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Helminth parasites in the wood mouse (*Apodemus sylvaticus*) from Algeria

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Abstract

*Helminth parasites in the wood mouse (*Apodemus sylvaticus*) from Algeria.* Helminth parasites of the wood mouse *Apodemus sylvaticus* (Rodentia, Murinae) were studied for the first time in Algeria. Fifty mice from Mizrana forest were examined in 2017. Our results showed a general prevalence of 82 % and a six species of helminths: four nematodes (*Heligmosomoides polygyrus*, *Syphacia stroma*, *Syphacia frederici* and *Rictularia* sp.) and two cestodes (*Hymenolepis* sp. and *Hydatigera parva larvae*). The most prevalent species was *S. stroma* (52.0 %), followed by *S. frederici* (46 %) and *H. polygyrus* (26 %). Infection rates in the analysed mice were higher in Nematoda (70 %) than in Cestoda (12 %). Host age was the most important factor determining the prevalence of helminth species, with adults being the most infected group. The differences were significant. No differences in prevalence were observed related to host sex or seasonality.

Key words: *Apodemus*, Forest, Algeria, Helminth

Resumen

*Helmintos parásitos en el ratón de campo (*Apodemus sylvaticus*) de Argelia.* Primer estudio de los helmintos parásitos del ratón de campo, *Apodemus sylvaticus* (Rodentia, Murinae) en Argelia. En total, se examinaron 50 individuos del bosque de Mizrana durante el año 2017. Nuestros resultados mostraron una prevalencia general del 82 % y se registraron un total de seis especies de helmintos: cuatro nematodos (*Heligmosomoides polygyrus*, *Syphacia stroma*, *Syphacia frederici* y *Rictularia* sp.) y dos cestodos (larvas de *Hymenolepis* sp. y *Hydatigera parva*). La especie más prevalente fue *S. stroma* (52,0 %) seguida de *S. frederici* (46 %) y *H. polygyrus* (26 %). Nematoda mostró una mayor tasa de infestación entre los ratones analizados (70 %) que cestoda (12 %). La edad del huésped fue el factor más importante y determinante respecto a la prevalencia de especies de helmintos. Las diferencias fueron significativas y los adultos el grupo más infestado. No se observaron diferencias de prevalencia relacionadas con el sexo del huésped ni con la estacionalidad.

Palabras clave: *Apodemus*, Bosque, Argelia, Helminto

Resum

*Helmints paràsits en el ratolí de bosc (*Apodemus sylvaticus*) d'Algèria.* Primer estudi dels helmints paràsits del ratolí de bosc, *Apodemus sylvaticus* (Rodentia, Murinae) a Algèria. En total, es van examinar 50 individus del bosc de Mizrana durant l'any 2017. Els nostres resultats van mostrar una prevalença general del 82 % i es van registrar un total de sis espècies d'helmints: quatre nematodes (*Heligmosomoides polygyrus*, *Syphacia stroma*, *Syphacia frederici* i *Rictularia* sp.) i dos cestodes (larves d'*Hymenolepis* sp. i *Hydatigera parva*). L'espècie més prevalent va ser *S. stroma* (52,0 %) seguida de *S. frederici* (46 %) i *H. polygyrus* (26 %). Nematoda va mostrar una taxa d'infestació més alta entre els ratolins analitzats (70 %) que cestoda (12 %). L'edat de l'hoste va ser el factor més important i determinant respecte a la prevalença d'espècies d'helmints. Les diferències van ser significatives i els adults el grup més infestat. No es van observar diferències de prevalença relacionades amb el sexe de l'hoste ni amb l'estacionalitat.

Paraules clau: *Apodemus*, Bosc, Algèria, Helmint

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Introduction

The wood mouse, *Apodemus sylvaticus* (Linnaeus 1758), is found throughout Europe and in parts of North Africa (Schlitter et al., 2021). The helminths of this species have been extensively studied in continental Europe (Ondríková et al., 2010), peninsular Europe (Milazzo et al., 2005, 2010; Torre et al., 2013), the British Isles (Behnke et al., 1999) and the Mediterranean Islands (Goüy de Bellocq et al., 2003) but information on the helminth fauna of North African wood mice (Morocco, Algeria and Tunisia) is lacking. Northern African wood mice populations are of south–western European origin, with the Maghreb probably having been colonized either across the Strait of Gibraltar during the Mesolithic, or as a result of anthropogenic translocation (Lalis et al., 2016). In Algeria, our study area, the presence of *A. sylvaticus* is known from 2,500–4,000 years ago from the Capelleti cave (Stoetzel, 2013).

