NITRIFIER BACTERIAL ACTIVITY LINKED TO MINERALIZATION OF SOIL ORGANIC MATTER: INDIVIDUAL BASED SIMULATIONS

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INTRODUCTION

The processes involved in Soil Organic Matter (SOM) turnover are performed by heterotrophic soil microorganisms. They use nitrogenous organic substrates as a source of energy and/or matter. If the content of N in the assimilated organic substance is enough to satisfy the newly biomass requirements then the Direct N assimilation takes place. Otherwise NH_4^+ or NO_3^- is assimilated from the soil into microbial biomass happening the N Immobilization. Hence the net production of NH_4^+, which is designated as net mineralization of N, is the difference between two opposing processes, N mineralization and N immobilization. The microbial process whereby NH_4^+ is oxidized to NO_3^- is referred to as nitrification [1].

MODELLING THE MICROBIAL ACTIVITY TO STUDY THE DYNAMICS OF C AND N IN SOIL ORGANIC MATTER (SOM)

The use of an individual approach in the modelling of microbial systems is a bottom-up approach which starts at the individual level of the investigated systems, and it tries to improve the understanding on how the system's properties emerge form the interaction among these parts [2].

An individual-based model, **INDISIM-SOM**, has been developed to study microbial activity in the mineralization and immobilization of C and N and nitrification of the soil organic matter [3,4,5].

INDISIM-SOM assumes:

- two groups of microbial cells (decomposer microorganisms and nitrifier bacteria) and nine types of substrate,

- five kinds of organic compounds differing on their C and N composition and their biodegradability, and four mineral compounds (NH_4, NO_3, CO_2 and O_2).

The evolution and behaviour of each microorganism is modelled taking into account individual actions and properties: uptake and metabolism of substrate, reproduction, death and lyses. Some of the specific points of nitrifier population are:

- Each nitrifier **uptakes** some of the substrate particles surrounding it (NH_4, CO_2 and O_2) from the spatial cell that it is occupying. The uptake depends on its individual maximum capability, which is function of the microbial surface in contact with the external medium, and also on the substrate availability [4,7].

- The uptaken substrate particles are **metabolised**. The nitrifier cell is modelled entirely as an autotrophic bacterium. The cell uses NH_4^+ for its cellular maintenance, but if there is not enough and more energy is still required it can be obtained by using its own biomass (endogenous respiration). The cell uses CO_2 and NH_4^+ to synthesize new biomass. The CO_2 is assimilated through the Calvin cycle.

Most soils have the capacity to bind ammonium from aqueous solution to the soil surface lowering the free NH_4^+ concentration, governing the rate of ammonia oxidation [9]. Therefore two different compartments of NH_4^+ have been considered. One of them is the ammonium in solution, which is diffused as other mineral and soluble organic compounds. The other one is the ammonium adsorbed on the colloids surface among other soil sites. Both forms of ammonium are in equilibrium and they are subject to a process of **adsorption and desorption** modelled by two constants. Only the ammonium in soil solution is available for microorganisms.

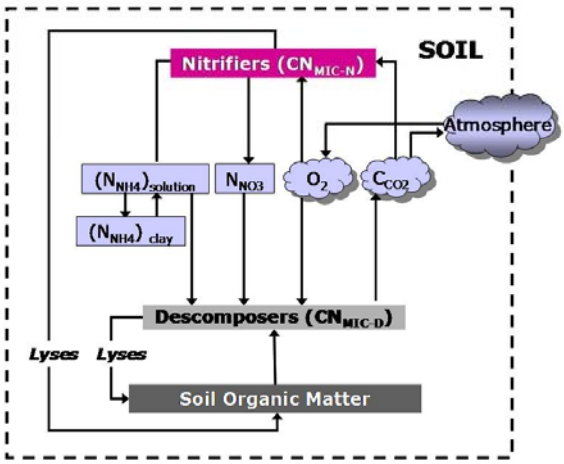

Figure 1 Sketch of nitrification process as is modeled in INDISIM-SOM

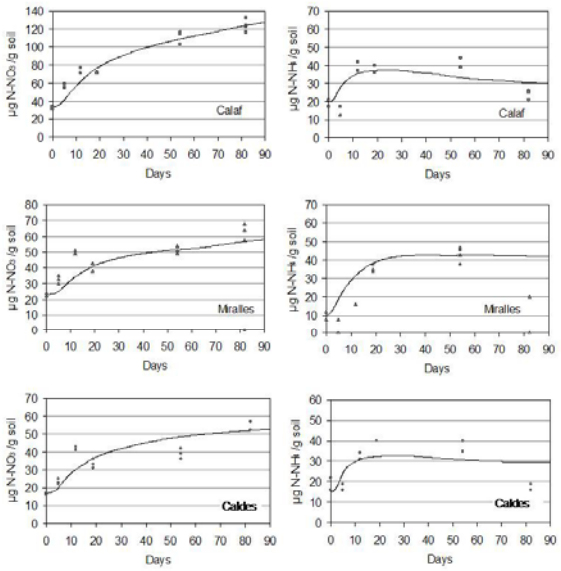

Figure 2 Cumulative ammonium and nitrate produced: experimental data from laboratory incubations of the three sampled soils (points) and simulations results representing the N-NH_4 and N-NO_3 compounds (lines).

EXPERIMENTAL AND SIMULATION RESULTS

The good fitting between the experimental results of soils and the simulated pools has been performed in order to calibrate the simulator INDISIM-SOM. With the same set of values for all the parameters considered in the nitrification model it has been possible to obtain the evolutions pointed out in Fig. 2 [5-7]. Figure 2 shows the cumulative production of ammonium and nitrate. The simulated temporal evolutions keeps up a correspondence with three sets of experimental data related to soils of Calaf, Miralles and Caldes.

INDISIM-SOM is a simulation model that shares the philosophy of the individual based models. It has been developed and it is ready to study diverse variables related to soil microbial activity to deal with soil C and N turnover.

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