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SPECIES OF THE GENUS *ELAPHOSTRONGYLUS* PARASITE OF SWEDISH CERVIDAE. A DESCRIPTION OF *E. ALCES* N. SP.

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SUMMARY. A description of *Elaphostrongylus alces* n. sp., a parasite of moose (*Alces alces* L.), is given. The main features differing *E. alces* n. sp. from the other two investigated species are the bottle shaped oesophagus and the oval bursa, which is about 150 μm × 200 μm.

E. rangiferi Mitskevith, 1960, a parasite of reindeer (*Rangifer tarandus tarandus* L.) and *E. cervi* Cameron, 1931, a parasite of red deer (*Cervus elaphus* L.) have both a club shaped or cylindrical oesophagus and a circular bursa. The bursa of *E. rangiferi* is about 160 μm in diameter, and the bursa of *E. cervi* is about 190 μm.

Each species has been found only in its normal host.

Key-words: Elaphostrongylus. E. alces n. sp. *Alces.* Cervidae.

Les espèces du genre *Elaphostrongylus* parasites des Cervidés en Suède. Description de *E. alces* n. sp.

RÉSUMÉ. *Elaphostrongylus alces* n. sp. parasite de l'Élan, a, surtout chez les femelles, un œsophage en forme de bouteille, la jonction musculo-glandulaire étant marquée par un brusque élargissement. La bourse caudale est ovalaire (environ 150 μm de haut et 200 μm de large).

E. rangiferi Mitskevitch, 1960, parasite du Renne et *E. cervi* Cameron, 1931, parasite du Cerf, ont un œsophage claviforme ou cylindrique et une bourse caudale arrondie. Celle de *rangiferi* a environ 160 μm de diamètre, celle de *cervi* environ 190 μm.

Chacune des trois espèces n'a été trouvée que chez son hôte particulier.

Mots-clés: Elaphostrongylus. E. alces n. sp. *Alces.* Cervidés.

Introduction

Metastrongylid nematodes of the genus *Elaphostrongylus* are parasites associated with loose connective tissue of the central nervous system and in the muscle fasciae of a variety of cervidae.

Cervidae known to be infected are: reinderr (*Rangifer tarandus tarandus* L.), Mitskevithc 1958, Ronéus and Nordkvist 1962, Bakken *et al.*, 1973), moose (*Alces alces* L.) (Stéen and Rehbinder 1986, Stuve 1986), red deer (*Cervus elaphus* L.)

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(Cameron 1931, Mason 1976), (*Cervus elaphus sibiricus*) (Lyubimov 1945), sika deer (*Cervus nippon* T.) (Lyubimov 1959, Pryadko 1967) and roe deer (*Capreolus capreolus* L.) (Nilsson 1971).

In 1930 Miller found a nematode, about 5 cm long, in the fasciae beneath the *musculus latissimus dorsi* of a Scottish red deer (*C. elaphus* L.). The nematode was given the name *Elaphostrongylus cervi* by Cameron (1931).

Later two more species of the same genus have been described: *Elaphostrongylus panticola* by Lyubimov (1945) from red deer *(C. elpahus sibiricus*) in Asia and *Elaphostrongylus rangiferi* by Mitskevitch (1960), from reindeer (*R. tarandus tarandus* L.).

The taxonomical position of these species is, however, not clarified. Kutzer and Prosl (1975) stated *E. panticola* to be synonymous with *E. cervi*. They also considered *E. rangiferi* to be synonymous with *E. cervi*.

On the other hand, Pryadko and Boev (1971) considered *E. cervi cervi*, *E. cervi panticola* and *E. cervi rangiferi* to be subspecies of *E. cervi*.

Furthermore, Kontrimavichus, Delyamure and Boev (1976) carefully presented three different taxa with the differences in host species and geographical distribution as the only support of subspecification: *E. cervi* Cameron 1931 in *C. elaphus* L. in Europe, *E. cervi panticola* Lyubimov 1945 in *C. elaphus sibiricus* and *C. nippon* in Asia, and *E. cervi rangiferi* Mitskevitch 1960 in *R. tarandus tarandus* L. in Europe. They also mentioned moose (*A. alces* L.) as the host for *E. cervi* as well as for *E. panticola*. More recently Lankester and Northcott (1979) have also questioned the division into species.

