D518 | EGU2020-301

How do nutrients stimulate terrestrial carbon degradation in stream hyporheic zones?

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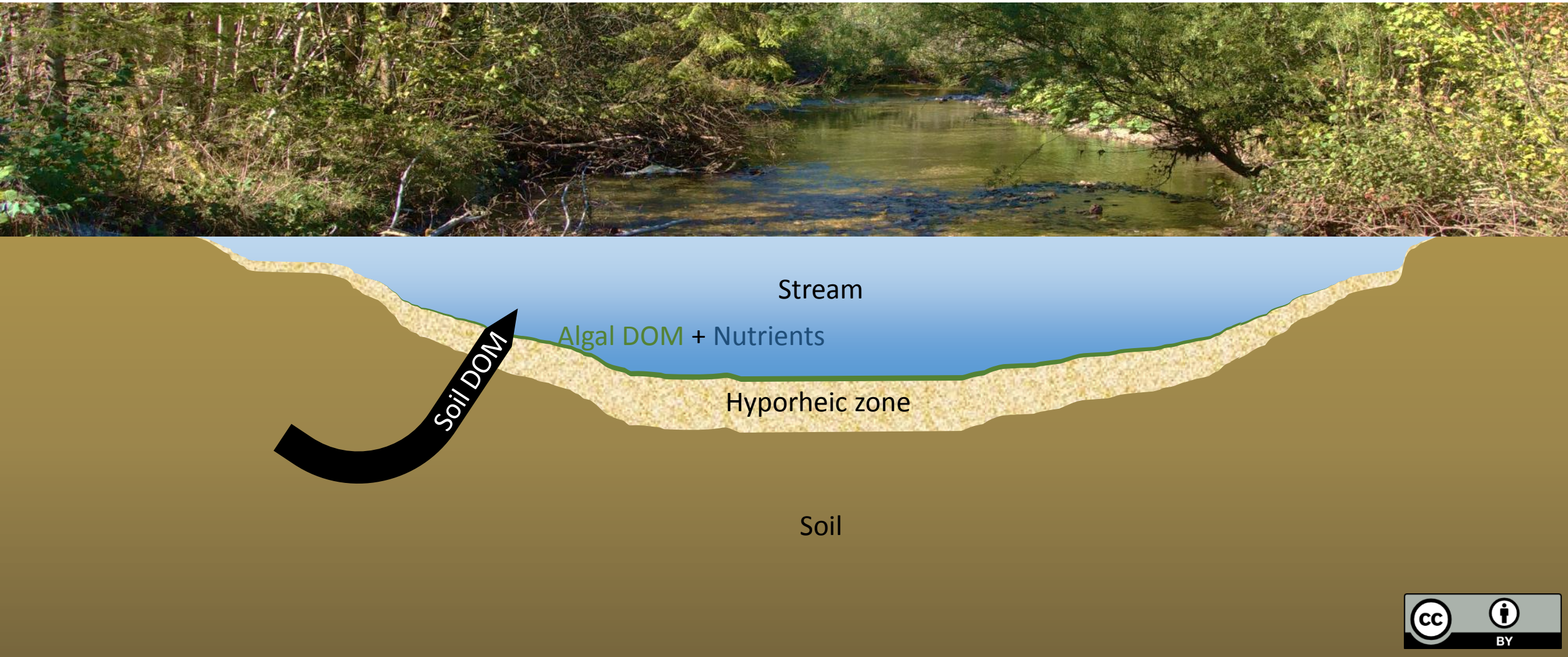
EGU2020 Sharing Geoscience Online – 5th May 2020
Online Meeting

