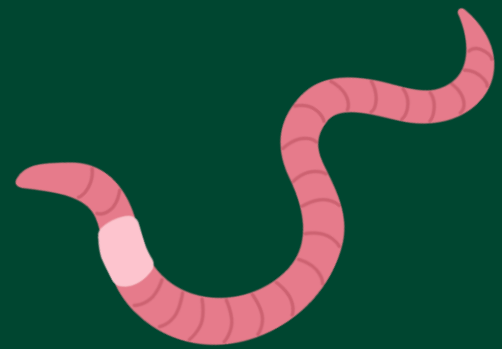
Earthworms as key soil engineers: Interactions with plants and the microbiome support the restoration of degraded soils

Anna Cibulková



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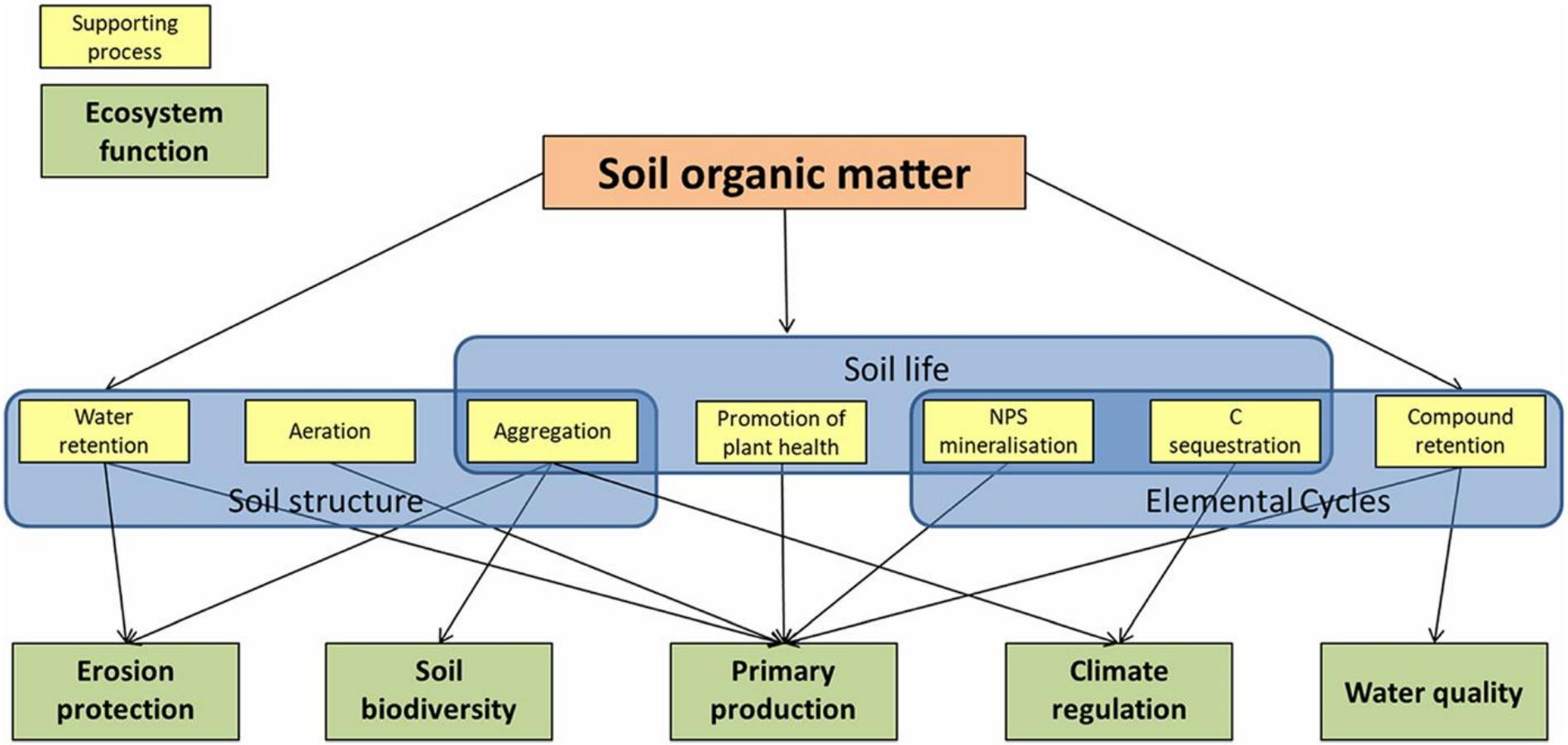
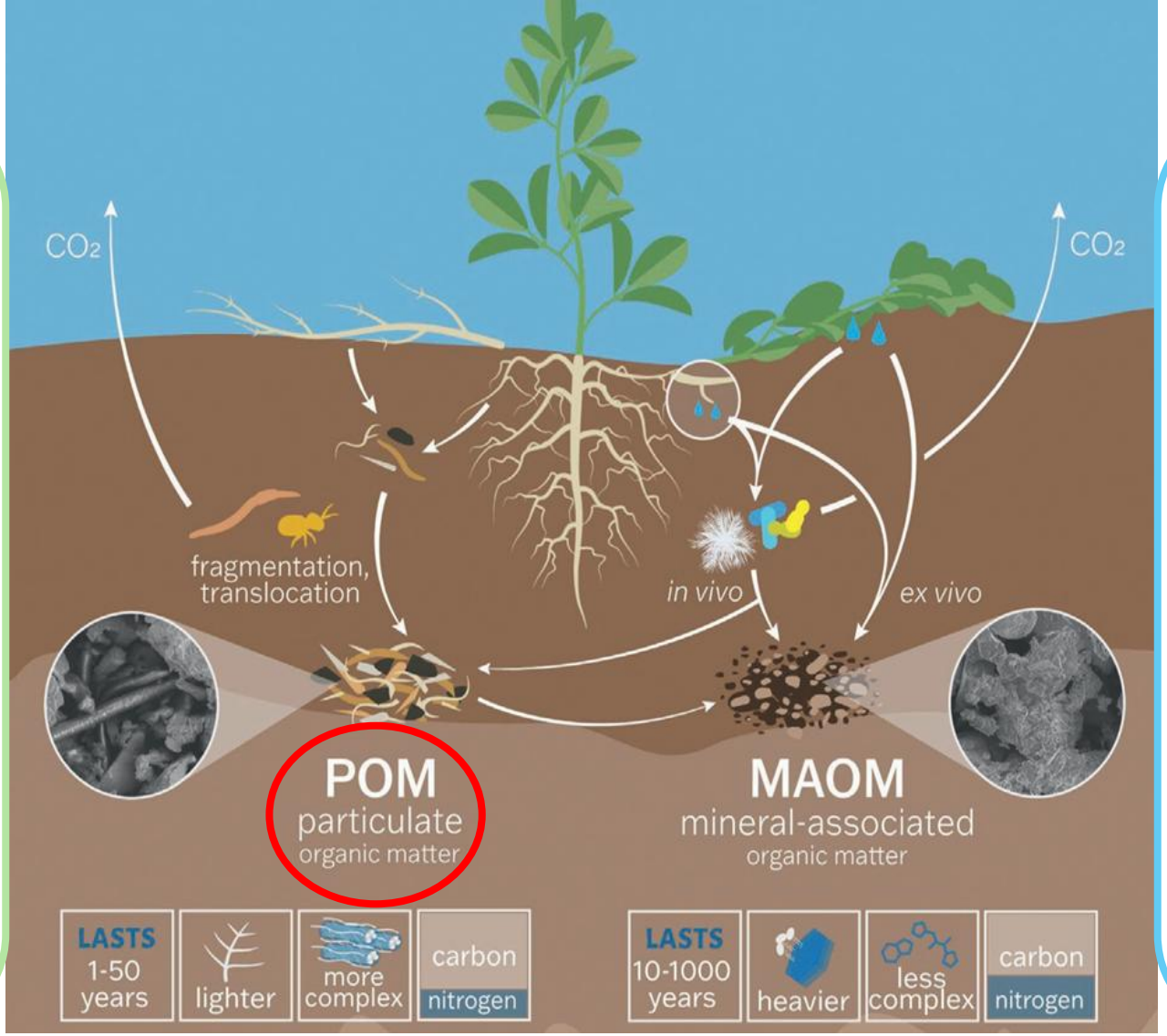


Hoffland et al. (2020), Plant and Soil

Without SOM, soil organisms cannot thrive, soil structure cannot develop, and soils cannot sustain their essential functions.
Increasing SOM is a key step in restoring degraded soils.

POM (Particulate Organic Matter)

- Unprotected (free POM, **fPOM**) or occluded in aggregates (occluded POM, **oPOM**)
- Plant- and fungal-derived compounds
- More complex compounds
- Higher, more variable C:N (10–40)
- Faster turnover (<10 years – decades)
- Does not saturate
- 35% SOC



Cotrufo & Lavallee (2022), Advances in Agronomy

MAOM (Mineral-Associated Organic Matter)

