo February. In the treated group, one reindeer was found infected (prevalence 7.1, relative density 0,1), whereas the infection level for the 19 untreated animals was much higher (prevalence 68.4, relative density 7,3). Our conclusion is that ivermectin is an effective agent against *L. arctica,* (and possibly against other pentastomids because of their similar arthropodal nerve system). This is the first report of ivermectin treatment against a pentastomid species. Additionally, the study confirmed that ivermectin was fully effective against the nose bot fly *Cephenemyia trompe.*

Key words: *Linguatula arctica, Rangifer tarandus, Cephenemyia trompe,* Pentastomida, Cervidae, reindeer, sinus worm, Ivermectin, treatment, anthelmintic, pesticide.

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Introduction

Treatment in reindeer

Ivermectin is a systemically active and very efficient compound against many nematodes, parasitic insects and acarines, but it has no effect against trematodes, cestodes, protozoa and bacteria (Campbell *et al.* 1983; Campbell 1985; Bruce 1987; Jackson 1989). Ivermectin paralyses the parasites, but compared with other neuroactive insecticides, this drug is considered to be slow-acting.

A suppression of the reproductive processes has been observed, and in ectoparasitic insects and acarins ivermectin interrupts the feeding mechanisms (Campbell 1985; Wright 1986). Ivermectin has proved to be highly efficient in the treatment of endoparasitic arthropods causing myiasis (Jackson 1989), including myiasis in reindeer (*Rangifer tarandus* (L.)).

Reindeer are troubled by many different helminth parasites, and each animal is normally infected by several parasite species simultaneously (Pryadko 1976; Tøllefsen 1983; Halvorsen 1986). Therefore, antiparasitic treatment has been used by reindeer veterinarians for a long time (Nordkvist 1967; Nieminen 1984). Nord-

kvist *et al.* (1983) considered ivermctin to be the overall most effective drug against reindeer parasites. Since 1983 many herding districts have started using this broad-spectrum agent to control parasites like the myiasis-inducing larvae of the nose bot fly and the warble fly, gastrointestinal nematodes and the nematodes causing elaphostrongylosis and dictyocaulosis (Nordkvist *et al.* 1983; 1984; Nieminen 1989; Soveri *et al.* 1990; Dieterich and Craigmill 1990).

Gastrointestinal parasitic infections in ruminants, even at a subclinical level, may cause significant weight reductions and anorexia, in particular among young animals (Coop *et al.* 1977; 1982; Symons 1985). Thus, ivermectin treatment of reindeer has improved their weight gain (Nieminen *et al.* 1984; Nordkvist *et al.* 1984; Heggstad *et al.* 1986; Heggstad 1988; Oksanen *et al.* 1992), and general body condition (Dieterich and Craigmill 1990).

Different treatment strategies have been used. Some Norwegian and many Swedish herders have treated calves, whereas Finnish, Alaskan and Canadian herders have used the drug nonselectively (Nordberg 1987; A. Karter, pers. comm.). The Scandinavian strategy underlines the importance of prevention rather than treatment (Norberg 1989; Haugerud 1990). Calves and young animals are also generally more affected by the reindeer arthropods than older animals (Persen *et al.* 1982). Nieminen (1989) concluded that ivermectin treatment pays economically. This statement should be critically questioned as economical gains may depend on the parasitological and ecologieal conditions, strategic assumptions and production and management systems (see Michel 1985; Norberg 1987; McKellar 1988; Lausund 1989; Haugerud 1989a).

The reindeer sinus worm

Among reindeer parasites, *Linguatula arctica* Riley, Haugerud and Nilssen 1987 had been overlooked until recently (Haugerud and Nilssen 1985; Riley 1986). This aberrant pentastomid (Haugerud 1988; 1989b) infects the nasal cavity of the host. Specimens are mostly found in the sinuses, hence the vernacular name. The parasite probably occurs throughout most of the holarctic distribution of the host (Haugerud 1986; Riley *et al.* 1987; Haugerud and Nilssen 1990). In the host population *L. arctica* seems to infect calves only. There is a direct transmission of the parasite from yearlings to newborn calves grazing on summer pastures when the former expell infective eggs with their nasal secretions (Haugerud 1988; Haugerud *et al.* in manus).