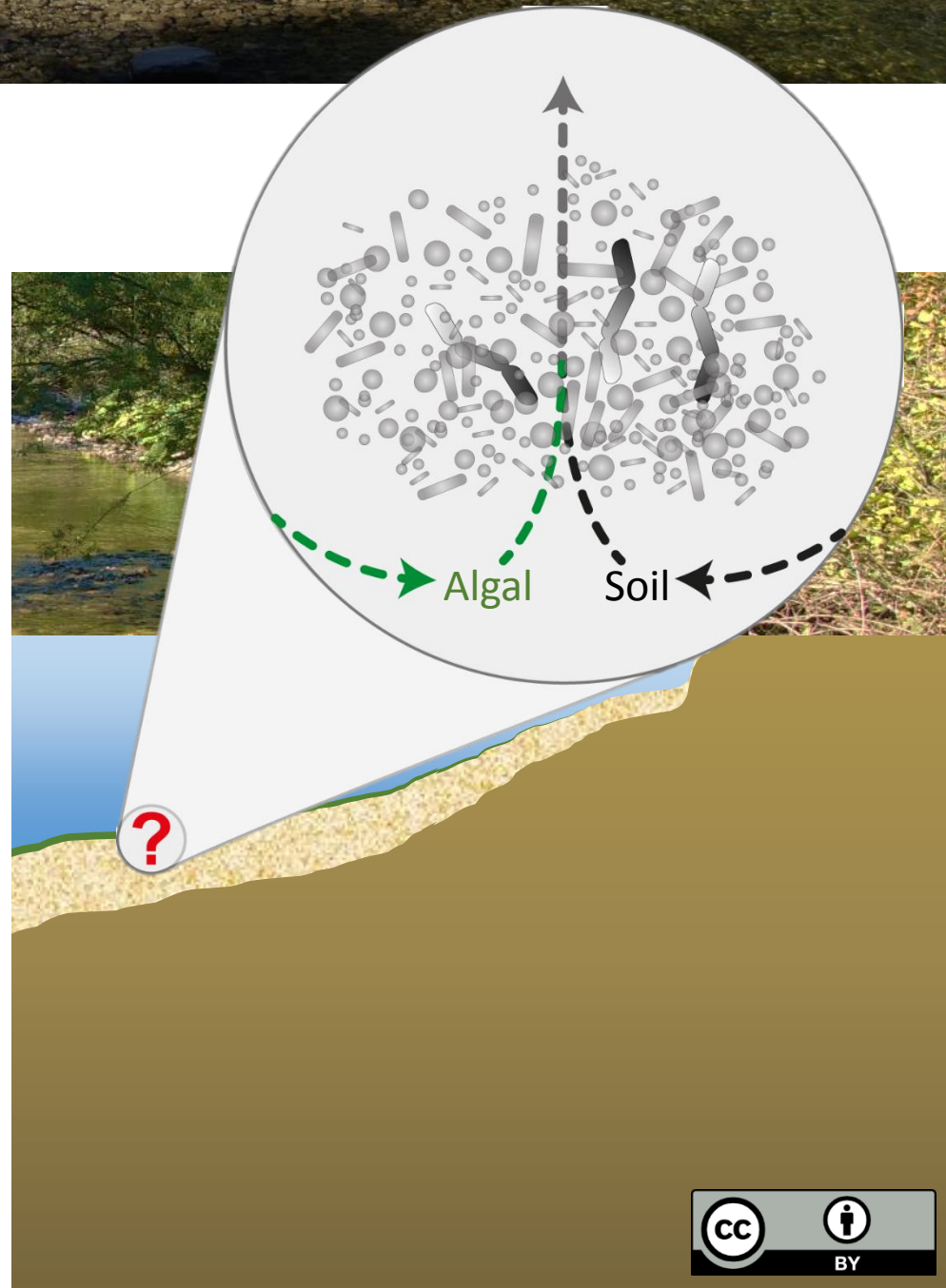
Introduction

The hyporheic zone of streams: where soil DOM meets algal DOM and nutrients



Question

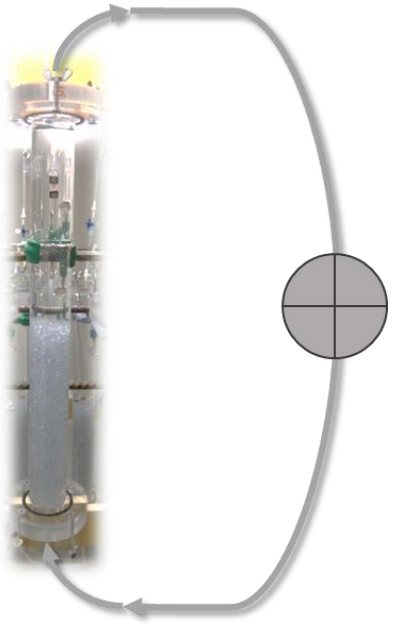
How do nutrients influence the respiration† of terrestrial DOM in the hyporheic zone?



†respiration is used here as an indicator for degradation of organic matter although complete degradation comprises a full sequence of transformations including also exoenzymatic degradation or assimilation

Methods – Experimental setup

a)



b)