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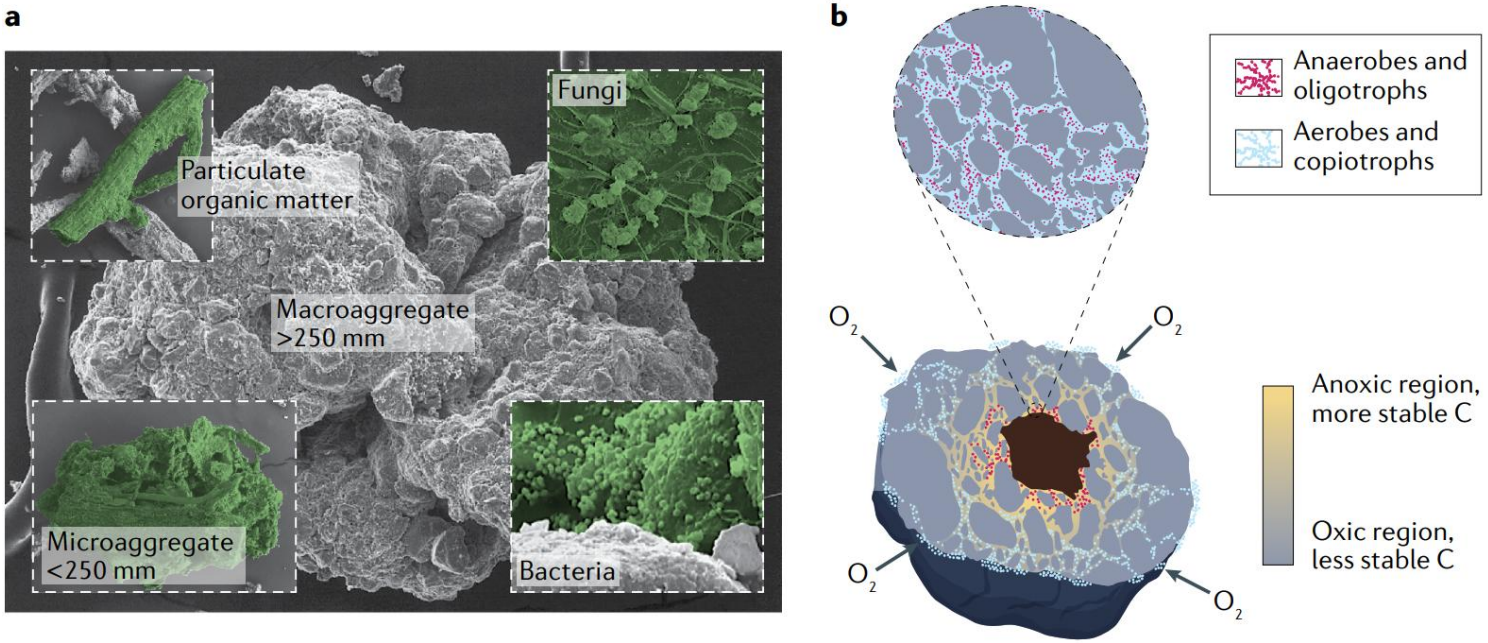
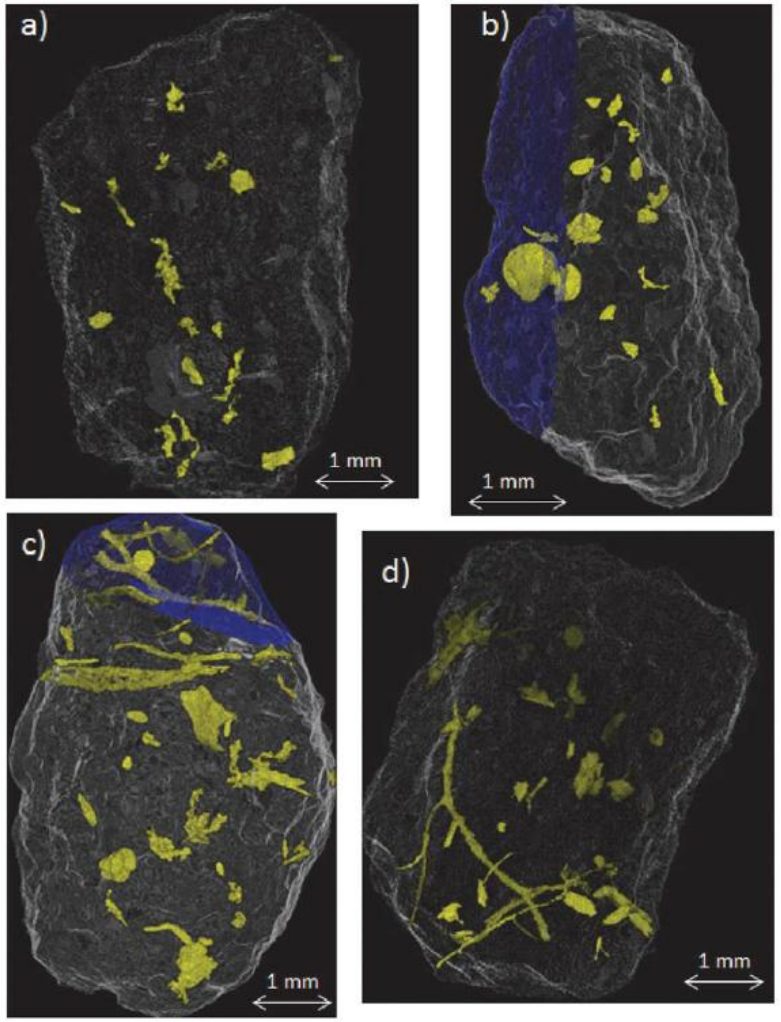
POM and MAOM differ in origin and stability, with POM being more vulnerable to change and MAOM more persistent but limited by mineral saturation.



Hartmann & Six (2022), Nature Reviews Earth & Environment



Kravchenko et al. (2014),
Soil Science Society of America Journal

oPOM is more stable because of reduced microbial access and oxygen diffusion.

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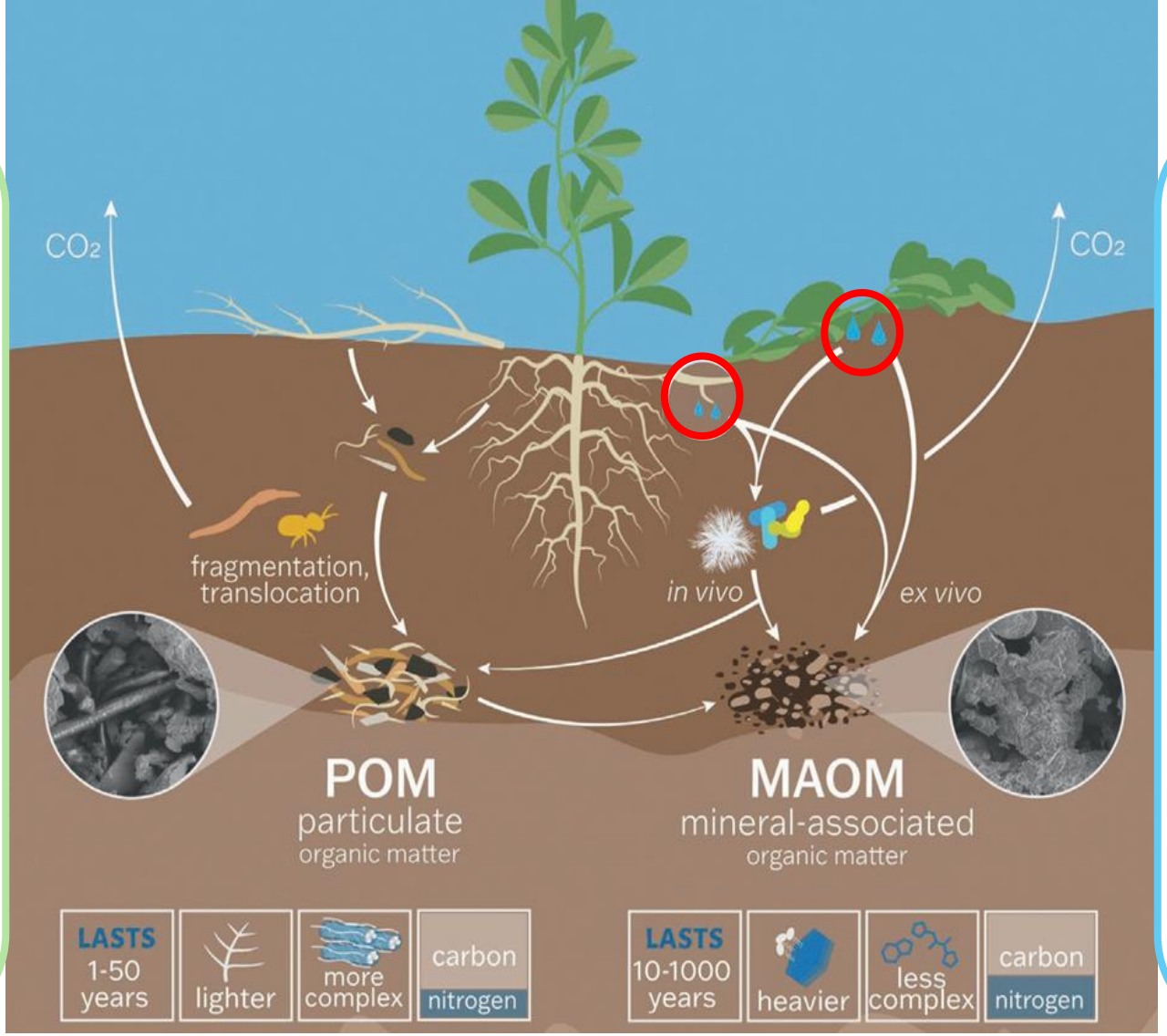

