

Biogeochemical pattern along increasing
ericoid shrubs encroachment in peatlands

*Biogeochemische Muster bei zunehmender
erikoidem Strauchbewuchs in Moorgebieten*

Alexandre Buttler

Moortagung WSL, 23-24 Sept. 2021

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Importance of peatlands (IUCN)

- They are critical for preserving global biodiversity, provide safe drinking water, minimize flood risk and help address climate change
- They store more carbon than all other vegetation types in the world combined
- Damaged peatlands are a major source of greenhouse gas emissions (annually almost 6% of global anthropogenic CO₂ emissions)

Observed pattern: shrub encroachment in peatlands

(e.g. tundra, also shown in the Swiss inventory)

Facts: *Sphagnum* is at threat since 30-50 years as a result of peat cutting and drainage, air N pollution, CO₂ enrichment, and more recently because of climate warming.

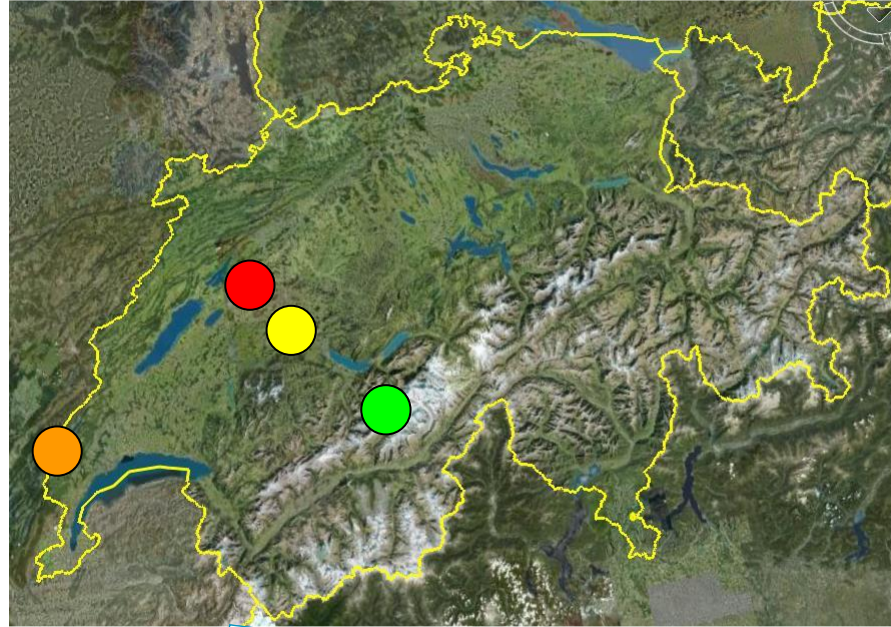
As a result, ericaceous shrubs and some graminoids take a competitive advantage on *Sphagnum*.

Aim: Investigate lawn vegetation in different climatic conditions to understand plant-soil interactions and biogeochemical processes in relation to increasing ericaceous shrubs encroachment.

Hypothesis: The change of plant litter quality with the change of vegetation has cascading effect on the soil biological processes.

Part I : Altitudinal gradient in Switzerland

- = 585 m asl
Lörmöos
- = 1035 m asl
Praz Rodet
- = 1406 m asl
Sortel
- = 1885 m asl
Hochrajen