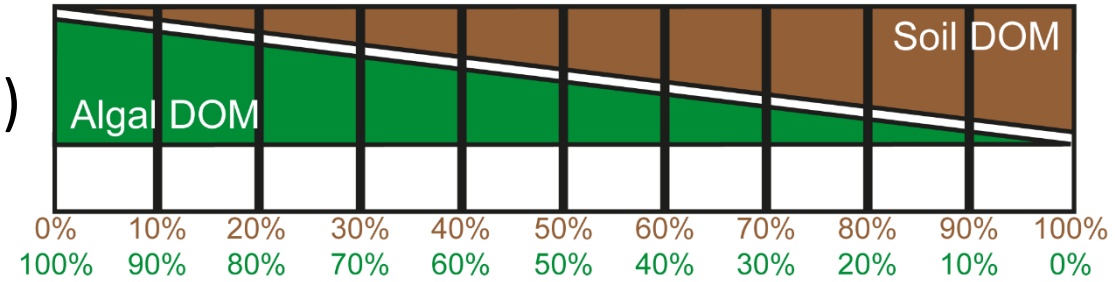


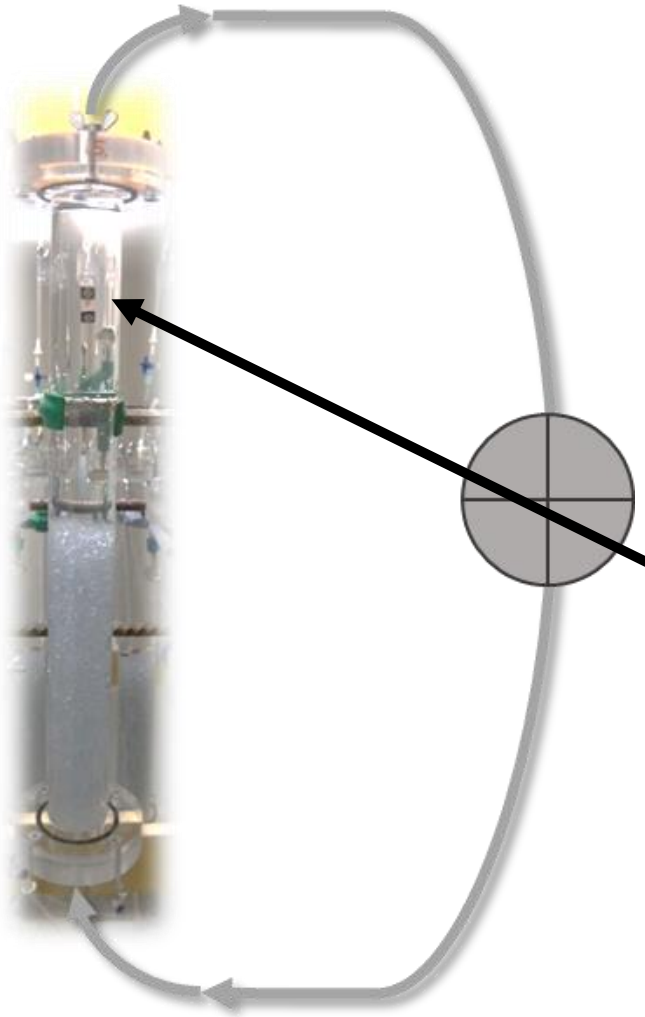
Figure 1. Experimental setup of a) laboratory flow-through microcosms, and b) the mixtures of algal and soil DOM for the gradient.

- Closed circulating microcosms equipped with glass beads inoculated in alpine headwater stream (pic on top)
- Incubations contained different mixtures of DOM extracted from algae and forest soil (pic below; black vertical lines mark the mixtures)
- Incubations run at ambient phosphorus concentrations and adjusted to the same level of the algal DOM (had highest phosphorus concentration)

➢ 11 different mixing regimes for the two phosphorus levels including the pure end members

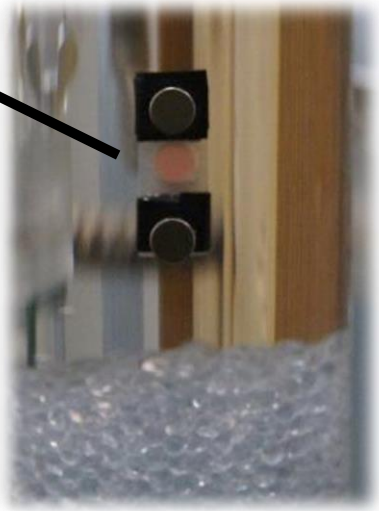
➢ comparable DOC levels for all (4.3 ± 0.6 mg L^{-1})

