Fire studies in Mallee (*Eucalyptus* spp.) communities of western New South Wales: spatial and temporal fluxes in soil chemistry and soil biology following prescribed fire

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The effects of prescribed fires on nutrient pools, soil micro-organisms, and vegetation patch dynamics were studied in three semi-arid mallee shrublands in western New South Wales. Repeated sampling of surface soil strata (0–2 and 2–4 cm) was undertaken at strategic times (immediately before and after the fire, after opening autumn rain, mid-season in the winter, and at the end of the spring) in five microsites (inner, middle and outer mallee litter zones, bare soil, and *Triodia* hummock). These samples were later analysed for pH, electrical conductivity, organic carbon and available nitrogen. The effect of fire on soil micro-organisms in these microsites was also examined by measuring nitrogenase activity and enumerating soil Acari.

Carbon and nitrogen levels were consistently higher in the inner mallee microsites whereas bare soil sites provided the lowest values. Significant microsite × soil depth interactions were recorded in two shrubland sites while highly significant ($P < 0.001$) depth × sampling time interactions were recorded in three sites. The most sensitive soil parameter with respect to microsite was electrical conductivity, particularly in the surface 0–2 cm stratum. Highest values were again recorded from the inner mallee microsites and the lowest from bare soil sites.

Nitrogenase activity was highest in soil samples associated with mallee litter and, where litter was removed by fire, activity decreased markedly except in the bare soil samples where activity was higher in the burnt samples. Soil micro-arthropod populations also declined notably following fire. Mites from the Prostigmata greatly outnumbered those from other suborders, a total of 12 families (15 genera) being enumerated in control sites compared with three families (three genera) only of Cryptostigmata. Nonetheless the most abundant mites were cryptostigmatids (*Aphelacarus* spp.) found in unburnt hummocks beneath *Triodia* plants.

The ecological and management implications of these spatial and temporal fluxes in soil chemistry and soil biology are discussed in relation to their effects on landscape processes, particularly water and nutrient redistribution.

INTRODUCTION

SEMI-ARID mallee vegetation in western New South Wales is largely confined to the sandplains and dunefields of the western part of the Murray Basin or Murray Lowlands landform Province (Wasson 1989), with smaller areas found in the Cobar region and north of Broken Hill. The dunefields are dominated by short, low linear dunes aligned west-east rising 2–6 m above the intervening swales and usually 200 to 1 200 m apart (Bowler and Magee 1978). The south-facing slopes are generally steeper than the north-facing slopes (Churchward 1963) and contain 7–20% clay and 5–15% $CaCO_3$ formed as illuvial B horizons, these sediments constituting the Woorinen Formation (Lawrence 1966).

On a smaller scale, these aeolian landforms characteristically exhibit a high degree of surface heterogeneity, ranging from large soil hummocks (5–10 m diameter) beneath individual mallee shrubs down to smaller hummocks (30–100 cm diameter) beneath porcupine grass *Triodia scariosa* syn. *T. irritans* (Noble 1984, 1989b). Intervening hummock soil surfaces are relatively level although finer-scale variations in topography such as animal tracks can also be recognized (Noble and Tongway 1986). Plant patchiness is characteristic of most arid and semi-arid ecosystems and results primarily from landscape processes mediating the redistribution of limiting resources, especially water and nutrients (Tongway and Ludwig 1990, 1994; Whitford and Parker 1989). Large-scale aerial photographs of *Triodia*/mallee often demonstrate vegetation patterning by both the overstorey and understorey communities which appears to be related to topography (Fig. 1).

Such heterogeneity not only has a significant influence on the distribution of mallee fuels, and consequent fire behaviour, but also the spatial distribution of post-fire nutrient deposition and

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