nature
climate change

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LETTERS

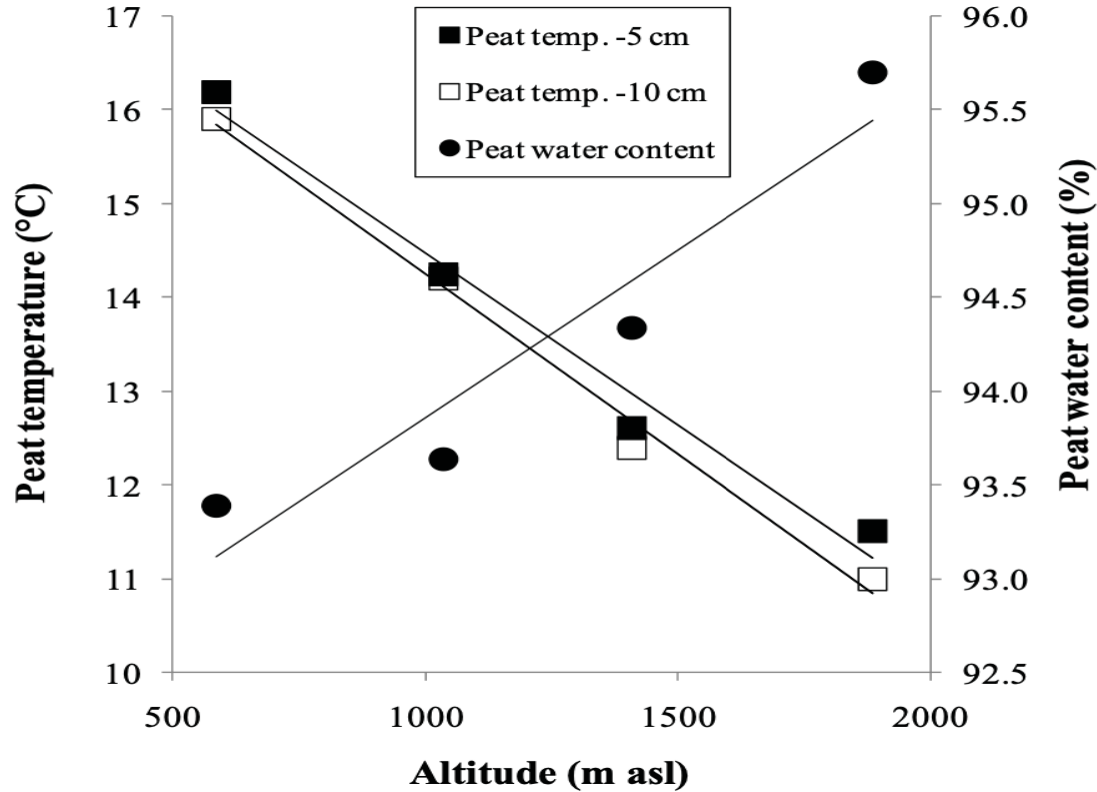
**Biogeochemical plant-soil microbe feedback in
response to climate warming in peatlands**

Luca Bragazza^{1,2,3*}, Julien Parisod^{1,2}, Alexandre Buttler^{1,2,4} and Richard D. Bardgett⁵

The studied lawn vegetation



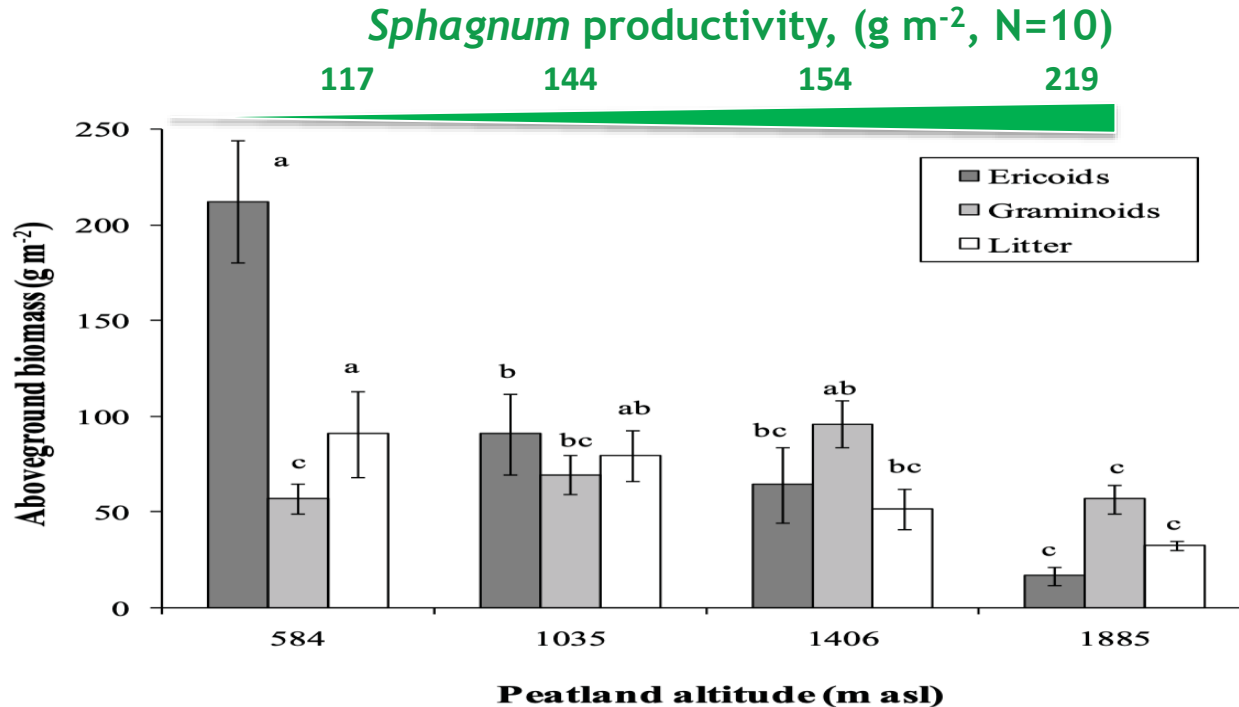
Temperature and water content in peat soil



