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Host age, sex related and seasonal dynamics of *Elaphostrongylus cervi* larvae in fenced and free living red deer

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ABSTRACT

First-stage larvae (L_1) of the so-called tissue worm or extra-pulmonary lungworm Elaphostrongylus cervi were detected in the faeces of red deer using the Baermann sedimentation method. Faeces samples of farmed (n=340) and free living deer (n=94) of different age categories and both sexes were collected and examined in 2005-2009. Dorsal-spined 364-452 µm long L_1 were counted and expressed as number of larva per gram (lpg). In calf samples L_1 appeared first time in January only. Wild calves represented a higher prevalence (61.1-80%) and lower intensity (25.2-90.2) than their farmed counterparts (33.3-45.5 and 80-292 lpg). Prevalence (33.3-83.3 %) and intensity (5.2-372.1) in wild hinds varied over seasons as well as in farmed hinds (36.8-90.5%, and 54.7-251.6). In farmed stags prevalence showed even larger variations (0-100%), meanwhile intensity values were low (4-31.3) except in March (144.7 lpg). The use of anthelmintics had just a short-term influence on the prevalence and intensity.
(Keywords: red deer **(***Cervus elaphus* L.), *Elaphostrongylus cervi* dorsal-spined larvae, L_1, Baermann method, prevalence, intensity)

ÖSSZEFOGLALÁS

Kerti és vadon élő gímszarvasok *Elaphostrongylus cervi* lárvaürítésének életkor-, ivar- és szezonfüggő dinamikája

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Az ún. kötőszöveti féreg vagy extrapulmonáris tüdőféreg első stádiumú lárváinak (L1) előfordulását vizsgáltuk gímszarvasok hullatékában a Baermann-féle ülepítéses módszerrel. Farmon tartott (n=340) és szabadon élő (n=94) különböző korú és mindkét ivarú szarvasok hullatékát gyűjtöttük és vizsgáltuk 2005-2009 között. A 364-452 µm hosszúságú L1-eket számoltuk, lárvaszám/gramm értékben kifejezve (lpg). Borjak mintáiban a lárvák csak januárban jelentek meg legkorábban. A vadon élő borjaknál magasabb prevalencia (61,1-80%) és alacsonyabb intenzitási értékeket (25,2-90,2) tapasztaltunk, mint farmon tartott kortársaikban (33,3-45,5% és 80-292 lpg). Vadon élő teheneknél a prevalencia (33,3-83,3%) és az intenzitás (5,2-372,1) is ingadozott az egyes hónapokban, csakúgy, mint a farm teheneknél (36,8-90,5% és 54,7-251,6 lpg). Farm bikáknál a prevalencia még változatosabb (0-100%) volt, miközben az intenzitási értékek alacsonyak (4-31,3) voltak kivéve márciusban (144,7 lpg). Az anthelmintikum-alkalmazás csak átmeneti hatást gyakorolt a prevalencia és intenzitás értékekre.
(Kulcsszavak: gímszarvas (*Cervus elaphus* L.), *Elaphostrongylus cervi* tüdőféreg lárvák, L_1, Baermann módszer, prevalencia, intenzitás)

INTRODUCTION

Red deer (*Cervus elaphus* L.) is the most important game animal in Hungary due to its outstanding quality and distribution, furthermore its role in game parks has recently grown. Therefore, to collect information on the health status, important diseases and parasites of the stocks is of basic importance. Among parasites *Elaphostrongylus cervi* (*Cameron*, 1931, Nematoda: Metastrongyloidea: Protostrongylidae) is a unique one migrating in the central nervous system (CNS) of the host during the postembrional development. This nematode is common in the CNS as well as in sceletal musculature of red deer overall in Eurasia (*Lankester*, 2001). First stage larvae (L1) are shed via the deer faeces and can detect using the Baermann sedimentation method (*Nemeséri and Holló*, 1972, *McKenna*, 1999). Their main characteristic is the dorsal spine near the tip of the tail, and are distinguishable from the L1 of *Varestrongylus sagittatus* (*Mueller*, 1890) according to the different body measurements. The total length is 364-452 µm in *E. cervi* L1 and 272-344 µm in *V. sagittatus* (*Kutzer and Prosl*, 1975; *Mason*, 1995; English et al. 1985).

The aim of this study was to monitor the seasonal dynamics of *E. cervi* L1 in faecal samples of fenced and free living deer in relation to age and sex.

MATERIAL AND METHODS

Study sites

To study the occurrence and migration of *E. cervi* in the CNS a large number of red deer (n=237) was examined between 2005 and 2009 in the Zselic Forest (Somogy county, South Transdanubian region).

A) Zselic Forest Hunting unit is managing 17,900 ha with 49% forest covering and 44.5% arable land. The habitat of this hill-country is strongly laid out in depth by plenty of gullies (ravines) and narrow main valleys with NS direction, laying between 130-300 m asl (above sea level). Characteristic soils are of poor quality (1% humus-content, 4.5-5.5 pH) medium hard and hard brown forest soils, sediment and alluvial soils.

