Above and below ground responses to the machair agricultural system

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Much of the conservational value of the machair is dependent on the maintenance of its crofting tradition (UK Biodiversity Group 1999) which is characterised by small scale, rotational mixed cropping and extensive grazing (UK Biodiversity Group 1999; Angus 2001). This combination of agricultural practices creates a complex and diverse mosaic of habitats and plant communities (Crawford 1990, 1997; Owen et al. 2001) which sustain a large diversity of invertebrates and birds (UK Biodiversity Group 1999).

Organic and low input agricultural systems, such as the machair, are reported to have a higher diversity of micro-organisms than intensely managed farms (Mäder et al. 2002; Hijri et al. 2006). Intensification has contributed to the loss of this below ground diversity in low input agricultural systems (Helgason et al. 1998; Bardgett 2005). The diverse microbial communities in soils are important for the maintenance of a wide range of ecosystem services (Wall 2004) and changes in below ground community composition (van der Heijden et al. 1998a; Allison et al. 2008) and diversity (van der Heijden et al. 1998b) could potentially make such systems less sustainable, reduce resilience to disturbance and result in changes in plant community structure. Due to the challenging nature of research on microbial communities, relatively little is known about soil systems in general and low input systems in particular, despite the obvious importance of these systems.

In order to gain a better understanding into the effects of land use practices and spatial and temporal variation on soil communities, an extensive study examining the bacteria and arbuscular mycorrhiza (AM) fungi community structure of machair soil was conducted in 2007 and 2008 along a latitudinal gradient on five islands in the Outer Hebrides. AM fungi and bacteria are two key components of soils and are considered to be important determinants of the ecosystem processes which drive above ground community composition (van der Heijden et al. 1998b; Wardle et al. 2004).

Individual cores of approximately 6 cm diameter containing soil and roots of each of two common machair plant species (*Bellis perennis* and *Festuca rubra*) were taken at three seasonal sampling times and a number of different locations, each including the three main land uses occurring on the machair; cropped, fallow and grassland. DNA was extracted from the roots and bulk and rhizosphere soil compartments from each core and, using general molecular methods, the structure of the bacteria and AM fungi community was assessed (Blackwood 2006). In addition, a survey of the plant communities at all sampling sites was carried out at the summer sampling point and various abiotic soil factors were measured.

Our initial results on a subset of samples suggest that the microbial community reflects the variation in land use on the machair. There are significant temporal ($P<0.001$), land use ($P<0.001$) and soil compartment ($P<0.001$) effects with a number of significant interactive factors, reflecting the complexity of these relationships. Results also suggest a relationship between the above ground vegetation, below ground bacterial community and moisture content of the soil within the different land uses and soil compartments. Further studies are being conducted to corroborate these correlations by assessing the impact of different plant communities and soil moisture levels on below-ground communities in glasshouse-based microcosm experiments.

To our knowledge this is the first study into the biotic communities in machair soils, despite the potential importance of these below ground components. Our aim is that the results from these investigations will not only contribute to a greater understanding of the machair soil system and its interaction with its vegetation but also to further gain an understanding into the effects of agronomic practices on soil communities and their function in general.

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