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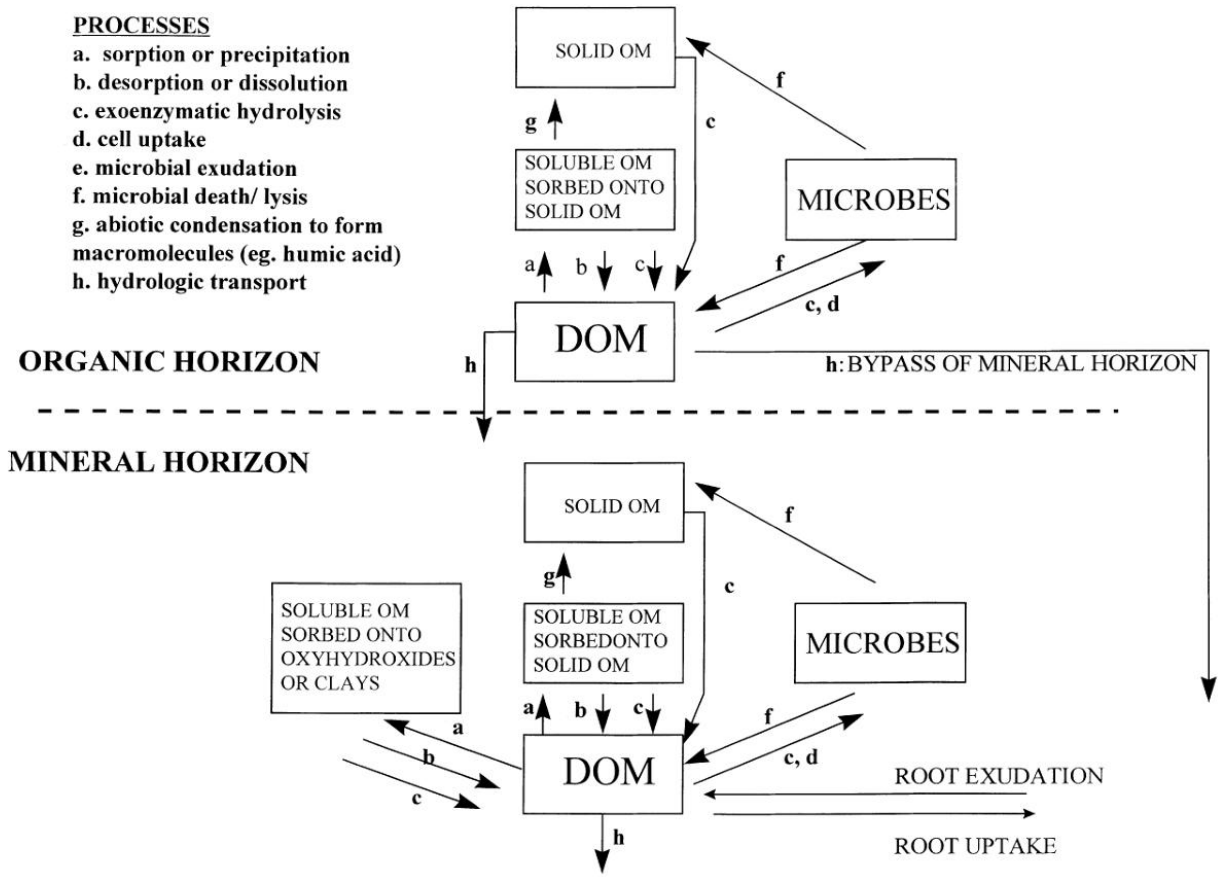

Qualls et al. (2000), Forest Ecology and Management

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DOM is the dynamic link between decomposition, microbes, and deep carbon transport, with a key role in MAOM formation.

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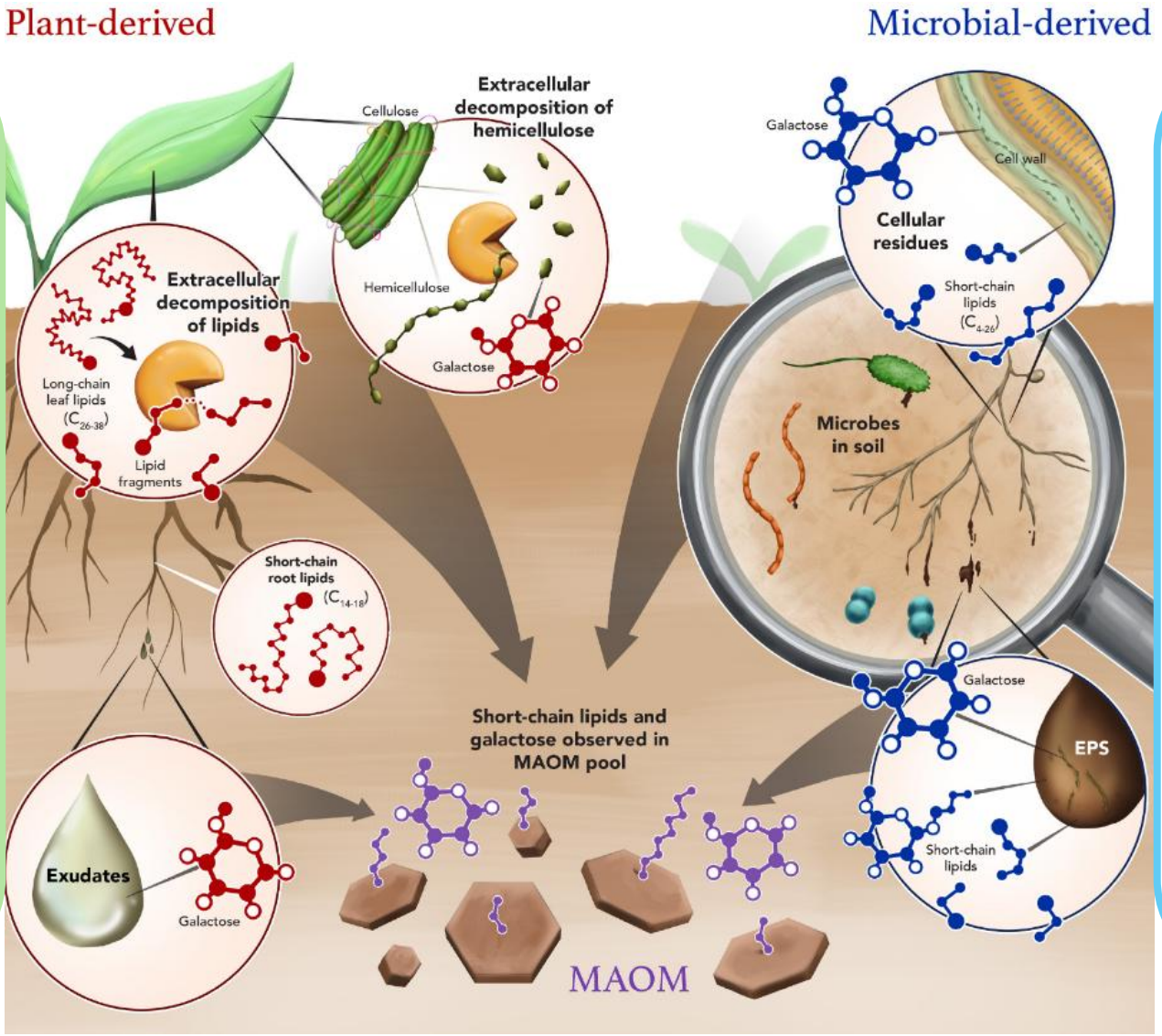

Whalen et al. (2022), Global Change Biology

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MAOM can be both microbially- and plant-derived.

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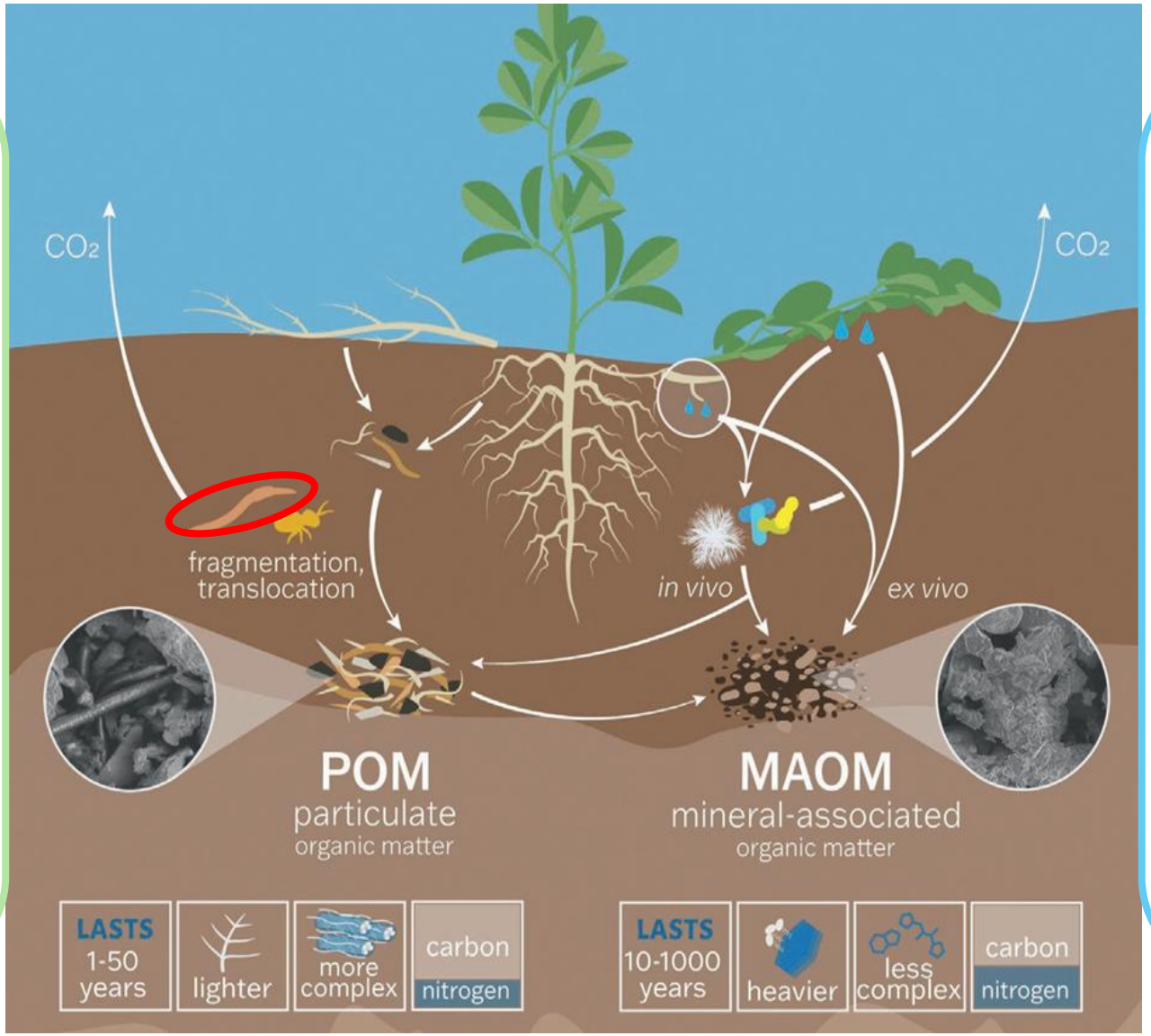

