# Lung nematodes of chamois, *Rupicapra rupicapra tatrica*, from the Tatra National Park, Slovakia

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## Abstract

A larvoscopic examination of faeces collected from localities inhabited by chamois in the Tatra National Park (TANAP) in 1997 demonstrated the presence of the lung nematodes *Muellerius* spp. (likely to be *M. tenuispiculatus* and *M. capillaris*) and *Neostrongylus linearis*. The overall prevalence of lung nematodes in chamois herds in TANAP was 48.4% with prevalences of 45.6% and 11.9% for *Muellerius* spp. and *N. linearis*, respectively. No significant differences in lung nematode prevalences were observed in the biotopes of TANAP with prevalence values of 44.9% being recorded in the High Tatras and 58.5% in the Belianske Tatras. Individual species were in equal proportion in both biotopes, although *N. linearis* was significantly less prevalent (11.2–13.8%). The prevalence of lung nematodes in the High Tatras varied from 25.0 to 84.2% within individual localities, while in the Belianske Tatras it was more proportionate (50.0–85.7%). In the High Tatras, the prevalence of lung nematodes in the chamois herds peaked during August, declining to its lowest in October. A similar prevalence was also recorded for *Muellerius* species, while the minimum prevalence of *N. linearis* was found in July. In the Belianske Tatras, the prevalence of lung nematodes including both species of *Muellerius* peaked in July and gradually decreased until October. On the other hand, *N. linearis* was most prevalent in October. The mean L1 count per gram faeces was low (7.6 ± 13.2 larvae $g^{-1}$).

## Introduction

Rare animal species, including chamois, are a group of animals given special protection. In the territory of Slovakia, the chamois is a native species to the Tatra National Park (TANAP), in the localities of the High, West and Belianske Tatras. The Park is spread over an area of 138 $km^2$ and is strictly conserved. Chamois living in this reserve are not only a glacial relic, but also a Tatra endemic subspecies (*Rupicapra rupicapra tatrica* Blahout, 1971).

The chamois of TANAP have continuously declined in number (Hell & Chovancová, 1995), the principal problem of its conservation being related to the protection of its biotope against negative anthropic factors, (Blahout, 1977; Chovancová, 1985, 1990) and with the maintenance of its genetic identity (Radúch & Kárč, 1981; Chovancová, 1985, 1990). Parasites also contribute to the decline in the number of this rare subspecies. Parasitic diseases, and in particular lung nematodes, contribute considerably to the morbidity of chamois in the TANAP (Erhardová & Ryšavý, 1967; Sattlerová-Štefančíková, 1987; Mituch *et al*., 1989), the National Parks of the Low Tatras (Štefančíková, 1994) and the Slovak Paradise (Krokavec & Krokavec, 1991; Ciberaj *et al.*, 1997) and also in other localities

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https://doi.org/10.1017/S0022149X00700538 Published online by Cambridge University Press

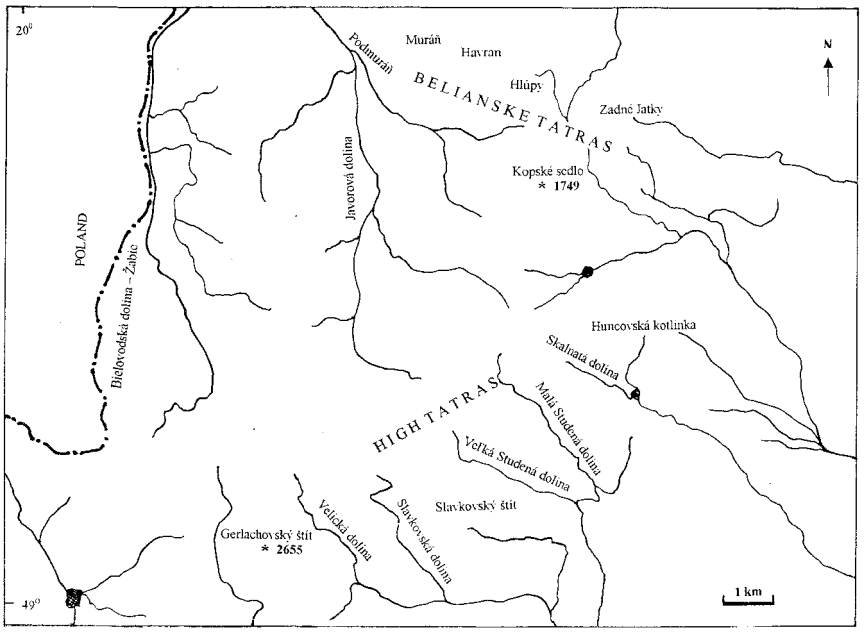


Fig. 1. Collecting sites for faecal samples of chamois herds in the Tatra National Park (TANAP).

