

Original vegetation type affects soil nematode communities

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Abstract

The effect of land use changes on the composition of nematode communities has been well documented, however, the applicability of such studies limited to areas with relatively uniform soil and environmental conditions. To determine whether the historical difference in vegetation types affects soil nematode communities during the land use change processes, we carried out a study along two transects where contrasting natural vegetation types (grass versus shrub) were replaced by tea monocultures. Soil nematode communities were compared between two transects at three chronosequence stages: natural vegetations, 3–7 years old tea plantations. Nematode abundance, generic richness, diversity, and proportions of bacterivores and fungivores were higher at each stage of GT transect (from grassland to tea plantation) than at the equivalent stage of ST transect (from shrubland to tea plantation), whereas lower values of maturity index and nematode channel ratio occurred at each stage of GT transect relative to ST transect. MDS ordination analyses, SIMPER analyses and β_w indices indicated that the difference in nematode community structure was greatest between the two 3-year-old tea plantations, although the greatest difference in environmental conditions was observed between two original vegetation habitats. This suggested that the original vegetation types may affect the following nematode community development; however, the effects can decrease over time. Different trophic groups responded to land use in different ways along the vegetational development. This supports the viewpoint that the addition of a common resource can evoke disparate responses from individual food-web components.

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1. Introduction

Land transformation by humans is probably the largest terrestrial driver of global change phenomena (Wardle, 2002). Over the last few centuries the extent and rate of land use and land cover change have been dramatic (Richards, 1990; Turner et al., 1990). For example, large areas of land covered by original vegetation (forests, grasslands, wetlands) have been taken into arable land due to an increasing demand for crop production in the

world (Háněl, 2003). Accompanying the obvious changes aboveground are less conspicuous but equally important changes belowground (Jackson et al., 2000; Hooper et al., 2000; Wolters et al., 2000; van der Putten et al., 2001). Previous studies detected that the land use changes often altered root and soil nutrients distributions (Schlesinger, 1977; Trumbore, 2000) and thus influenced the belowground biological community (Hendrix et al., 1986; Beare et al., 1992; Frey et al., 1999). However, the consequences of land use changes can be predicted only if the dynamics and functional interactions of plant and soil biota are fully understood (Bardgett et al., 1993).

Among soil biota, nematodes possess attributes that are useful to reflect the consequent changes belowground in the course of land use changes (Bernard,

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1992; Wasilewska, 1997; Ferris et al., 2001; Neher et al., 2005). They are good environmental indicators because of their strong relationships with land management (Todd, 1960; Neher and Campbell, 1994; Liang et al., 1999; Donegan et al., 2001; Fiscus and Neher, 2002) and aboveground vegetation (Ingham et al., 1985; Bongers and Bongers, 1998; Bongers and Ferris, 1999; Yeates, 1999). Studies addressing the differences in soil nematode community have investigated, for example, the changes from grassland to pine plantations (Yeates et al., 1997, 2000), from forest to arable land (Wasilewska, 1979), from shrubland through grassland to wheat (Yeates and Bird, 1994), from grassland to arable land (Hodda and Wanless, 1994), from cultivated field to meadow land (Háněl, 2003; Kardol et al., 2005) and from wetland to reclaimed land (Wu et al., 2002, 2005). Most studies indicated that land use changes markedly affect soil nematode community (Yeates and King, 1997; Yeates, 1999; Wardle, 2002; Urzelai et al., 2000), although the direction of these effects appears to be idiosyncratic and case specific (Freckman and Ettema, 1993). Given the importance of land use changes in determining the composition of nematode communities, the applicability of such study appears limited to areas with relatively uniform soil and environmental conditions (Yeates, 1999).

The aim of the present study was to determine whether the historical difference in vegetation types affects soil nematode community development following land use changes. We carried out the study in two adjacent sites in a mountainous area where small scale changes in land use occurred. These two sites had contrasting natural vegetation types (herbaceous versus woody vegetations), which were replaced by tea monocultures simultaneously. Soil nematode communities were compared at three chronosequence stages of the land use regime: natural vegetations, 3–7 years old tea plantations. In order to assess potential shifts in soil nematode community composition and functioning, we analyzed both the taxonomical and trophic composition of the soil nematode communities. Given the fact that the residual roots of original vegetations affect soil nematodes, and that the effects from residual roots decrease over time, we hypothesized that (i) the soils with contrasting natural vegetation types have most different nematode community structure, and the difference decreases over time after the vegetation replacement, and (ii) different nematode trophic groups respond to vegetation changes differently, and their changing trends across the land use history will also differ.

2. Materials and methods

2.1. Study area

The study sites were located in Xujiaba (24°32'N, 101°01'E; altitude 2450 m above sea level), which is at the center of Ailaoshan Mountains National Nature Reserve in southwestern China. The mean annual temperature is 11.3 °C and precipitation averages 1931.9 mm per annum. Two sites of ca. 1.5 ha were selected to represent two transects with contrasting original vegetation types, i.e., herbaceous and woody vegetations. At both sites, part of the natural vegetation was replaced by tea monocultures in 1997 and 2001, respectively. Thus, each site contains natural vegetation and tea plantations of different ages (3–7 years old). These two study sites are about 1 km apart, and under the same geographical and climatic conditions. The site characteristics are given below.

- (1) GT (grassland to tea plantation) transect: a transect from grassland to tea plantations. This transect comprises three stations representing one natural vegetation stage and two tea plantations of different ages. Each station is ca. 0.5 ha in area. At the beginning of tea planting, the soils were plowed and harrowed. Thereafter, the tea plantations were manually hoed in the inter-row area and fertilized twice a year.
 - G (grassland): an original vegetation stage with *Stellaria vestita* Kurz (Caryophyllaceae) in high density and nearly 100% vegetation coverage;
 - GT3 (grassland to tea plantation for 3 years): a 3-year-old tea plantation of *Camellia sinensis* (Linn.) O. Ktze (Theaceae, common name “tea plant”) monoculture started from grassland;
 - GT7 (grassland to tea plantation for 7 years): a 7-year-old tea plantation of *C. sinensis* monoculture started from grassland.
- (2) ST (shrubland to tea plantation) transect: a transect from shrubland to tea plantations. In accordance with GT transect, ST transect also comprises three stations. Each station is ca. 0.5 ha in area. The tillage management of the tea plantations in ST transect is the same as those in GT transect.
 - S (shrubland): an original vegetation stage with shrub, dominated by *Vaccinium duclouxii* (Levl.) Hand-Mazz (Ericaceae), *Pteridium revolutum* (Bl.) Nakai (Pteridaceae, common name “hairy bracken”) and *Sinarundinaria nitida* (Mitf.) Nakai (Gramineae, common name “fountain bamboo”);

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