

Research Note

First report on the helminthfauna of the yellow-necked mouse, *Apodemus flavicollis*, in the Iberian Peninsula

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Summary

Information about the prevalence of helminth parasites of the yellow-necked mouse, *Apodemus flavicollis*, in the Iberian Peninsula is almost non-existent and there is no reliable data reported from Spain. Fourteen *A. flavicollis* from the Erro River valley (Navarre, Spain) were examined for endoparasites, between February 2001 and July 2002. Thirteen specimens (92.9 %) of the total sample were parasitized by at least one of the following six helminth species: one trematode (*Corrigia vitata*), one cestode (*Taenia parva* larvae) and four nematodes (*Trichuris muris*, *Calodium hepaticum*, *Heligmosomoides polygyrus* and *Syphacia stroma*). This is the first report about the helminthfauna of *A. flavicollis* in the Iberian Peninsula. Nevertheless, a larger number of hosts should be analysed to complete these preliminary results and to adequately characterize the helminth community of this rodent. The finding of *C. hepaticum*, the causative agent of human capillariosis, stands out.

Keywords: Helminth community; *Apodemus flavicollis*; yellow-necked mouse; Erro river valley; Iberian Peninsula

Introduction

The yellow-necked mouse, *Apodemus flavicollis*, is a forest rodent widely distributed in Europe, with the exception of some areas of the Iberian Peninsula and western France (Blanco, 1998). In Spain, its presence is restricted to the north of the country (Torre *et al.*, 2009), although the morphological similarity between this rodent and the wood mouse, *A. sylvaticus*, the most widespread small mammal in forest of this country (Torre *et al.*, 2002), makes the study of its real distribution very difficult, which has not well delimited yet. In fact, in the Iberian Peninsula the ecology of the yellow-necked mouse has hardly been studied, and knowledge about the helminth parasites of this rodent is virtually non-existent (Arrizabalaga & Torre, 2007). However, in other European regions, several studies about the helminth community of the yellow-necked mouse (Mészáros & Murai, 1979; Mažeika *et al.*, 2003, 2015; Hildebrand *et al.*, 2004; Kucia

et al., 2006; Klimpel *et al.*, 2007; Hildebrand, 2008; Hildebrand & Zalešný, 2009; Ondříková *et al.*, 2010; Bjelić-Čabrilo *et al.*, 2013; Čabrilo *et al.*, 2016) and about the influence of helminths on the ecology of *A. flavicollis* (Ferrari *et al.*, 2004, 2007, 2009; Perkins *et al.*, 2008) have been carried out. Nevertheless, further studies in other ecosystems, such as the northern regions of the Iberian Peninsula, where it is not an uncommon species, are needed to shed light on the helminth community and provide valuable information about the ecology of this murid species.

On the other hand, rodents have demonstrated to be a frequent reservoir of zoonoses, and this capacity has already been observed in some forest ecosystems of the Iberian Peninsula. For example, in the Erro river valley, Navarre, other rodent species have been found to be parasitized by zoonotic helminths (Sainz-Elipse *et al.*, 2004; Debenedetti *et al.*, 2015), therefore, also necessitating the analysis of *A. flavicollis* as a potential reservoir of human zoonoses.

The aim of the present study is to present preliminary data on the helminth community of the yellow-necked mouse, as the first part of a more extensive future study, making it the first report on the helminth species parasitizing *A. flavicollis* in the Iberian Peninsula, and the presence of zoonotic helminths in this rodent species.

Material and Methods

The study area is located in the region of Navarre, and comprises the western Pyrenean valley of the Erro river flowing into the Aragón river and finally into the Ebro river (Fig. 1). The valley is 50 km long and descends from 820 m to 460 m. The climatology in the highest part is sub-Atlantic and sub-Mediterranean in its middle and lower parts. The dominant vegetation in its highest part consists of acidophile Atlantic forests with lush pastures and beech trees; oak trees are predominant in its middle part; its lower part is used agriculturally and the river bank is occupied by poplar groves (Galicia & Escala, 2009).