Shrubs encroachment

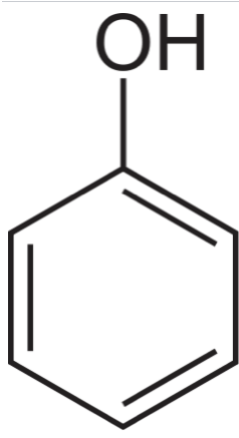


Above-ground plant biomass and standing litter

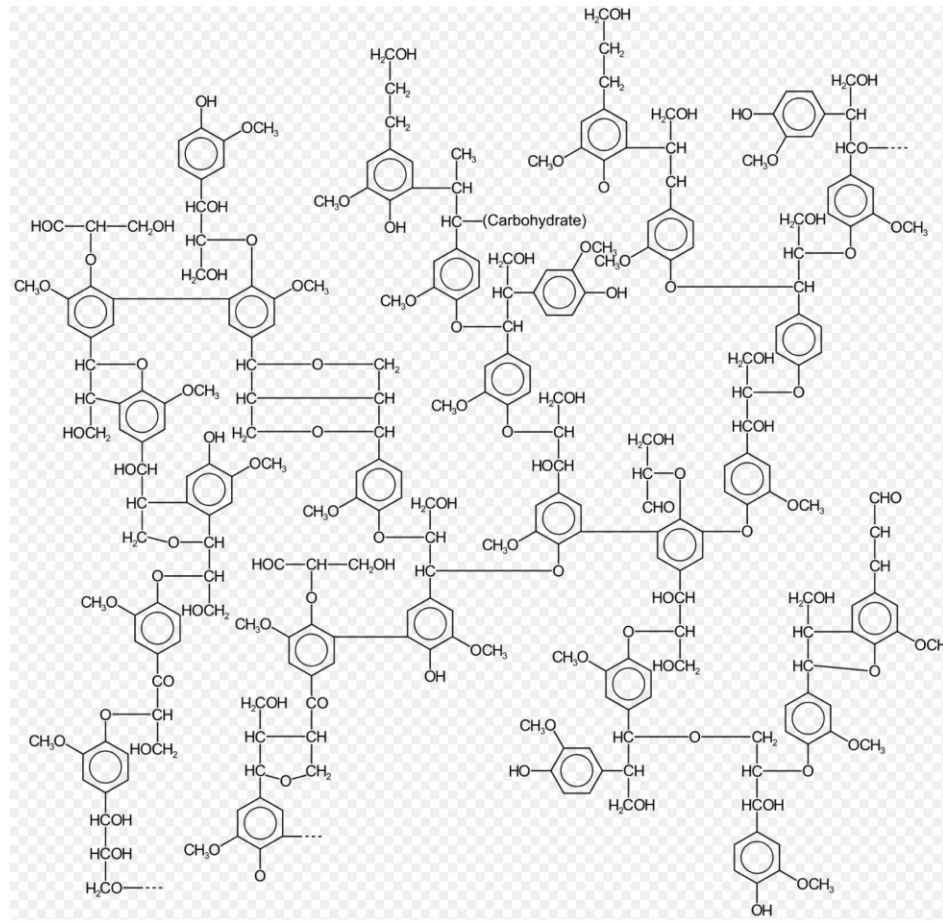


Polyphenol content in above-ground plant biomass (g m^{-2} ; N=10)

