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Analysis of litter decomposition and mesofauna activity in different California grasslands using a classical litterbag approach and a bait lamina system

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Abstract

The dynamic of litter decomposition is essential for soil fertility and the establishment of certain plant communities. In California grassland the mediterranean climate limits the decomposition to a short period of time only. Moreover the quality of grass litter produced is poor. Three different types of grasslands were tested using litterbags and bail lamina for the mesofauna activity: (1) annual grassland, representing a mixture of mainly non-native annual grasses, (2) restored perennial grassland, former annual grassland now planted with native perennials; (3) relict perennial grassland, representing an undisturbed community of native perennial grasses. Moreover a bare soil control was included into the investigations.

The slowest decomposition rates occurred when annual grassland litter was placed on the surface of tilled, bare soil. The highest rates were observed for the annual grassland. Restored and relict sites were quiet close indicating a relation between plant cover and decomposition rates of litter. The bail lamina test system showed that, after 70 days in the spring, slightly more activity occurred in the annual grassland (36% of bait used) vs. 28% in the relict and restored perennial grasslands. This activity is far lower than what is typical of mesic temperate forest or farmland soils in Europe. For all sites with perennial grasses a certain vertical and horizontal pattern was observed. Feeding activity of mesofauna decreased gradually with depth between 0 and 8 cm and the decrease was less pronounced when further away from the bunchgrass. More specific investigations on mesofauna in California grassland soils are needed to understand the functional impact of soil fauna in this semi arid climate.

Keywords: annual grassland, perennial grassland perinnial, restoration, carbon turnover, , Kupfer,
Humusform, Zersetzerrefugium,
Ecotoxicology,
copper, humus form, decomposer refuge

Introduction

In the Carmel Valley of California, large areas of native grassland were cultivated (1880-1930). When tillage stopped, annual grasses invaded croplands, and grain production was replaced by annual grassland and cattle grazing. The native bunchgrasses did not re-establish and European annual grasses (cf. Avena spp., Bromus spp.) invaded. Today native perennial grassland is limited to small relict sites. Target of restoration is the conservation of native bunchgrass species and the reestablishment of their typical communities.
The investigations reported here were carried out to quantify litter turnover rates and biological (faunal) activity.

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Material and Methods

The distribution of litter in the three grassland types was taken 3-dimensional using a so called “litter point frame”. Ten thin steel pins are placed in a frame of 1 m in length and about 1 m in heights. Applied in a vertical manner this set-up allowed to describe the litter distribution in heights on a short transect. It turned out that annual and restored annual grassland supported more litter that was some what away from the soil compared to the relict site. The relict site showed less litter in total and a very nested distribution of both bunchgrass plants and litter.

Litterbags filled with plot specific litter were exposed to decomposition in the three different grasslands for nearly one year beginning in late October before the first fall rains. The treatments in litterbags were:

(1) annual grassland on the soil surface
(2) restored perennial grassland with three placements, near the bunch on the surface (nb), between the bunches on the surface (bb), and on top of the bunches about 15 cm above the surface (tb). These litter bags were placed on stilts.
(3) relict perennial grassland, again (nb and bb)
(4) on the surface of a tilled bare soil control

Results and Discussion

As found for a number of other biological features (Potthoff et al. 2005, Potthoff et al. 2006) litter turnover was clearly reduced when the plot supported no plants. The placement of litter had no effect. Even the placement without soil contact showed dry weight losses in the same range as the surface placements. In a total range between 30 and 70% of lost dry matter from the litter the losses in annual grassland were significantly higher than in perennial grassland. There was no difference whether the perennial grassland was restored or relict.

Bait lamina sticks (Torne 1990; Larink 1993) were exposed to the three grassland sites during the wet season. Sticks were placed randomly in the annual grassland and the tilled bare soil control. The bunchgrass sites they were applied in increasing distances from a bunch (0, 5, 10, 15 and 20 cm).

Bait lamina showed a very low activity of soil mesofauna. The test provided evaluable results not earlier as 70 days after exposition. No differences due to distance from the bunches were observed in the perennial sites.

