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Dark microbial CO2 fixation in temperate forest soils increases with CO2 concentration

Marie Spohn[1], Karolin Müller[2], Carmen Höschen[3], Carsten W. Müller[3], and Sven Marhan[2]
[1]University of Bayreuth, Bayreuth, Germany (marie.spohn@uni-bayreuth.de)
[2]University of Hohenheim, Stuttgart, Germany
[3]Technical University of Munich, Freising-Weihenstephan, Germany

Dark, that is, nonphototrophic, microbial CO_2 fixation occurs in a large range of soils. However, it is still not known whether dark microbial CO_2 fixation substantially contributes to the C balance of soils and what factors control this process. Therefore, the objective of this study was to quantitate dark microbial CO_2 fixation in temperate forest soils, to determine the relationship between the soil CO_2 concentration and dark microbial CO_2 fixation, and to estimate the relative contribution of different microbial groups to dark CO_2 fixation. For this purpose, we conducted a ^{13}C-CO_2 labeling experiment. We found that the rates of dark microbial CO_2 fixation were positively correlated with the CO_2 concentration in all soils. Dark microbial CO_2 fixation amounted to up to 320 µg C kg^{-1} soil day^{-1} in the Ah horizon. The fixation rates were 2.8–8.9 times higher in the Ah horizon than in the Bw1 horizon. Although the rates of dark microbial fixation were small compared to the respiration rate (1.2%–3.9% of the respiration rate), our findings suggest that organic matter formed by microorganisms from CO_2 contributes to the soil organic matter pool, especially given that microbial detritus is more stable in soil than plant detritus. Phospholipid fatty acid analyses indicated that CO_2 was mostly fixed by gram-positive bacteria, and not by fungi. In conclusion, our study shows that the dark microbial CO_2 fixation rate in temperate forest soils increases in periods of high CO_2 concentrations, that dark microbial CO_2 fixation is mostly accomplished by gram-positive bacteria, and that dark microbial CO_2 fixation contributes to the formation of soil organic matter.

Reference

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