49 23 24 5.8

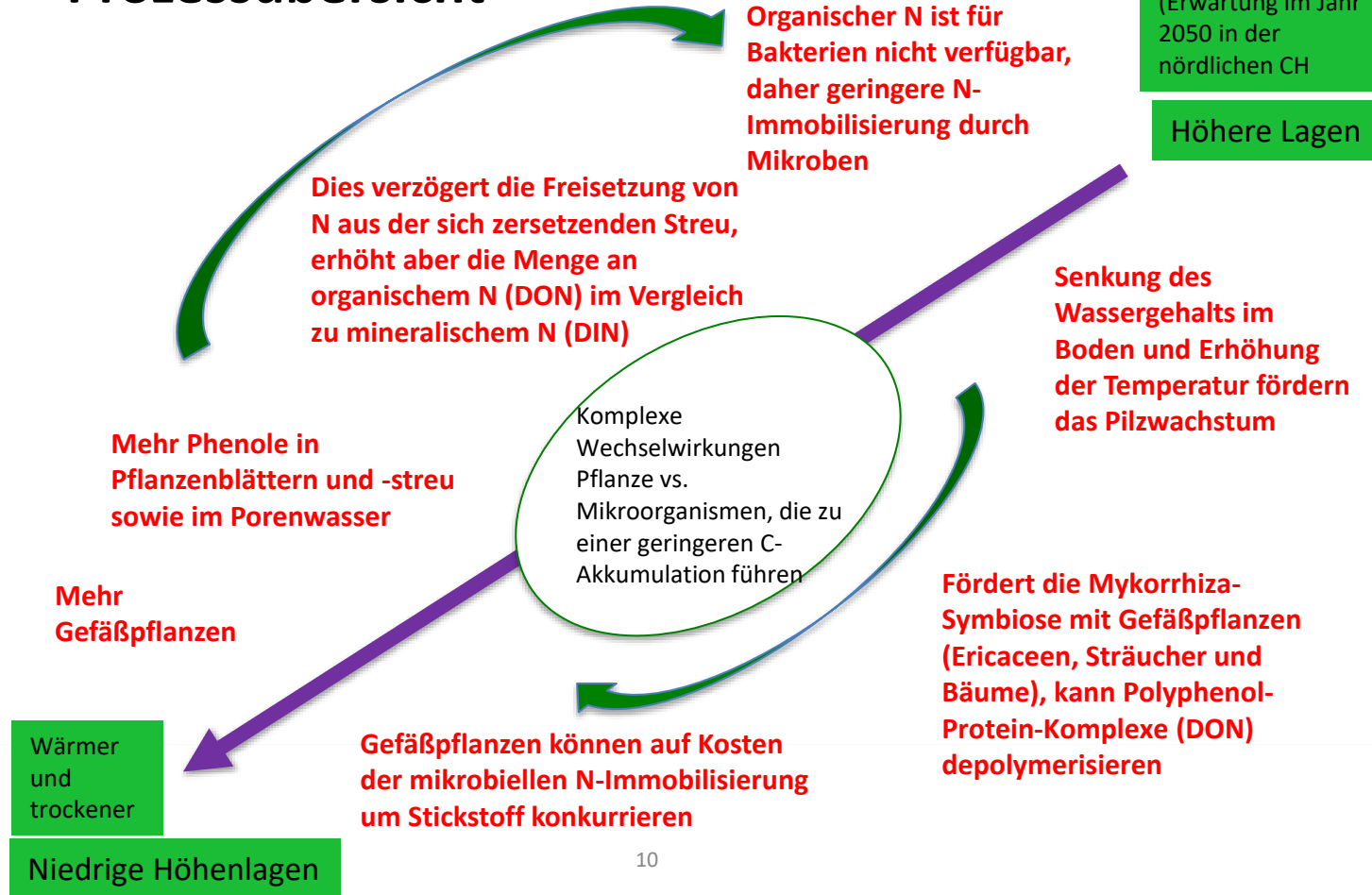


The basic unit:
Phenol



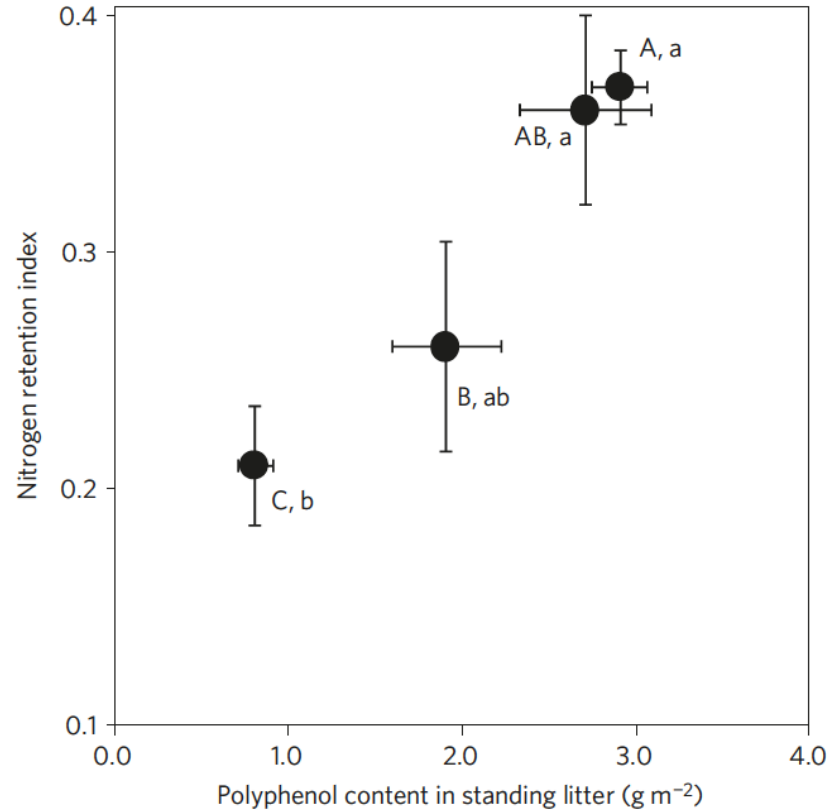
Example of a complex polyphenol: Lignin

