Species-specific responses to plant phenology and temperature control plant-mediated methane emissions in a northern boreal fen

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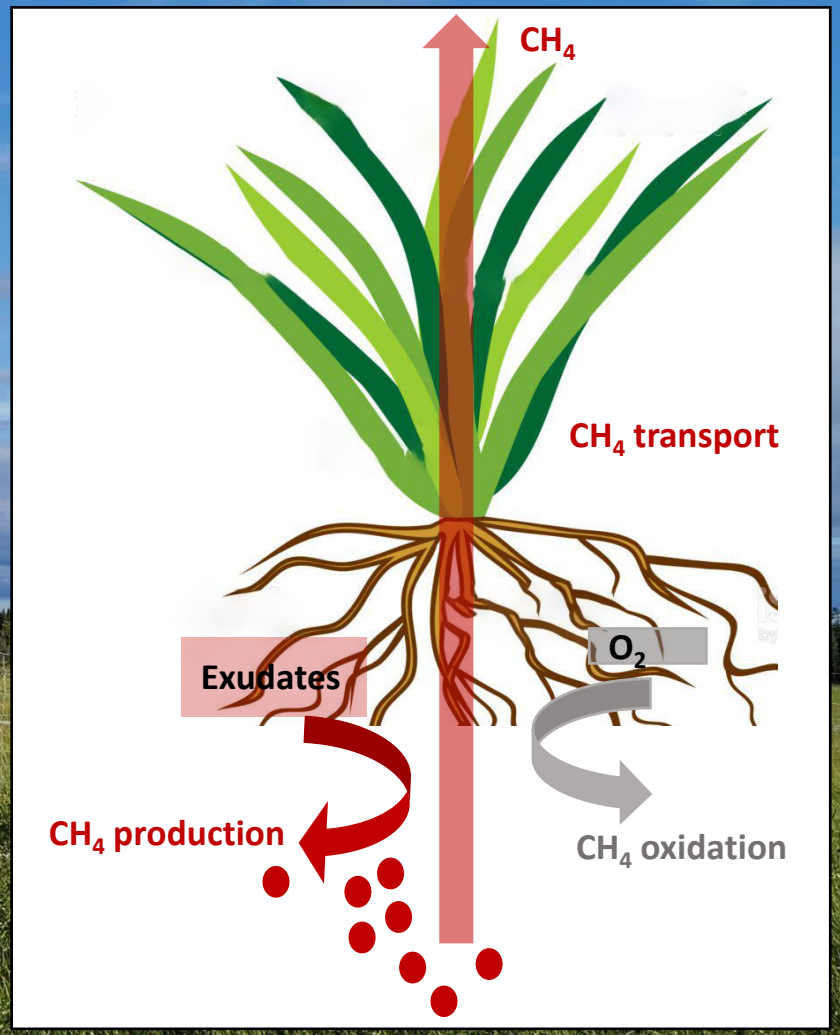
Motivation

- Plants play a central role in CH_4 emissions from peatlands;
- Increasing evidence has highlighted **the importance of the effect of plant-mediated CH_4 transport** in controlling CH_4 emissions from peatlands;
- **Environmental factors** controlling plant CH_4 transport are uncertain and **the effects of plant phenology** on species-specific transport are unknown.



Aim and hypothesis

- Evaluate the relative importance of plant phenology and environmental factors in controlling plant CH_4 transport rates of plant species belonging to different plant functional types;
- Reveal species-specific CH_4 transport rate and efficiency.

