Neurological disorder in two moose calves (*Alces alces* L.) naturally infected with *Elaphostrongylus alces*

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Abstract: Two months old moose calves exhibiting neurological signs were videotaped, killed and necropsied. The parasite *Elaphostrongylus alces* (Steén et al 1989) was found epidurally along the meninges of the spinal cord, and in the muscle faciae of the thoracic and lumbar regions. Progressive inflammatory processes were present in the epineurium, perineurium and endoneurium. Accumulations of inflammatory cells, eosinophils, lymfocytes and macrophages, were found around eggs and larvae and frequently, around regional blood wessels. The neurological disturbances in the moose calves were pronounced, with locomotive abnormalities and ataxia. They showed weakness in the hindquarters, with uncoordinated and swaying movements of the hind legs. In addition, one of the calves was lame on the left forelimb. The muscles of the leg were visibly atrophic.

The lesions produced by *E. alces* at the lumbar nerve roots and in the *cauda equina* are suggested to be the cause of the clinical signs observed.

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Introduction

Elaphostrongylus spp. are parasitic nematodes associated with the central nervous system and muscle fasciae of a variety ofcervids (Cameron 1931, Lyubimov 1945, Mitskevich 1958, Roneus and Nordkvist 1962, Kummeneje 1974, Krutzer and Prosl 1975, Mason et al 1976, Sugar 1978, Steén and Rehbinder 1986, Stuve, 1987).

Elaphostrongylus spp. have been knovn to cause neurologic disorders in wild and domesticated cervidae, as red deer *(Cervus elaphus* L.) (Borg 1979), maral deer *(Cervus elaphus sibiricus)* (Vsevolodov and Pryadko 1964) and reindeer *(Rangifer tarandus tarandus* L.). (Roneus and Nordkvist 1962, Kummeneje 1974).

Experimental infections have been performed in different cervids, as caribou *(Rangifer tarandus caribou)* (Lankester 1977), reindeer (Mitskevich 1964), red deer (Watson 1982) and moose *(Alces alces* L.) (Lankester 1977, Stuve and Skorping 1987.) Watson (1982) reported that *E. cervi* infection in red deer calves, produced exercise intolerance, blindness, hind limb incoordination and nervous disorders. A moose calf infected with L3-larvae obtained

from caribou showed pronounced weakness primarily affecting the hindlimbs. The process progressed rapidly until the calf after four months was unable to stand up (Lankester 1977). Stuve and Skorping (1987) experimentally infected a moose calf with *Elaphostrongylus* larvae obtained from moose. The moose calf showed neurological disorders, but recovered

The present study is the first to report on a natural infection with *E. alces* in two wild moose calves with clinical manifestation of neurological disorders.

Material and methods

In May 1987 two approximately 11 months old moose calves, one male and one female, exhibiting neurological signs, were found in the county of Lapland in the northern part of Sweden. They were studied and videotaped before being killed and necropsied.

The brain and the whole spinal cord with nerve roots were removed and examined for *E. alces* and pathological lesions. Skeletal muscles were examined for the occurence of the parasite. Visceral organs were inspected macroscopically and microscopically. The brain, spinal cord, nerve roots, fasciae from skeletal muscles and visceral organs were fixed in 10% formaline and prepared for histology. Nematodes found were fixed in heated 70% ethanol and identified. Bone marrow fat content was examined according to the method of the Nordic Committee on Food analysis (1955).

Results

Neurological signs

Case 1.

The female calf appeared week, uncoordinated and indifferent to human proximity. She rose with difficulty, leaning her cheek against the ground in order to gain and support balance (Fig 1, 2). When standing, her hind limbs were shivering, unsteady and weak, and the lumbar region was lowered (Fig 3).

When rising and standing on her carpal joints, she had difficulties to lift the hind part of her body with the hind legs. She was able to rise to a standing position only by supporting herself against a tree. When standing the hind legs were notably weaker than the front legs, and the left hind leg was often abducted. The calf put most of her weight upon her front legs when walking with unsteady swaying movements of the hind quarters and a broad gait (Fig 4). Forced to move, she lifted the forelimbs abnormally high and brought them down in a stamping fashion. She easily stumbled over when handled or even when walking on slightly uneven ground. The calf did not seem to be mentally affected and was alert.

Case 2.

The male calf was observed in an area of approximately 50 m^2 that was totally browsed. Like the female calf he appeared weak, uncoordinated and indifferent to disturbance. In attempts to rise he often remained in a position of a "sitting dog". He was lame in his left forelimb, which had atrophic muscles (Fig 5). When standing the body weight was mainly supported by the right forelimb and the left hind limb. The left front leg was frequently adduated (Fig 6). When forced to turn, the animal's hind quarters swayed even while standing on both hindlegs (Fig 7, 8, 9). He frequently stumbled over when moving (Fig 10, 11, 12, 13). The hind leg gait was abnormally broad (Fig 6). The calf seemed to be aware and alert.

Gross pathological findings

In both calves several adult *E. alces* were found epidurally in the lumbar region of the spinal canal and in the cauda equina. In the male calf, parasites were also located epidurally in the thoracic region. The presence of *E. alces* was caracterized by hemorrhage and oedema in the surrounding tissues.

Parasites were also found in the fasciae of the thoracic and lumbar muscles without surrounding reactions. The bone marrow fat content was low (0.01%; 3.5% respectively), and both calves were emaciated.

Histopathological findings

In the connective tissue surrounding the spinal cord, close to the nerve roots, aggregates of mainly mononuclear leucocytes around blood vessels were a common finding. The inflammatory reaction was generally characterized by oedema, hemorrhages and infiltrations by lymfocytes, plasma cells, eosinophiles and macrophages. Signs of intensive phagocytosis were seen as macrophages were partly or completely filled by detritus masses.