Prozessübersicht

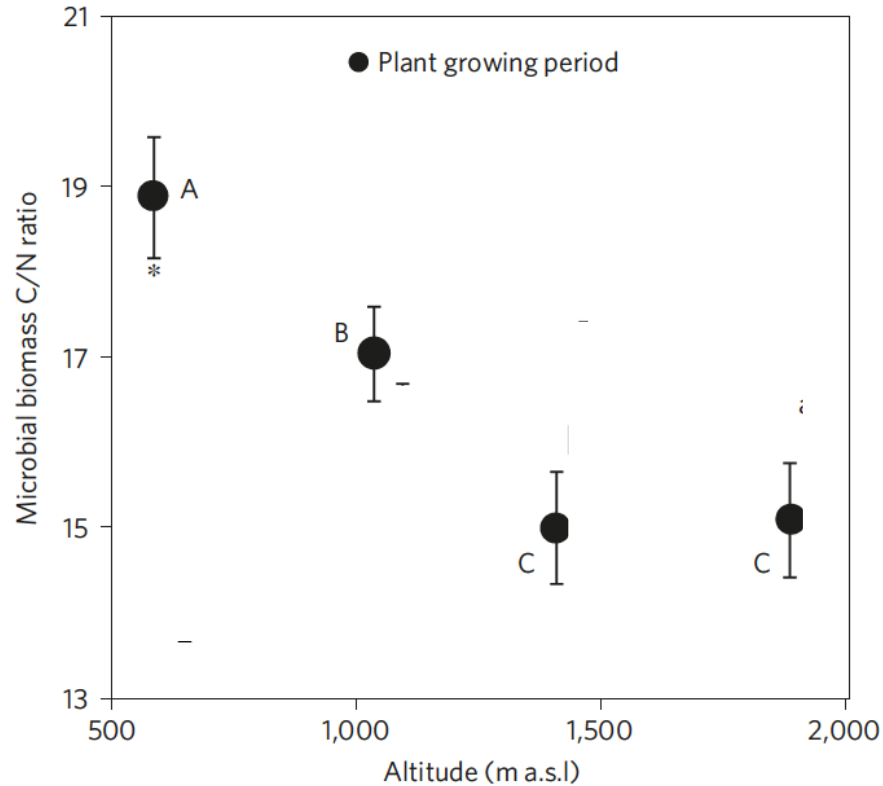


N retention during litter decomposition

Ratio of N
content in
standing litter
to tissue N
content in
