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Oestrosis in Red Deer from Spain

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ABSTRACT: A survey of naso-pharyngeal myiasis affecting red deer (*Cervus elaphus*) in southern Spain was conducted. The parasites involved were the larvae of *Pharyngomyia picta* and *Cephenemyia auribarbis* (Diptera:Oestridae), which coexist sympatrically within this host. Males and older animals had higher prevalences and intensities of fly larvae. Differences in behaviour and habitat use by male and female deer, and the increase of head size in older males are possibly responsible for this. There were low densities of *C. auribarbis* while *P. picta* was the species most frequently observed, although both oestrids were located in the same host cavities. The earlier larviposition by *C. auribarbis*, and its faster larval development may reflect asynchronous life-cycles of both oestrids; this may decrease inter-specific competition between these sympatric species.

Key words: Botfly, *Cephenemyia auribarbis, Cervus elaphus*, inter-specific competition, Oestridae, *Pharyngomyia picta*, sympatric species.

Pharyngomyia picta infects the naso-olfactory and pharyngeal cavities of deer in Europe. Its main host is the red deer (*Cervus elaphus*), although it is assumed that this species does not show a host-specifity as pronounced as seen in the European species of the genus *Cephenemyia*. The genus *Cephenemyia* is restricted to the Holarctic region and the larvae parasitize deer belonging to the subfamilies Cervinae and Odocoileinae. The imagos of all *Cephenemyia* spp. have a general appearance like that of bumble-bees (Zumpt, 1965). The main host for *C. auribarbis* is the red deer, although both oestrid species also infect the fallow deer (*Dama dama*) (Ruiz et al., 1993). In central and western Europe adult *P. picta* fly from June to August (Seguy, 1928; Drozdz, 1961a), while *C. auribarbis* imagos are active from May to July (Brauer, 1863; Seguy, 1928; Cameron, 1932).

As reported for certain *Cephenemyia* spp., adults seem to be attracted by the CO_2 expelled by hosts (Anderson and Olkowski, 1968; Anderson, 1989). Anderson (1975) evidenced different strategies for larviposition by *Cephenemyia* sp. adult females and recognition of these flies by experienced deer with subsequent behavioral response to evade larviposition by oestrid females. Cogley and Anderson (1981) suggested a dependence by these parasites on the anatomy of the host's muzzle for larval invasion. They also noted a positive thermotropism and a negative phototropism by *Cephenemyia* sp. first-instar larvae.

Mixed infections of red deer due to *P. picta* and *C. auribarbis* have been commonly reported in Europe (Drozdz, 1961b; Zumpt, 1965; Sugar, 1974, 1976; Gil Collado et al., 1985; Ruiz and Palomares, 1993; Ruiz et al., 1993). The main goal of this study was to improve our knowledge on the epidemiology of these parasites, and to analyze their co-occurrence within the same host individuals.

From November 1994 to February 1996, 521 red deer (244 males and 277 females) were examined for oestrid larvae. Samples came from different game reserves located in the Sierras de Cazorla, Segura y Las Villas Natural Park, Jaén Province (38°30′N, 2°45′E); Sierra Morena, Ciudad Real, Jaén and Córdoba provinces (38°17′N, 3°45′W and 38°26′N, 4°19′W); Guadalcanal (38°06′N, 5°49′W) y Cazalla (37°56′N, 5°45′W), Sevilla Province; Ubrique (36°40′N, 5°25′W) and Alcalá de los Gazules (36°29′N, 5°43′W), Cádiz Province (southern Spain). Availability of samples was limited by the official hunting period from October to February.

TABLE 1. Prevalence and intensity of parasitism by two species of nasal bots in red deer from Spain according to host sex and age.

Category	n[a]	% Prevalence	Intensity of parasitism		
			Min[b]	Max[c]	$\bar{x} \pm$ SD[d]
Age class (yr)					
<1	35	57	1	84	20.1 ± 16.8
1–3	118	76	1	104	23.8 ± 20.9
4–6	115	89	1	102	21.2 ± 19.4
7–9	116	88	1	106	28.9 ± 26.9
>10	137	94	1	145	29.4 ± 28.6
Males	244	94	1	145	32.9 ± 27.2
Females	277	77	1	106	12.1 ± 17.2
TOTAL	521	85	1	145	25.8 ± 23.9

[a] n = number examined.
[b] Min = minimum.
[c] Max = maximum.
[d] $\bar{x} \pm$ SD = mean ± standard deviation.