Materials and methods

Nematodes were collected from moose (*A. alces* L.), reindeer (*R. tarandus tarandus* L.) and red deer (*C. elaphus* L.) in Sweden. The material originated from animals found dead or from animals shot during the hunting season in October. The sampling from reindeer was performed on slaughtered animals.

In moose the nematodes were found mainly epidurally along the spinal cord, whereas in the reindeer and red deer they were located in the muscle fasciae.

The nematodes were fixed in 70 % ethanol, heated to 70° C and thereafter measured and made descriptive drawings of.

The *Elaphostrongylus* material from moose consisted of 18 females and 18 males, from reindeer 14 females and 11 males, and from red deer 1 female and 2 males.

Results

Common morphological traits

Mouth rounded; buccal capsule very short, hexagonal in optical section in an en face view. External labial papillae and amphids are located on six small peri-

buccal ridges *(Figs. 1A and 1B)*. Tegumental sheath is absent but the external layer of the cuticle is differentiated.

Oesophagus short and thick. Deirids small and enclosed in a thickening of the cuticle, subsymmetrical and situated on the level of the excretory pore. Nerve ring anterior to the excretory pore *(Figs 1E and 1F)*. Excretory glands very voluminous, 2 to 4 mm long.

Female: Tail very short, rounded and with the vulva situated in the posterior part. Ovijector unpaired, 1 to 2 mm long, ending in a strong sphincter, unpaired posteriorly and splitting into two branches anteriorly. Each uterus directly connected to either of the branches of the sphincter *(Fig. 1D)*. None of the females examined carried mature eggs.

Male: Spicules are well illustrated by many authors (Lyubimov 1945, Mitskevitch 1960, Lankester and Northcott 1979). The axis of the spicules, of a spongy appearance, are concave interno-posteriorly in its anterior half and concave anteriorly in its posterior half. It supports two large alae, the postero-internal being almost as long as the entire spicule, the antero-external one is limited to two thirds of the terminal end of the spicule *(Fig. 1C)*. The gubernaculum has its posterior end granular and the anterior end thinner and less chitinous.

Specific morphological traits

— *Elaphostrongylus cervi* Cameron, 1931.

Three specimens were examined. Some measurements, indicated with a question mark, are not given because of damage to the specimens.

Female (one specimen): Length 62 mm; maximum width 200 µm; nerve ring 135 µm and excretory pore 150 µm from anterior end; oesophagus? µm long; excretory glands 2,900 µm long; vulva 215 µm from posterior end; common vestibule 1,930 µm long; tail 50 µm long.

Male (two specimens): Length 38 and ? mm; maximum width 170 and 170 µm; anterior ends damaged and unmeasurable; spicules 235 and 230 µm long; gubernaculum? and 95 µm long; bursa 180 and 180 µm high, 200 and 200 µm wide *(Fig. 2C)*.

— *Elaphostrongylus rangiferi* Mitskevitch, 1960.

Twenty-five specimens were examinated.

Female (three specimens): Length 50, 49, 49 mm; maximum width 210, 220, 225 µm; nerve ring 145, 130, 165 and excretory pore 195, 180, 220 µm from anterior end; oesophagus 660, 700, 680 µm long; excretory glands 2,600, 3,100, 3,750 µm long: vulva 640, 280, 225 µm from posterior end; common vestibule 1,600, 1,950, 1,600 µm long; tail 70, 75, 70 µm long.

Male (three specimens): Length 36, 33, 32 mm; maximum width 190, 220, 220 µm; nerve ring 150, 140, 150 µm and excretory pore 200, 200, 150 µm from anterior end; oesophagus 670, 580, 580 µm long; excretory glands 3,300, 2,900, 2,600 µm long; spicules 212, 222, 230 µm long; gubernaculum 75, 75, 75 µm long; bursa 150, 155, 140 µm high and 160, 160, 155 µm wide *(Fig. 2A)*.

