ECOLOGICAL MODELLING 215 (2008) 200–206

available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/ecolmodel

# Detrital ontogenic model including decomposer diversity

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ARTICLE INFO

*Article history:*
Published on line 2 April 2008

*Keywords:*
Detritus
Recalcitrant
Labile
Fungus
Bacteria
Trophic dynamics
Detritivore
Coexistence

ABSTRACT

Detritus influences the structure and dynamics of the living species. The quality of detritus tied by the degree of colonization such that it may be more useful in some cases to consider them as grouped entities as higher consumers in detrital branch may not distinguish between the consumption of detritus and micro-organisms that fed on it. Detritus and producer-based food models both suggest that energy supply limits the length of food chains. However, in detrital food chain the amount of dead organic matter is needed to support micro-detritivores (bacteria and fungi) is lower on average than would be required to support physiological and morphologically comparable herbivores in grazing food chain. Many questions concerning detritus and diversity are only recently beginning addressed. These include: (1) what are the factors that determine species richness in detrital communities? (2) How does diversity of detritivores affects key rates and fate of detritus processing and ultimately feed back to producer productivity and ecosystem diversity? (3) How does species diversity of organisms associated with detritus differ at different stages of its ontogeny?

In this present work a dynamic model of two pools of detritus (recalcitrant and labile pool), and decomposers (fungus and bacteria) is considered. The behavior is explored after varying the consumption of labile material by fungi, the transfer rates from one pool of detritus to another and the amount of recalcitrant material entering the system. The model is also sensitive to changes in other parameters, for example changes in assimilation and production efficiencies of microbes to reflect changes in the quality of detritus. The model behavior shows the coexistence at equilibrium between fungal and bacterial population is possible which depicted as a function of the rate of transfer from recalcitrant pool to the labile. At low rates of fungi mediated transfer of detritus, fungi are favored over bacteria. Coexistence of bacteria and fungi also depends on the amount of recalcitrant material entering the system; if inputs are dominated by labile material (that is recalcitrant input is low), fungi cannot survive. However increasing input of recalcitrant material leads to coexistence and input labile material that are high relative to other inputs can generate bacteria dominated system.



## 1. Introduction

The non-living nature of detritus influences the structure and dynamics of living species in three ways. Unlike living organisms detritus neither reproduces, nor directly affects the input of new material. This density independence in the accrual rate of detritus exemplifies a quintessential donor controlled process (Pimm, 1982), secondly its ontogeny is dependent in part on the actions of other species, in that when consumed detritus under goes transformation (i.e. ontogeny) as it decomposes

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0304-3800/$ – see front matter 
doi:10.1016/j.ecolmodel.2008.02.020

from one form to another. Finally detritus does not require energy for maintenance, hence has the capacity to serve as reservoirs of energy or supplement the energy needs of consumers that have been traditionally viewed to rely only on living organisms for energy. Moreover the naturally evolved differences and human induced alterations in material fluxes between pools of detritus, living organisms and inorganic nutrients have had global consequences with respect to carbon storage nutrient translocation, environmental pollution and climate change (Cebrian and Duarte, 1995).

Many questions concerning detritus and diversity are only recently beginning to be addressed. These include: (1) what are the factors that determine species richness in detrital communities? (2) How the diversity of detritivores affects key rates and fate of detritus processing and ultimately feedback to producer productivity and ecosystem diversity? (3) How does species diversity of organisms associated with detritus differ at different stages of its ontogeny? The diversity and abundance of microbial population is related to both the diversity and quality of detritus substrates (Moore et al., 2004).

To address some of the above questions particularly the last question and on the basis of theoretical approach a dynamic model with two pools of detritus—the recalcitrant and labile pool and two forms of decomposers, i.e. fungi and bacteria is considered.