above-ground
plant biomass



Nutrient content in microbial biomass (C/N ratio)

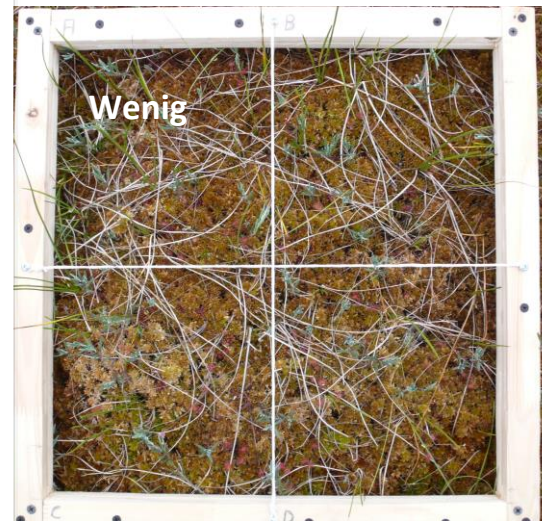
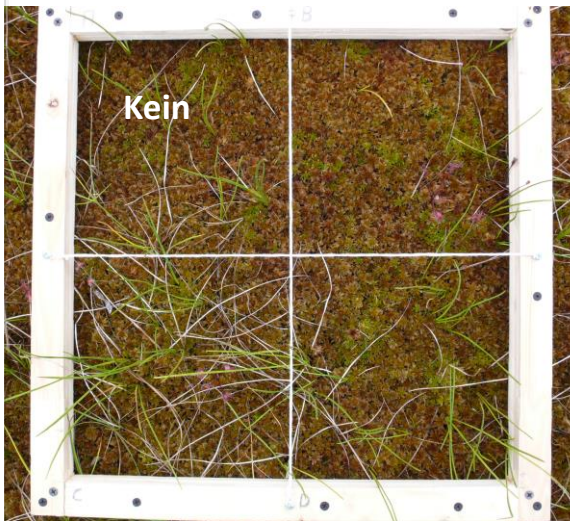