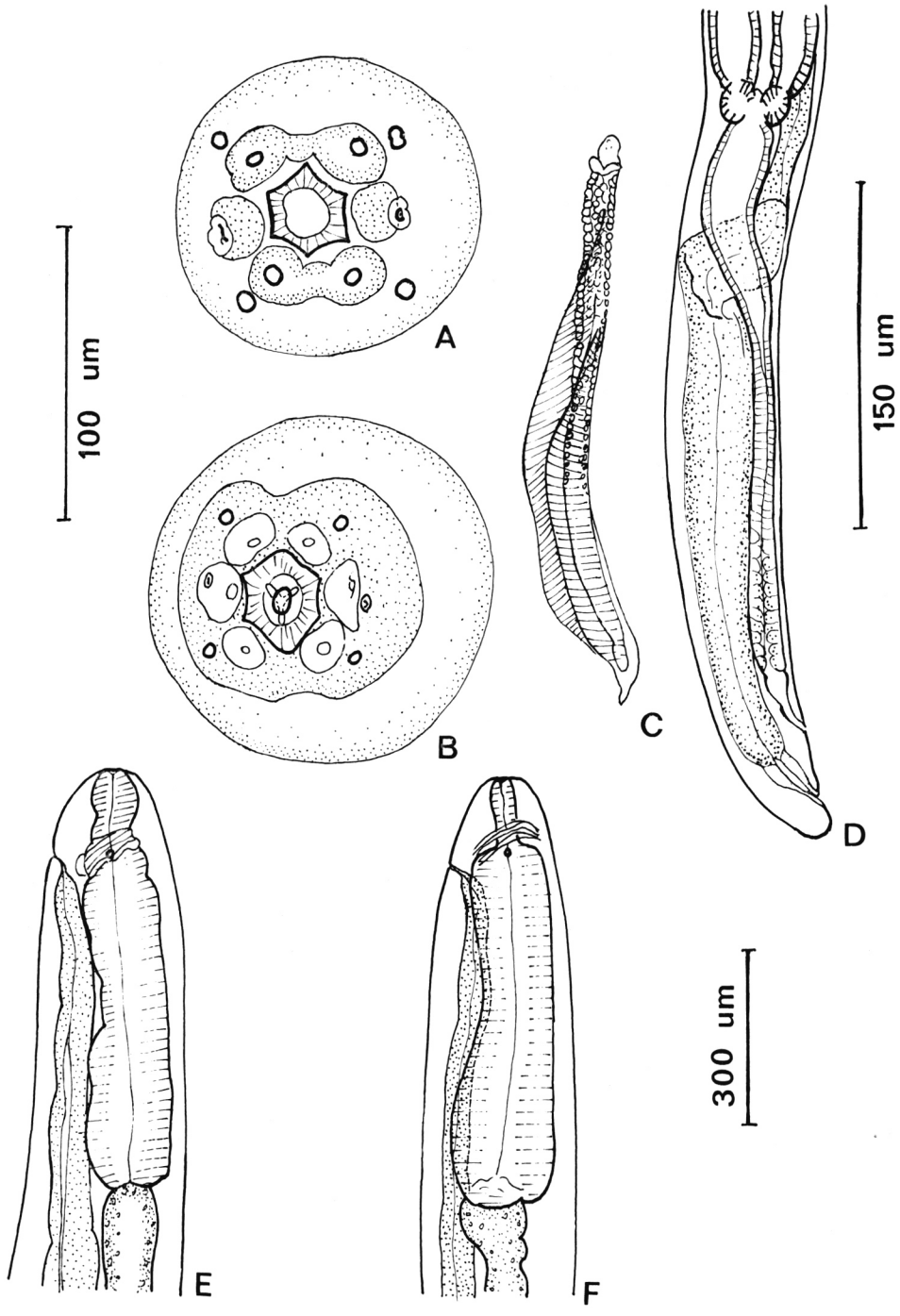

FIG. 1. — A: *E. rangiferi*, female, head, en face view. B: *E. alces*, female, head, en face view. C: *E. alces*, right spicule. D: *E. rangiferi*, female, head, posterior end, right view. E: *E. alces*, female, anterior end, left view. F: *E. alces*, male, anterior end, left view. Bar-scales: A, B: 100 μm, C: 150 μm, D, E, F: 300 μm.