Experiment design

- **Site**

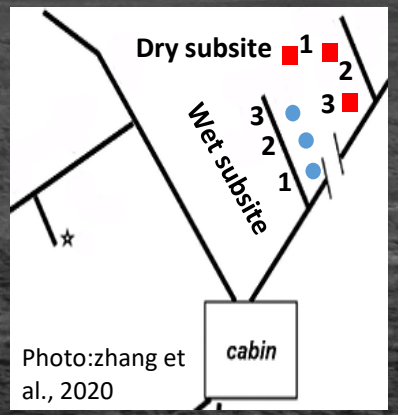


Photo:zhang et al., 2020

- **Species**

Sedge: Carex rostrata

Horsetail: Equisetum fluviatile

Shrub: Betula nana

Shrub: Salix lapponum

Forb: Comarum palustre

Forb: Menyanthes trifoliata

- **CH_4 flux**

Herb chamber

Shrub chamber

Ancillary measurement

Soil temperature

Porewater CH_4 concentration

Water table level

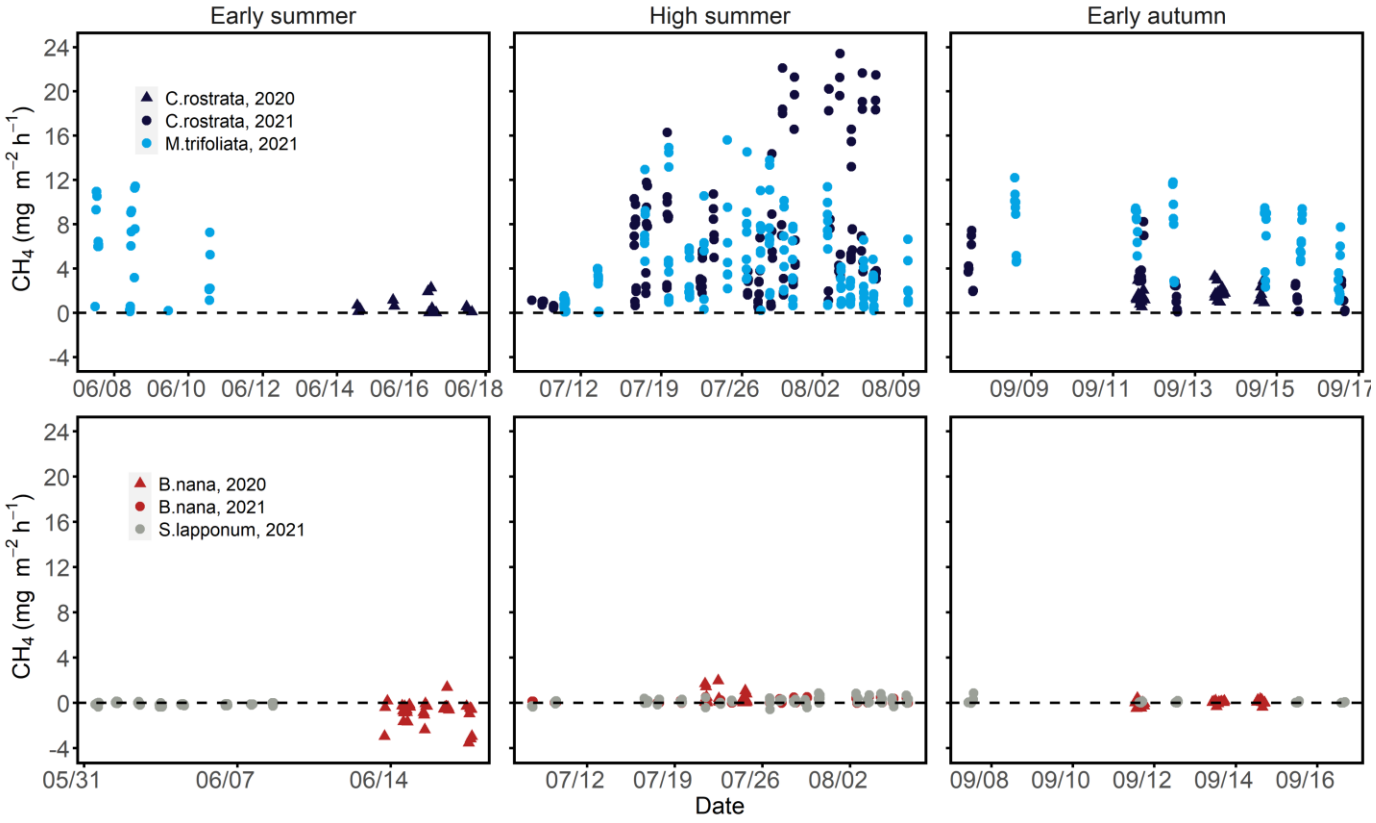
- **Timetable**

Early summer

High summer

Early autumn

Results: Seasonal variations in CH_4 transport rate and main drivers



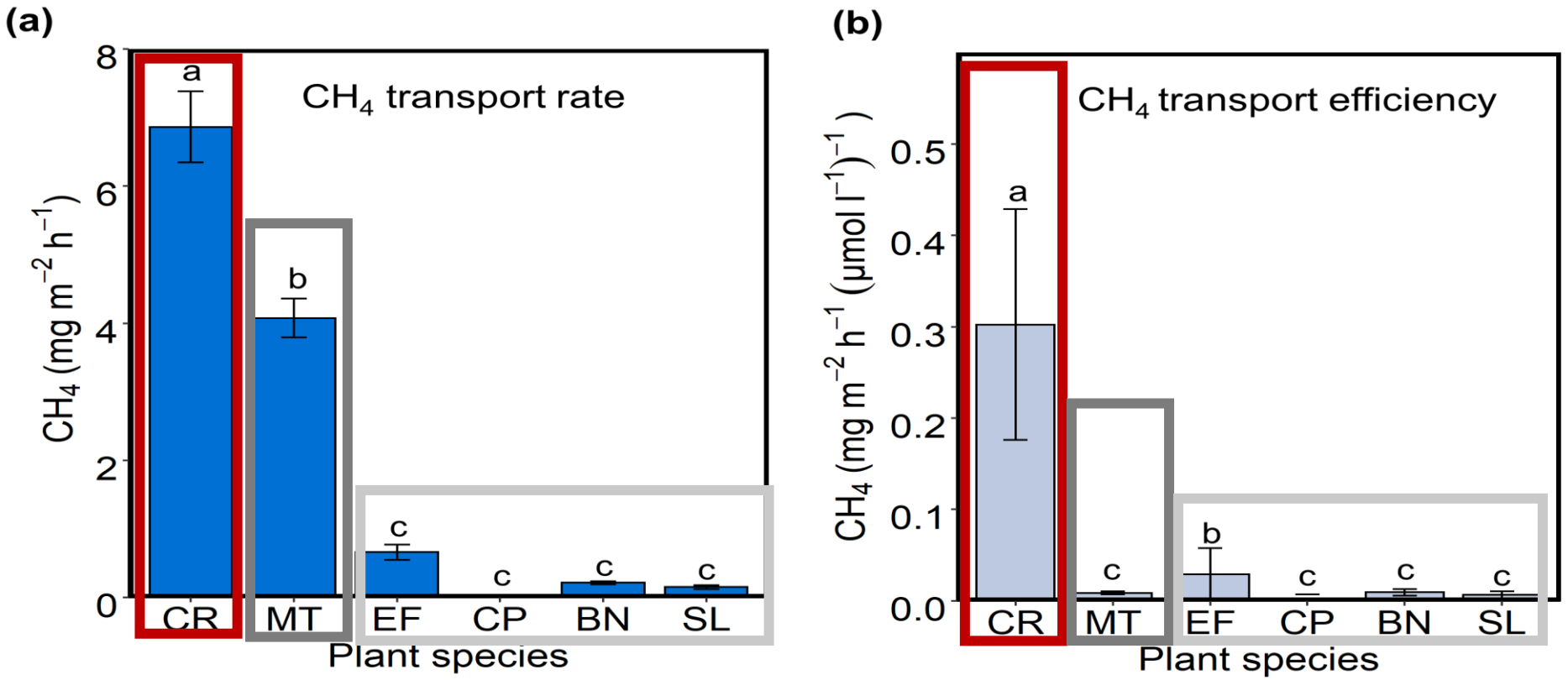
Fixed part	Estimate	SE	P value
Constant (High summer)	4.41	1.07	< 0.001 ***
T_{15}	-0.24	0.07	0.001 **
Season (Early autumn)	-7.96	1.69	< 0.001 ***
T_{15}* Season (Early autumn)	0.72	0.16	< 0.001 ***
Random part			
SD (Sample ID)	0.63		
SD (Measurement year)	0.84		
Residual SD	0.62		

1) Seasonal variations in CH_4 transport rate of *C. rostrata*, which was primarily driven by seasonal plant development (phenology, indicated by measurement campaign), and only secondarily affected by peat temperature at depth of 15 cm (T_{15});

2) None of the investigated variables influenced seasonal variations in CH_4 transport rate of M. trifoliata, B. nana, and S. lapponum.

Results: Species-specific CH_4 transport rate and efficiency

$$CH_4 \text{ transport efficiency} = \frac{CH_4 \text{ transport rate}}{15 \text{ cm } CH_4 \text{ concentration}}$$



Wrap up

1) Clear seasonal variations in CH_4 transport rate of *C. rostrata*, which was primarily driven by plant phenology and only secondarily by rhizospheric peat temperature;

2) CH_4 transport rates of *B. nana* and *S. lapponum* were constantly limited, but CH_4 transport rate of *M. trifoliata* was constantly high. None of the investigated variables influenced seasonal variations in CH_4 transport rate of *M. trifoliata*, *B. nana,* and *S. lapponum*.

3) CH_4 transport rate and efficiency varied significantly between species. *C. rostrata* and *M. trifoliata* were two important CH_4 transporters, but *M. trifoliata* had significantly lower CH_4 transport efficiency than that of *C. rostrata.*

For questions or suggestions, I would be happy to be in contact!

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