Deer heads were collected, stored, and examined according to Ruiz and Palomares (1993) and Ruiz et al. (1993). Age of deer was determined following criteria given by Larson and Taber (1980) and Dimmick and Pelton (1994); five host age classes were considered (Table 1).

Location of each parasite was recorded, and oestrid larvae were identified according to Cameron (1932), Grunin (1957), Zumpt (1965), and Draber-Monko (1975). Prevalence and intensity of parasitism were derived according to Margolis et al. (1982) and Bush et al. (1997). In order to compare prevalence and intensity of parasitism between different host sex and age classes, we used the χ^2 as well as Levene's F tests (Sokal and Rohlf, 1995) which were performed with the BMDP program (Dixon, 1990). Type material (five third-instar larvae of each species) was deposited at the Museo Nacional de Ciencias Naturales (CSIC) (Madrid, Spain).

Prevalence of oestrosis reached 85% (n = 521), *Pharyngomyia picta* being the species most frequently observed, 85% of the total larvae collected (11,433). *Pharyngomyia picta* affected 77% of hosts examined, and *C. auribarbis* larvae were found in 46% of red deer in our study. The 39% of deer were simultaneously parasitized by both oestrid species. Prevalence of oestrosis was significantly higher (χ^2 = 30.538; d.f. = 1; P < 0.0001) in males (94%) than in females (77%). Prevalence also increased with host age (Table 1). Annual prevalence did not show significant differences (χ^2 = 0.79; d.f. = 2; P = 0.4525) within the study period (1994–1996) but reached highest values (up to 96%) in winter months.

The mean intensity (± SD) of parasitism obtained was 25.8 ± 23.9 larvae/host individual; 24.1 ± 21.4 for *P. picta* larvae and 7.2 ± 6.1 for *C. auribarbis* bots. Intensity in male deer was significantly higher than in females (F = 57.63; d.f. = 1; P < 0.0001). Number of bots/host infected also increased with host age (Table 1). The intensity of parasitism reached values of over 40 bots/host in February–April. Nevertheless, the modal value for intensity of both oestrid species was 1 larva/host parasitized.

Data obtained on frequencies of number of larvae indicated that *P. picta* showed a negative binomial distribution (K = 3.03; $\bar{x}$ = 2.62; variance = 6.46), while that for *C. auribarbis* fitted to a Poisson distribution (K = 6.62; $\bar{x}$ = 0.60; variance = 0.72) (Diggle, 1983).

Location of larvae belonging to different instars was similar for both species. First-instar larvae (L_1) were mainly located in the naso-olfactory area (86% of L_1 *P. picta*, and 98% of L_1 *C. auribarbis*). With regard to the second-instar larvae (L_2), most of these were found in the gnathocranium (64% of L_2 *P. picta* and 61% of L_2 *C. auribarbis*), although important numbers (36% of L_2 *P. picta* and 39% of L_2 *C. auribarbis*) were located in the splanchnocranium. Most of the third-instar larvae (L_3) were collected from the deer gnathocranium (93% of L_3 *P. picta* and 93% of L_3 *C. auribarbis*).

When analyzing monthly percentage of each larval instar for both species (Fig. 1), we observed that increases of L_1 *C. auribarbis* larvae did not happen at the same time as those for *P. picta*, with a difference