The oesophagus is club shaped; there is no obvious swelling of the oesophagus at the musculo-glandular junction. The bursal rays and mainly the dorsal one are extremely variable; the dorsal ray often has a thick, bifurcated peduncle with slightly unequal appendages on each bifurcation. Genital cone rounded with prominent medium region. The teratological specimens are frequent, i. e. a specimen with the right side rays 4, 5, 6, and 8 atrophied *(Fig. 2B)*. Rays 4 and 8 are short, almost always shorter than the dorsal ray.

— *Elaphostrongylus alces* n. sp.

Thirty-six specimens were examined.

Female (four specimens, the first one is the holotype): Length 63, 65, 55, 62 mm; maximum width 310, 320, 290, 300 μm; nerve ring 185, 150, 95, 105 μm and excretory pore 165, 165, 105, 130 μm from anterior end; oesophagus 750, 740, 850, 830 μm long; excretory glands 3,600, 3,400, 3,500, 2,950 μm long; vulva 220, 190,

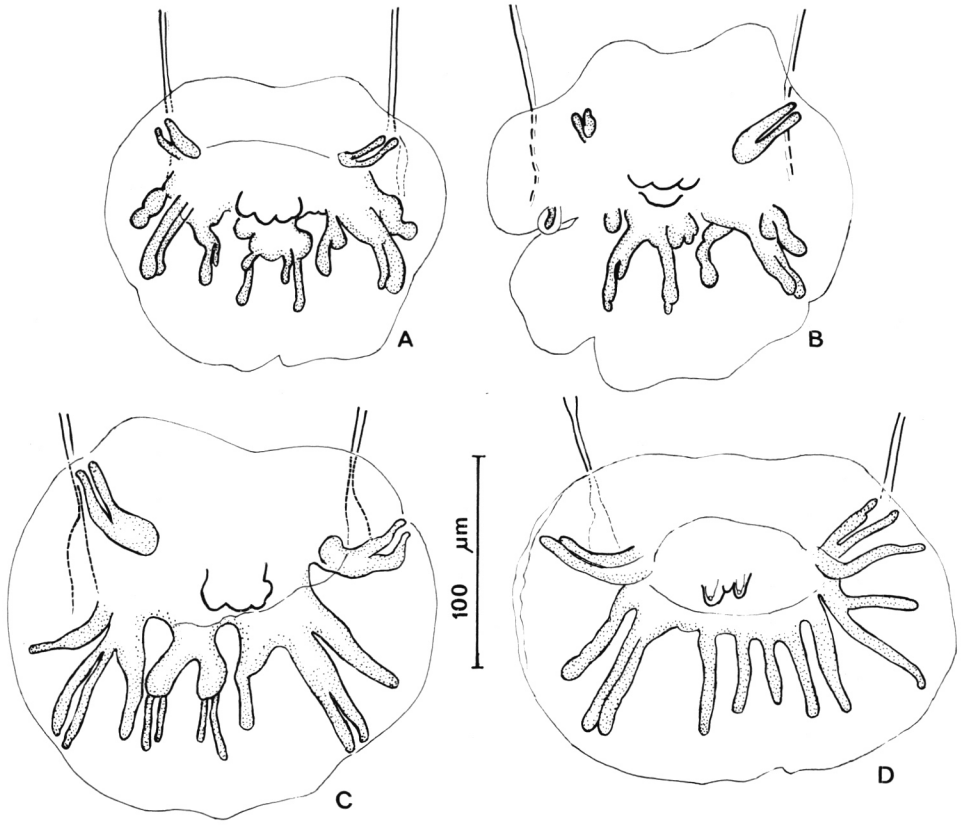

FIG. 2. — Caudal bursa, ventral view. A: *E. rangiferi*, Sweden. B: *E. rangiferi*, Sweden (teratological specimen with a stump in place of the right ribs 4, 5, 6, and 8). C: *E. cervi*. D: *E. alces*.