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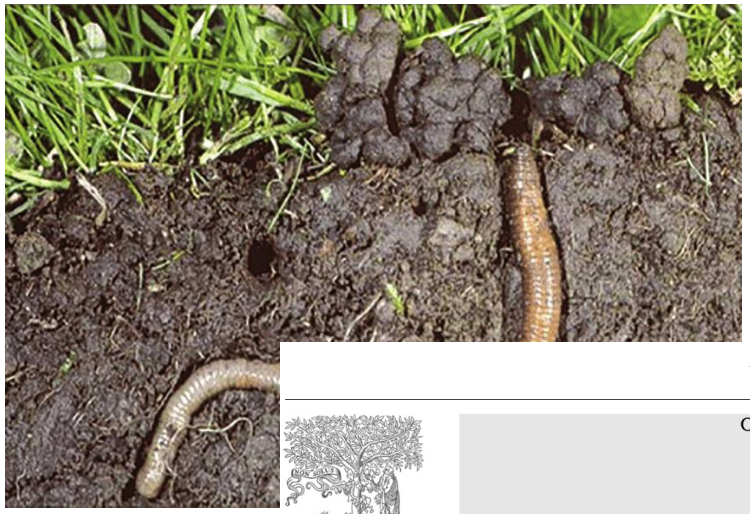
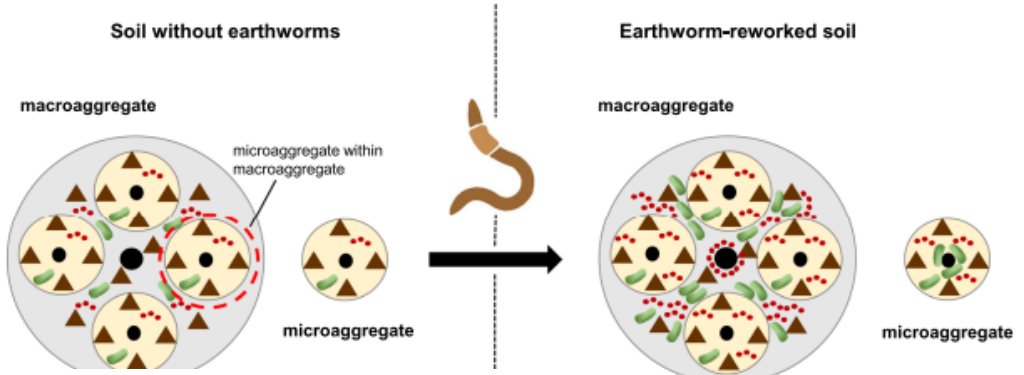


Teh et al. (2017



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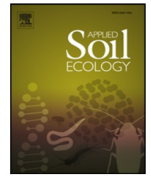
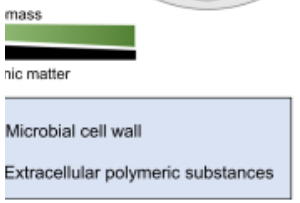




Biology

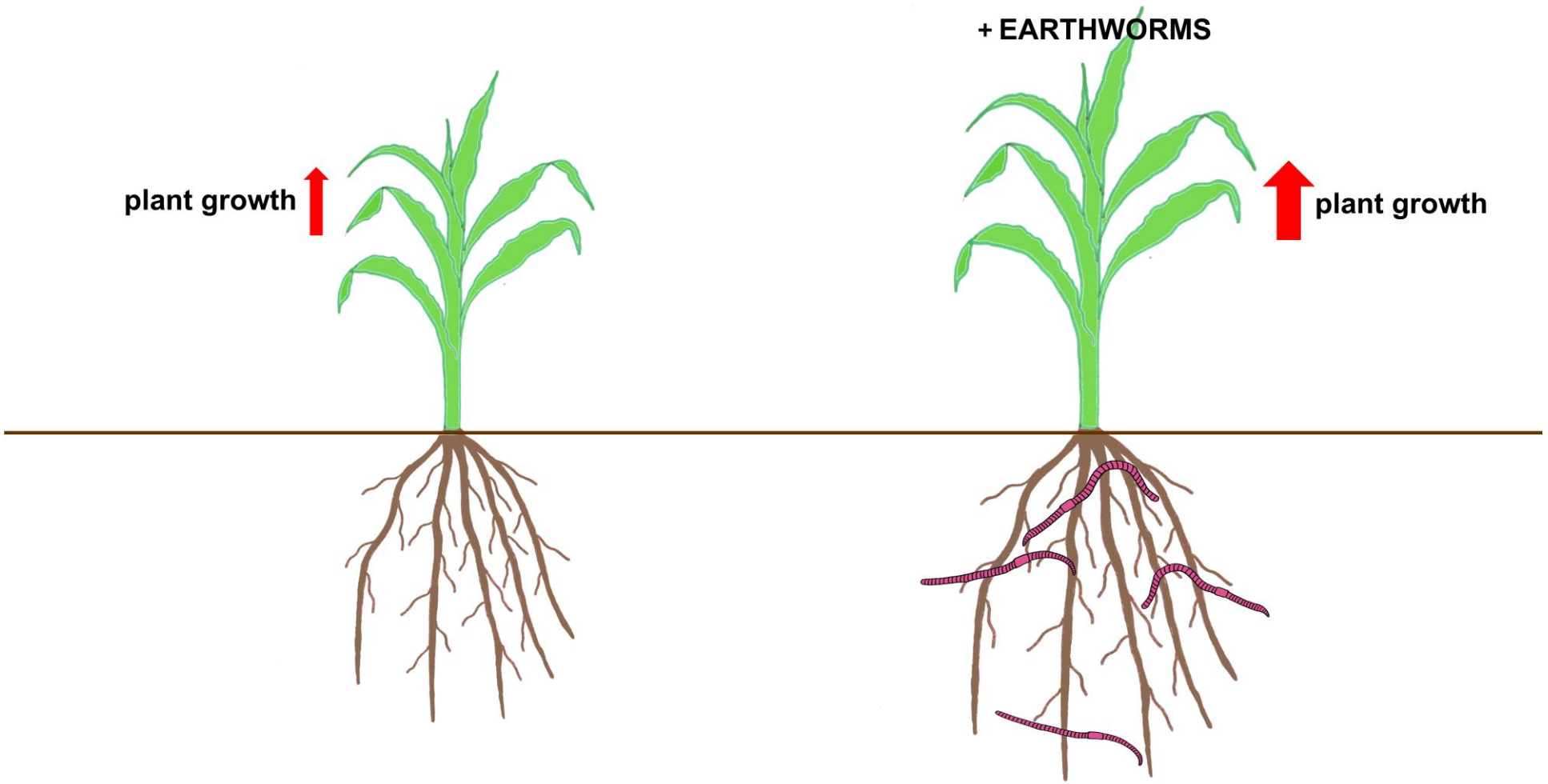
Research paper

Rhizosphere synergy: The role of endogeic earthworms in nutrient cycling, plant growth, and soil organic matter stabilization

Anna Cibulková *, Hana Šantrůčková, Eva Kaštovská

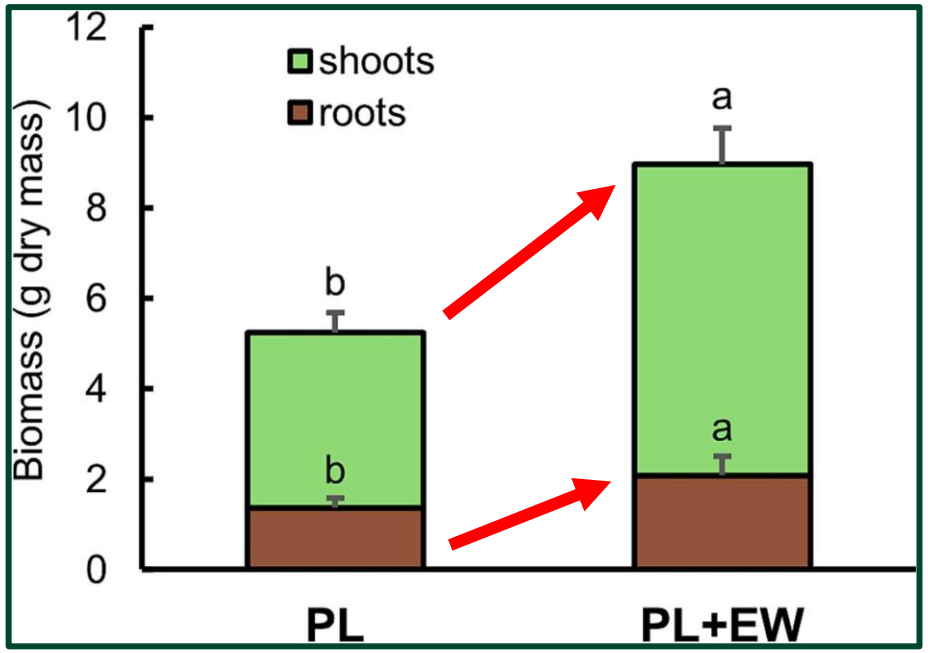
Faculty of Science, Department of Ecosystem Biology, University of South Bohemia in České Budějovice, Branišovská 1760, 37005 České Budějovice, Czech Republic

Earthworms aerate soil, create biopores, mic organic matter into soil with with their casts forming stable aggregates.



Earthworms promote plant growth through N recycling and nitrate availability, while enhancing plant P uptake and its accumulation in microbial biomass.

PL: plant only
PL+EW: plant+earthworms



PL

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Earthworms promote plant growth through N recycling and nitrate availability, while enhancing plant P uptake and its accumulation in microbial biomass.

