Influence of grazing on soil microbial communities on a mixed grass prairie ecosystem

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Introduction The grazing of ungulates is the predominant use for much of the world's semiarid rangelands. Grazing these lands can result in significant changes not only in the vegetation community but also in the soil physical, chemical and biological properties. Changes in soil physical and chemical properties and the plant community can potentially lead to changes in soil microbial communities which may have long-term ramifications for nutrient cycling and carbon (C) sequestration. The objective of this research was to ascertain the influence of three long-term grazing treatments on soil microbial communities.

Materials and methods In May 2003, two replicates of three different grazing treatments were sampled; an ungrazed exclosure (EX); grazed season-long continuous light (CL) and; a grazed season-long continuous heavy (CH) treatment. These three grazing treatments had been initiated in 1983. In each replicated paddock, sampling was undertaken along a permanent 50 m transect and soils sampled at 0-5, 5-15, 15-30 and 30-60 cm depth increments. After sieving (< 2 mm) and air-drying, soils were rewetted and incubated and microbial respiration measured, using a base-trap method, at three (3d-MR) and 21 d (21d-MR). Nitrogen (N)-mineralisation was also determined by calculating the amount of inorganic N (Ni: NO_3 + NH_4) produced over the course of the 21 d incubation. Microbial biomass carbon (MBC) was determined using the chloroform fumigation-incubation method. A second set of soil samples were collected at the 0-5 and 5-15 cm depth increments along the transects for phospholipid fatty acids (PLFA) biomarker analyses.

Results There were distinct treatment differences in the 3d-MR, 21d-MR, and N-mineralisation in the order CL > EX >> CH. There was 8% greater nitrate in the CL treatment compared to the EX and CH treatments suggesting possible differences in the nitrifying populations between the CL treatment compared to the EX and CH treatments. Microbial biomass C was higher in the CL than the EX treatment and both were much greater than the CH treatment. Multiple analysis of variance using PLFA biomarkers indicated a significant grazing treatment effect at both depths examined. Results show the microbial community structure in the CL treatment was distinct from that in the CH grazed treatment whereas the EX treatment was intermediate.

Discussion and conclusion The results of this work suggests that in these prairie ecosystems, which have co-evolved with native ungulates over many millennia, light grazing (the CL treatment was grazed at ~35% lower stocking rate than that recommended by the Natural Resources Conservation Service) is beneficial to the soil community. Previous work by Hamilton & Evans (2001) found that clipping of a C_3 plant stimulated the release of root exudate C compounds which in turn increased microbial biomass as well as NO_3, NH_4 and potential N-mineralisation, compared to unclipped plants. Many of the changes observed in the microbial communities probably also reflect the influence that grazing has had on the plant community composition. Cool season (C_3) perennial grasses are the predominant group under the CL treatment, whereas C_4 (warm-season) perennial grasses dominate CH, and C_3 perennial grasses and forbs co-dominate the EX. It would appear that under very heavy grazing, much of the C that would normally be available for root exudation is instead put into the production and replacement of grazed plant parts. The changes in N-mineralisation were probably due to the C_4 dominated plant communities tieing up more N in plant material as compared to the C_3 dominated plant communities with this reducing the availability of inorganic N in the soil (Wedin, 1999). This change, together with potential variation in root exudation, appears to have given rise to different microbial communities (as evidenced by the PLFA results and the observed differences between other measures of microbial activity) evolving in each of the three grazing treatments.

References

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