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Elaeophorosis in Red Deer from Spain

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ABSTRACT: Elaeophorosis, caused by *Elaeophora elaphi,* was observed in red deer (*Cervus elaphus*) from Toledo Province (Spain) for the first time. Adult specimens of *Elaeophora elaphi* were found in the hepatic vessels of nine of 151 red deer between October 1994 and September 1995; intensity of infection was two to 18 nematodes per host. Adult nematodes were only found during the period from fall through early spring. No differences were present between sex or age groups. Parasites were not found in a limited sample from fallow deer (*Dama dama*). Blood samples were negative for the presence of microfilariae.

Key words: Cervus elaphus, Elaeophora elaphi, Dama dama, fallow deer, red deer, survey.

Elaeophorosis is caused by nematodes of the genus *Elaeophora* that localize in the heart and arterial vasculature of ruminants and horses. Currently six species are recognized in the genus, with most being limited to cervid or bovid hosts from the Palearctic, Nearctic, and Africa (Table 1). Some species have been regarded as serious pathogens in ruminant hosts, but in many cases data for life history, epidemiology, and an understanding of the mechanisms for pathogenesis are limited (Hibler and Adcock, 1971; Carrasco et al., 1995).

In the present study we report new findings on the distribution of elaeophorosis in red deer (*Cervus elaphus*) and fallow deer (*Dama dama*) in central Spain. The survey for the occurrence of *Elaeophora* sp. in red deer and fallow deer was undertaken in "Quintos de Mora", a government-owned and managed park located near Toledo (Spain; 39°25′N, 4°04′W). The 6,864 ha park is composed of two different habitats including a plateau at 800 m above sea level crossed by the Las Navas River, and a mountainous area reaching 1,235 m in elevation. Survey for parasites extended over a 1 yr period and involved monthly collections from October 1994 to September 1995. One hundred fifty one red deer in three age groups, <1-yr-old, 1- to 2-yr-old and >2-yr-old and representing two sex-classes were collected and examined. In contrast, collections of fallow deer were limited to 17 animals and as a consequence the focus of the study was on *C. elaphus.*

Immediately following collection, prior to transport to the necropsy facility at the park, blood samples were drawn from the heart of each animal. At the necropsy, filarial worms found in the hepatic vessels were collected, counted, and fixed in phosphate buffered formalin (5%). Necropsies were generally conducted a short time after death in order to avoid potential postmortem migration of nematodes as described for *E. schneideri* by Adcock and Hibler (1969). Blood samples were filtered through a filter (5 μm mesh) and stained (methylene blue 1/1,000) prior to microscopic examination to check the possible presence of microfilariae. Adult filarial nematodes were studied as temporary whole mounts cleared in phenol-alcohol (80 parts melted phenol crystals and 20 parts absolute ethanol) and examined with light microscopy using differential interference contrast optics. In males, the tail was dissected from some specimens to examine the characteristics of the caudal papillae.

Specimens were consistent with those of *E. elaphi,* and the caudal structure in males was as described by Hernández-Rodríguez et al. (1986) (Fig. 1). Representative specimens are deposited in the U.S. National Parasite Collection (USDA, Agricultural Research Service, Beltsville, Maryland, USA; USNPC Nos. 88805–

TABLE 1. Geographical distribution, hosts, and location in the host of *Elaeophora* spp.

Elaeophora spp.	Distribution	Location	Definitive host	Reference
E. poeli	Asia and Africa	Aorta and heart	Bovidae	Sonin (1966)
E. boehmi	Europe	Arteries of limbs	Equidae	Supperer (1953)
E. schneideri	USA	Carotid arteries and branches	Cervidae (*Odocoileus virginianus*,[a] *O. hemionus*,[a] *Cervus elaphus canadensis*, *C. nippon*), *Ovis aries*	Hibler and Adcock (1968)
E. abramovi	Europe and Asia	Hepatic vessels	Cervidae (*Alces alces*, *Cervus elaphus canadensis*, *Rangifer tarandus*)	Oshmarin and Belous (1951)
E. elaphi	Spain	Hepatic vessels	Cervidae (*Cervus elaphus*),[a] *Ovis aries*	Hernández-Rodríguez et al. (1986) Carrasco et al. (1995)
E. sagittus	Africa	Heart	Bovidae	Bain and Haesevoets (1974)

[a] The usual definitive host.

FIGURE 1. Male ventral caudal end of *Elaeophora elaphi* from red deer showing the pattern of the papillae. Bar = 25 μm.

