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Modelling three-dimensional fungal growth in response to environmental stimuli

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Abstract

Most fungi grow by developing complex networks that enable the translocation of nutrients over large distances. Spatially explicit mathematical models are able to capture both the complexity of the fungal network and the biomass evolution, as such providing a powerful alternative to classical modelling paradigms. Unfortunately, most of these models restrict growth to two dimensions or confine it to a lattice, thereby resulting in unrealistic representations of fungal networks. In addition, interactions between fungi and their environment are often neglected.

In response, this work presents a lattice-free three-dimensional fungal growth model that accounts for the interactions between the *in silico* fungus and different substrates and media. A sensitivity analysis was carried out to identify the key model parameters for future calibration. Finally, a scenario analysis covering a variety of growth conditions was conducted to illustrate the broad scope of the model and its ability to replicate *in situ* growth scenarios.

Keywords: Fungal growth, Spatially explicit modelling, Lattice-free model, Fungal growth scenarios, Fungal network, Tropisms.

1. Introduction

Fungi develop complex networks that function as efficient transport structures along which nutrients can be translocated over large distances, as such covering local needs (Boddy et al., 1999; Dickson and Kolesik, 1999). Thanks to these structures, fungi are able to grow and survive even in the most extreme conditions (Magan, 2007), which explains why these organisms are present in most natural and man-made ecosystems. Fungi are decomposers of organic material, making them essential for the proper functioning of nutrient cycles in natural ecosystems (Krivtsov et al., 2006). In human ecosystems, fungi cause damage

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