Pentastomids are arthropods (Riley 1986), and they are now regarded as an atypical group of parasitic crustaceans (Grygler 1983; Schram 1986; Abele *et al.* 1989). Because of their arthropodal connection it has been anticipated that ivermectin would have an effect against *L. arctica* (Haugerud 1986; Haugerud and Nilssen 1990). This suggestion has not been investigated previously, and nor have other pentastomids been tested for the susceptibility to anthelmintics (Jones and Riley 1991). In the literature, information is scarce about treatment of linguatulosis (Riley 1986), and a Biosis literature search failed to find papers on the control of linguatulosis.

The objective of this field investigation was to test the effect of *ivermectin* on a pentastomid species. The reindeer host was treated at a date and with a dose normally used for the oestride larvae.

Material and methods

Management of experimental herd

The host material included calves belonging to the Bals-Skum siida (reindeer herding group) of the Spalca reindeer district (District no 33) in the municipality of Kautokeino, Finnmark county, northern Norway. Their summer pastures are at 70°N at the coast in Troms county, about 200 km from the continental winter habitat in Øvre Anarjåkka National Park near the Finnish border. The spring herd consisted of about 3000 animals with an additional 1300 calves in the autumn.

Ivermectin was injected subcutaneously during the reindeer's southward migration on Dec. 6. 1990. At this time the siida corralled for the first winter slaughtering near the church village of Kautokeino, before the herd was driven the last 75 km to the Anarjåkka pastures. In ultimo Febrnary, the animals selected for the second slaughtering were driven from Anarjåkka to the abattoir of Kautokeino where they were slaughtered on Feb. 28. 1991.

Experimental animals, design and treatment

Calves are the only *Linguatula*-infected segment of the host population, and during winter the

whole parasite population is probably found in the reindeer host. Ontogenetically, these parasites have reached the copulative stage in December (Haugerud 1988), and they were hypothesised to be in a susceptible stage for treatment at that time.

In our trial 80 calves (about 6 % of the total number of calves) of both sexes were randomly captured inside the fences, treated and marked with spray-paint around the neck. Each experimental calf, with an estimated live weight of 40–50 kg, was given 1 ml (dosage 200–250 µg/kg) ivermectin subcutaneously (Ivomec 1 %). The remaining animals in the herd were left untreated. After treatment the calves were released with the untreated animals, and they joined the herd to the winter pastures. Untreated calves, selected at random, were used as control animals.

Nearly three months after treatment, some of the animals in the herd were slaughtered at the Kautokeino abattoir. The heads of all treated calves (14 animals) were identified by the spray mark and collected for laboratory investigation at the University of Tromsø. At the same time 19 heads of untreated calves were randomly collected as a control group.

Laboratory examinations

In the laboratory, the heads were sagittally sectioned and examined under surgical light, and the nasal bones were removed and the sinuses exposed. The parasites, 3 to 12 cm in length, could then be easily discovered (Haugerud 1988). To be sure that all parasites present would be found, each sample was rinsed and sieved, using a special technique originally used for sampling first instar larvae of the reindeer nose bot fly (Nilssen and Haugerud, in manus). This procedure therefore gave additional data on the effect of ivermectin on *C. trompe*.

Statistical analysis

The results were tested statistically with chi-square and Fisher exact tests in Systat, version 5.2 (Systat 1992).

Results

Table 1 summarises the presence of *L. arctica* and *C. trompe* in the treated and untreated (control) groups of reindeer. Table 2 gives additional epidemiological data of *L. arctica* (terminology from Margolis *et al.* 1982), and these data are compared with the results from a previous study of untreated calves (Haugerud 1988).

