



## **Stabilization of soil organic N by biotic and abiotic processes**

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Nitrogen is a major nutrient element influencing the cycling of organic matter in the biosphere. As a limiting growth factor, the concentration of N in both its organic and inorganic forms is closely related to biological productivity in terrestrial and aquatic systems. N is not a static entity, but takes part in a series of interconnected reactions that constitute the N-cycle. During this cycle, part of the nitrogen is incorporated into biologically refractory organic material that is sequestered from the overall nutrient cycle. The importance of this N for soil organic matter formation is well recognized but little is known about the mechanism(s) responsible for its resistance.

Applying solid-state  $^{15}\text{N}$  NMR spectroscopy, amides, most likely deriving from proteinaceous material were found to represent the major organic N-fraction in soils. This survival of amides is an ubiquitous phenomenon and exists even into the stage of fossilization of organic matter rich deposits. Their recalcitrance against microbial degradation was attributed to steric hindrance within N-containing biopolymers or encapsulation into a hydrophobic macropolymeric network, but also to incorporation into the cores of aggregates that are not accessible to microorganisms. Adsorption onto the mineral phase may support their resistance against degradation. However, some evidence was found that amides are newly formed by microbiologically mediated condensation reactions of N-containing pollutants and humic matter. Alternatively, abiotic condensation via Maillard reactions or 1,4  $\beta$ -oxidation on quinones was suggested. In particular in region with frequent vegetation fire, burning represents a further important mechanism for abiotic N-stabilization. This process transforms originally microbiologically accessible and labile N compounds into heterocyclic aromatic structures and Maillard products. Due to their high recalcitrance their formation is expected to sequester N on a long term.

With this present contribution, evidences for almost all concepts of soil organic N-stabilization will be given and discussed. In summary, it seems that the importance of the individual mechanism depends on the chemical and physical conditions of the respective environment. Therefore, a major reason for the lack of the understanding and prediction of organic N dynamics may be because several mechanisms operate simultaneously and are difficult to distinguish with presently available approaches. To find and improve such techniques certainly should be a major focus of future