The inflammatory changes in the meninges often extended to the spinal nerve roots. Granulomas were observed around eggs and larvae. They were surrounded by a thin capsule of connective tissue. Infiltrates by mainly lymfocytes, were frequently found to extend into the nerve tissue, invading the epineurium, perineurium and endoneurium.

Discussion

The locomotive abnormalities with symptoms of ataxia, as incoordination, swaying of the hindquarters, broad and stamping gait and a certain amount of hypermetria suggest paralysis of ascending proprioceptive nerve fibers.

It is known that the long proprioceptive nerve fibers in the spinal cord and in the dorsal ganglia are those to be injured first by compression. (de Lahunta 1977).

The extent of the inflammatory reactions strongly indicates the possibility of a compression of the nerve fibers by hemorrhages, oedemas, granulomas and perivascular cuffings, causing the described functional nervous disturbances. Due to the circumstances during the examination of the animals, paralysis due to compression of efferent nervfibres can not be excluded as the spinal nerves, carry both afferent and efferent nervfibres. The locomotive disturbances described, might also be explained by the lesions shown in the epineurium, perinerium and endonerium, of the spinal nerves.

The epidural location of the nematodes and the inflammatory changes, as seen in moose, differs from that in other cervidae, where the parasites and the histopathological changes are found in the subdural and the subarachnoidal spaces (Roneus and Nordkvist 1962, Polyanskya 1963, Pryadko et al 1963, Mitskevich 1964, Barus and Blazek 1973, Prosl and Kutzer 1980). Whether the locomotive disturbances described in these two cases are solely due to the nervous tissue lesions, or partly caused by inanition and exhaustion, is difficult to evaluate.

It is thus necessary to perform experimental studies in order to obtain more conclusive data on the neurological effects of infestations by *E. alces* in moose.

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Fig. 1. Female moose calf rising with difficulty.

Fig. 2. Leaning her cheek against the ground to gain balance.

Fig. 3. Lumbar region is lowered.

Fig. 4. The gait is broad.

Fig. 5. Male moose calf with lame and atrophic left forelimb.

Fig. 6. Abnormally broad hindleg gait and the left frontleg adducted.

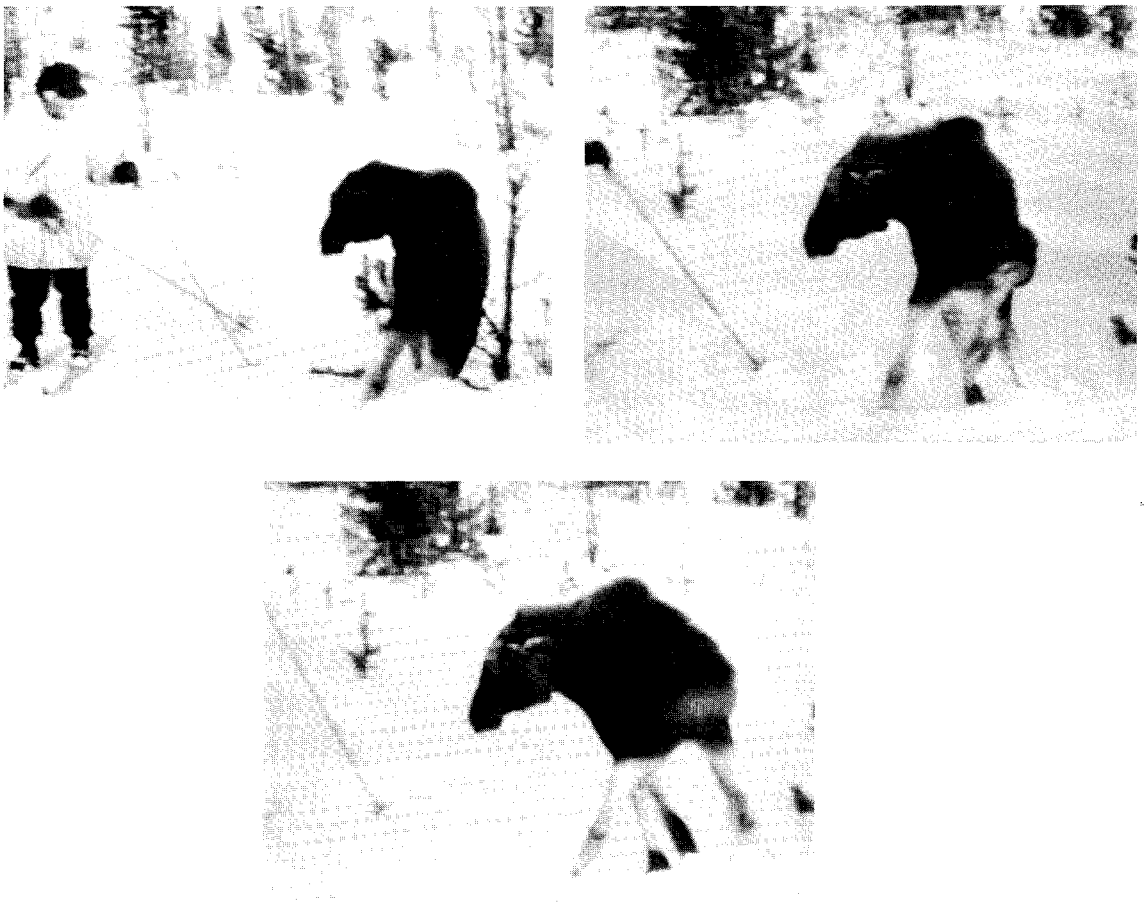

Fig. 7-9. Forced to turn, the hindquarter is swaying, weak and unsteady.

Fig.10-13. When moving, the male moose calf frequently stumbled over.