CT: control
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EW: earthworms only
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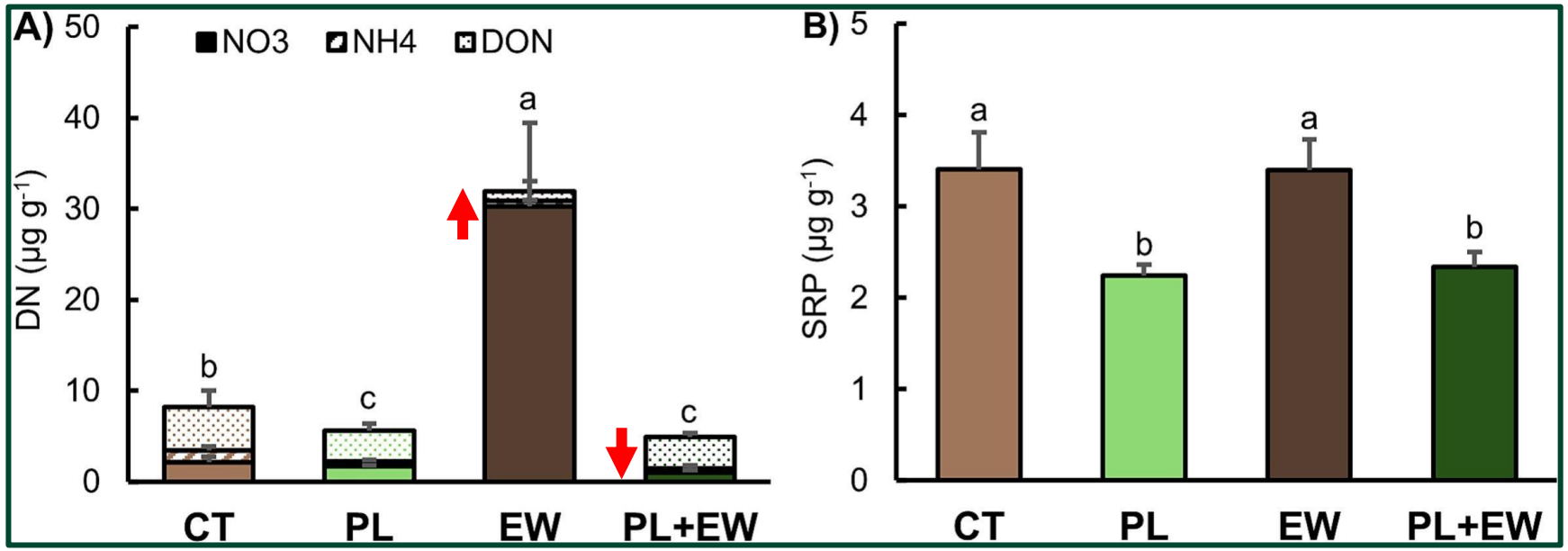

Plant biomass

	N (mg g^{-1})	P (mg g^{-1})
Aboveground biomass		
PL	7.3±1.1^{a}	2.2±0.2^{a}
PL+EW	↑7.8±0.5^{a}	↓1.8±0.1^{b}
Belowground biomass		
PL	5.5±0.5^{b}	1.0±0.1^{a}
PL+EW	↑6.3±0.2^{a}	↓0.9±0.1^{a}

Microbial biomass

	MBP (μg g^{-1})
CT	183.9±33.4^{b}
PL	152.1±38.4^{b}
EW	156.2±13.7^{b}
PL+EW	↑326.6±37.6^{a}

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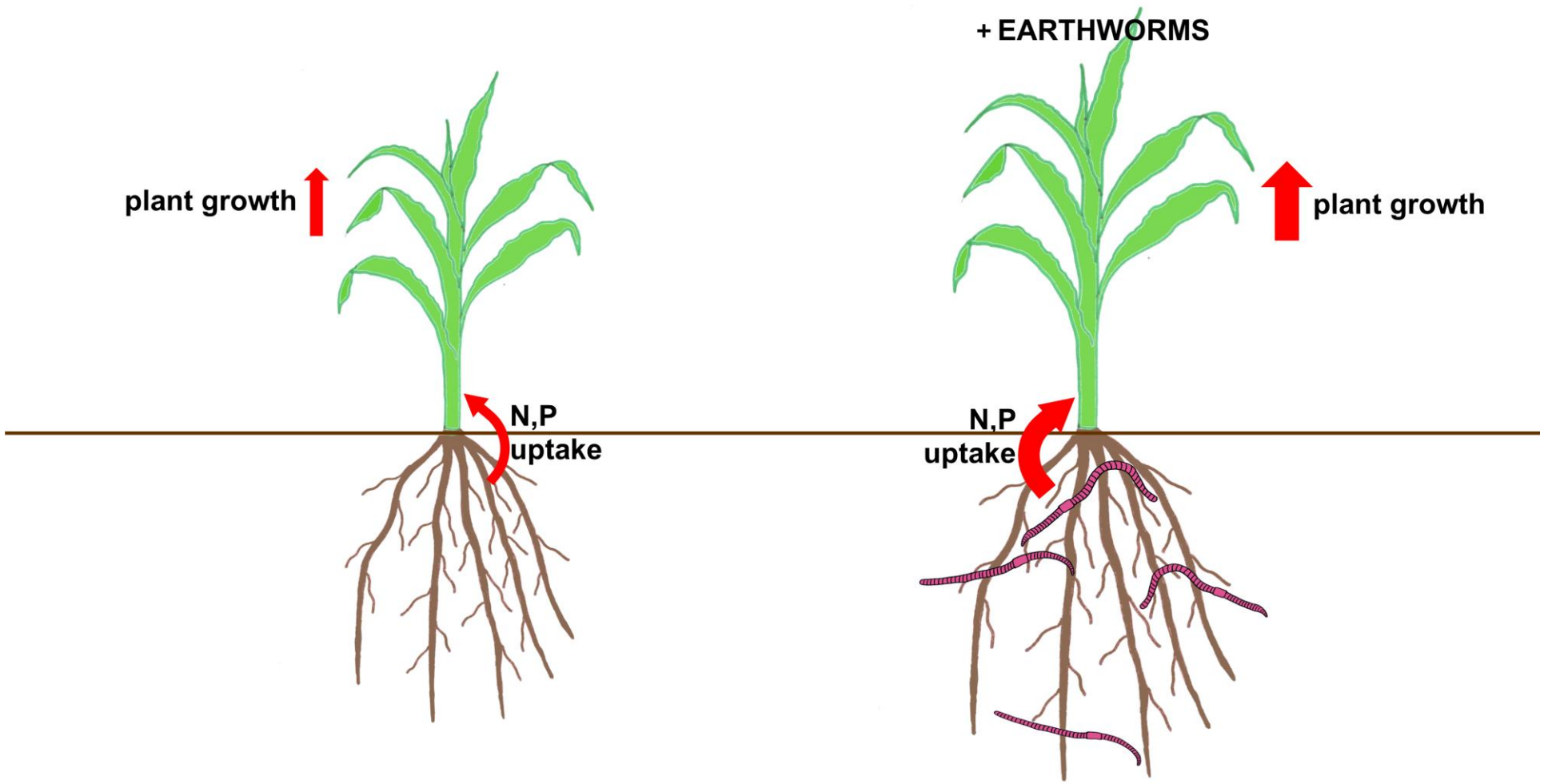

