



Earthworms Facilitate Net Carbon Sequestration in Soil

Scientists from South China Botanical Garden, Chinese Academy of Sciences, together with colleagues from the University of Georgia, the US Environmental Protection Agency, etc. revealed that earthworms can facilitate net carbon sequestration in soil, although the humble animals are often found stimulating CO₂ emissions. Published as a highlight article in *Nature Communications* (DOI: 10.1038/ncomms3576), their finding contradicted a recent claim from a meta-analysis paper in *Nature Climate Change* that earthworm presence in soils leads to a 33% increase in CO₂ emissions.

Biotic interactions between soil invertebrates and microbiota play essential roles in regulating land-atmosphere exchanges of carbon and carbon-cycle feedbacks on climate change. A timely and debatable topic is how earthworms interact with microbiota and, thus, affect carbon sequestration. Earthworms were often found to stimulate CO₂ emission, especially in short-term experiments, but they have also been reported to enhance carbon stabilization in soil aggregates in some longer-term experiments. However, more experimental data support the view that earthworms reduce carbon sequestration due to the fact that CO₂ emission is easier to detect than carbon stabilization.

In their study, Prof. FU Shenglei, Dr. ZHANG Weixin et al. hypothesized that neither an increase in CO₂ emission nor the one in stabilized carbon would entirely reflect the earthworms' contribution to net carbon sequestration; that is, the impacts of earthworms on the two coupled processes of carbon mineralization and carbon stabilization should be studied simultaneously.

The results suggested that, firstly, although earthworms accelerate carbon mineralization, the total amount of CO₂ that can potentially escape from the soil with earthworms differs little from soil containing no earthworms because the capacities of carbon mineralization of earthworms and soil microbiota are similar. Most previously studies did not note this and, thus, were likely to conclude that earthworms



Earthworm on the forest floor. The processes and magnitude that earthworms impact net carbon sequestration are debatable.

decrease carbon sequestration only because CO₂ emission was often enhanced by earthworms.

Secondly, given that an increase in carbon mineralization (C_{\min}) and carbon stabilization (C_{sta}) may be a natural consequence of an increased pool of activated carbon, the pool size of the activated carbon (C_{act}) and its allocation pattern into carbon mineralization and carbon stabilization then determine the net carbon sequestration. The study revealed that the presence of earthworms is more likely to create a carbon sink as the carbon stabilized by earthworms outweighs that converted to CO₂ during carbon mineralization. Thus, the researchers introduced the new concept of sequestration quotient (SQ, $C_{\text{sta}}/C_{\text{act}}$) to quantify the unequal processes. The patterns of CO₂ emission and

net carbon sequestration are predictable by comparing SQ values between treatments with and without earthworms. The global contribution of earthworms to carbon cycling may be clearer when the ranges of SQ values have been determined at different time-scales in a range of systems with variable environmental characteristics (e.g., climate, plant diversity, root carbon input, soil texture and food web structure). In addition, the concept of SQ could also be helpful to estimate the contributions of other factors/

treatments (not only earthworms) to net soil carbon sequestration.

Prof. FU's group has now initiated a project to quantify the SQ values and the contribution of earthworms to carbon sequestration in a long term field experiment at Heshan National Field Research Station of Forest Ecosystem, China.

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Earthworm exclusion by electric shocking to quantify their contribution to net carbon sequestration in field site at Heshan National Field Research Station of Forest Ecosystem, China. (Photos: ZHANG Weixin)

