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Low litter N constrained earthworm-induced soil carbon pools loss across differing C:N litters

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Earthworms regulate soil carbon (C) and nitrogen (N) pools via modifying soil microbial biomass and extracellular enzyme activities. However, previous studies on earthworm-driven C and N cycling considered only C or N, reflecting single-element limitation. Understanding the stoichiometric variation of microbial biomass and extracellular enzyme activities would help to reveal the mechanisms of how earthworms affect the coupled soil C and N dynamics.

A microcosm experiment was conducted to access how earthworms influenced microbial stoichiometry and different fractions of soil C and N pools in the presence of six different litters with contrasting C:N ratio ranging from 22 to 150. A treatment without litter was used as control.

Earthworm biomass increased with the decreasing of litter C:N ratio except clover litter, indicating earthworms was constrained by N availability. Earthworms reduced particulate organic nitrogen (PON) and soil total nitrogen (TN), but the extent was less than the C content in the corresponding fractions, leading to a decline in soil C to N ratio. Extracellular enzyme allocation was commonly regarded as a proxy of the microbial biomass requirements, however, earthworms altered C- and N-degrading extracellular enzyme activities but have no effects on soil microbial biomass C:N ratio. Earthworms efficiently stimulated C- rather than N-degrading related enzymes in the presence of rich N litters, accelerating C metabolism and resulting in soil C pools loss and decline in soil C:N.

In conclusion, earthworms significantly decreased soil C:N ratio when earthworms was unconstrained by soil N availability. Earthworm-driven reduction on soil C pools and relative N retention was linked to changes in the soil enzyme activities, highlighting the pivotal roles of soil microbial stoichiometry in regulating soil C and N dynamics.