In Algeria, the wood mouse is distributed from sea level up to 2,000 m, from the coast to mountainous zones, and in several types of habitats (Kowalski, 1985; Kowalski et Rzebik–Kowalska, 1991; Khidas, 1993; Hamdine and Poitevin, 1994). As previously reported, *A. sylvaticus* is the commonest species in high–altitude forests and mountains (Khidas, 1993, Khidas et al., 2002; Khammes, 2008). Despite this wide–ranging distribution, no surveys of

helminth parasite have yet been conducted on this rodent species in Algeria. This study of these Maghreb populations (and as an introduced species) is thus of special interest. The aim of our study was to report data for the helminths of *A. sylvaticus* in Algeria for the first time.

Material and methods

Study site

The study site was located in the Mizrana forest (36º 50' N and 4º 4' E and 850 m a.s.l.) in the Kabylia region in the north of Algeria. This forest is located in a humid bioclimatic zone and is composed of mixed cork (*Quercus suber*) and holm (*Quercus ilex*) oak forest. Trapping was carried out in a species–poor understory consisting mainly of *Erica arborea*, *Calycotome spinosa* and *Cytisus triflorus*.

Trapping and characterization of specimens

Wood mice were trapped over 10 months (January–November, excluding May) in 2017 to assess helminth diversity. Thirty metal live–traps, baited with bread mixed with fish meat (sardines), were set and, depending on external conditions, trapping campaigns were conducted over periods of 2–4 days.

Weight, sex, body length and reproductive status were recorded for each individual. The maturity of males was determined by the position and size of the testicles and the seminal vesicles following Kowalski (1985). Female activity was evaluated by external (vagina perforated and teats easily visible) or internal characteristics (development of embryos and presence of scars on uterus). Captured mice were categorized into one of three age categories (juveniles, young adults, or adults) based on dental wear (Birkan, 1968).

Examination of gut contents and visceral organs

Mice were dissected and gastrointestinal tracts and livers were removed, stomach, duodenum, small intestine and large intestine were separated and transferred to large Petri dishes containing a standard saline solution. They were then carefully examined both by the naked eye and under a low–power binocular microscope for helminth parasites (Ribas et al., 2011). Helminths were collected, counted and stored in labelled Eppendorf tubes containing 70 % ethanol. They were then processed using general helminthological methods and identified following previous descriptions. The ecological terminology and quantitative parameters used followed Bush et al. (1997). Descriptive parameters and their confidence intervals for statistical analyses were calculated using quantitative parasitology (Reiczigel et al., 2019) using Fisher's exact test. Data were analysed according to season using the climatic characteristics of the surveyed site.

Results

A total of 50 *A. sylvaticus* were captured (representing 810 trap–nights) and screened for parasites as follows: January (n = 6), February (n = 6), March (n = 10), April (n = 5), June (n = 6), July (n = 4), August (n = 6), September (n = 2), October (n = 3) and November (n = 2). By age, captures were as follows: juveniles (22 %), young adults (16%), and adults (62%). Our results showed a general prevalence of 82 %, with a total parasite load of 2,585 helminths.

Four species of nematodes were recovered: *Heligmosomoides polygyrus*, *Syphacia stroma*, *Syphacia frederici* and *Rictularia* sp., and two species of cestodes were identified: *Hymenolepis* sp. (body cavity) and *Hydatigera parva* larvae (body cavity).

Table 1. Prevalence and intensity of helminth species in *A. sylvaticus* from Algeria.

Tabla 1. Prevalencia e intensidad de especies de helmintos en A. sylvaticus *en Argelia.*

Species	Microhabitat	Infected mice	Prevalence (%)	Intensity
Nematoda		41		
S. stroma	Duodenum, small intestine	26	52.0	64.42
S. frederici	Large intestine and caecum	22	46.0	32.13
H. polygyrus	Duodenum, small intestine	20	42.0	4.90
Rictularia sp.	Stomach, small and large intestine	13	26.0	4
Cestoda		6		
Hymenolepis sp.	Body cavity	4	8.0	1.75
Hydatigera parva larvae	Body cavity	2	4.0	1.0

No mice were found to be infected with all six helminth species. The highest co–infection was four of the six helminth species. The number of worms per host varied for each species: 0–547 for *S. stroma;* 0–126 for *S. frederici*; 0–26 for *H. polygyrus*; 0–29 for *Rictularia* sp.; 0–3 for *Hymenolepis* sp. and 0–1 for *Hydatigera parva* larvae.

More mice (70 %) were infected by Nematoda than by Cestoda (12 %); the genus *Syphacia* was the most prevalent. *Syphacia stroma* was the most prevalent species (52.0 %) with the highest mean intensity (64.42 parasites/host) and a total of 1,675 identified worms. The second commonest species, *S. frederici*, had a helminth prevalence of 46 %, with a mean intensity of 32.13 parasites/host. Twenty mice were hosts to *H. polygyrus* but with a slightly lower prevalence than the previous helminth species (42.0 %) and lower mean intensity (4.90 parasites/host). The spirurid nematode *Rictularia* sp. was recovered from thirteen mice, with a 260 % rate infection and mean intensity of 4 parasites/host. The two recovered cestodes (*Hymenolepis* sp. and *H. parva* larvae) both had a lower prevalence and mean intensity (details in table 1).