Methods – Parameters



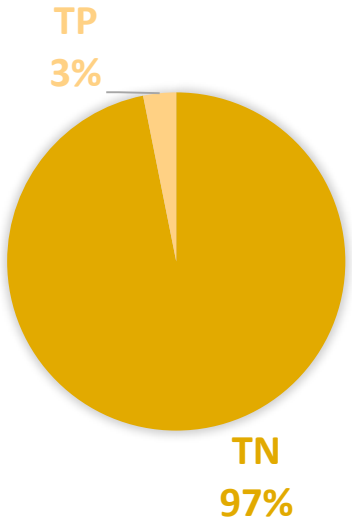
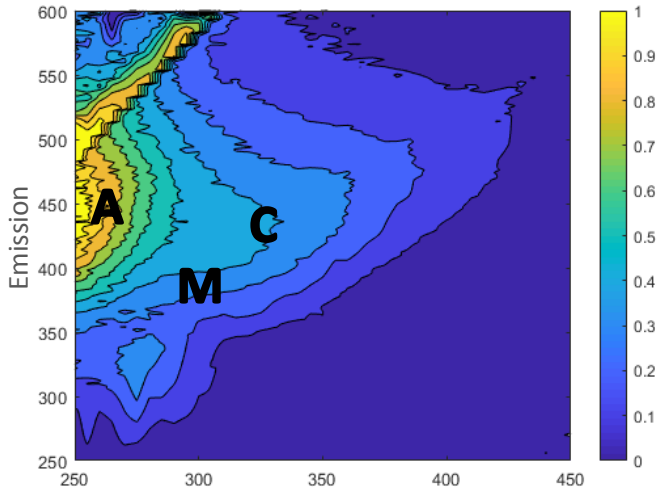
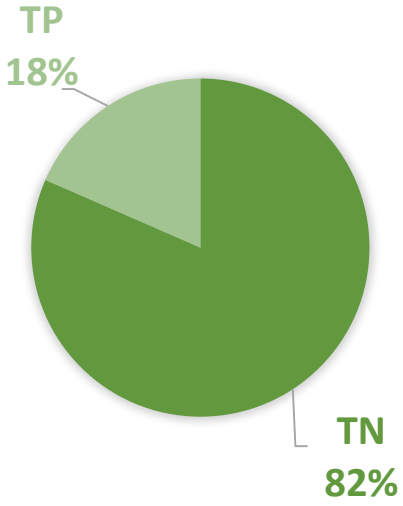
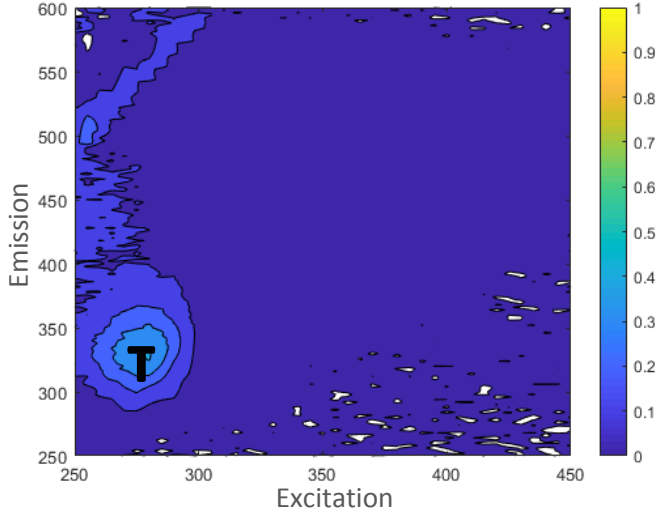
Nutrient analyses (TDN, $N\text{-}NO_3$, $N\text{-}NO_2$, $N\text{-}NH_4$, and TDP, SRP) at start and end

Quality of dissolved organic matter at start and end via absorbance and fluorescence



Respiration via oxygen sensor spots

Large differences in the composition of DOM sources

	Nutrients	Fluorescence
Soil DOM	 ➢ C:N:P soil = 226:68:1 (phosphorus limited)	 Mostly humic-like organic matter
Algal DOM	 ➢ C:N:P = 38:10:1 (carbon limited)	 Only fresh-like organic matter