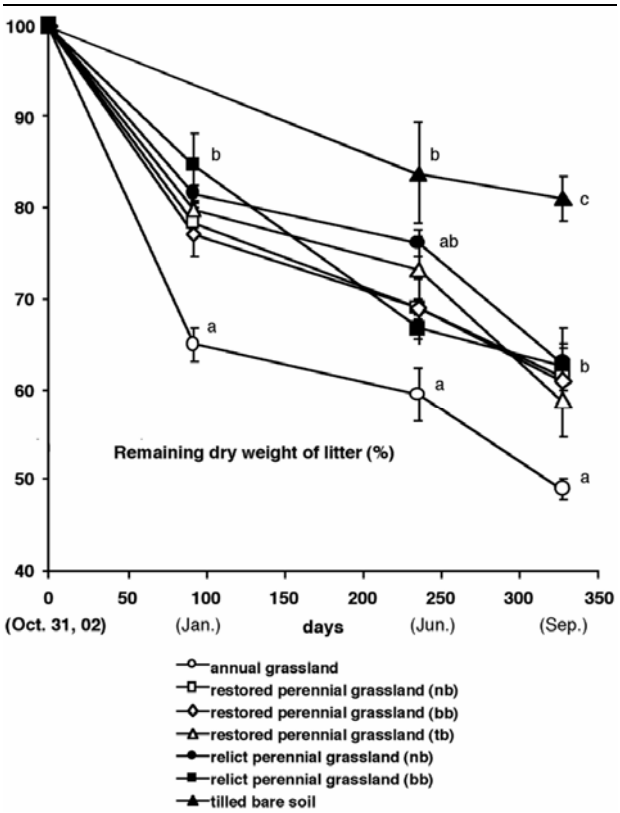

Figure 1: Dry weight losses from litterbags in relict and restored perennial grassland and in annual grassland at Hastings Reserve, Carmel Valley. The abbreviations “nb,” “bb,” and “tb” indicate litterbag placements near a bunch on the soil surface, between bunches on the soil surface, or suspended on top of a bunch (15 cm above the surface), respectively. Litter was from the grasses present in each ecosystem, except that annual grassland litter was placed on the tilled bare soil. Tilled bare soil indicates a plot supporting no plants. n=5, statistical comparison of means using the Tukey HSD Test.

A decreasing activity with depth was indicated by a number of bait sticks. This reduction was not significant and showed no pattern fitting to the treatment set-up. In total the activity in annual grassland was slightly higher than in the perennial sites (36% of baits taken vs. 28 %).

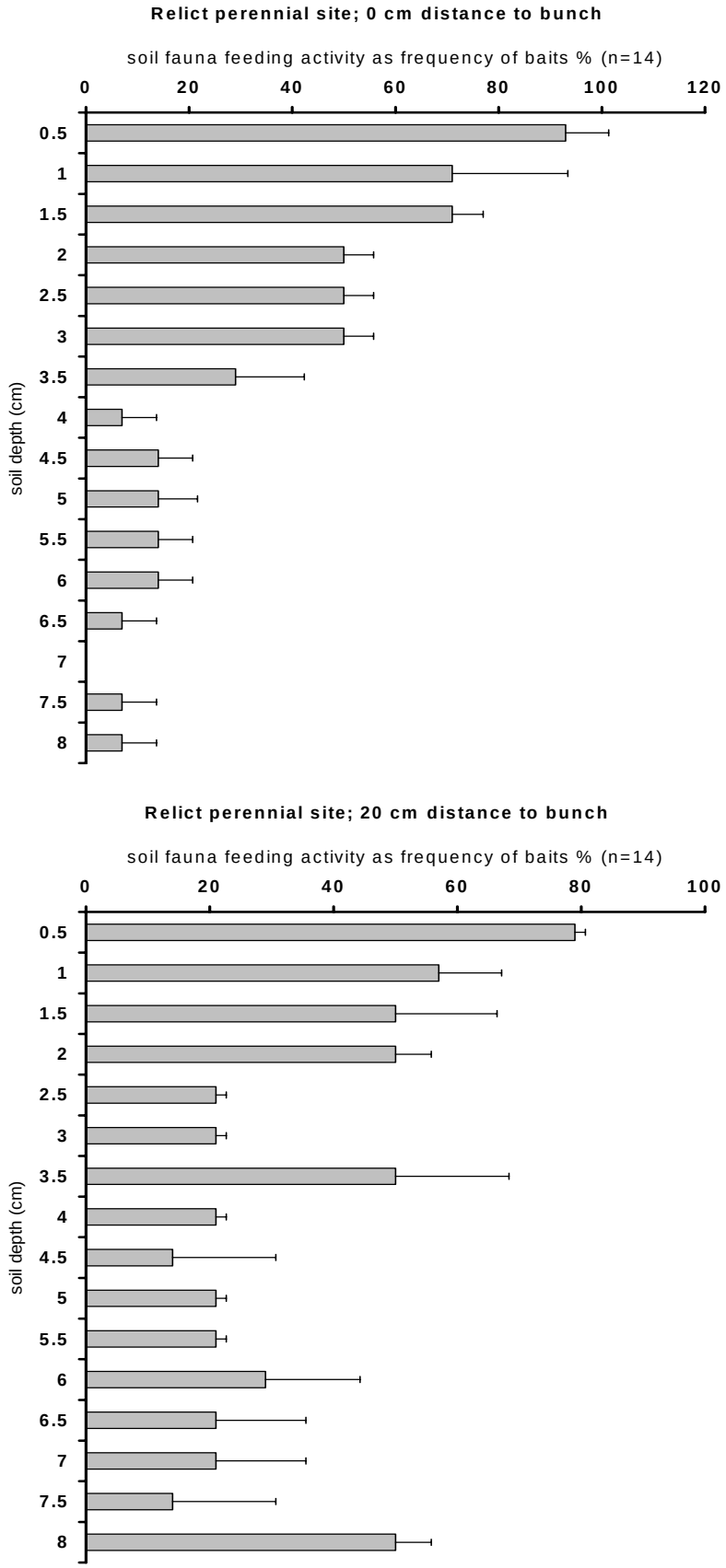

Figure 2: Mesofauna feeding activity in a relict perennial bunchgrass plot as indicated by the bait lamina test for the 0 and 20 cm distance from a bunch. Activity is expressed as the ratio of baits taken to total number of baits provided after 70 days of bait exposition in soil. Number of strips tested = 14; error bars show standard deviation.

We conclude that

(1) low biological activity faces low litter quality indicating litter accumulation
(2) decomposition is mostly microbial
(3) the balance of primary production and litter decomposition is not clearly understood for the grasslands

Screening of soil fauna and lab incubations for the decomposition potentials under controlled conditions should be applied as further investigations.

Further reading:

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