(Dollinger, 1974; Balbo *et al*., 1975; Hörning, 1975; Bioca *et al*., 1976; Clark Genchi *et al*., 1984; Cancrini *et al*., 1985; Diez *et al*., 1990).

The aims of the present study were to assess the prevalence of lung nematodes in chamois under the conditions of the TANAP.

## Materials and methods

### *Characteristics of chamois habitats*

The Tatra mountains constitute the northernmost and highest part of the 1200 km long arch of the Carpathians. As far as the distribution of chamois is concerned, the High Tatras and Belianske Tatras, differing in their geographical, orographical, geological, trophic and climatic conditions, are the most important sites. The geomorphological and orographical conditions are favourable with respect to chamois conservation.

The habitats under study are situated at the subalpine to alpine vegetation level with an altitude of 1749–2655 m above sea level (fig. 1). The Tatras climate is continental with typical features of an alpine climate, characterized by extreme fluctuations in temperature. At the height of average summits, with the characteristics of grassy uplands, the winter extends from mid-October to early May.

### *Collection and examination of faeces*

In 1997, during July to October, 252 faecal samples from chamois were collected from the soil in various localities in the TANAP. First stage larvae (L1) were isolated from a weighed sample (3–5 g) by the Baermann's larvoscopical method and counted and identified under microscope at a magnification of 100×. The degree of infection was assessed from the larval count per gram of faeces with 10 larvae per gram representing a poor infection and 100 larvae a moderate infection. Differences in the prevalence of lung nematodes in the biotope studied during the year 1997 were statistically evaluated by the $\chi^2$ test. The mean larval count per gram of faeces was assessed using the Mann–Whitney test (Reisenauer, 1970).

## Results

The larvoscopical examination of faeces showed the presence of *Muellerius* spp. (likely to be *M. capillaris* and *M. tenuispiculatus)* and *Neostrongylus linearis*. The total prevalence of lung nematodes (table 1) in chamois herds of TANAP was 48.4% with species of *Muellerius* representing 45.6% and *N. linearis* being significantly less prevalent, at 11.9% ($\chi^2$ test, $P < 0.05$). Two main biotopes of TANAP showed no significant differences in the total prevalence of lung nematodes (High Tatras 44.9%, Belianske Tatras 58.5%) and in the prevalence of individual nematode species, with significantly higher values recorded for *Muellerius* spp. (High Tatras 41.7% and Belianske Tatras 56.9%) compared with *N. linearis* (11.2% and 13.8%, respectively) ($\chi^2$ test, $P < 0.05$).

The chamois herds in the High Tatras (table 1) showed considerable variability in the prevalence of lung nematodes, with a maximum of 84.2% in Huncovská kotlinka and a minimum of 25% in Slavkovská dolina. A similar trend was observed in the case of *Muellerius* spp., whereas *N. linearis* occurred unevenly. The localities in Belianske Tatras showed more proportionate prevalences of lung nematodes in chamois herds ranging from 50% to 66.6%, except for a high prevalence value of 85.7% in Podmuráň. Comparable prevalences were also recorded here for *Muellerius* spp., whereas *N. linearis* again occurred unevenly.

With regard to individual months of the year (table 2), a

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Table 1. Prevalences of lung nematodes in chamois herds from localities in the Tatra National Park (TANAP).

| Locality | No. of faecal samples examined | Lung nematodes | Prevalence (%) *Muellerius* spp. | *N. linearis* |
|---|---|---|---|---|
| High Tatras | 187 | 44.9 | 41.7 | 11.2 |
| Bielovodská dolina - Zabie | 18 | 38.8 | 33.3 | 11.1 |
| Slavkovská dolina | 16 | 25.0 | 25.0 | 12.5 |
| Velká Studená dolina | 26 | 69.2 | 61.5 | 30.7 |
| Velická dolina | 93 | 34.1 | 27.9 | 9.7 |
| Skalnatá dolina | 15 | 66.6 | 66.6 | 0 |
| Huncovská kotlinka | 19 | 84.2 | 84.2 | 0 |
| Belianske Tatras | 65 | 58.5 | 56.9 | 13.8 |
| Hlúpy | 13 | 53.8 | 53.8 | 0 |
| Kopské sedlo | 12 | 66.6 | 58.3 | 16.6 |
| Zadné Jatky | 17 | 52.9 | 52.9 | 41.1 |
| Havran | 16 | 50.0 | 50.0 | 0 |
| Podmurán | 7 | 85.7 | 85.7 | 0 |
| Total (TANAP) | 252 | 48.4 | 45.6 | 11.9 |