Respiration stimulated by phosphorus addition

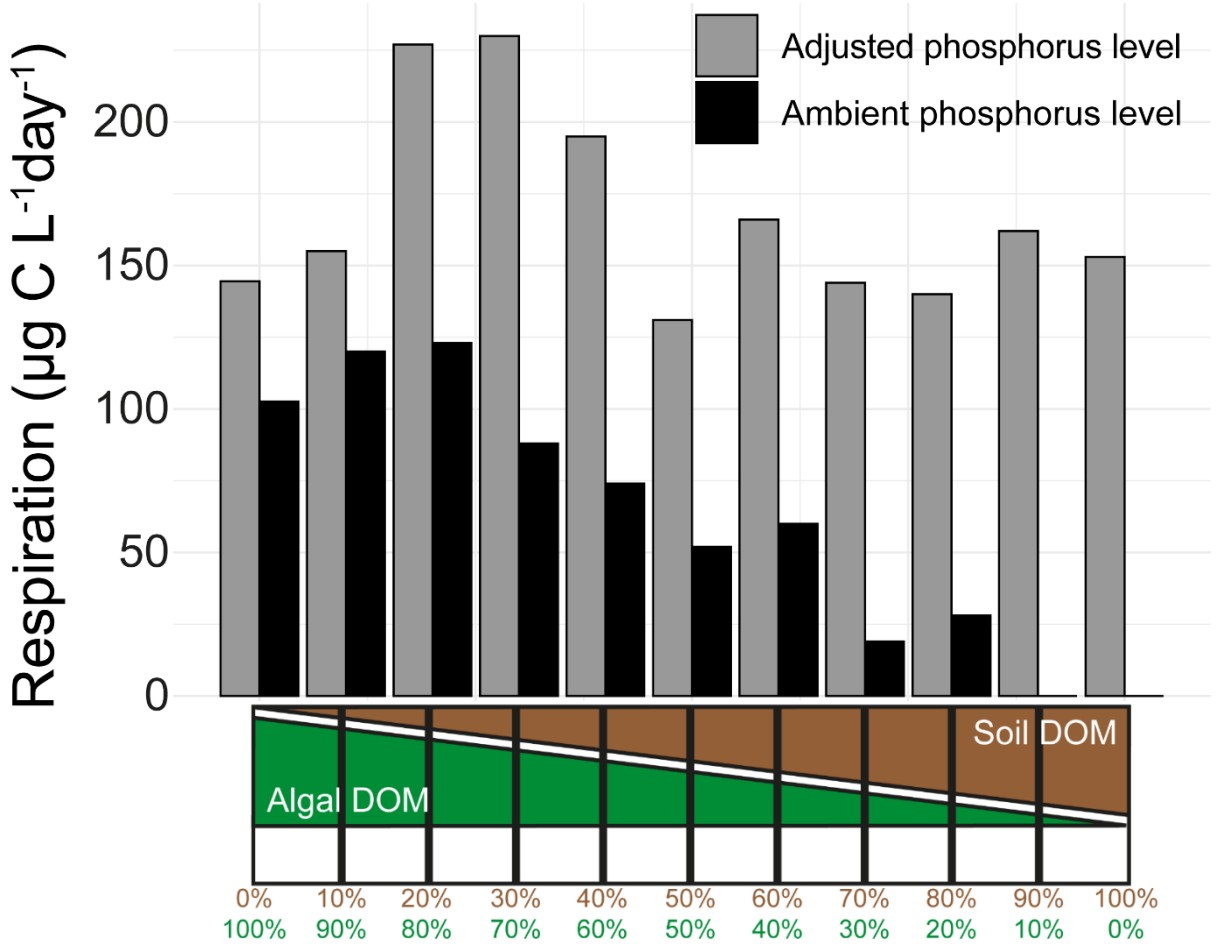


Figure 2. Microbial respiration in HZ microcosms (in µg C L^{-1} day^{-1}) at ambient (black) and adjusted phosphorus concentrations (gray).

1. Ambient phosphorus level (black):
   - Decreasing respiration rate with increasing soil DOM fraction
   - Soil DOM not respired

2. Adjusted phosphorus level (gray):
   - Respiration rate high across the whole gradient
   - Soil DOM respired when phosphorus not limiting

Terrestrial humic-like DOM degraded after adjustment?

