Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12592

Soil fauna and the fate of soil organic carbon in northern forests

ADRIAN A WACKETT[1,2,3], KYUNGSOO YOO[2], ERIN K CAMERON[4,5], NICOLAS A JELINSKI[2], NATHANIEL LOOKER[2,6], CAROLINA OLID[1,3,7,8], HANNA JONSSON[1,3], SAÃºL RODRÍGUEZ-MARTÍNEZ[1,3], LEE E FRELICH[2] AND JONATAN KLAMINDER[1,3]

[1]Umeå University
[2]University of Minnesota-Twin Cities
[3]Climate Impacts Research Centre
[4]University of Helsinki
[5]Saint Mary's University
[6]Soil Health Institute
[7]Swedish University of Agricultural Sciences
[8]University of Barcelona

Presenting Author: wacke051@umn.edu

Soils are the largest terrestrial reservoir of organic carbon, a disproportionate amount of which is stored in northern forested regions. Improving current representations of soil organic carbon (SOC) dynamics in Earth system models requires a better understanding of the processes regulating the relative proportions of particulate organic carbon (POC) and mineral-associated organic carbon (MAOC) in soils. There have been recent efforts to map POC and MAOC stocks at continental scales based on intrinsic soil properties and land cover types; however, the role of soil fauna in shaping the balance between POC and MAOC remains under-explored. Here, we use the formerly glaciated forests of northern North America and Fennoscandia as a natural laboratory to assess how introductions of non-native earthworms affect the quantity of POC and MAOC in northern temperate, boreal, and Arctic forest soils. Through integrative analysis of both new and previously published data collected along earthworm invasion chronosequences, we show that incipient and ongoing earthworm invasions are actively transforming northern forest soils from a POC- to an MAOC-dominated system, suggesting that soil fauna – and bioturbation/soil mixing more broadly – plays a deterministic but previously unacknowledged role in governing the balance of high-latitude SOC forms. Our findings also suggest that the negative effect of earthworm invasion on the POC:MAOC ratio in northern forest soils is at least comparable to the predicted impacts of climate warming. Furthermore, our results also provide a tentative explanation for the 'earthworm dilemma' by demonstrating that earthworm effects on net SOC stocks are contingent on community successional dynamics during invasion. We find that earthworms stimulate differential effects on bulk SOC stocks over annual (no change), decadal (SOC loss), and centennial (SOC gain) timescales, and show that these effects can be explained by earthworm-mediated changes in the balance of POC:MAOC as the invasion proceeds. Our study highlights the critical but under-appreciated importance of soil fauna and species invasions in modulating SOC cycles at global scales, and emphasizes that earthworm invasions into northern forests will profoundly alter the balance of POC and MAOC in northern forest ecosystems, with implications for riverine carbon export and global biogeochemical cycles.