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Fire regimes and soil-based ecological processes: implications for biodiversity

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Introduction

Fire is part of the environment and has shaped the composition, structure and distribution of plant and animal communities of many Australian ecosystems over millions of years. In this chapter, we focus on sclerophyll forests, woodlands and heathlands of southern Australia that rank among the most fire-prone ecosystems in the world and where it is likely that climate change will have a further impact on both fire regimes and biodiversity (Steffen *et al.* 2009; Williams *et al.* 2009). We will concentrate on potential changes in the nature of existing ecosystems over years and decades, and the interaction of fire with litter- and soil-dwelling biota and the ecosystem processes they bring about, rather than discussing century-scale changes in biome distribution due to altered fire regimes. In these environments, fires generally result in complete or partial combustion of the understorey and litter layer, and partial or complete defoliation of the tree canopy. These outcomes set the basis for our discussion of fire impacts on soil-based ecological processes and biodiversity.

The litter-soil system is a heterogeneous environment characterised by the continuing search for energy, water and nutrients by a wide range of organisms. The major biological components of soils are plant roots, microorganisms (microbes) and soil animals – each of these groups play a critical part in the function of ecosystems through its role in the breakdown and decomposition of organic matter and the release of materials to the soil environment and atmosphere. Through these ecological processes, the biota has a positive influence on the availability of nutrients for plant growth.

Soils harbour a multitude of organisms from a wide range of taxa that spend at least part of their life cycle below ground. The diversity of the dominant soil-dwelling organisms (microbes and soil animals) is often several orders of magnitude greater than above-ground biodiversity (Bardgett 2005). The small-scale heterogeneity that characterises the soil environment allows for multiple complex habitats and associated diversity (Wall *et al.* 2005; Decaëns 2010). A significant body of work describes the biodiversity and functioning of the soil subsystem (see André *et al.* 2002; Bardgett 2005; Bardgett *et al.* 2005), with Wardle (2002) providing a synthesis and discussion of above- and below-ground ecological processes and linkages. Most of this work has, however, been undertaken in agroecosystems, with fewer studies investigating natural environments. Additionally, the role of fire in this regard has received little attention and is poorly understood (Wardle 2002; Bardgett 2005). With changing management practices involving the use of fire, concern has recently been expressed about the potential impacts of