   The average annual temperature is 10.5 °C due to the intermediate climate with mild winters due to the Mediterranean and Oceanic influences. Precipitation is slightly above 700 mm/year with peaks in June and October. Dominant forest communities (42% of the area) are beech – wood (*Vicio oroboidi – Fagetum*), hornbeam – sessile oak (*Querco petraeae – Carpinetum praeillyricum*), silver lime – turkey oak (Tilio argenteae – Quercetum – cerris), pedunculate oak – ash – fluttering elm (Querco – Ulmetum) and sragnantwater elder – ash (Almeto – Fraxinetum pannonicae) groves (*Marosi and Somogyi*, 1990). Forests are interrupted with scattered pastures and small areas with crops.

   Determinant game is red deer, living together with high density wild boar (*Sus scrofa ferus*), moderate density roe deer (*Capreolus capreolus*), low density fallow deer (Cervus s. *Dama d*.) and moufflon (*Ovis musimon*).

B) Bőszénfa Deer Farm is situated inside the Zselic Forest, therefore the habitat characteristics are similar as detailed above. The size of the Farm is 1,300 ha including the Deer Farm Unit with 600 ha. The dominant species kept is red deer, other games are fallow deer and wild boar.

Sampling and diagnosis

Free living red deer were examined mainly during the hunting season (September-February). Fresh faecal samples (n=94) were collected from shot animals directly from

the rectum at the carcass storing sites. On the paddocks of the deer farm (Bőszénfa) fresh faecal pellet heaps were collected too in different seasons. L1 larvae were extracted from 6-8 g faeces after 18-20h using the Baermann beaker sedimentation method (*Nemeséri and Holló*, 1972, *McKenna*, 1999). Larvae were counted and expressed as number of L1 per gram of wet pellet (lpg), and identified to genus level according to their morphology and linear dimensions. The morphology and size of the dorsal-spined larvae were similar to the L1 larvae of Elaphostrongylinae (*Kutzer and Prosl*, 1975).

Anthelmintic treatment of farmed deer

Deer kept on the farm (Bőszénfa) were treated annually. Calves several times annually, first time in July, second time in late October (or early November) then in six-weekly intervals until end of April, while older deer only once a year: hinds together with calves at second time, stags in August.

Anthelmintic treatment was supplied usually orally (in food or drench).

Statistical analysis

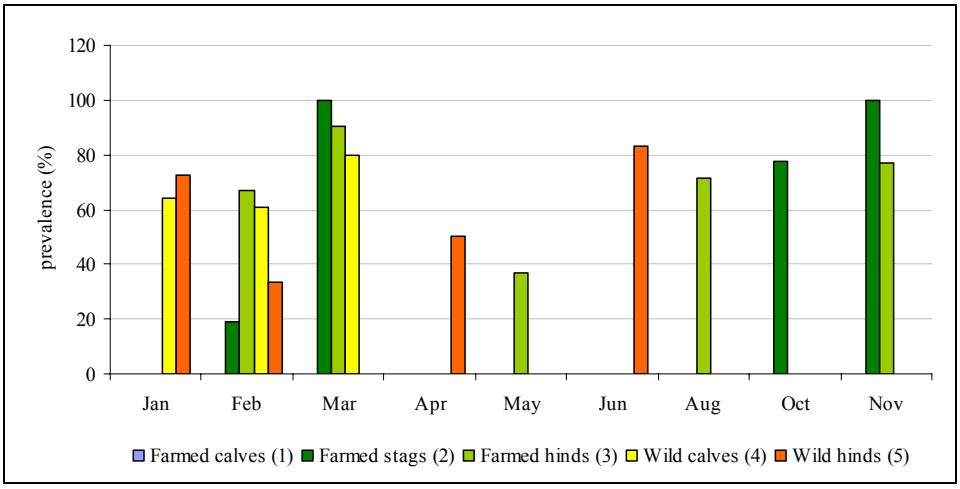
Data were analysed by Microsoft Excel and Quantitative Parasitology 3.0 Programs. Prevalence and intensity values of the different deer group samples such as age, sex and farmed or wild, respectively were calculated using the descriptions of *Margolis et al.* (1982).

RESULTS

To get detailed impression monthly prevalence values of all deer groups are shown in *Figure 1.*

Figure 1

Monthly prevalence values of *E. cervi* L1 excretion of the different red deer groups



1. ábra: Az E. cervi lárvaürítés havonkénti prevalenciája az egyes szarvascsoportokban

Farmon élő borjak(1), Farmon élő bikák(2), Farmon élő tehenek(3), Vadon élő borjak(4), Vadon élő tehenek(5)

