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Does litter decomposition rate indicate species status in the plant community of alpine meadow?

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Introduction

Litter decomposition is the physical and chemical breakdown of dead plant material, which is affected by the litter quality, environmental conditions and the composition of decomposer communities (Parton *et al.* 2007). Within biomes, environmental conditions set a similar background broadly (Berg *et al.* 1993; Moore *et al.*, 2001; Raich *et al.* 2006; Parton *et al.* 2007) and microbial communities are assumed to be 'functionally equivalent' in terms of carbon metabolism (Andr n and Balandreau 1999). Consequently, litter quality has been considered as the predominant control on the rate of decomposition of organic matter in the ecosystem (Cornwell *et al.* 2008). Litter quality was closely related with nutrient use efficiency (NUE), which covers a variety of physiological processes, including the relation between the nutrient content of a plant and its growth rate (Small 1972) and the partitioning of nutrients between litterfall and 'resorption' pathways (Vitousek 1982). Nutrient use efficiency plays an important role in the success of plants in intra- and interspecies competition in natural ecosystems (Small 1972). Here we hypothesis that the plant community structure, which was decided by earlier NUE interactions, may correlate with the litter decomposition rates.

Methods

Study sites

The experiment was located in the east of the Qinghai-Tibetan Plateau, in the typical alpine meadow ecosystem in Maqu county, Gansu province, Northwest China (101°53'N, 33°40'E). The experiment was done on a flat 50m x 50m plot, which was enclosed at the end of May 2010.

Vegetation survey and plant material collection

In the middle of August 2010, 2011 and 2012, five 0.5m x 0.5 m quadrats were harvested randomly from the enclosure grassland plot. The height, coverage and mass of each plant in the quadrat were recorded and cut just above the soil surface. Plants were oven dried at 65°C to constant weight. The importance value (IV) was calculated as:

$$IV = (\text{relative coverage} + \text{relative height} + \text{relative mass})/3$$

Litterbags and experimental design

We collected litter samples in the middle of October 2010

and divided each sample into two similar, pre-weighed subsamples. One subsample was used for the initial litter quality analysis. The other subsample were used for the experiment.

We put 5 grams of each plant litter into standardised 10x15 cm nylon bags made of 2 mm mesh. Each plant litter treatment had 8-10 replicates. The bags were placed horizontally on the soil surface and fixed with pegs through the whole year (from 1st of November 2010 to 1st of November 2011). Upon harvest, litter was removed from the bags, cleaned by removing external material, and dried at 65°C to constant weight.

Decomposition rate constants (k) for each litter type were determined using a negative exponential model (Olson, 1963):

$$\ln(X_t) = \ln(X_0) - kt \quad (1)$$

where: X_t equals the amount of mass left at time t ; X_0 is the initial mass of litter; and t is time in years. The coefficient k was derived from the data and the simple linear regression relationship between k and IV among different years was established.

Results

The mean decomposition coefficient (k) among different species was 0.54, and the largest difference in decomposition rate was 5.1 fold. We analysed the relationship between decomposition rate constants for plant species over three years, and found no significant correlation. However, when excluding the effect of dominant species, the correlation coefficient (r) increased from 0.001 in 2010 to 0.648 in 2012 (Fig.1). We speculated that the dominant species captured much resources and reduced the nutrient available to the other species in the community.

Conclusion

Under the pressure of dominant species, the other species litter decomposition rates provide some indication of their potential status in alpine meadow after grassland enclosure is enacted under government policies. However, further research is needed to confirm these results.

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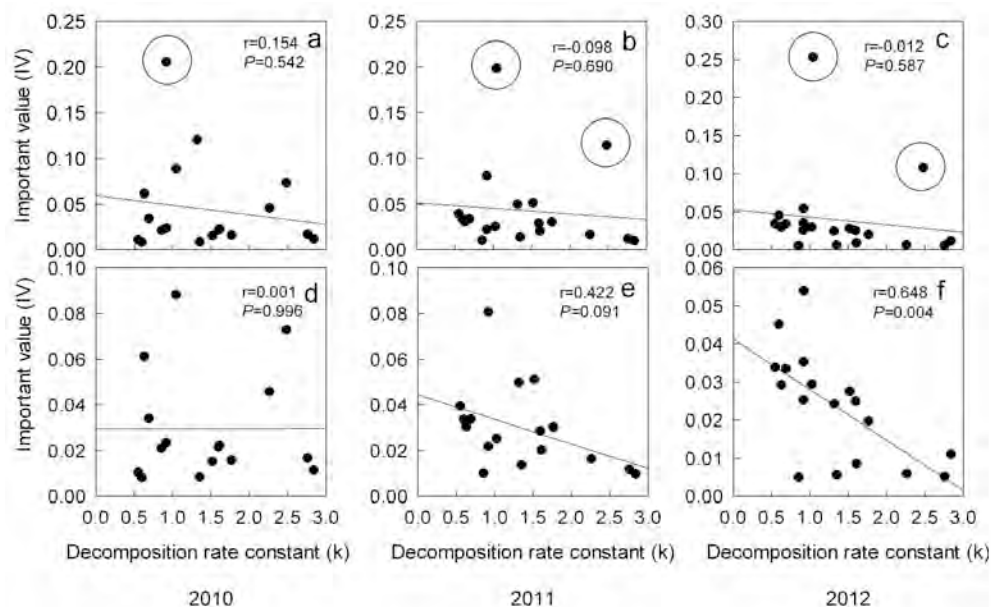


Figure. 1 The relationship between the decomposition rate constant (k) and the important value (IV). Panel a, b, c include the dominant species marked with a circle. Panel d, e, f exclude the dominant species.

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