Part II : Latitudinal gradient accross Europe

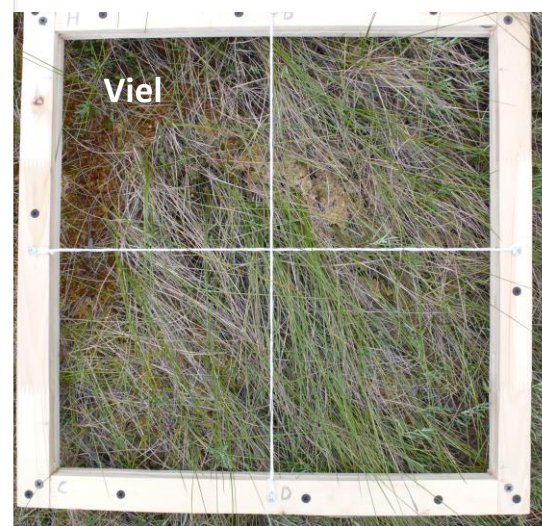
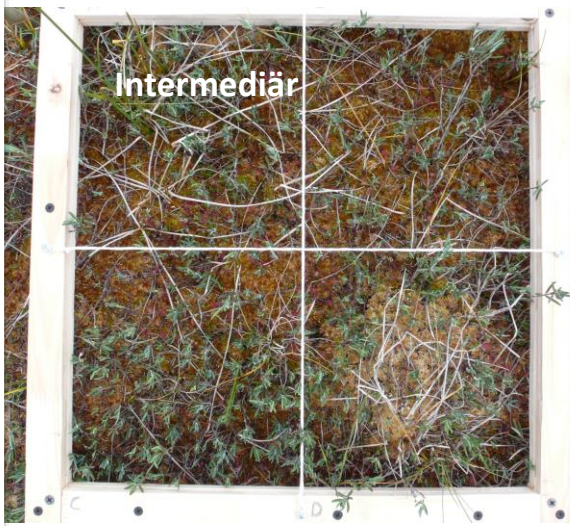


Biogeochemical pattern along increasing ericoid shrubs encroachment in three peatlands across Europe

Alexandre Buttler^{1,2,3}, Luca Bragazza⁴, Fatima Laggoun^{5,6,7}, Sebastien Gogo^{5,6,7,8},
Marie-Laure Toussaint⁹, Mariusz Lamentowicz¹⁰, Bogdan H. Chojnicki¹¹, Michał
Słowiński¹², Małgorzata Zielińska Neumann¹⁰, Elena Lapshina¹³, Daniel Gilbert⁹,
Rodolphe Schlaepfer^{1,3}, Vincent E.J. Jassey¹⁴



Gradient of
increasing
cover of
*Andromeda
polifolia*

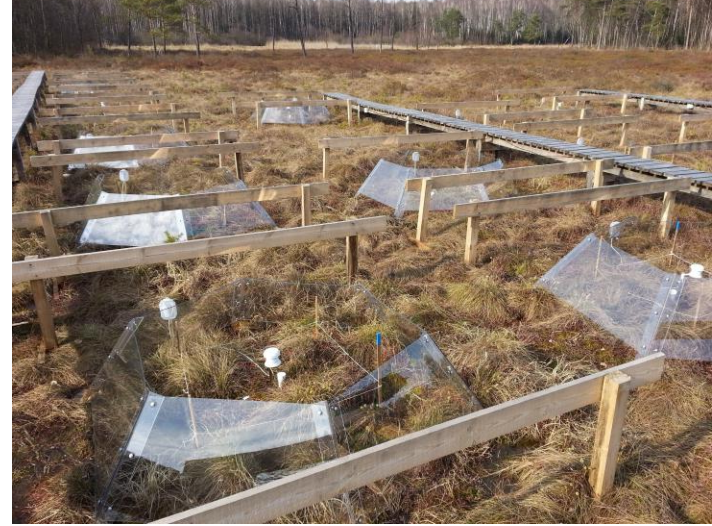


50x50 cm
plots
categorised
using plant
abundance
analysis
based on
images

Mukhrino UNESCO field site in Siberia
(ClimireSiber Interact Project)



Linje field site in Poland
(CLIMPEAT Swiss-Poland project)