88808) and in the Parasite Collection of the Departamento Patología Animal I (Universidad Complutense de Madrid, Madrid, Spain).

Elaeophora elaphi, a filarial worm found in the hepatic vessels, was originally described in red deer from Córdoba (Spain) by Hernández-Rodríguez et al. (1986). It was reported subsequently from the type host at Ciudad Real (Spain) by Carrasco et al. (1995, 1998), but had not been observed previously in Toledo. In cervids, only this species and *E. abramovi* (Table 1) occur in the hepatic vessels. Hernández-Rodríguez et al. (1986) provided a distinct differential diagnosis for species of *Elaeophora,* and the males of *E. elaphi* and *E. abramovi* are distinguished by diagnostic features of the caudal papillae and "area rugosa". The original description of the male tail is augmented by our Figure 1.

Infected animals, and adult nematodes, were only found during the period extending from fall through early spring in months of October to March. The numbers of red deer examined and the distribution of infected animals during this 6 mo period were 1/19, 3/18, 2/18, 1/18, 1/13, and 1/10 in October, November, December, January, February, and March, respectively. Red deer examined in the remaining sampling periods, 10 in April and nine each in May, June, July, August and September, were uninfected. Among those red deer found to be hosts (five males and four females) parasites were found in all age-classes (one in <1-yr-old; four in 1-to-2-yr-old; and four in >2-yr-old). Statistical analysis (Chi-square and Fisher's Test) demonstrated no significant differences in infection between males and females (P = 0.8706) or among age groups (P = 0.9934). Microfilariae were not observed in blood samples.

The prevalence of infection found in the current study (6% across the annual sampling period) was lower than that reported by Carrasco et al. (1995) in red deer collected from an adjacent area (Ciudad Real; between September and April there were 23% with parasites, but the prevalence was 41% if we counted those with just lesions typical of *E. elaphi*). In our study, infected animals were found only from October to March. Considering prevalence only within this 6 mo period, 8% were infected; no explanation is available for this apparent difference between geographic localities. This prevalence of infection is relatively low compared to data for such species as *E. schneideri* in North American cervids. It is possible that large variations in prevalence may be typical, as indicated by localized differences in the distribution of infection for *E. schneideri* in mule deer (*Odocoileus hemionus*) ranging from 4 to 90% in western North America (Hibler and Adcock, 1971).

Intensity of infection ($\bar{x}$ = 9, range = 2–18 nematodes) in our study was comparable to that reported by Carrasco et al. (1995) for *E. elaphi* in red deer. Additionally, Mtei and Sanga (1990) reported less than eight nematodes per host in a study involving *E. poeli* in over 4,000 asymptomatic cattle. In the current study histology was not performed, but macroscopic lesions were not observed. The absence of such visible lesions as thrombi in the portal system contrasts with observations by Carrasco et al. (1995).

Madden et al. (1991) found that moose (*Alces alces*) when parasitized by more than 40 adult *E. schneideri* were ataxic, wandered in circles, and had poor body condition. In contrast, all hosts in the current study were in good condition and apparently were healthy. This may be attributable to the infections of low intensity demonstrated in red deer from Toledo. Moreover, pathological effects could be related to the host-specificity. For example, *E. schneideri* does not provoke any clinical signs in its normal mule deer definitive host. Alternatively, in other cervids (*C. nippon* and *C. elaphus canadensis*) and in domestic sheep it is the causative agent of dermatitis, blindness, nervous signs, and occasionally death (Adcock and Hibler, 1969; Hibler and Adcock, 1971). Thus, the host may have an important influence on the distribution of disease attributable to infections of *Elaeophora* spp. This also may be of importance in Toledo, where the fallow deer is sympatric with red deer. Although only 17 fallow deer have been examined no filarial worms were found.

In the present study there were no microfilariae in blood samples from infected red deer; similar result were reported by Carrasco et al. (1995). They suggested that the occurrence of microfilaremia was transitory and may be correlated with the seasonal occurrence (summer) of a biting-fly acting as the vector for *E. elaphi.* In *E. schneideri* microfilariae may be present in capillaries of the skin on the forehead and face, but not in general circulation (Kemper, 1938; Foreyt and Foreyt, 1979). Kemper (1938) also obtained microfilariae from cutaneous lesions. Additional studies are

necessary to elucidate the life cycle for *E. elaphi,* with particular emphasis on determination of the arthropod intermediate host(s) and patterns of localization for microfilariae in the cervid definitive host.

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