peak in the prevalence of lung nematodes in chamois herds in the High Tatras occurred in August with a significant decline in October, compared with other months. Similar monthly patterns of infection were shown by *Muellerius* species, while the minimum prevalence of *N. linearis* was found in July. ($\chi^2$ test, $P < 0.05$). In Belianske Tatras, a peak in the prevalence of lung nematodes and also both *Muellerius* spp. was recorded in July with a gradual decline in values through to October. The prevalence of *N. linearis* peaked in October.

The total mean count of nematode larvae per gram of faeces in TANAP (table 2) was low $7.6 \pm 13.2$, ranging from $5.2 \pm 7.2$ to $8.2 \pm 14.4$ for individual species, and it was a little higher in the High Tatras than in the Belianske Tatras. The larval count for *Muellerius* spp. in the High Tatras was significantly higher in July relative to other months, whereas in Belianske Tatras it was significantly higher in July relative to October (table 3). The larval count for *N. linearis* showed no significant seasonal differences in both biotopes studied (table 4).

## Discussion

The occurrence of lung nematodes in chamois has suggested that these strictly conserved endemic animals of TANAP are parasitized predominantly by *Muellerius* spp. and less so by *N. linearis*. Erhardová & Ryšavý (1967) also reported the occurrence of *Dictyocaulus viviparus*, associating this species with the transfer from deer. Mituch (1969) found both species of *Muellerius* in the lungs of chamois and larvae of the genera *Bicaulus* and *Cystocaulus* in the faeces. Mituch *et al*. (1989) later reported the species *N. linearis* and *D. viviparus,* whereas Rajský & Beladičová (1987) identified only two species of *Muellerius*. Sattlerová–Štefančíková (1982, 1987) found the same species as those presented in the present study.

The prevalence of lung nematodes in the chamois herds of TANAP in the summer and autumn of 1997 was higher than that reported by Rajský & Beladičová (1987) and lower than that detected by Sattlerová-Štefančíková (1987) and also lower than the prevalence reported by Štefančíková (1994) from the Low Tatra National Park. The most prevalent lung nematode species in chamois from different territories of Europe and New Zealand are species of the genus *Neostrongylus*, *Muellerius* and *Protostrongylus.* Species of *Dictyocaulus* were less frequent and *Cystocaulus* spp. very sporadic as reported by Štefančíková (1994).

Table 2. Seasonal prevalences and mean number of larvae per gram of faeces of lung nematodes in herds from localities within the Tatra National Park (TANAP).

| | Lung nematodes | | *Muellerius* spp. | | *N. linearis* | |
|---|---|---|---|---|---|---|
| Locality/Month | Prevalence (%) | L1/g ± S.D. | Prevalence (%) | L1/g ± S.D. | Prevalence (%) | L1/g ± S.D. |
| High Tatras | 44.9 | 8.7 ± 15.5 | 41.7 | 9.4 ± 16.8 | 11.2 | 5.8 ± 7.9 |
| July | 73.1 | 25.9 ± 22.8 | 73.1 | 15.9 ± 20.4 | 7.7 | 8.8 ± 5.6 |
| August | 85.0 | 4.3 ± 4.8 | 85.0 | 3.6 ± 3.8 | 30.0 | 6.6 ± 6.3 |
| September | 60.9 | 2.4 ± 1.6 | 56.5 | 2.6 ± 1.7 | 10.9 | 1.8 ± 1.1 |
| October | 17.9 | 7.2 ± 16.4 | 16.8 | 7.4 ± 18.9 | 8.4 | 6.9 ± 11 |
| Belianske Tatras | 58.5 | 5.4 ± 5.6 | 56.9 | 5.4 ± 5.5 | 13.8 | 3.8 ± 5.5 |
| July | 83.3 | 8.8 ± 7.2 | 83.3 | 8.8 ± 7.2 | 0 | 0 |
| August | 63.6 | 3.1± 2.2 | 63.6 | 2.9 ± 1.5 | 18.1 | 3.8 ± 4.7 |
| September | 50.0 | 3.8 ± 1.4 | 50.0 | 3.8 ± 1.5 | 9.1 | 3.7 |
| October | 37.5 | 3.1 ± 4.4 | 37.5 | 2.6 ± 2.4 | 25.0. | 3.8 ± 6.6 |
| Total (TANAP) | 48.4 | 7.6 ± 13.2 | 45.6 | 8.2 ± 14.4 | 11.9 | 5.2 ± 7.2 |