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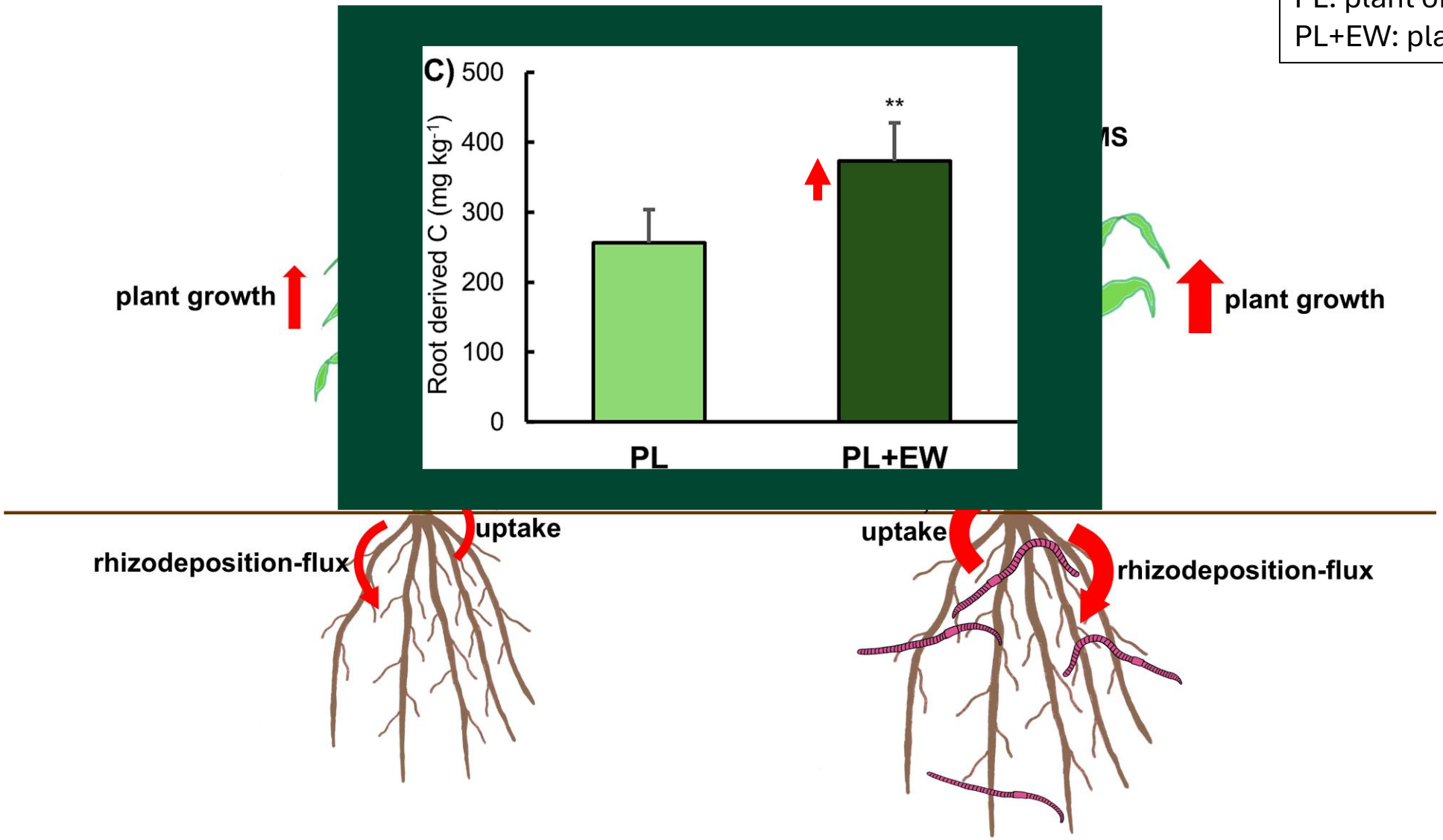
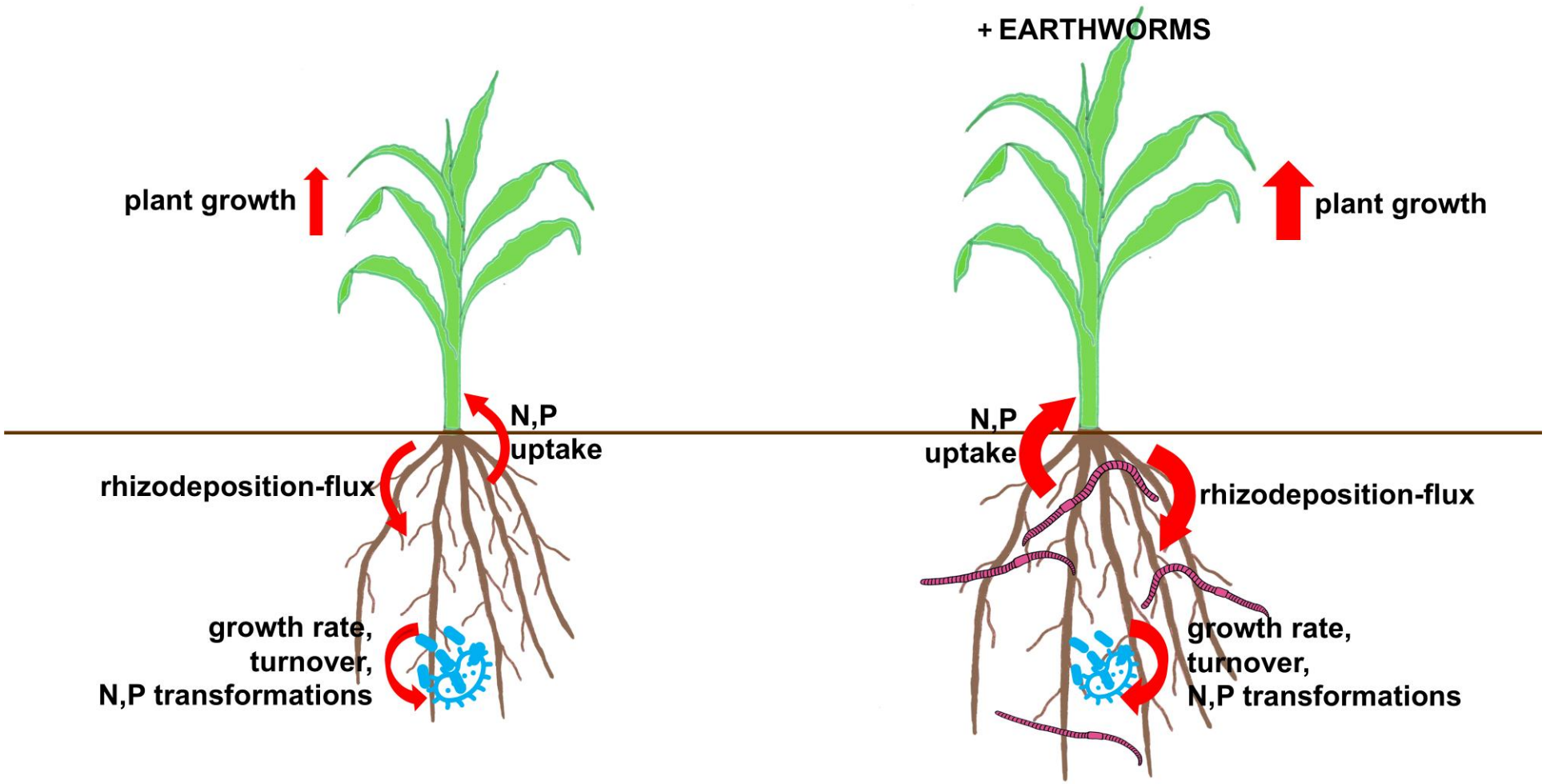


By stimulating plant growth, earthworms enhance rhizodeposition, indirectly shaping the SOM dynamics in the rhizosphere.



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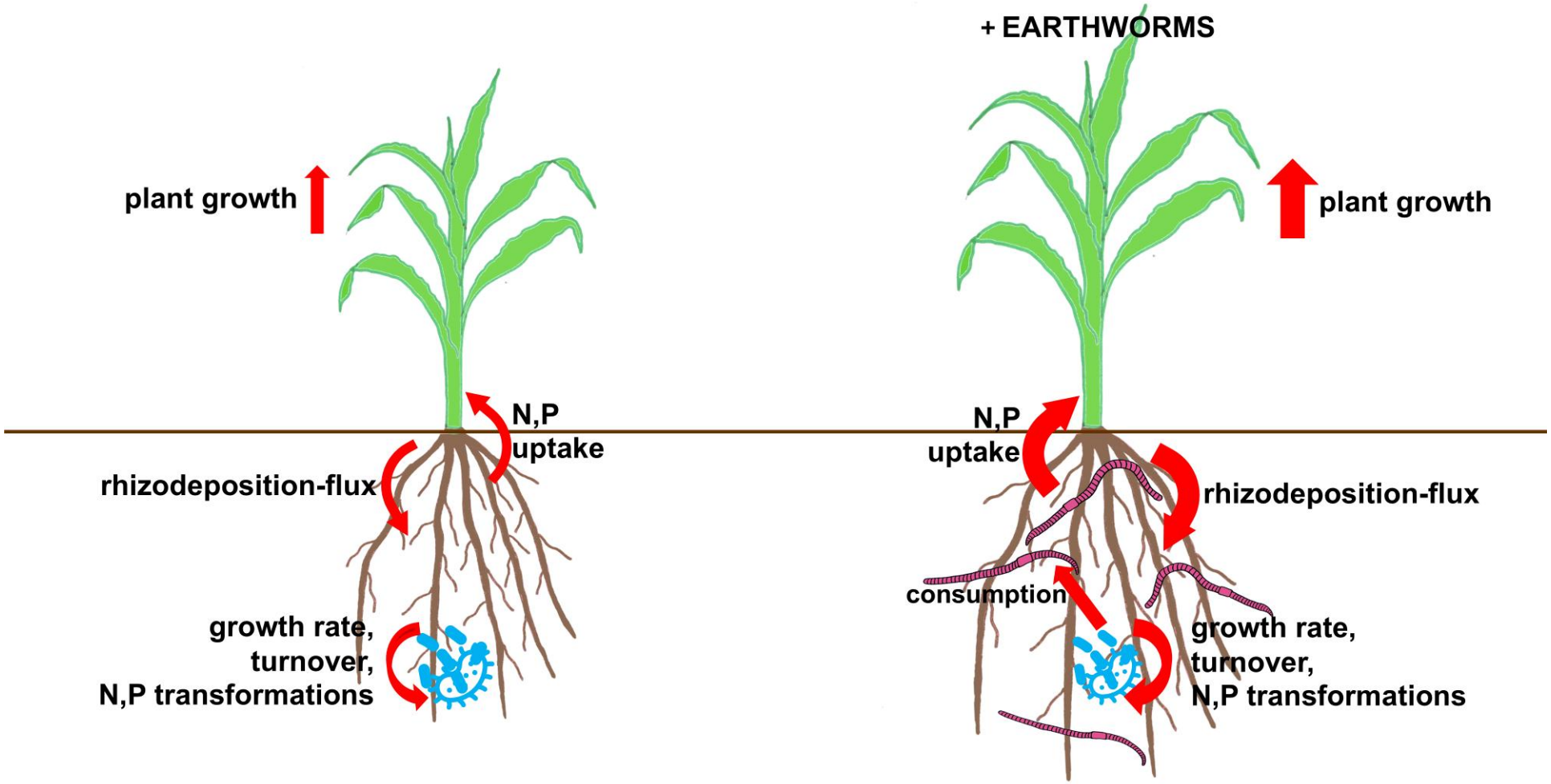
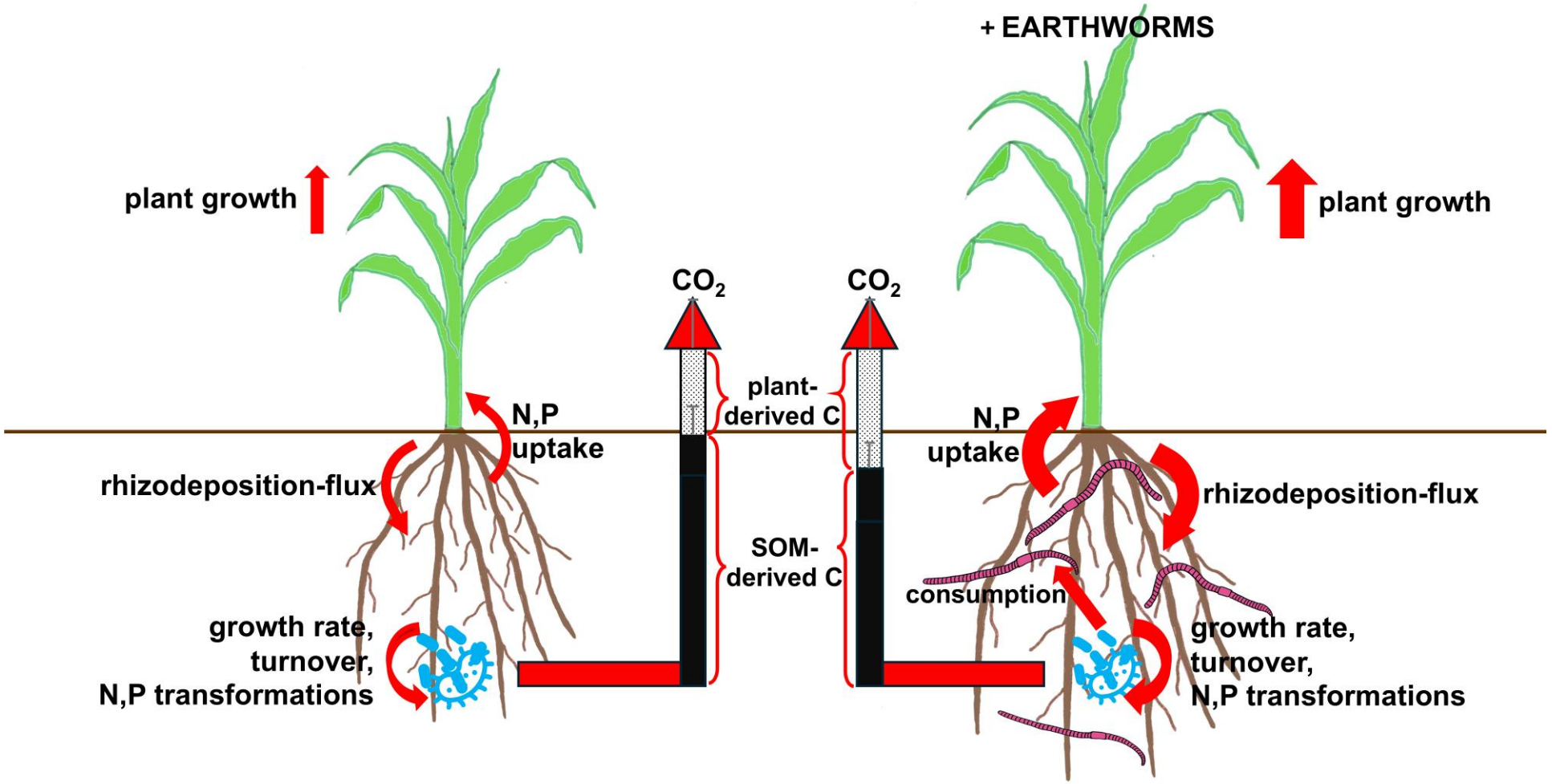