Differences in host sex prevalence between male (88.2 %) and female (68.8 %) mice were not significant (*P*–value = 0.12). In contrast, the general prevalence varied significantly (***$P < 0.01$) and increased between age cohorts: juveniles (36.4 %), young adults (87.5 %) and adults (96.8 %). The overall helminth prevalence was slightly higher in summer (93.8 %) but this was not significant (*P*–value: 0.41) if compared to the other seasons: winter (83.3 %), spring (73.3 %) and autumn (71.4 %) (table 2).

Table 2. Prevalence of helminth species in male and female *A.sylvaticus* over the seasons in Algeria.

Tabla 2. Prevalencia de especies de helmintos en machos y hembras de A. sylvaticus*, así como en las diferentes estaciones, en Argelia.*

Host sex	Infected mice	Prevalence (%)	*P*–value
Host ssex			
Males	30	88.2	
Females	11	68.8	0.12
Host age			
Adults	30	96.8	
Young adults	7	87.5	< 0.01*
Juveniles	4	36.4	
Season			
Summer	15	93.8	
Winter	10	83.3	0.41
Spring	11	73.3	
Autumn	5	71.4	

Discussion

This study presents the first data for a helminth community in wood mice in Algeria. Six helminth species were recorded, with a predominance of Nematoda and with *S. stroma,* followed by *S. frederici* and *H. polygurus* as the most prevalent species. Previous studies of *A. sylvaticus* helminths from the Magreb are limited to reports of a number of helminth species but with no accompanying ecological data (Bernard, 1963, 1967). The following species have been recorded in Tunisia from *A. sylvaticus*: *Aonchotheca annulosa*, *Aspiculuris tetraptera*, *Eucoleus bacillatus*, *Heterakis spumosa*, *Protospirura muris*, *Rictularia proni* and *Syphacia stroma* (Bernard, 1963); *Heligmosomoides polygyrus*, *Longistriata seurati* and *S. stroma* (Bernard 1967). Only one species has been recorded from Morocco: *Rictularia proni,* by Dollfus (1960). The most prevalent helminths in our study (*H. polygyrus*, *S. stroma* and *S. frederici*) are specific to *Apodemus*, and have been reported to be the most prevalent species in the Iberian Peninsula, the origin of the Algerian wood mice populations. In Portugal, Eira et al. (2006) recorded a total of 12 helminth species in 557 mice: *H. polygyrus* was the most prevalent followed by *S. stroma* and *S. frederici*. Also detected in high prevalence was *Angiostrongylus dujardini*, which could be an artefact due to the particular ecological conditions of the area. In southern Spain (Sierra Espuña), Fuentes et al. (2004) isolated 13 helminth species from 74 mice; the nematode *S. frederici* and the cestode *Pseudocatenotaenia matovi* were the most prevalent and most abundant. The helminth parasite community of 150 wood mice from the Erro valley (Spain) consisted of 14 species, with the nematode *H. polygyrus* being the most prevalent (Debenedetti et al., 2014). In Serra Calderona Natural Park, Fuentes et

al. (2010) studied the helminth community of wood mice in a burnt area and in a control area (unburnt) over several years. They detected 17 helminth species in 564 wood mice analyzed, the prevalence being lower in the control area than in the burnt area. *S. stroma* was the most prevalent helminth parasite in the burnt area, while *H. polygyrus* was the most prevalent in the control area. As the life cycle of *H. polygyrus* includes free–living stages (Anderson, 1992) local environment conditions could determine the prevalence in our Algerian populations studied, where this species was not as prevalent as in some of the above–mentioned studies in the Iberian Peninsula. The greatest number of helminth species isolated (21) in wood mouse populations to date is from the Massane Natural Reserve (south–east France), where the most frequent parasite was *H. polygyrus* (Torregrosa–Orts et al., 1987). Our study suggests that the low parasite species richness in the wood mouse at the study site in Algeria could be the consequence of the human introduction of this host. The loss of parasites in the event of a host introduction has been reported in introduced populations of *A. sylvaticus* on islands (Goüy de Bellocq et al., 2003), and in other rodents such as the squirrel *Atlantoxerus getulus,* introduced into the Canary Islands from Morocco (López–Darias et al., 2008). However, it is important to note that the small sample size in our study probably underestimates the full parasite specific richness, as indicated by Feliu et al. (1997). In conclusion, this study provides the first record of helminth species in *A. sylvaticus* from Algeria. Nevertheless, as helminthic diversity in *A. sylvaticus* in Algeria is far from being well–studied, further studies exploring more localities are required.

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