325, 230 μm from posterior end; common vestibule 3,600, 3,400, 1,500, 1,300 μm long; tail 215, 195, 180, 185 μm wide, and 65, 80, 65, 65 μm long.

Male (four specimens, the first one is the allotype): Length 39, 33, 30, 29 mm; maximum width 230, 240, 220, 240 μm; nerve ring 100, 95, 110, 95 μm and excretory pore 150, 165, 150, 150 μm from anterior end; oesophagus 750, 800, 750, 750 μm long; excretory glands 2,300, 3,100, 3,500, 2,350 μm long; spicules 225, 225, 210, 220 μm long; gubernaculum 100, 90, 95, 110 μm long; bursa 150, 130, 140, 130 μm high and 215, 195, 180, 185 μm wide *(Fig. 2D)*.

The oesophagus, especially in the females, is bottle shaped, the muscular part being narrow, the glandular part broad. The dorsal bursal ray is often divided into three simple subequal branches, but variations and teratological forms are not uncommon. Genital cone with large papillae on the ventral lip; the sides more prominent than the center, Rays 4 and 8 are usually long; equal to or longer than the branches of the dorsal ray *(Fig. 2D)*.

— Comparative measurements of the bursa in *E. alces* and *E. rangiferi*.

When the bursa is fully spread out in ventral view, its shape and the measurements are characteristic. The relative size (height/width) is as follows:

In 11 specimens from moose: 0.70; 0.63; 0.73; 0.67; 0.71; 0.78; 0.67; 0.70; 0.75; 0.70; 0.67.

In 7 specimens from reindeers: 0.93; 0.96; 0.90; 0.93; 0.97; 1.00; 1.07.

Discussion

In domesticated reindeer (*R. tarandus tarandus* L.) the nematode *E. rangiferi* has been shown to cause central nervous symptoms (Ronéus and Nordkvist 1962). The disease, which has been recognized for centuries, may lead to heavy losses, especially among calves (Bakken and Sparboe 1973).

Since 1984 an increasing number of Swedish moose, especially calves, have been found dead from elaphostrongylosis, particularly in the northern counties (Stéen and Rehbinder 1986).

From parasite transmission point of view, it is of great importance to establish whether *Elaphostrongylus* from moose is identical with the species already described in reindeer or red deer, of if it is a separate species.

Taxonomical data from *E. cervi* and *E. rangiferi* are given in *Table I* together with our own data of *E. alces*.

Characteristics for *E. alces*, *E. rangiferi* and *E. cervi* are shown in *Table II*.

The data show that there are differences between *E. alces* and *E. rangiferi* in Sweden. The latter fits well with the description of *E. rangiferi* given by Mitskevitch (1960).

However, measurements do not always allow a differentiation between species because, within a species, measurements may vary with the age of the parasite, with the intensity of the infection, with the immunological condition of the host, etc.

