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Research paper

# Lungworms in Alpine ibex (*Capra ibex*) in the eastern Alps, Italy: An ecological approach

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ABSTRACT

Host-parasite relationships have been frequently investigated in mountain dwelling ungulates, though mostly focusing on gastrointestinal nematodes. On the contrary, very few studies were conducted on broncopulmonary nematodes, which may result in severe parenchymal lesions and act as predisposing factor for multifactorial pneumonia. The epidemiological and ecological features of lungworms infecting an Alpine ibex population in the Eastern Alps, Italy, were non-invasively investigated by means of a modified Baermann technique with an original quantitative methodology.

Out of a total of 269 samples collected monthly from July to November 2013 and from July to October 2014, 212 (78.8%) were positive for *Muellerius* and 26 (9.7%) for *Protostrongylus*, whereas *Neostrongylus* and *Cystocaulus* were less prevalent (4.1% and 0.7%, respectively). None of the investigated samples tested positive for dictyocaulids. The genus *Muellerius* showed the highest larval output intensity (134.2 L1/g), followed by *Protostrongylus* with 33.8 L1/g. A contrasting age-related pattern of *Muellerius* and *Protostrongylus* was revealed, with the former significantly more prevalent and abundant in adult animals, while the latter in kids. Due to the limited accessibility of the study area during winter and spring, it was difficult to describe clear seasonal trends in larval output, although *Muellerius* showed a minimum in the late summer and a rise in the autumn.

The newly developed diagnostic method showed a fair repeatability, thus representing an interesting tool to investigate the ecology of lungworms in protected species, such as the A. ibex. Based on results, ibex in the Marmolada massif seem to have an ecologically stable relationship with their lungworm community.



## 1. Introduction

Though commonly asymptomatic in domestic and wild ruminants, lungworm infection may result in a range of gross lesions, and occasionally cause fatal pneumonia (Panayotova-Pencheva and Alexandrov, 2010). The cross transmission of lungworms between domestic and wild ruminants pasturing in the same areas has been reported in North America (Foreyt et al., 2009). Besides, lungworm infection has been called into question as a predisposing factor in the development of severe bacterial or multifactorial pneumonia (Jenkins et al., 2007).

At the same time, in the last decades many researchers investigated parasitic diseases of wildlife, following an ecological approach (Crofton, 1971; Hudson and Dobson, 1995; Wilson et al., 2002) and developing different epidemiological indexes (*e.g.*: prevalence, intensity, abundance, index of aggregation k, richness index). The main aims of these investigations were to evaluate the structure of parasite biocenoses, to assess the stability of the relationship between host and parasite populations, to identify parasite species more prone to interspecific transmission and finally to evaluate potential sanitary risks where different domestic and wild host populations live in sympatric conditions (Hudson and Dobson, 1995). At present, most of such ecological studies conducted in free-ranging Alpine ruminants concentrate on gastrointestinal parasites, investigating the adult stages in culled animals (Zaffaroni et al., 1997, 2000; Citterio et al., 2006) and/or the eggs output in faeces (Stancampiano et al., 2001; Brambilla et al., 2013), which

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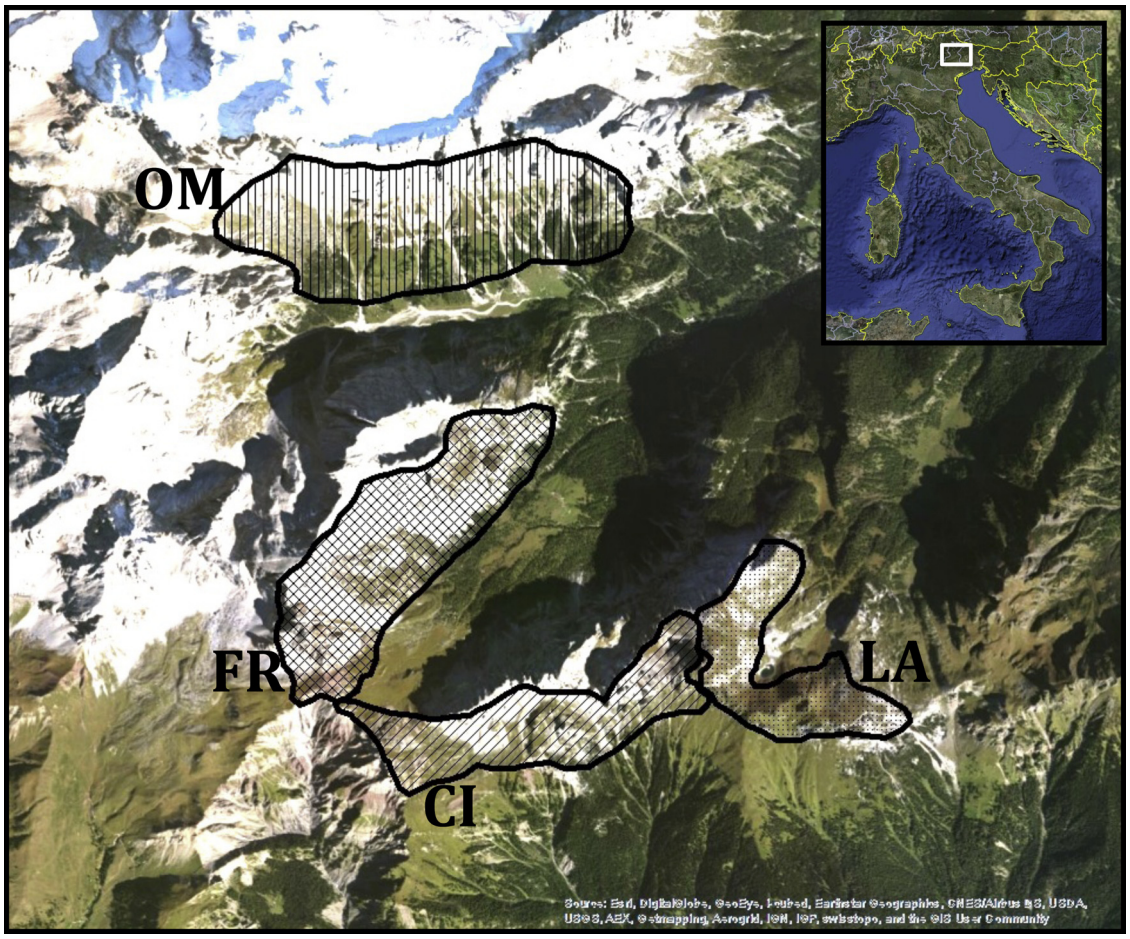


