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# HELMINTH COMMUNITIES OF WOOD MOUSE (*APODEMUS SYLVATICUS*) ON THE RIVER AVENA (CALABRIA, SOUTHERN ITALY)

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ABSTRACT - Helminth parasites of woodmouse *Apodemus sylvaticus* were studied from May 1993 through to June 1994 on the River Avena (Calabria, southern Italy), which, as other Mediterranenan rivers, is dry for most of the year. Trapping sites were located in three different habitats of the river: slopes, shores and the riverbed. A total of 106 animals was captured and screened for the presence of helminths. Five endoparasitic species were detected: *Corrigia vitta*, *Rictularia proni*, *Heligmosomoides polygyrus*, *Syphacia stroma* and *S. frederici*. Four helminth species were recorded from the riverbed and shore sections, whereas only *H. polygyrus* and *S. frederici* were found on the slopes. *Syphacia frederici* occurred at every trapping site. The total prevalence was 25.5% and total mean intensity was 27.2 parasites/mouse. No statistical significant difference was found for both the prevalence and mean intensity of infection between either habitats or sexes, suggesting that, from the point of view of the helminth community, the study area should be considered as a single habitat.

*Key words*: endoparasites, rodents, fiumara, Southern Italy

RIASSUNTO - ***Comunità elmintica del topo selvatico (*Apodemus sylvaticus*) lungo il fiume Avena (Calabria, Italia meridionale)***. Da maggio 1993 a giugno 1994, sono stati studiati gli elminti parassiti di *Apodemus sylvaticus* nella Fiumara Avena (Calabria). I topi selvatici (N = 106) provenivano da 3 diversi habitat della fiumara: pendio, riva e letto. Sono state identificate 5 specie di endoparassiti: *Corrigia vitta*, *Rictularia proni*, *Heligmosomoides polygyrus* , *Syphacia stroma* e *S. frederici*. Di queste specie, quattro sono state reperite nel letto e nelle rive della fiumara, mentre *H. polygyrus* e *S. frederici* sono state riscontrate solo nel pendio. *S. frederici* è stata rilevata in ogni habitat. Complessivamente, la prevalenza è risultata pari al 25,5% e l'intensità media a 27,2 parassiti/roditore.
La prevalenza e l'intensità media non sono variate né tra gli habitat della fiumara né tra i sessi, suggerendo che la fiumara può essere considerata, dal punto di vista della comunità elmintica, come un unico habitat.

*Parole chiave*: endoparassiti, roditori, fiumara, Italia meridionale

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## INTRODUCTION

The Italian term "fiumara" (pl. fiumare) applies to medium and low-course rivers of southern Italy, including the islands of Sardinia and Sicily. These rivers are typical of the Mediterranean area, having a dry, gravelly riverbed for most of the year. The riverbed is sunny, owing to the scarcity of vegetation. A study carried out on the small mammals of this particular ecosystem (Cagnin *et al*., 1996) showed that, except for rats (*Rattus* sp.), which were not recorded because the traps used were unsuitable, the woodmouse *Apodemus sylvaticus* (Rodentia, Muridae) was the dominant species among both rodents (85.7 %) and small mammals (61.75 %).
*Apodemus sylvaticus* is an opportunistic rodent which may colonize man-altered environments, such as burned areas, areas with high levels of human activity (e.g. mining areas), cultivated fields and fiumare (Arrizabalaga *et al*., 1992; Fons *et al*., 1992; Halle, 1993; Fuentes *et al.,* 2007; Cagnin *et al*., 1996; Rathke and Bröring, 2005). The woodmouse is a suitable model to study helminth distribution in the rather inhospitable environment of the fiumara riverbed, where non-stable woodmouse populations are likely to dwell (Cagnin *et al*., 1996). The aim of this study was to investigate and compare the helminth communities of the woodmouse in different habitats of the fiumara Avena. Particularly, we hypothesized that heteroxenous helminth species would be influenced by the aridity of the fiumara, while monoxenous species were expected to behave like their host species.

## STUDY AREA AND METHODS

The fiumara Avena is situated on the north-east coast of Calabria region (southern Italy) (Fig.1). The climate is typical Mediterranean, with arid summers receiving <500 mm of rain (Ciancio, 1971). The vegetation of the fiumara depends on soil composition and stability and water availability, resulting in three different habitats: the riverbed, the slopes and the shores symmetrically distributed on both riversides. The slopes vary in gradient, and can be covered by the

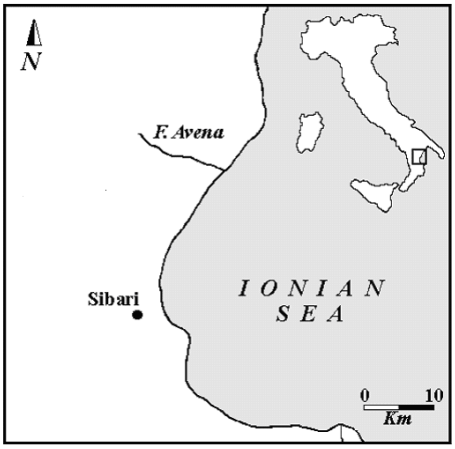


Figure 1 - Study area.

