Documentation of DEMENTpy v1.0

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1 Structure

DEMENTpy is a spatially explicit, trait- and individual-based microbial model that is built from the bottom up from gene all the way up through community to system-level emergent functions.

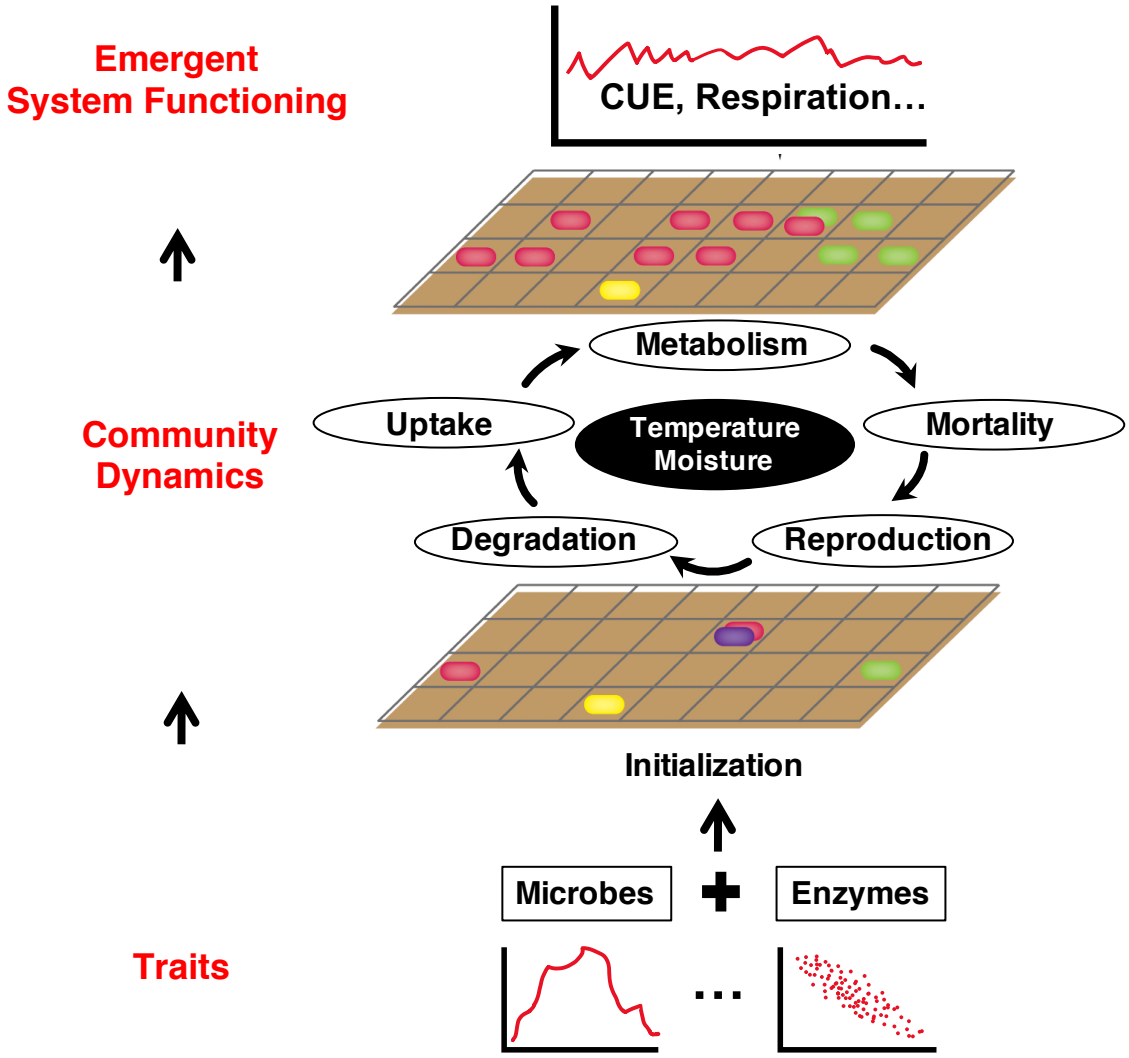

Figure 1: DEMENTpy Structure from traits through community to system-level emergent processes.

