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# Nematode communities of grazed and ungrazed semi-natural steppe grasslands in Eastern Austria

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## Summary

Soil nematode communities were investigated at eight semi-natural steppe grasslands in the National Park Seewinkel, eastern Austria. Four sites were moderately grazed by horses, cattle and donkeys, four were ungrazed. Nematodes were sampled on four occasions from mineral soil, and their total abundance, diversity of genera, trophic structure and functional guilds were determined. Altogether 58 nematode genera inhabited the grasslands, with *Acrobeloides*, *Anaplectus*, *Heterocephalobus*, *Prismatolaimus*, *Aphelenchoides*, *Aphelenchus*, *Tylenchus* and *Pratylenchus* dominating. Mean total abundance at sites was 185—590 individuals per 100 g soil. Diversity indices did not separate communities well, but cluster analysis showed distinct site effects on nematode generic structure. Within feeding groups the relative proportion of bacterial-feeding nematodes was the highest, followed by the fungal- and plant-feeding group. Omnivores and predators occurred in low abundance. The maturity indices and plant parasite indices were characteristic for temperate grasslands, but the abundance of early colonizers (*c-p* 1 nematodes) was low. A high density of fungal-feeding *c-p* 2 families (Aphelenchoidae, Aphelenchoididae) resulted in remarkably high channel index values, suggesting that decomposition pathways are driven by fungi. Nematode community indices of all sites pointed towards a structured, non-enriched soil food web. At most sites, grazing showed little or no effect on nematode community parameters, but total abundance was higher at ungrazed areas. Significant differences in the percentage of omnivorous nematodes, the sum of the maturity index, the number of genera and Simpson's index of diversity were found at one long-term grazed pasture, and this site was also separated by multi-dimensional scaling (MDS).


## Introduction

Traditional human intervention involving grazing by large herds of horses and cattle during the last

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century characteristically formed the landscape of the Seewinkel region, eastern Austria. The edaphic and geological conditions, coupled with grazing led to the development of short and open steppe grasslands (Rauer and Kohler, 1990). The grasslands between Lake Neusiedl and the Hungarian border are characterised by a particularly high biodiversity along with a variety of rare and thermophilic plant and invertebrate species (Koo, 1994). The cessation of extensive grazing in the mid-20th century caused to shrink these former grassland areas up to 45% due to the expansion of reed from the shore of the adjacent Lake Neusiedl and an increase of shrubs and trees (Rauer and Kohler, 1990). Protection and conservation of the remaining dry to sub-humid grasslands was therefore the main goal of a controlled grazing management programme at selected sites in the National Park Seewinkel (Rauer and Kohler, 1990; Korner et al., 1999b). Positive effects of these management techniques on avian, plant and invertebrate diversity have been reported (Rauer and Kohler, 1990; Korner et al., 1999a; Zulka and Milasowszky, 1998).

Above-ground grazing is known to affect soil biota through, for example, the consumption of phytomass (Bardgett and Wardle, 2003), microclimatic changes of soil temperature and moisture (Freckman et al., 1979; Ingham and Detling, 1984; Merrill et al., 1994), deposition of dung (Bardgett et al., 1998a), and soil compaction (Petersen et al., 2004). Soil nematodes occur in high abundance and diversity in grasslands (Ettema and Yeates, 2003) and their populations can also reflect above-ground grazing treatments (Merrill et al., 1994; Bardgett et al., 1997, 1998b; Wall-Freckman and Huang, 1998). Recent studies have focussed on effects of livestock grazing on soil dwelling nematodes. The most pronounced influence was a change in abundance and diversity according to livestock grazing intensity (Mulder et al., 2003; Bardgett et al., 1998a; McSorley and Frederick, 2000; Smolik and Rogers, 1976). Freckman et al. (1979) found elevated populations of bacterial-feeding nematodes in grazed grasslands and related this to higher food resource (microorganisms) availability, for example, due to the deposition of animal excreta. Furthermore, densities of root-feeding nematodes were positively affected by above-ground grazing through reduced plant resistance and microhabitat modification (Ingham and Detling, 1984).

Although nematode communities of temperate grassland and pasture habitats have been extensively studied (e.g. Seidenschwarz, 1923; Gerber, 1981; De Goede and Bongers, 1998; Popovici and Ciobanu, 2000), little information is available about nematode communities of semi-natural steppe grasslands and about the effect of moderate grazing as a nature conservation tool.

The present study (1) investigates and compares the diversity and community structure of soil nematodes in the steppic grasslands included in the grazing management programme of the National Park Seewinkel and (2) examines whether moderate grazing used as a management tool affected nematode communities.

## Materials and methods

### Study area, study sites

The study was conducted in the western part of the National Park Seewinkel (45°46′N, 16°47′E, 115 m a.s.l.) located approx. 40 km southeast of Vienna, Austria. The long-term mean annual air temperature in the region is 10 °C, the mean annual precipitation 600 mm (Bundesanstalt für Bodenkartierung, 1986). Soils in the region are sandy with low nutrient status and include partly salt-affected chernozems (Nelhiebel, 1980). Investigations were performed at four pairs of sites (eight sites) of former pastureland, on which human intervention (grazing) was stopped in the mid-20th century. Four sites were then grazed again with different intensity (Table 1), four sites were left ungrazed.

Visual differences were evident between the grazed and ungrazed areas: the vegetation cover of grazed areas was incomplete; the swards were uniformly short (5–10 cm) with almost no litter layer, resulting in high insolation at the soil surface. Ungrazed high swards (30–70 cm) showed a dense vegetation cover and a distinct litter layer (5–7 cm).

### Nematode sampling and extraction

Eight replicate soil samples were taken randomly at each site with a cylindrical steel corer (2.1 cm diameter) to a depth of 10 cm in May, July, August and September 2002. Samples were bulked, mixed and stored in polyethylene bags at 4 °C. All nematodes extracted from 100 g soil with modified Baermann funnels (24 h) were heat killed, fixed in 4% formaldehyde, counted and identified to genus level on glycerol slides after Bongers (1988), Jairajpuri and Ahmad (1992), Mai and Mullin (1996) and Loof (1999, 2001). Each nematode was recorded as juvenile or adult. Soil water content was determined by drying the samples at 104 °C for 24 h and organic content as loss on ignition. pH was