The mastozoological material included in this preliminary study consisted of a total of 14 yellow-necked mice, *A. flavicollis*, 6 males and 8 females. The hosts were captured between February 2001 and July 2002 in various parts of the study area. UTM coordinates of locations of capture are: 30N 625 4751 (1♂; 1♀); 625 4752 (2♂♂); 625 4753 (1♂); 626 4742 (1♂); 628 4736 (1♀); 629 4763 (1♂; 1♀); 630 4758 (5♀♀).

Regarding the helminthological techniques, the extraction and collection of helminths as well as the study and identification of helminth species were carried out according to Fuentes *et al.* (2000). The study concerning the helminth community composition was based on the measure of the prevalence, the mean intensity, the median intensity, the mean abundance and the range of parasitization, according to Bush *et al.* (1997). The species richness, the number of helminth species detected and the frequency of occurrence of the number of helminth species were also analysed.

Results

Thirteen hosts (92.86 %) were found to be parasitized (all analysed host with the exception of a male) by at least one of the six helminth species identified: one trematode, *Corrigia vitia*; one cestode, *Taenia parva* larvae; and four nematodes, *Trichuris muris*, *Calodium hepaticum*, *Heligmosomoides polygyrus* and *Syphacia stroma*. The number of parasitized hosts, the prevalence, the mean intensity, the median intensity, the mean abundance, the range as well as the sex of parasitized hosts of each helminth species are shown in Table 1. The highest prevalence was detected in the geohelminth *H. polygyrus* (85.71 %), whereas the oxyurid *S. stroma* showed the highest mean abundance (15.79 helminths/host).

Helminth infracommunities were composed of up to four species, although 35.71 % of the infracommunities were composed of one species only, and the mean value of species richness was 1.9.

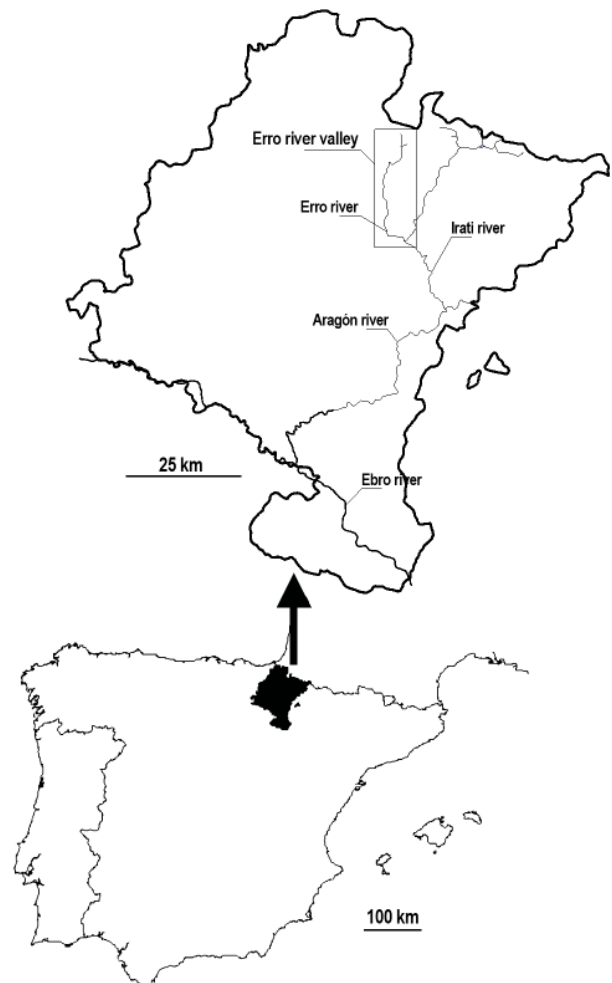


Fig. 1. Geographical location of the Erro river valley in the Iberian Peninsula and in Navarre

Discussion

This preliminary study presents the first data on the helminth species parasitizing *A. flavicollis* in the Iberian Peninsula, being in agreement with the other, previously mentioned, European studies on the yellow-necked mouse. However, the number of helminth species detected is generally lower than in those studies but in accordance with the low number of mice analysed.