Mediterranean maquis, including *Quercus ilex* and *Pistacia lentiscus*, or by *Pinus halepensis* woods. In some areas, the natural vegetation is replaced by *Eucalyptus* spp. or olive-grove plantations (*Olea europaea). S*hores are usually covered by shrubs of *Tamarix africana*, *Nerium oleander*, *Vitex agnus-castus* or young formations of *P. halepensis*. In the riverbed, the annual *Chenopodium bothrys* is found on pebbles, while the herbaceous *Helicrysum italicum* and *Artemisa variabilis* are common in gravelly areas (Spampinato, 1990; Biondi *et al*., 1994).
Two transects were set up transversely to the river axis (Fig. 2), at a distance of 1 km from each other; for each transect, six trap-

ping stations were established, each including ten pitfall traps set at 10-m intervals (Fig. 2) (see Cagnin *et al*., 1996 for details on the preservation of samples from pitfall traps). Traps were checked monthly from May 1993 to June 1994. The age of trapped individuals (juveniles *vs*. adults) was assessed according to their dental wearing (Adamczewska-Andrezejewska, 1967).

The collection and analysis of the data was performed separately for the right and the left side of the fiumara. Helminths were removed from the digestive tracts of each *A. sylvaticus*, grouping data according to the habitat and side of collection (Tab. 1).

Standard helminthological techniques were applied for species identification. Platyhelminthes were stained in acetic carmine, dehydrated in a series of alcohols, cleared in xylol and mounted in Canada balsam. Nematodes were extemporaneously mounted in Amann lactophenol.

The chi-squared ($\chi^2$) test was used, together with Yates continuity correction, to compare helminth prevalence between habitats. The Kruskal-Wallis' test was used to compare mean intensities among habitats, while the Mann-Whitney U test was used to test for differences between sexes.

All statistical analyses were performed by InStat 3.0 for Macintosh (Version 3.0, September 2003). The terminology used was as defined by Bush *et al*. (1997).

## RESULTS

In total, 106 *A. sylvaticus* - 60 (55.60%) males and 45 (42.45%) females, 82 (77.4%) mature adults and 24 immature adults (22.6%) -, were captured and analysed to assess their parasite load.

The 736 parasites collected belonged to five helminth species, including one digenetic trematode and four nematodes: *Corrigia vitta* (Dujardin, 1845) (Dicrocoeliidae); *Rictularia proni* (Seurat, 1915) (Rictulariidae); *Heligmosomoides polygyrus* (Dujardin, 1845) (Heligmosomidae); *Syphacia stroma* (Linstow, 1884) and *Syphacia frederici* (Roman, 1945) (Oxyuridae). The total prevalence was 25.5% and total mean intensity was 27.2 parasites/mouse.

No statistically significant difference was found for both the overall prevalence and mean intensity between either habitats (respectively: $\chi^2 = 1.28$, P = 0.86; 4 d.f. = 4; K-W $\chi^2 = 3.06$, P = 0.55; 2 d.f.; Tab. 1), or sexes (respectively: $\chi^2 = 5.12$; P = 0.27; 4 d.f.; U = 61.0, P = 0.24). None of the juveniles trapped was infected.

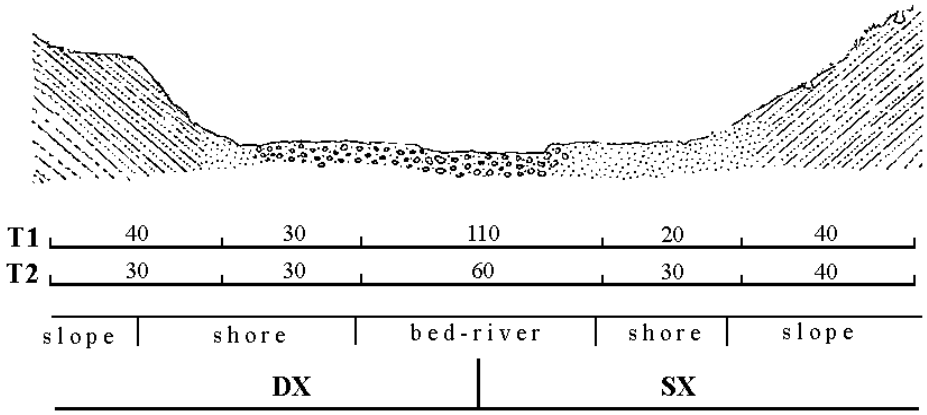


Figure 2 - Total and partial lengths of each transect in the fiumara Avena (T1 = transect 1, 240 m; T2 = transect 2, 190m; all section measurements are expressed in m).