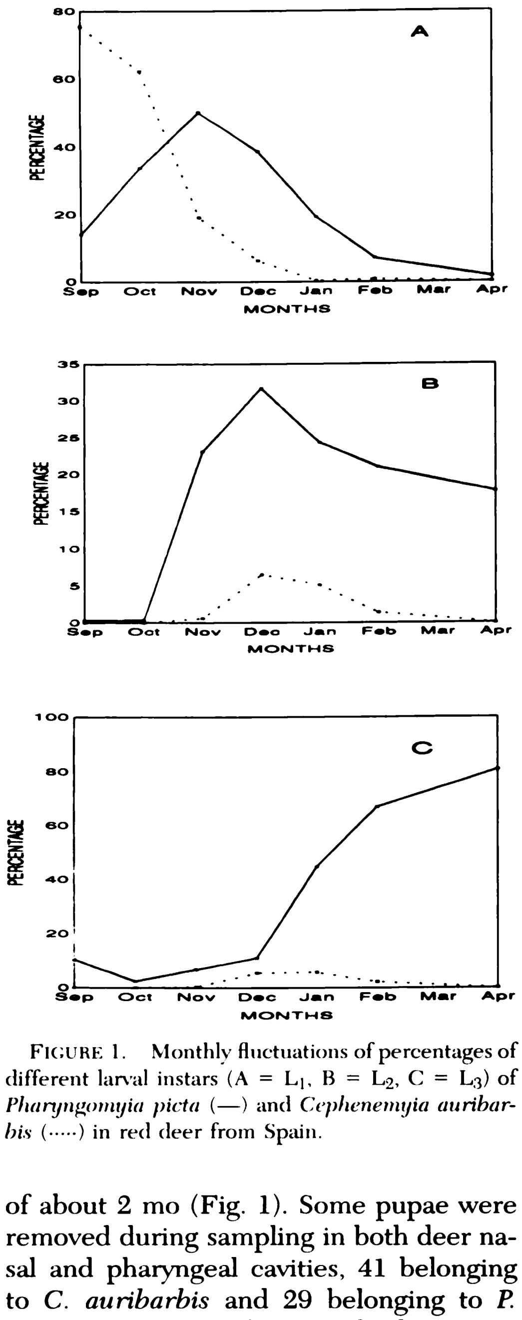

FIGURE 1. Monthly fluctuations of percentages of different larval instars (A = L_1, B = L_2, C = L_3) of *Pharyngomyia picta* (—) and *Cephenemyia auribarbis* (·····) in red deer from Spain.

of about 2 mo (Fig. 1). Some pupae were removed during sampling in both deer nasal and pharyngeal cavities, 41 belonging to *C. auribarbis* and 29 belonging to *P. picta*. Over 95% of *C. auribarbis* pupae were found during December and January, while almost 90% of *P. picta* pupae were collected in February.

The mean prevalence of nasal bots in red deer obtained in our study was similar to those values reported in previous studies for the same geographic area (Ruiz and Palomares, 1993; Ruiz et al., 1993), and correspond well with those given by other authors (Drozdz, 1961b; Sugar, 1974, 1976; Gil Collado et al., 1985). As expected, prevalence of *P. picta* was higher than that obtained for *C. auribarbis*, and adult deer were more frequently parasitized than younger animals. However, this is the first report of males being more severely parasitized, in terms of both prevalence and number of bots. Pérez et al. (1996) reported a significantly higher prevalence of oestrosis due to *Oestrus caucasicus* in Spanish ibex (*Capra pyrenaica*) females.

These above differences in prevalence and intensity of nasal bots may be explained by (1) differential activity patterns and habitat use by male and female deer (Soriguer et al., 1994); (2) spatial distribution and location of adult flies; and/or (3) differential behaviour patterns of both host sexes when attacked by flies larvipositing, with subsequent differences in infection success. With regard to the third point, we also consider the fact that groups of fawns may improve their defense against flies.

The increased number of larvae with host age and in males (Table 1) seems to be related to increasing head size, providing greater availability of suitable habitat for parasites. Alternatively, the lower prevalence shown by *C. auribarbis*, together with the small number of larvae/host and the type of distribution within the host sample, may reflect low densities of this oestrid species with respect to those of *P. picta*.

As a standardized value, the mean intensity, or the average intensity of a particular parasite species among the infected individuals of a particular host species (Margolis et al., 1982; Bush et al., 1997) was used. Nevertheless, frequently we observed asymmetric or biased distributions. In such cases we think that the mean intensity (± SD), together with the modal value could describe their pattern of abundance in a better way.

The larval maturation period is shorter for *C. auribarbis* (Cameron, 1932; Zumpt, 1965; Sugar, 1974; Gil Collado et al., 1985). In this sense, we have observed how *C. auribarbis* larvae reach larger size and heavier weight than *P. picta* larvae, despite L_1 *P. picta* being almost twice the size of *C. auribarbis*. When analyzing monthly frequencies (Fig. 1), we also observed that increases of L_1 larvae did not happen simultaneously in both oestrid species, *C. auribarbis* increases occurred about 2 mo earlier. A similar trend was observed regarding L_3 larvae and pupae. Ruiz and Palomares (1993) noted little coincidence between percentages of different larval instars and pupae for both oestrid species. In our opinion these differences in larval and pupal phenology must be considered as a part of the asynchronous life-cycles of these oestrid species; this may help reduce the inter-specific competition between these sympatric diptera.

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