Through their feeding on microbes, earthworms help moderate microbial biomass and sustain turnover.



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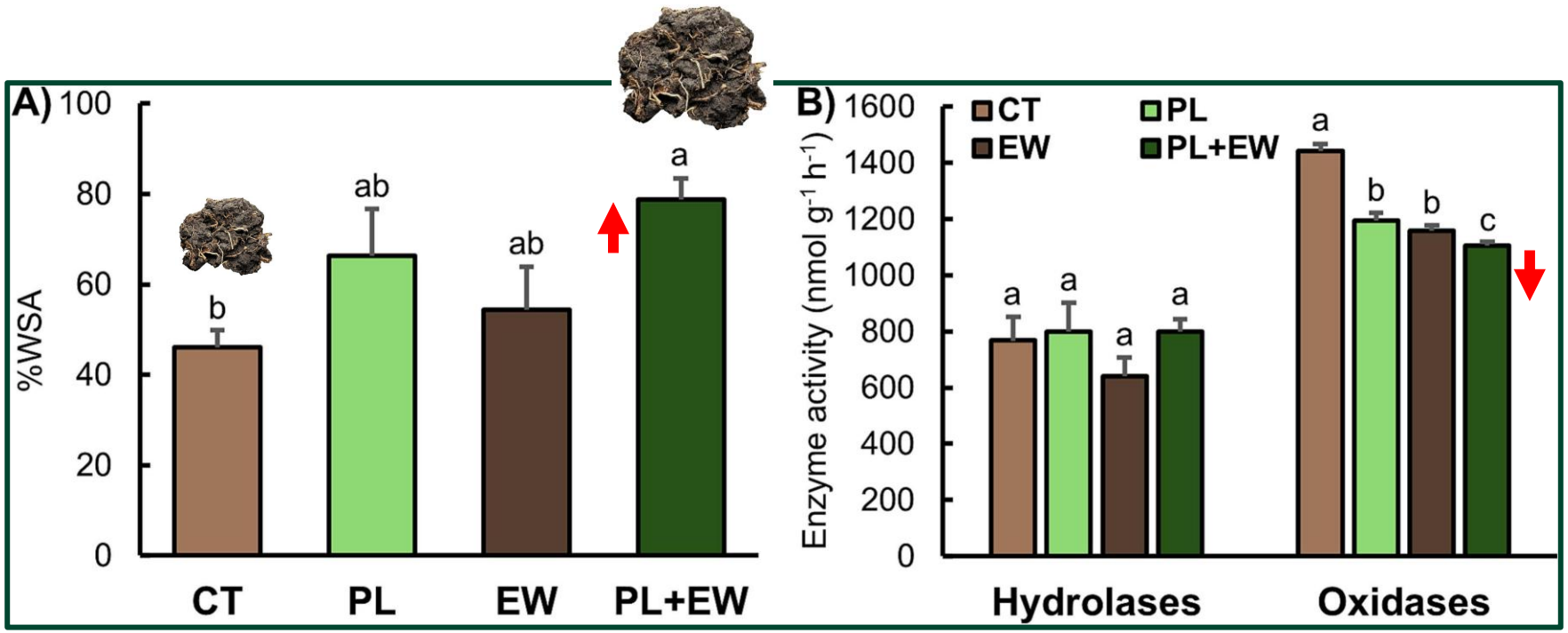
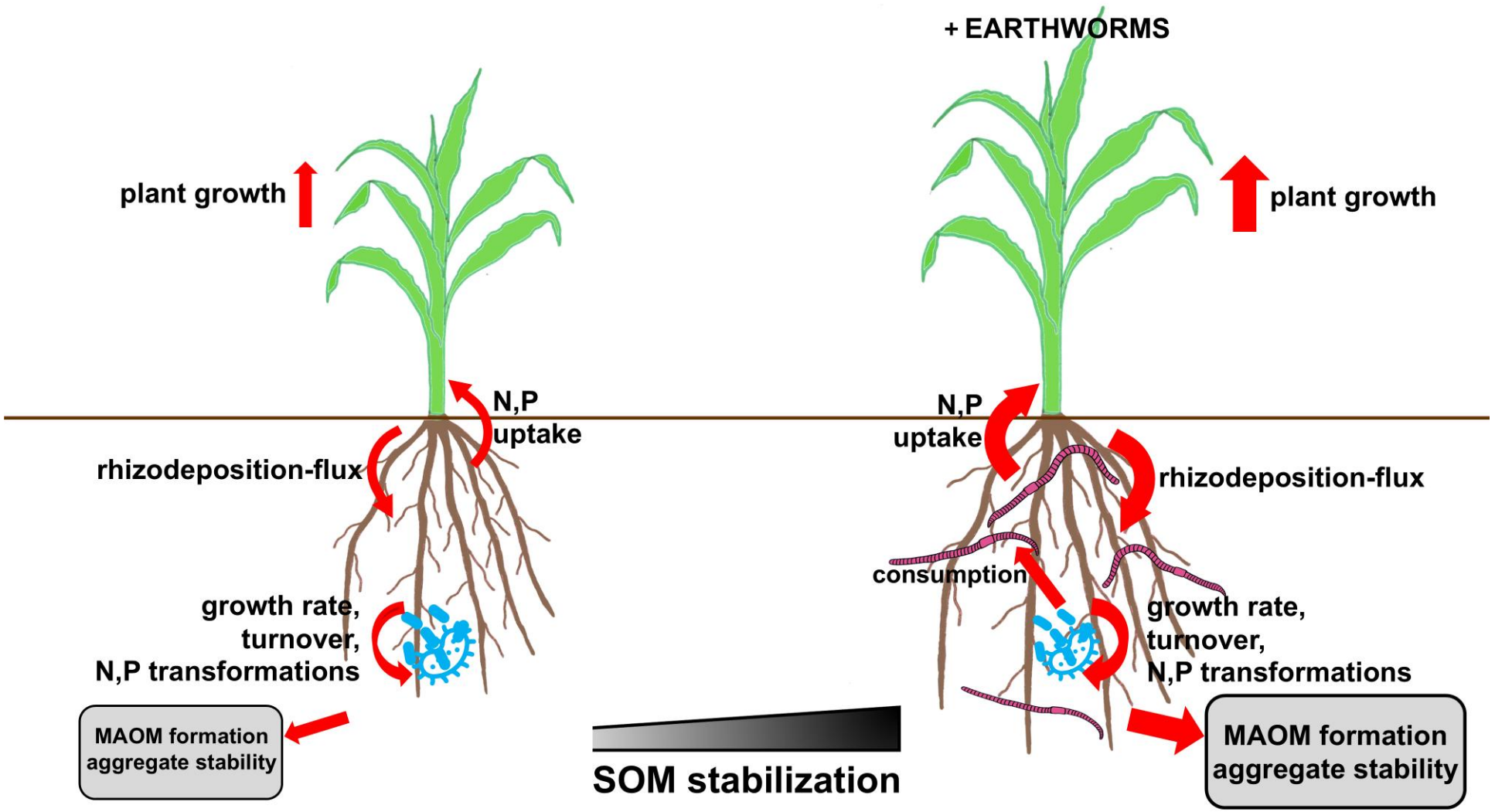
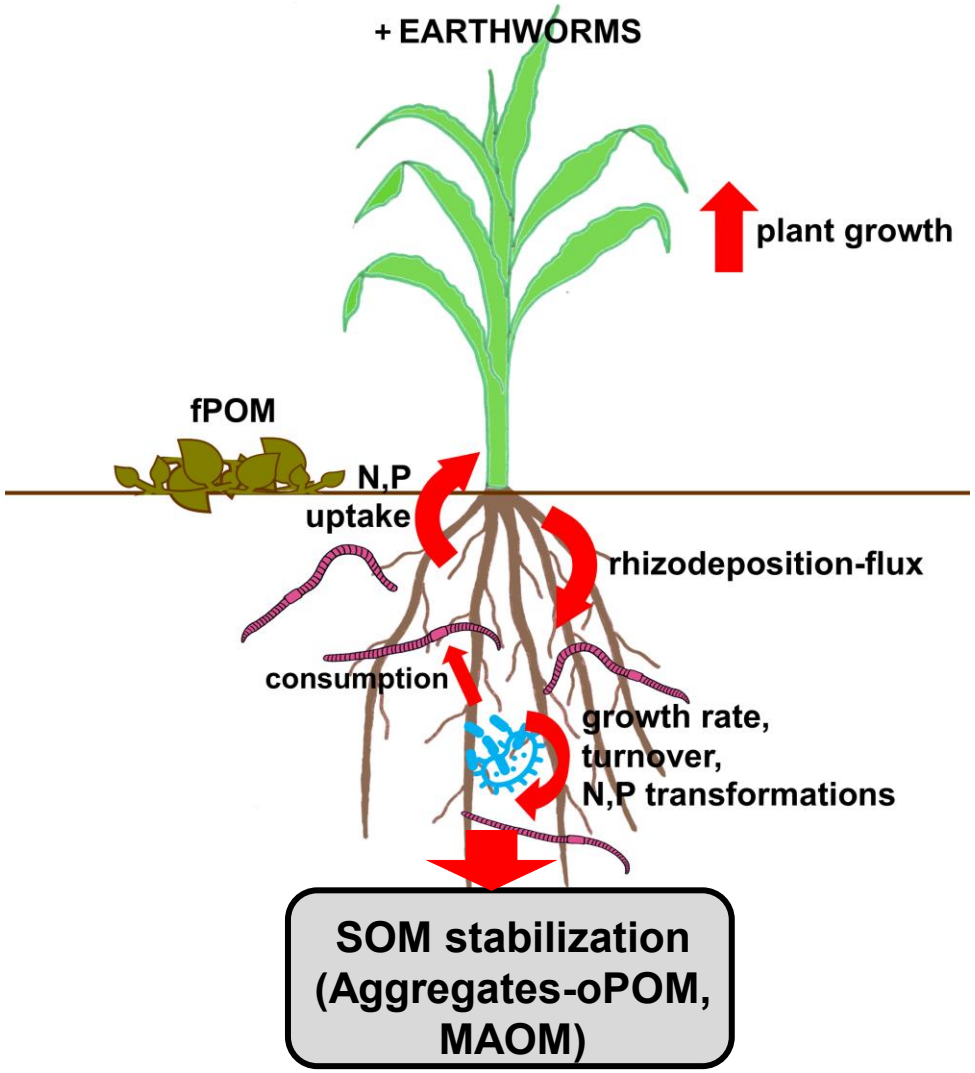