https://doi.org/10.1017/S0022149X00700538 Published online by Cambridge University Press

Table 3. Mann–Whitney U tests of mean larval counts (larvae per gram of faeces) of *Muellerius* spp. from Tatra National Park (TANAP).

| | | High Tatras | | | |
|---|---|---|---|---|---|
| Locality | Month | July n=19 | August n=17 | September n=26 | October n=16 |
| Belianske Tatras | July | – | U=53.5 | U=78.0 | U=54.0 |
| | n=15 | | p=0.0006 | p=0.0001 | p=0.0012 |
| | August | U=24.0 | – | U =203.5 | U=122.0 |
| | n=7 | p=0.4455 | | p=0.6638 | p=0.6140 |
| | September | U=27.0 | U=15.5 | – | U=205.0 |
| | n=6 | p=0.1611 | p=0.4320 | | p=0.9381 |
| | October | U=27.0 | U=27.0 | U=18.0 | -- |
| | n=9 | p=0.0157 | p=0.6338 | p=0.2885 | |

Table 4. Mann–Whitney U tests of mean larval counts (larvae per gram of faeces) of *N. linearis* from Tatra National Park (TANAP).

| | | High Tatras | | | |
|---|---|---|---|---|---|
| Locality | Month | July n=2 | August n=6 | September n=5 | October n=8 |
| Belianske Tatras | July | – | U=3.0 | U=0.0 | U=4.0 |
| | n=0 | | p=0.3173 | p=0.5282 | p=0.2963 |
| | August | U=0.0 | – | U =5.0 | U=18.0 |
| | n=2 | p=1.0000 | | p=0.0679 | p=0.4386 |
| | September | U=0.0 | U=0.0 | – | U=15.5 |
| | n=1 | p=1.0000 | p=1.0000 | | p=0.5100 |
| | October | U=0.0 | U=5.0 | U=0.0 | – |
| | n=6 | p=1.0000 | p=0.5582 | p=1.0000 | |

The predominance of *Muellerius* spp. was also observed by Chroust (1991) in chamois in Jeseníky (Czech Republic). On the other hand, Kotrlá *et al.* (1984) reported *N. linearis* as a dominant species in chamois from Lužické hory, Česká Kamenice and the High Tatras. A higher occurrence of this species was also reported by Hörning (1975) in the Swiss Alps, by Kutzer & Hinaidy (1969) and Stroh (1936) from the Austrian Alps and by Diez *et al*. (1984, 1987, 1990) in the Reres Reserve in Spain.

Differences in species composition, prevalences and the intensities of infection in chamois are influenced by a number of ecological factors, such as geographic, geomorphological, climatic and trophic conditions of the biotope, in addition to host migration and the occurrence of intermediate hosts. In TANAP, the intermediate hosts of lung biohelminths include various species of terrestrial snails. The biotope of the High Tatras differs considerably from that of Belianske Tatras, which has a substantial impact on the species structure and the density of the mollusc, as intermediate hosts (Sattlerová-Štefančíková, 1987).

The current status of lung nematodes in chamois of TANAP is determined by several factors. Harsh climatic conditions occurring over several years at the time of littering the young, and the presence of predators and increasing anthropic interference have decimated the chamois population which in turn has resulted in the lower dissemination of the lungworm propagative stages into the environment. This has limited the infection of the intermediate and definitive hosts and hence the current infection rate is lower than the 100% prevalence of lung nematodes recorded 12 years ago by Sattlerová-Štefančíková (1987) in the same territory.

## Acknowledgements

This paper was partially supported by the VEGA grant agency No. 2/5012/98 and by the National Environmental Fund. We wish to thank RNDr. M. Špakulová, CSc., Parasitological Institute of the Slovak Academy of Sciences, Košice, for her assistance with the statistical evaluation.

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(Accepted 10 February 1999)