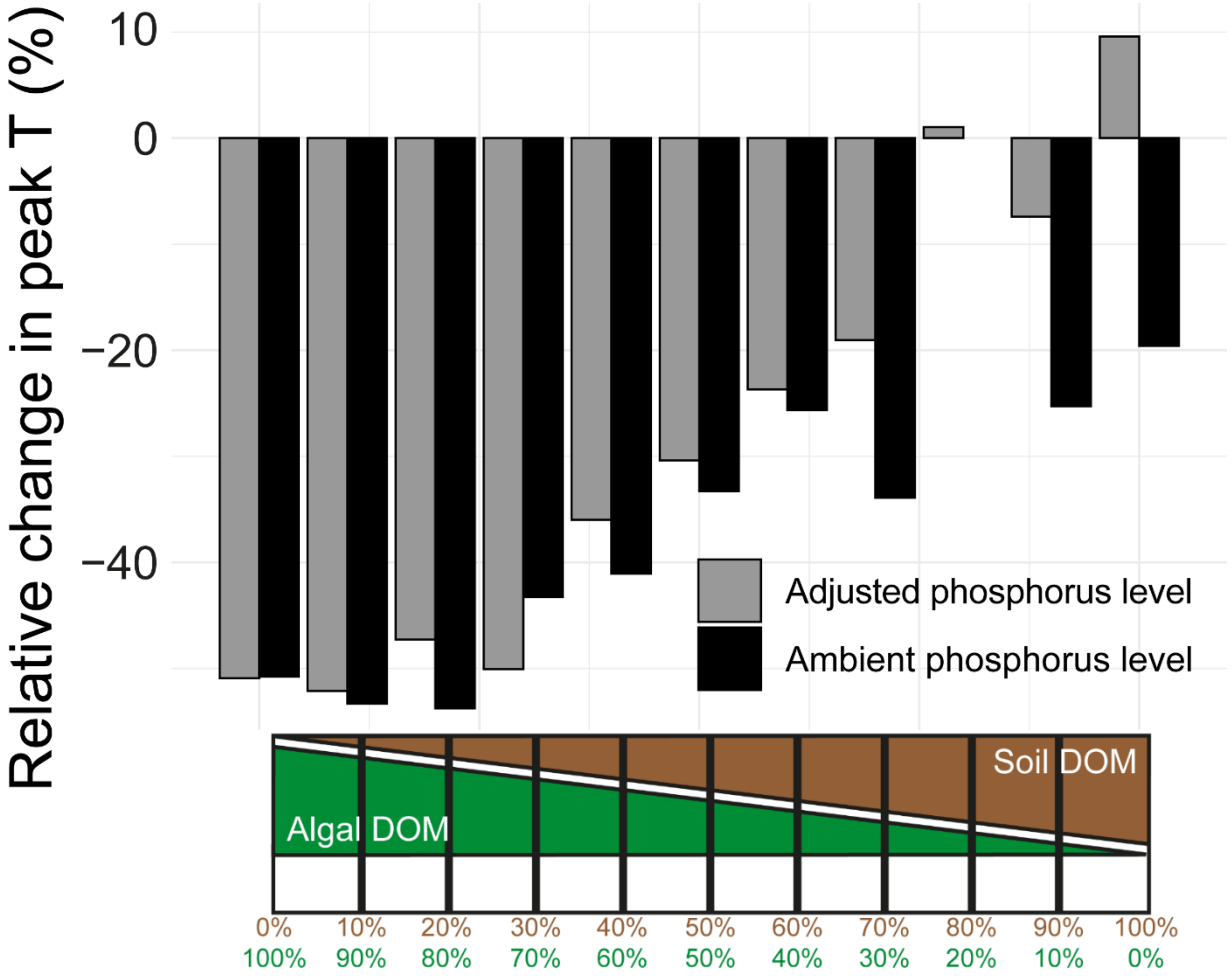


Figure 3. Relative change in peak T (%) from start to end compared to the start values at ambient (black) and adjusted phosphorus concentrations (gray). Positive values indicate an increase from start to end and vice versa.

Tryptophan-like peak T:

- Indicator of fresh-like organic matter (Coble 1996*)
- Peak T change decreases with increasing soil DOM fractions
- Decrease higher at ambient phosphorus level at high soil DOM fractions

*Coble PG. 1996. Characterization of marine and terrestrial DOM in seawater using excitation-emission matrix spectroscopy. Marine chemistry 51:325–46.

Terrestrial humic-like DOM degraded after adjustment?