The geohelminth *H. polygyrus* is, as well as in the majority of the previous studies carried out, the most prevalent helminth species. Some authors even emphasize the role of this parasite in the ecology of this host, proposing the binominal yellow-necked mouse/*H. polygyrus* as an ideal model to investigate heterogeneities in host/parasite dynamics, after having found sex-biased differences in susceptibility to parasite infection as well as in the ability to modulate helminth transmission (Ferrari *et al.*, 2004, 2007; Perkins *et al.*, 2008). On the other hand, Ferrari *et al.* (2009) also reported the significance of this helminth species in the coinfection with other para-

Table 1. Helminth community of *Apodemus flavicollis* in the Erro river valley
n, number of infected hosts; %, prevalence; MI, mean intensity; Mdl, median intensity; MA, mean abundance

Helminth species	n	%	MI	Mdl	MA	Range	Host sex
TREMATODA							
<i>Corrigia vitta</i>	3	21.43	1.33	1.00	0.29	1 – 2	1♂; 2♀♀
CESTODA							
<i>Taenia parva</i> larvae	2	14.29	1.00	1.00	0.14	1	1♂; 1♀
NEMATODA							
<i>Trichuris muris</i>	3	21.43	1.67	1.00	0.36	1 – 3	1♂; 2♀♀
<i>Calodium hepaticum</i>	1	7.14	2.00	2.00	0.14	2	1♂
<i>Heligmosomoides polygyrus</i>	12	85.71	12.17	6.50	10.43	2 – 37	5♂♂; 7♀♀
<i>Syphacia stroma</i>	6	42.86	36.83	18.50	15.79	1 – 146	2♂♂; 4♀♀

sites, finding that changes in the tick *Ixodes ricinus* infestation of *A. flavicollis* are related negatively to changes in *H. polygyrus* abundance, and that these changes occur as a cause-effect process.

The oxyurid *S. stroma* was also found to be a component species of the helminth community of *A. flavicollis*. Ondříková *et al.* (2010), among other authors, also detected a high level of parasitization of this helminth species in this host, reporting, as in the present report, a large abundance.

The finding of the metacestode of *T. parva* confirms the role of *A. flavicollis* as a frequent prey of the common genet, *Genetta genetta*, since, according to Casanova *et al.* (2000), the life cycle of this cestode in the Iberian Peninsula is completed by rodents of the genus *Apodemus*, as the intermediate host (carrying the larvae in the abdominal cavity) and *G. genetta* as the definitive host (carrying the adult in the intestine).

The absence of trematodes with an aquatic life cycle is in accordance with the results of previous studies carried out in the Mediterranean mouse and the wood mouse in this ecosystem. However, in the yellow-necked mouse, as well as in the other two murid species analysed in this enclave, *C. vitta*, a trematode which uses land snails as its first intermediate host (Sainz-Elise *et al.*, 2004; Debenedetti *et al.*, 2015), was detected. This fact underlines the big similarities in the ecological habits of the yellow-necked mouse and the other murid species that share this habitat.

Furthermore, the detection of the capillariid *C. hepaticum* stands out, given that this helminth is the causative agent of the rare conditions of hepatic capillariosis and spurious infections in humans (Fuehrer *et al.*, 2011). This parasite was also reported to parasitize other murids in this ecosystem, having been found as a co-dominant species of the helminth community of the Mediterranean mouse, *Mus spretus*, (Sainz-Elise *et al.*, 2004) and the wood mouse, *A. sylvaticus*, (Debenedetti *et al.*, 2015). Consequently, the potential role of the yellow-necked mouse in the Erro river valley as a reservoir of helminth zoonoses, as already shown in

other European regions (Hildebrand *et al.*, 2009) and in the north of Turkey (Çelebi *et al.*, 2014), should be confirmed.

The present study, for the first time, reports on the helminth community of the yellow-necked mouse, *A. flavicollis*, in the Iberian Peninsula. Nevertheless, these results must be considered preliminary due to the low number of individuals analysed. Future studies with a larger number of mice are required in order to carry out a more precise characterization of the helminth community of the yellow-necked mouse, to shed light on the ecological relationships of this rodent species with its helminth parasites. Moreover, the presence of a zoonotic helminth species is noteworthy, and the role of this rodent as a reservoir of hepatic capillariosis should be confirmed.

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