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Litter production, soil organic matter dynamics and microbial activity in two coeval forest stands on Mount Vesuvius

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Forest ecosystems in different climatic zones may accumulate different amounts of soil organic matter (SOM) with different chemical-physical properties. C inputs to SOM are related to net primary production, however C accumulation in the soil largely depends on the balance between net primary production and decomposition. On the other side rates of SOM decomposition are the major control over the supply of mineral nutrients to vegetation and thus over primary production.

This study was performed in two coeval (36 years old), adjacent forest stands, a Corsican pine (Pinus nigra Arn.) and a Black locust (Robinia pseudoacacia L.) forest (Atrio del Cavallo, 40˚49'N, 14˚26'E; 810 a.s.l.). The two forests were implanted in 1970 on piroclastic material of the last eruption of Mount Vesuvius (1944). We assessed the quantity and the quality of SOM in a vertical gradient in the continuum of the litter layer, humus layer and mineral soil for the whole soil profile. Moreover we estimated litter production and decomposition, litter and mineral soil (0-5cm) respiration as well as microbial biomass and total and active fungal biomass.

Litter fall (measured throughout the years 2006-2008) was higher in the Corsican pine than in the Black locust stand (5234 vs. 2396 g/m2/y). Black locust leaf litter and Corsican pine needle litter reached respectively 60 % and 50% of initial mass after 600 days in situ decomposition. Consistently with the lower litter input and the higher decomposition of black locust, the amount of organic C in the organic soil layers (litter + humus), was significantly higher in the Corsican pine as compared to the Black locust stand (2702 vs. 1636 g/m2). In contrast, in the mineral layers (0-15 cm) the amount of soil organic C was slightly higher in Black locust than in Corsican pine stand (136 vs. 116 g/m2). Litter quality, decomposition dynamics, and SOM quality and activity may help to understand the reason for the uneven distribution of organic carbon along the profile of the two stands. In the early decomposition phase (0 - 200 d) decomposition rate was higher in black locust litter (2.15 vs.1.6 mg/g/d), in the late phase (200 – 600 d) an opposite trend was observed (0.39 vs.0.76 mg/g/d). This suggests that in the late stage of decomposition Black locust litter is more recalcitrant as compared to Corsican pine litter. 13C CPMAS NMR spectra show that the degree of aromaticity of newly-shed leaves, as well as of litter and humus, was higher for Black locust than for Corsican pine. Respiration measurements, at 25 ˚C and 55% WHC, of litter layer samples gave higher values for pine than for Black locust (259.1 vs. 47.8 mg/g/h; values averaged from seasonal samplings). Likewise respiration of uppermost (0-5 cm) mineral soil was higher for pine than for Black locust forest (34.8 vs 17.3 mg/g/h; values averaged from seasonal samplings). Notably in the uppermost mineral soil layer (0-5 cm), the coefficient of endogenous mineralization (CEM) was lower in the black locust than in the pine forest (0.16 vs. 0.63 mg C-CO2 / g Corg) indicating that SOM is more recalcitrant to decomposition and is mineralized slowly.

Active and total fungal biomass of litter and soil were higher in pine than in black locust forest. Microbial activity and diversity (Degens, 2000) were lower in litter and soil of black locust, likely due to the more recalcitrant organic matter; however allelopathic effects on microbial communities of compounds produced by black locust, that is an alien species, can not be excluded.