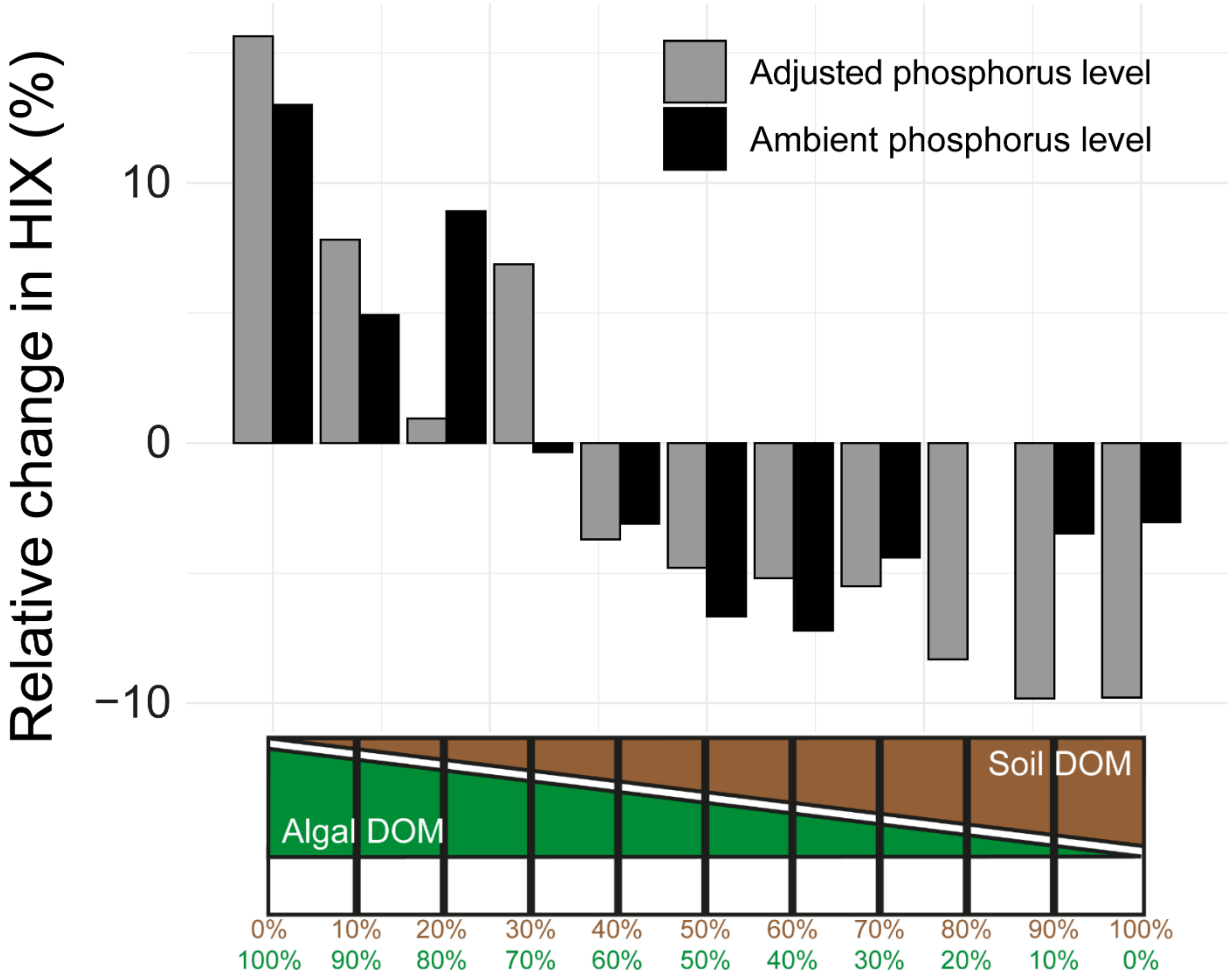


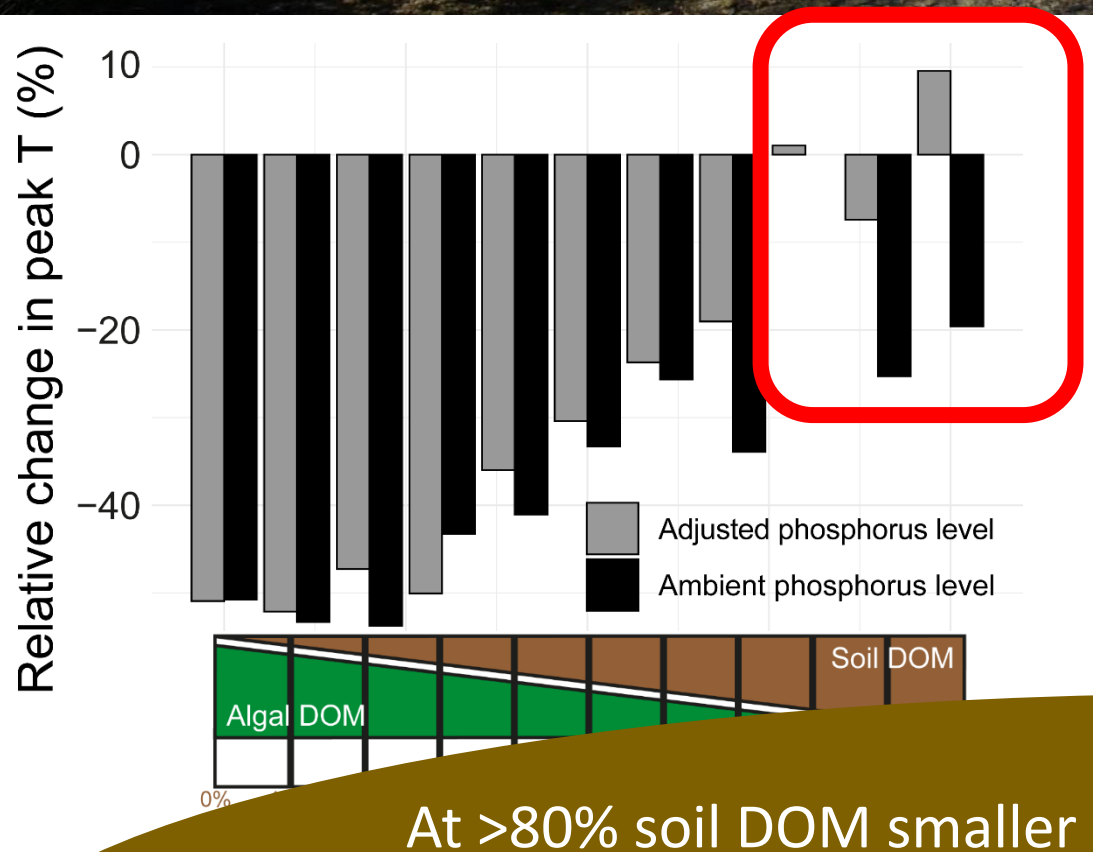
Figure 4. Relative change in humification index (HIX) (%) from start to end compared to the start values at ambient (black) and adjusted phosphorus concentrations (gray). Positive values indicate an increase from start to end and vice versa.