1.1 Modelling Unit

The modelling unit in DEMENTpy is an individual taxon, which is illustrated as below:

2 Community Initialization

3 Processes

DEMENTpy is mechanistically explicit model that simulates processes including degradation, uptake, metabolism, mortality, and reproduction. These processes are introduced as below.

3.1 Degradation

3.2 Uptake

3.3 Metabolism

DEMENTpy now explicitly calculates metabolic production of transporters, enzymes, and osmolytes. However, it is noteworthy that for each of these three categories, it is still far from being explicit, especially for osmolyte, which, though it is assumed to have differing genes within each individual taxon and among different taxa, has constant stoichiometry without knowing specific osmotic compounds.

As regards enzyme, different taxa produce different enzymes that have differing kinetic parameters. These different enzymes still have the same stoichiometry, but entail differing metabolic costs for production by different taxa.

Similar to enzyme, ...

3.4 Mortality

Mortality is implemented in DEMENTpy as both a deterministic and a stochastic process. Firstly, a microbial cell dies when its mass reaches a threshold value. In the current version of DEMENTpy the threshold value is assumed to be a constant among taxa. In addition, microbial cells die from a stochastic process, which is, atop a basal mortality probability (differentiated between bacteria and fungi), constrained by drought intensity and drought tolerance, and functional group. These two pro-

cesses are executed with the deterministic process preceding the stochastic one. The mortality probability is calculated following:

Parameters involved in this mortality process include:

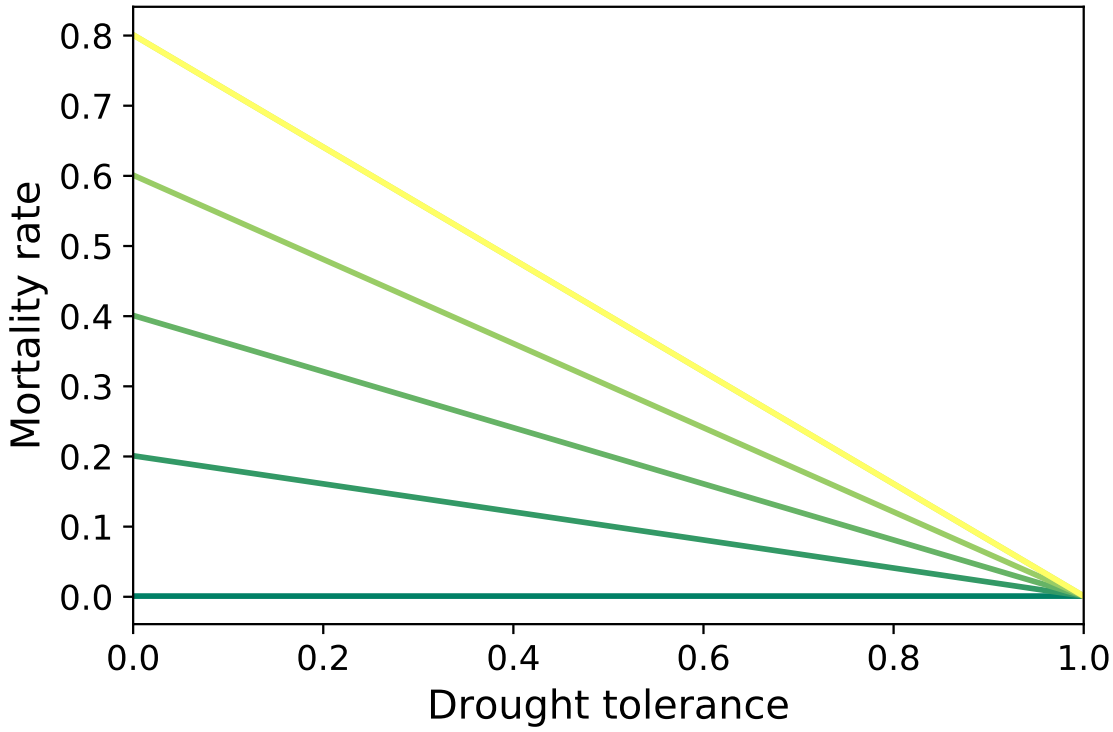

Figure 2: Microbial mortality as a function of drought and tolerance.

3.5 Reproduction

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4 Simulation Protocol

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5 DEMENTpy Programming Structure

6 Running DEMENTpy

DEMENTpy is open source project, of which the code is archived on GitHub at: https://github.com/bioatmosphere/DEMENTpy.