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Modelling fungal growth in heterogeneous soil: analyses of the effect of soil physical structure on fungal community dynamics

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Fungi play a pivital role in soil ecosystems contributing to plant productivity. The underlying soil physical and biological processes responsible for community dynamics are interrelated and, at present, poorly understood. If these complex processes can be understood then this knowledge can be managed with an aim to providing more sustainable agriculture. Our understanding of microbial dynamics in soil has long been hampered by a lack of a theoretical framework and difficulties in observation and quantification. We will demonstrate how the spatial and temporal dynamics of fungi in soil can be understood by linking mathematical modelling with novel techniques that visualise the complex structure of the soil. The combination of these techniques and mathematical models opens up new possibilities to understand how the physical structure of soil affects fungal colony dynamics and also how fungal dynamics affect soil structure. We will quantify, using X ray tomography, soil structure for a range of artificially prepared microcosms. We characterise the soil structures using soil metrics such as porosity, fractal dimension, and the connectivity of the pore volume. Furthermore we will use the individual based fungal colony growth model of Falconer *et al.* 2005, which is based on the physiological processes of fungi, to assess the effect of soil structure on microbial dynamics by qualifying biomass abundances and distributions. We demonstrate how soil structure can critically affect fungal species interactions with consequences for biological control and fungal biodiversity.