**Fig. 1.** Study area and sub-areas (FR:Franzedas; LA: Lago Negher; OM:Ombretta; CI : Cime d'Auta).

is a non-invasive approach highly valuable for non-hunted wild populations. On the contrary, lungworms were rarely investigated, possibly also because of the absence of an international standardised approach for quantification of larval output, such as the McMaster technique for gastrointestinal parasite.

In fact, limited data are published on lungworm ecology and epidemiology in mountain dwelling ungulates in Europe. The few papers available on lungworms of Alpine ibex (*Capra ibex*) reported the presence of protostrongylid infection, with different prevalence values amongst genera (Balbo et al., 1975; Manfredi et al., 1996, 2012), and the absence of dyctiocaulids. Similarly, few studies were conducted in the genetically related Iberian ibex (*Capra pyrenaica hyspanica*). In this species, four different genera of Protostrongylids and *Dictyocaulus filaria* were identified, either as adults or larvae (Acevedo et al., 2005; Alasaad et al., 2009), showing a widespread incidence of multiple infections of bronchopulmonary nematodes.

The main objective of this research was to describe the epidemiological and ecological features (*e.g.*: prevalence, intensity, environmental risk factors) of bronchopulmonary nematode infection in the isolated colony of A. ibex of the Marmolada massif, north-eastern Italy.

## 2. Materials and methods

### 2.1. Study area and animals

The ibex colony of the Marmolada massif was founded in 1978–1979, with the reintroduction of 10 individuals from source and never extinct population of the Gran Paradiso National Park (western Italian Alps). The population steadily increased at a yearly rate of 21% until 2003, when the estimated size reached more than 500 heads. During the winter 2003–2004, the colony experienced a dramatic crash caused by the combined effects of a sarcoptic mange epidemic and harsh weather conditions (Scillitani et al.,

**Table 1**
Environmental characteristics of each sub-area.

| | Sub-areas[a] | | | |
|---|---|---|---|---|
| | FR | LA | OM | CI |
| Area size (ha) | 160.7 | 82.8 | 211.9 | 109.2 |
| Mean hillshade[b] | 50.4 | 140.7 | 9.9 | 97.7 |
| Land cover (%) | | | | |
| Shrubland and forest | 6.9 | 0.0 | 16.9 | 1.6 |
| Grassland | 33.2 | 83.7 | 36.0 | 52.9 |
| Rocks and scree | 60.0 | 16.3 | 47.1 | 45.5 |

[a] FR: Franzedas; LA: Lago Negher; OM: Ombretta; CI: Cime d'Auta.
[b] 0 (shadow) → 255 (illumination).

**Table 2**
Number of collected samples for each sub-area.

| | Sub-areas | | | | |
|---|---|---|---|---|---|
| | FR | LA | OM | CI | Total |
| Collected samples (N) | 61 | 66 | 84 | 58 | 269 |
| Males | 1 | 66 | 3 | 0 | 70 |
| Females | 47 | 0 | 47 | 33 | 127 |
| N/D (adult) | 7 | 0 | 22 | 14 | 43 |
| Kids | 6 | 0 | 12 | 11 | 29 |