## 2. The model

As an illustration of the importance of the integrative framework for detritus, we present the simple dynamic model using four dimension differential equations incorporating detrital ontogeny and decomposer diversity (Fig. 1). The model contains a recalcitrant detrital pool (RD), a labile detrital pool (LD), a bacterial population (Bact), feeding on labile detrital pool (LD), and a fungal population (Fungi) feeding on both recalci-

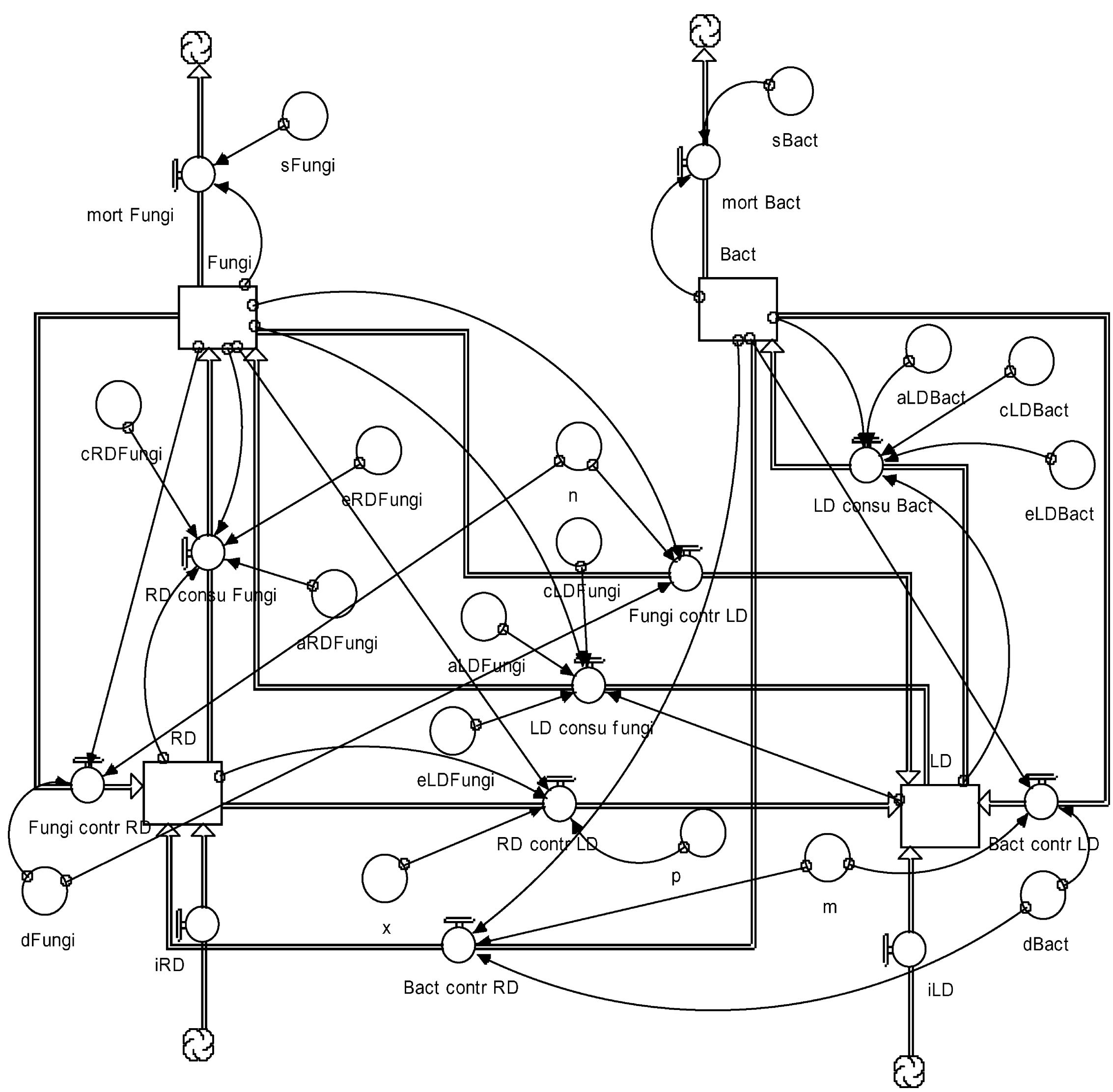


**Fig. 1 – Conceptual model (drawn with Stella software) rectangle boxes represent the state variables—recalcitrant detritus pool (RD), labile detritus pool (LD), fungus (Fungi) and bacteria (Bact). Bold arrows indicate flow in between the compartments, from outside to the compartments and from inside of the compartment to the outside. Circles with arrows show all forcing functions.**