TABLE I

	E. cervi Cameron 1931	*E. cervi* Kutzer Prosl 1975	*E. cervi* Stéen *et al.*	*E. rangiferi* Mitskevitch 1960	*E. rangiferi* Stéen *et al.*	*E. panticola* Lyubimov 1945	*E. alces* Stéen *et al.*
♀							
Body length	55 mm	49-58 mm	62 mm	33.8-50.3 mm	49-50 mm	41 mm[1]	62-65 mm
Body width	200 µm	227-237 µm	200 µm	200-280 µm[2]	210-225 µm	200-260 µm[1]	290-320 µm
Oesophagus	600 µm	640-730 µm	—	590-650 µm	660-700 µm	670-800 µm	740-850 µm
Vulva-tip	200 µm	193-257 µm	250 µm	174-277 µm	225-640 µm	200-270 µm	100-325 µm
Anus-tip	70 µm	50-67 µm	50 µm	42-62 µm	70-75 µm	40-50 µm	65-80 µm
♂							
Body length	38 mm	29-38 mm	38 mm	26.5-34.2 mm	32-36 mm	25-37 mm	29-39 mm
Body width	150 µm	233-277 µm	170 µm	210-250 µm	190-220 µm	200-240 µm[1]	220-240 µm
Oesophagus	500 µm	630-700 µm	—	550-640 µm	580-670 µm	660-770 µm	750-800 µm
Spicula	200 µm		230-235 µm		212-230 µm	202-237 µm	210-225 µm
sin.	equal, stout blunt	87-220 µm		200-217 µm			
dx.		193-233 µm		217-238 µm			
Gubernaculum	75 µm	60-78 µm	95 µm	47-63 µm	75 µm	62-73 µm	90-110 µm
forms		strongly chitinised well developed					
Rays	ventral rays, short and blunt. Dorsal ray split to its broad base. The externo-dorsal ray is entirely solitary	greatly variable	rays 4; 8 medium length		rays 4; 8 short	between the dorsal and the externo-dorsal rays is situated an extra ray	rays 4; 8 long
Caudal bursa			circular 180-180 µm		circular 140-155 µm high, 155-160 µm wide		ova 130-150 µm high, 180-215 µm wide

1. The largest body width.
2. Body width in the middle.

TABLE II. — Characteristics of *E. alces* from moose (*A. alces* L.), *E. rangiferi* from reindeer (*R. tarandus tarandus* L.) and *E. cervi* from red deer (*C. elaphus* L.) in Sweden due to our data.

E. alces
Body width of female > 280 μm.
Oesophagus bottle shaped.
Caudal bursa oval, about 150 μm high and 200 μm wide.
Bursal rays 4 and 8 long.
Gubernaculum length > 90 μm with an anterior irregularity.
Genital cone with large papillae on the ventral region.
E. rangiferi
Body width of female < 280 μm.
Oesophagus club shaped.
Caudal bursa circular, about 160 μm in diameter.
Bursal rays 4 and 8 short.
Gubernaculum length < 80 μm.
Genital cone with prominent medial region.
E. cervi
Body width of female < 280 μm.
Oesophagus cylindrical.
Caudal bursa circular, about 190 μm in diameter.
Bursal rays 4 and 8 of medium length.
Gubernaculum length > 90 μm.
Genital cone with prominent medial region.

This explains why different authors (Pryadko and Boev 1971, Kutzer and Prosl 1975) comparing the data of the litterature with their own, have reached the conclusion that the species were synonymous.

Several constant differences should, however, be emphasized:

— there are conspicuous differences between the body-width and length in female *E. alces* compared with other known species of *Elaphostrongylus*;

— the oesophagus is bottle shaped in *E. alces*, but club shaped in *E. rangiferi* and cylindrical in *E. cervi*;

— the anterior end of the glandular oesophagus is abruptly enlarged in *E. alces*, while on the other hand, the anterior end of the glandular oesophagus is about the same size as that of the posterior end of the muscular part, and the border between the two parts is inconspicuous in *E. rangiferi*;

— bursal rays 4 and 8 are long in *E. alces* but short in *E. rangiferi* and *E. cervi*;

— the caudal bursa is oval in *E. alces* but circular in *E. rangiferi* and *E. cervi*.

Furthermore, the relative size and the dimensions of the bursa in *E. alces* versus *E. rangiferi* show differences: (0.70 ± 0.013) and (0.98 ± 0.023) respectively, given as mean and standard error. This comparison leads to a T-value of 10.6 using the Students T-test. The most reliable characteristics for differentiating species are the shape and dimensions of the bursa and the shape of the oesophagus.

Hence, the observations presented show that *Elaphostrongylus* from moose (*Alces alces* L.) is sufficiently disting from any known form of *Elaphostrongylus* to be placed in a new species.

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