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Plant traits explain landscape-scale variation in C stocks and soil microbial communities

F.T. de Vries (1), P. Manning (2), and R.D. Bardgett (1)

(1) Soil and Ecosystem Ecology, Lancaster Environment Centre, Lancaster University, Lancaster, LA1 4YQ, (2) School of Agriculture, Food and Rural Development, University of Newcastle, Newcastle, NE1 7RU

In recent years, plant traits have been found to relate to ecosystem processes such as rates of nitrogen mineralisation and decomposition, but also to the composition of the soil microbial community. Most evidence for these patterns, however, comes from relatively small-scale, within-field studies, and relationships are often based on data derived from plants grown in monoculture. It is not clear, therefore, if these same patterns can be observed at landscape or regional scales where such relationships might be overwhelmed by the effects of abiotic factors, including soil physical and chemical properties and climate. Here, we sampled 180 grasslands across England to assess the importance of plant traits, expressed as community-weighted means (CWM), for determining soil carbon stocks and microbial communities, on top of abiotic factors such as climate and soil properties, such as texture and pH. We fitted statistical models to data detailing the climate, soil properties, vegetation, carbon (C) and nitrogen (N) stocks, and microbial communities (assessed using PLFAs) of this wide range of grassland types. We found that total soil C and N stocks were explained by a combination of abiotic factors, whereas for the separate pools plant traits appeared to be important: the active C fraction (>250 μm) decreased with a greater CWM of the plant trait specific leaf area (SLA), and the stable pool of physically and biochemically protected C (0.45-50 μm) increased with greater CWM leaf N content. Plant traits were also explained variation in soil microbial community composition across these grasslands, and in particular the fungal-to-bacterial biomass ratio decreased with increasing CWM leaf N content. In a subset of 22 grasslands in the Yorkshire Dales, we found that N leaching in the field increased with greater leaf N content, and that retention of added N was greater with increasing fungal abundance, because of greater immobilisation in microbial biomass. Collectively, these results show that on a landscape scale, plant traits can explain variation in both C stocks and microbial community composition, and that linkages between plant traits and soil microbes determine ecosystem N retention.