L. arctica was found in one calf in the treated group (7.1 %) (table 1). In the untreated group the prevalence was 68.4 %, which is higher than comparable data from other herds (table 2).

Table 1. Effect of *ivermectin* treatment on the prevalence of *L. arctica* and *C. trompe* in reindeer. The number of reindeer calves with and without the reindeer sinus worm and the reindeer nose bot fly in the treated and untreated (control) group three months after treatment.

		Treated (n=14)		Untreated (n=19)	
L. arctica	Present	1	Prev:	13	Prev:
	Absent	13	7.1	6	68.4
C. trompe	Present	0	Prev:	17	Prev:
	Absent	14	0	2	89.5

Table 2. Epidemiological data on *L. arctica* from treated and untreated reindeer calves. N = number of calves investigated; n = total number of *L. arctica* specimens.

Group	N	n	relative density	mean intensity	prevalence
Treated	14	2	0.1	2.0	7.1
Untreated	19	138	7.3	10.6	68.4
Untreated[1)]	25	58	2.3	4.1	56.0

1) February/March data from Haugerud (1988)

As uninfected calves were also present in the control group, there is a certain probability that the low prevalence in the treated group appeared by chance. However, there was a highly significant lower prevalence in the treated group than in the control group. The probability that the lower prevalence of *L. arctica* in treated animals was caused by chance, was according to the chi-square test: $p = 0.0016$ (x^2 (Yates corrected) = 10.01, df = 1); and the Fisher exact test (two-tail): $p = 0.0009$. The corresponding values for *C. trompe* were: $p = 0.000002$ ($x^2 = 22.38$) and $p = 0.0000001$. (See table 1). Hence, the conclusion is that ivermectin kills the pentastomid *L. arctica* in reindeer.

All calves in the control group were infected with one or both of the nasal arthropods. No first instar larva of *C. trompe* was found in the treated group, whereas the prevalence of *C. trompe* was 89.5 % in the untreated group (table 1).

There were no morphological differences between the specimens of *L. arctica* found in the treated calf and those found in the untreated animals.

Discussion

As hypothesised, ivermectin was an efficient agent against *L. arctica.* and our field trial confirmed earlier results that ivermectin is a highly efficient drug against nose bot fly larvae (Nordkvist *et al.* 1983; 1984).

Ivermectin was, however, not fully (100 %) effective against *L. arctica*, as the parasite was found in one of the treated animals. This may be due to resistance to the drug, or to errors originating from the field situation at treatment or at the abattoir at sampling. Moreover, a stressful situation while gathering the animals combined with cold temperature and dense hair-coats, renders the possibility of incompletely or badly set injections (see Dieterich and Craigmill 1990). Sublethal concentrations of the drug can result in apparently normal and complete arthropod life cycles (Jackson 1989). The working conditions were also difficult at the abattoir. Even with all the practical problems and small samples, the main results are indeed highly significant.

Our study showed that ivermectin has a good effect against adult *L. arctica* which lives free in the sinuses where it feeds on body fluids. The effect on younger stages will probably be even better because these earlier (and smaller) arthropod instars may be more susceptible than the older developmental stages (Jackson 1989).

The possible impact of ivermectin treatment at population level of *L. arctica* has been discussed (Haugerud and Nilssen 1990). Theoretically, the life cycle of *L. arctica* makes it especially vulnerable to antiparasitic treatment. With extensive treatment in semidomestic reindeer calves, wild reindeer will be a very important reservoir to save this parasite species as a part of the biodiversity.

At present we know little about the possible effects of *L. arctica* on its host, and consequently about need for treatment. However, if reindeer are treated with ivermectin to control other parasites, e. g. the reindeer oestrids, then *L. arctica* will be killed as well.

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Errata

to Rangifer No. 13 (3)–1993:

In the paper by Haugerud *et al.* under References, page 160 the following two references were missing.

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