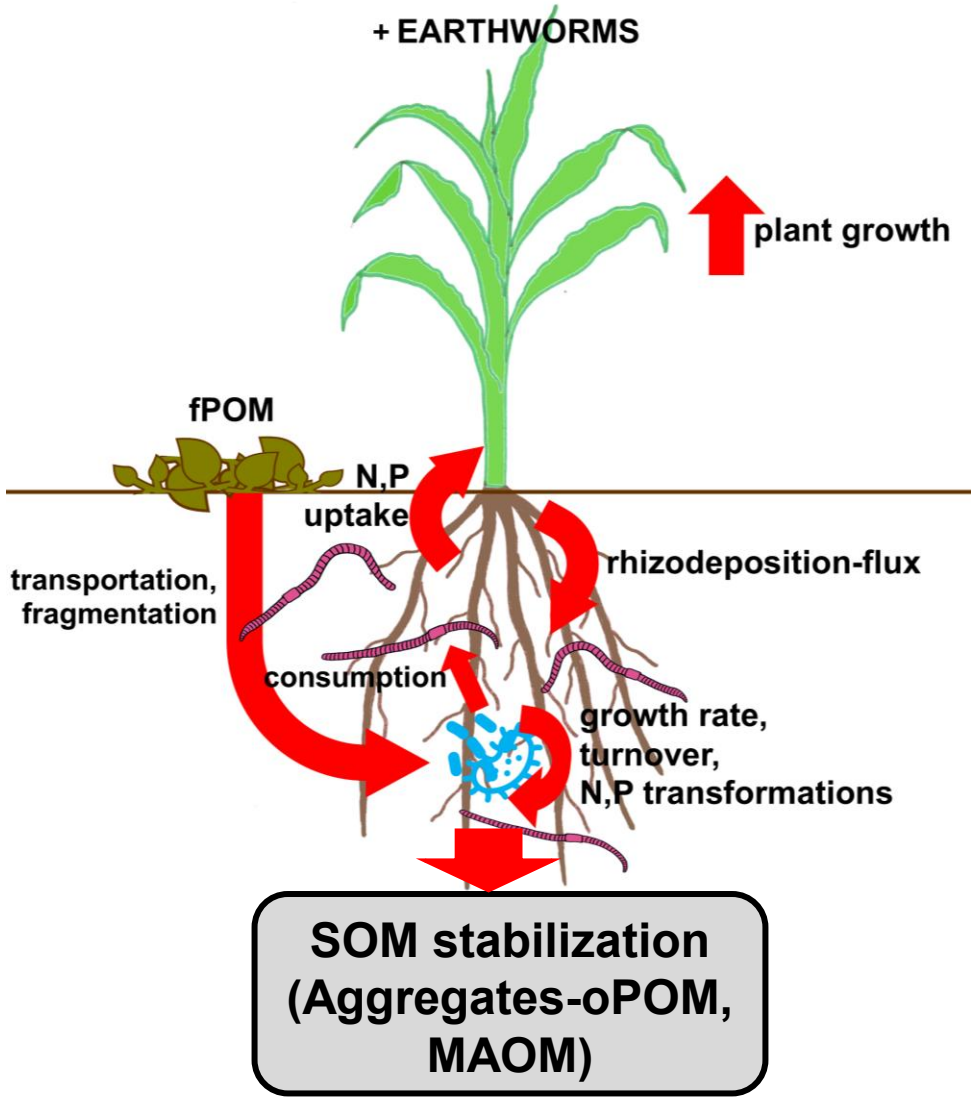
In combination with plants, earthworms amplified aggregation processes, leading to high aggregate stability and enhanced protection of SOM.



Earthworms, plants, and microbes form a positive loop stabilizing soil organic matter.



Positive loop: Earthworms + Plants + Microorganisms



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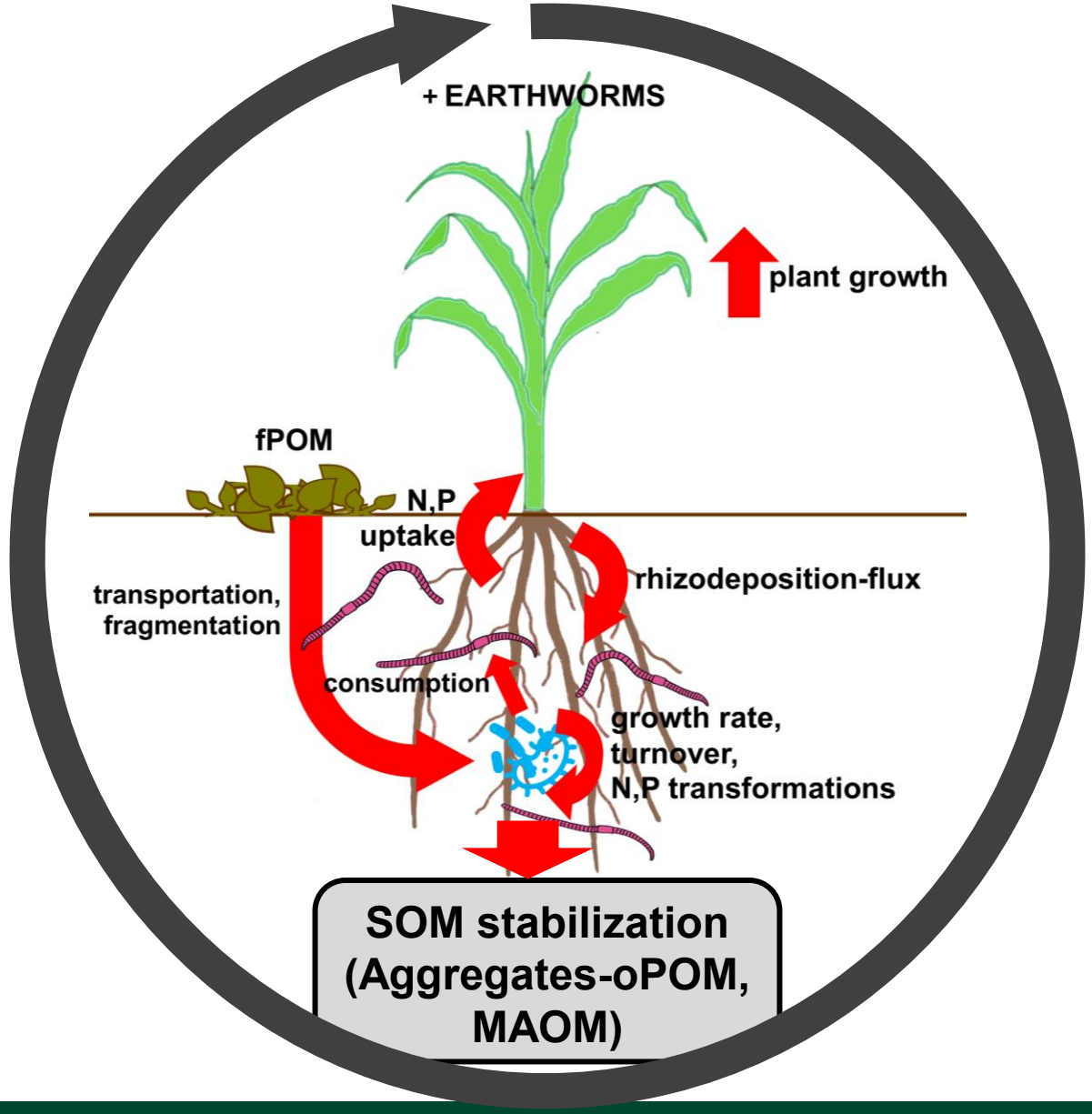
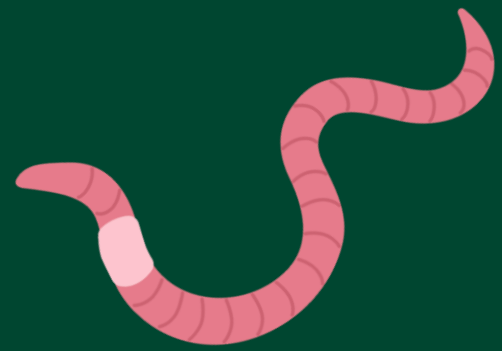


Positive loop: Earthworms + Plants + Microorganisms

Thank you for your attention!



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