On both slopes the same two species were present: *H. polygyrus* and *S. frederici*; while in both the shore and riverbed communities four species were found (Tab. 1). *C. vitta* and *R. proni* are heteroxenous, while the other three species are monoxenous.

In the fiumara, helminth total prevalence in *A. sylvaticus* was lower than those obtained for other habitats in the same study area (Milazzo, 2001).

The endoparasitic fauna of *A. sylvaticus* in the River Avena includes helminth species commonly found in European *Apodemus* species (Asakawa and Tenora, 1996; Feliu *et al.*, 1997; Goüy De Bellocq *et al.*, 2002, 2003; Milazzo *et al.*, 2005). Currently, 14 species of helminths have been described for *A. sylvaticus* in Calabria region (Milazzo *et al.*, 2005).

In contrast, cestodes were not found, despite the wide distribution of hymenolepidids and anoplocephalids in Calabria (Goüy De Bellocq *et al.*, 2002, 2003; Milaz zo *et al.*, 2005). The absence of larval cestodes could be indicative of low-density populations of carnivores in the study area.

The life cycle of the heteroxenous helminth species found in the fiumara includes a range of oribatid mites and insects as intermediate hosts. As an example, *R. proni* is known to have or-

Table 1 - Prevalence, mean intensity and range (min-max) calculated for each helminth species in relation to different sections of the "fiumara" Avena (N° e.= number of hosts examined; N° i.= number of hosts infected; P(%) = prevalence; MI = mean intensity ±SD; Np = total number of parasites found; range = min-max per host.

| | | Right Slope | Right Shore | Riverbed | Left Shore | Left Slope |
|---|---|---|---|---|---|---|
| N° e. | | (n=23) | (n=38) | (n=12) | (n=14) | (n=19) |
| N° i. | | (4) | (8) | (4) | (4) | (7) |
| P (%) | | 17.40 | 21.05 | 33.33 | 28.57 | 36.84 |
| MI±SD | | 9.25±9.21 | 29.75±37.0 | 33.0±26.06 | 57.0±69.16 | 14.43±20.21 |
| Species | | | | | | |
| | P (%) | - | - | 8.33 | 7.14 | - |
| *C. vitta* | MI ±SD | - | - | 3.0±0.0 | 4.0±0.0 | - |
| | Np | - | - | 3 | 4 | - |
| | P (%) | - | - | 8.33 | - | - |
| *R. proni* | MI ±SD | - | - | 13.0±0.0 | - | - |
| | Np | - | - | 13 | - | - |
| | P (%) | 4.34 | 2.63 | 8.33 | - | 21.05 |
| *H. polygyrus* | MI±SD | 2.0±0.0 | 23.0±0.0 | 4.0±0.0 | - | 3.75±2.5 |
| | Np (range) | 2 | 23 | 4 | - | 15 (1-7) |
| | P (%) | - | 2.63 | - | - | - |
| *S. stroma* | MI±SD | - | 1.0±0.0 | - | - | - |
| | Np | - | 1 | - | - | - |
| | P (%) | 13.04 | 21.05 | 25.0 | 21.42 | 21.05 |
| *S. frederici* | MI ±SD | 11.6± 9.60 | 26.75±33.83 | 37.33±26.5 | 74.66±72.81 | 21.05±23.04 |
| | Np (range) | 35 (3-22) | 214 (1-100) | 112 (16-67) | 224 (13-155) | 86 (1-49) |

thopterans, dermapterans and coleopterans as intermediate hosts (Anderson, 2000).

The dry habitat of the riverbed probably plays an important role in shaping the level of diversity and density of these invertebrates. The absence of *C. vitta* (which, as other dicrocoeliids, is supposed to have a terrestrial heteroxenous life cycle with two intermediate hosts) on the slopes of the fiumara could be explained by the patchy distribution of the maquis, substituted by *Eucalyptus* spp. and *O. europaea* plantations that are unfavourable habitats for several gastropod species, which include the first intermediate hosts of this parasite.

Although rodent dispersal is probably hindered by the severe ecological conditions (such as aridity, insulation and lack of vegetation) of the fiumara, it appears that, in contrast, these conditions are favourable for the transmission of *H. polygyrus*, the typical monoxenous geohelminth of *Apodemus* spp. (Abu-Madi *et al*., 1998), which was found in woodmice from most trap sites. Unexpectedly, the only parasite recorded for all habitats was the oxyurid *S. frederici*. This is unsurprising because oxyurid worms of the genus *Syphacia* are transmitted by retroinfection and oral infection from eggs in the perianal region (Anderson, 2000).

As both the prevalence and mean intensity of parasites did not vary between the habitats considered, probably the fiumara can be considered as a single habitat unit from a helminthological point of view, with its special environmental conditions shaping the helminth community.

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