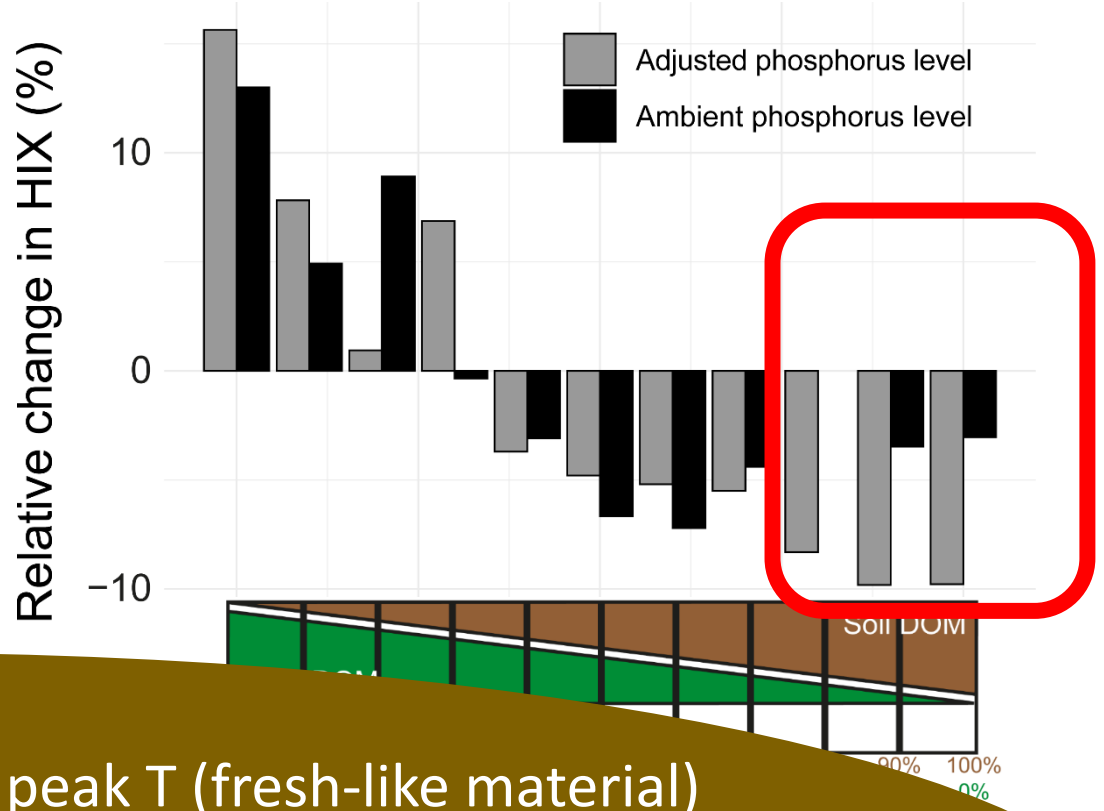
Humification index (HIX):

- Indicator of humic substance content (Ohno 2002*)
- HIX change positive (produced) at high algal but negative (degraded) at high soil DOM
- HIX change higher at adjusted phosphorus level at high soil DOM fractions

*Ohno, T. 2002. Fluorescence inner-filtering correction for determining the humification index of dissolved organic matter. Environmental Science & Technology, 36(4):742-746.

Terrestrial humic-like DOM degraded after adjustment?





At >80% soil DOM smaller changes in peak T (fresh-like material)
and larger changes in HIX (humic-like material)

→

Humic-like DOM „better“ degraded after nutrient adjustment?

Summary and conclusions

How do nutrients influence the respiration and thereby terrestrial DOM degradation in the hyporheic zone?

SUMMARY

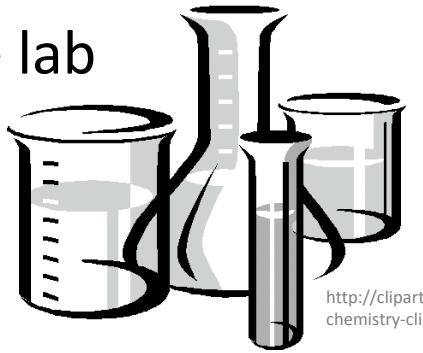
1. Both DOM sources have distinctly different nutritional composition.
2. Phosphorus adjustment stimulates microbial respiration in the hyporheic zone to similar levels across gradient likely boosting terrestrial DOM degradation.
3. Nutrient adjustment renders humic matter available to microbes

CONCLUSIONS

- Microbial respiration is sensitive to nutrient addition in the hyporheic zone.
- Terrestrial DOM is not recalcitrant to degradation *per se*.

Acknowledgement

Support in the lab



http://cliparting.com/free-chemistry-clipart-39783/

Gertraud Steniczka
Beate Pitzl
Hermann Hofreiter

Financial support

https://www.pinterest.co.uk/pin/444800900679213048/

Support with data analysis

http://www.clipartpanda.com/clipart_images/data-analysis-clipart-data-62375550

Renata Pinto