The monthly distribution, of the faecal prevalence and mean intensity of *E. cervi* L1 are shown in *Tables 1-5* according to age and sex as well as the status of deer (farmed or wild). Intensity values and min.-max. number of larvae are expressed as number of larvae in gramm faeces (lpg). *E. cervi* larvae were not detected in calf faeces until January, at about 7-8 months of age. In the January-March period the prevalence reached high levels (61.1-80%) with moderate mean intensity levels (25.2-90.2) in wild calves (*Table 1*). In contrast, in the faeces of farmed calves (*Table 2*) the prevalence values were relatively low (33.3-45.5%) with higher mean intensity levels (80-292). However the prevalence values show little changes, the mean intensity is markedly decreased during the spring period. In wild yearling and adult hind prevalence levels varied over seasons (*Table 3*). High levels occurred in January (72.7%) and June (83.3%), then much lower ones in February (33.3%) and April (50%), with marked changes in the mean intensity (between 5.2-372.1). In farmed yearling and adult hinds (*Table 4*) both prevalence and intensity (90.5%, 251.6) peaked in March. Later the prevalence was lowest in May (36.8%), while intensity showed little changes on a lower level (54.7-82.6). In samples of farmed stags (*Table 5*) prevalence varied from 0% (June) to 100% (March and November). The intensity was very low (4) in February, highest (144.7) in March and moderate in October (31.3) and November (30.7).

Table 1

***E. cervi* L1 in faeces of wild calves**

Month (1)	**Jan**	**Feb**	**Mar**
n	14	18	5
Prevalence (%) (2)	64,3	61,1	80
Mean intensity (3), lpg	25,2	147,6	82,8
Min. number of larvae (4)	2	2	2
Max. number of larvae(5)	70	800	280

1. táblázat: Első stádiumú E. cervi lárvák vadon élő borjak hullatékában

Hónap(1), Prevalencia (2), Átlagos intenzitás(3), Min. lárvaszám(4), Max. lárvaszám(5)

Table 2

***E. cervi* L1 in faeces of farmed calves**

Month (1)	**Mar**	**Apr**	**May**
n	27	33	33
Prevalence (%) (2)	33,3	45,5	36,36
Mean intensity (3), lpg	292	112,5	80
Min. number of larvae (4)	43	1	4
Max. number of larvae (5)	780	650	210

2. táblázat: Első stádiumú E. cervi lárvák kerti borjak hullatékában

Hónap(1), Prevalencia (2), Átlagos intenzitás(3), Min. lárvaszám(4), Max. lárvaszám(5)

Table 3

***E. cervi* L1 in faeces of wild yearling and adult hinds**

Month (1)	**Jan**	**Feb**	**Apr**	**Jun**
n	22	15	14	6
Prevalence (%) (2)	72,7	33,3	50	83,3
Mean intensity (3), lpg	83,8	5,2	372,1	9,6
Min. number of larvae (4)	1	1	35	1
Max. number of larvae (5)	690	14	1800	25

3. táblázat: Első stádiumú E. cervi lárvák vadon élő ünők és tehenek hullatékában

Hónap(1), Prevalencia (2), Átlagos intenzitás(3), Min. lárvaszám(4), Max. lárvaszám(5)

Table 4

***E. cervi* L1 in faeces of farmed yearlings and adult hinds**

Month (1)	**Feb**	**Mar**	**May**	**Aug**	**Nov**
n	6	21	38	14	36
Prevalence (%) (2)	66,7	90,5	36,8	71,4	63,9
Mean intensity (3), lpg	144,8	251,6	82,6	54,7	74,4
Min. number of larvae (4)	1	1	4	1	1
Max. number of larvae (5)	520	850	620	280	570

4. táblázat: Első stádiumú E. cervi lárvák kerti ünők és tehenek hullatékában

Hónap(1), Prevalencia (2), Átlagos intenzitás(3), Min. lárvaszám(4), Max. lárvaszám(5)

Table 5

***E. cervi* L1 in faeces of farmed stags**

Month (1)	**Feb**	**Mar**	**Oct**	**Nov**
n	16	7	9	7
Prevalence (%) (2)	18,8	100	77,8	100
Mean intensity (3), lpg	4	144,7	31,3	30,7
Min. number of larvae (4)	1	8	1	1
Max. number of larvae (5)	7	520	70	72

5. táblázat: Első stádiumú E. cervi lárvák kerti bikák hullatékában

Hónap(1), Prevalencia (2), Átlagos intenzitás(3), Min. lárvaszám(4), Max. lárvaszám(5)

DISCUSSION

E. cervi L1 can be detected in faeces of red deer with varying prevalence and mean intensity values all year round, what is in harmony with the results of other surveys (*Kutzer and Prosl*, 1975, *Demiaszkiewicz*, 1985, *Vicente et al*., 2006).

This study has shown that calves, either free living or farmed, started excreting *E. cervi* L1 in faeces after six months of age. The prevalence of larvae tends to be high in wild calves afterwards (*Table 1*). In farmed calves the prevalence values were lower together with varying mean intensity levels.

However *Kutzer and Prosl* (1975) stated that L1 emission of *E. cervi* peaked in the late winter, in this monitoring it was similar in the samples of farmed hinds (*Table 4*) only. In wild hinds (*Table 3*) and farmed stags (*Table 5*) both prevalence and intensity values were varying in accordance with *Vicente et al.* (2006), but in an other survey (*Vicente et al.*, 2005) there was no seasonal variation in prevalence.

The use of anthelmintics once (for older deer) or twice (for calves) a year had just a short term influence probably on the prevalence and intensity values, according to other experiences (eg. *Rodriguez et al.*, 2005).

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