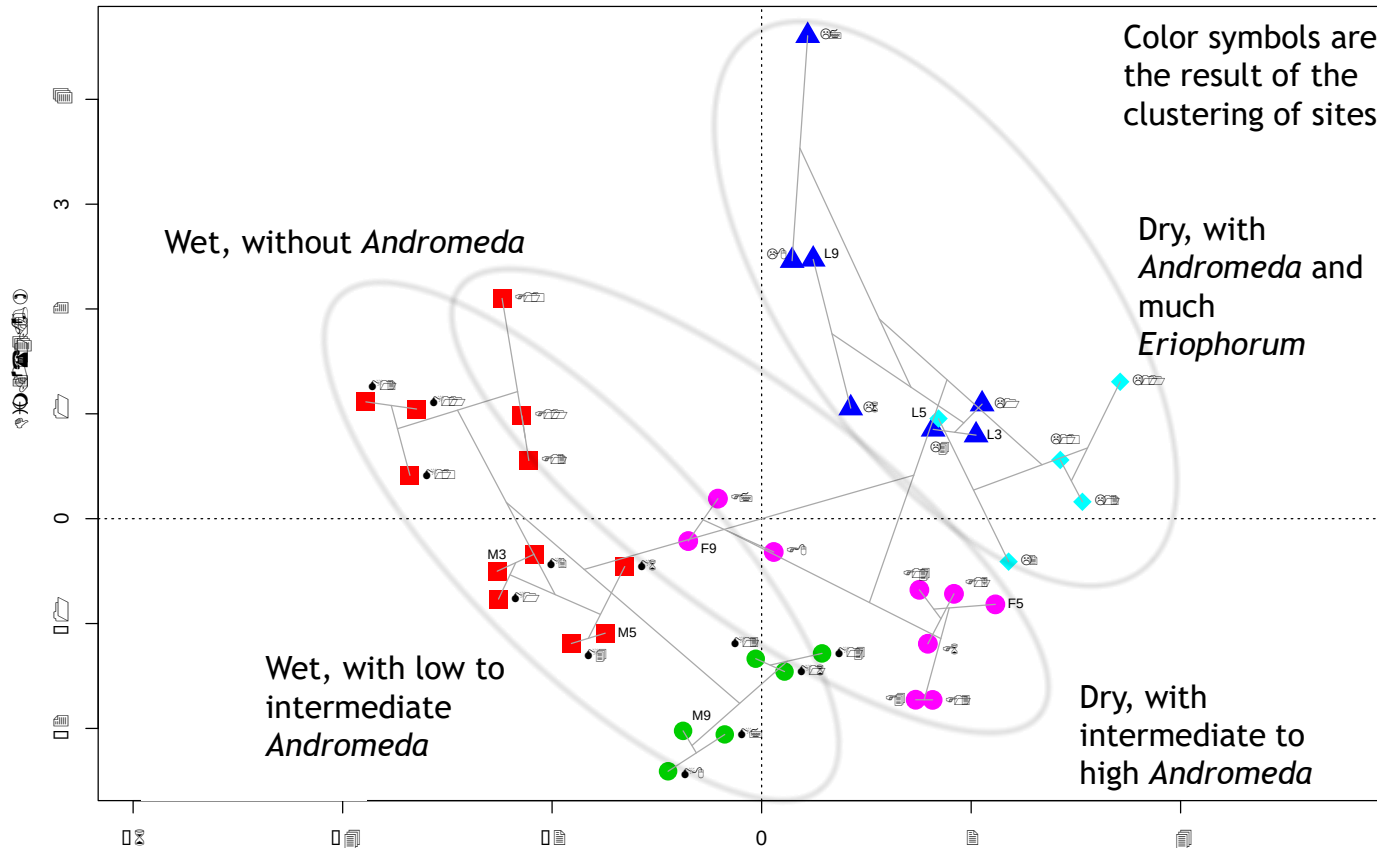


Open Top Chambers (OTC)
warming and drying
experiments

Forbonnet, Frasne field site in France
(French ANR PEATWARM project)



MFA analysis (factorial map of sites)



MFA analysis (factorial analysis of groups of biogeographical variables)

Legend:

- Biomass of vascular plants and litter (red)
- Pore water chemistry (green)
- Enzymes activities in peat (blue)
- Microorganisms in *Sphagnum* mosses (magenta)
- Phenols in vascular plants and litter (orange)
- Plant frequencies (grey)

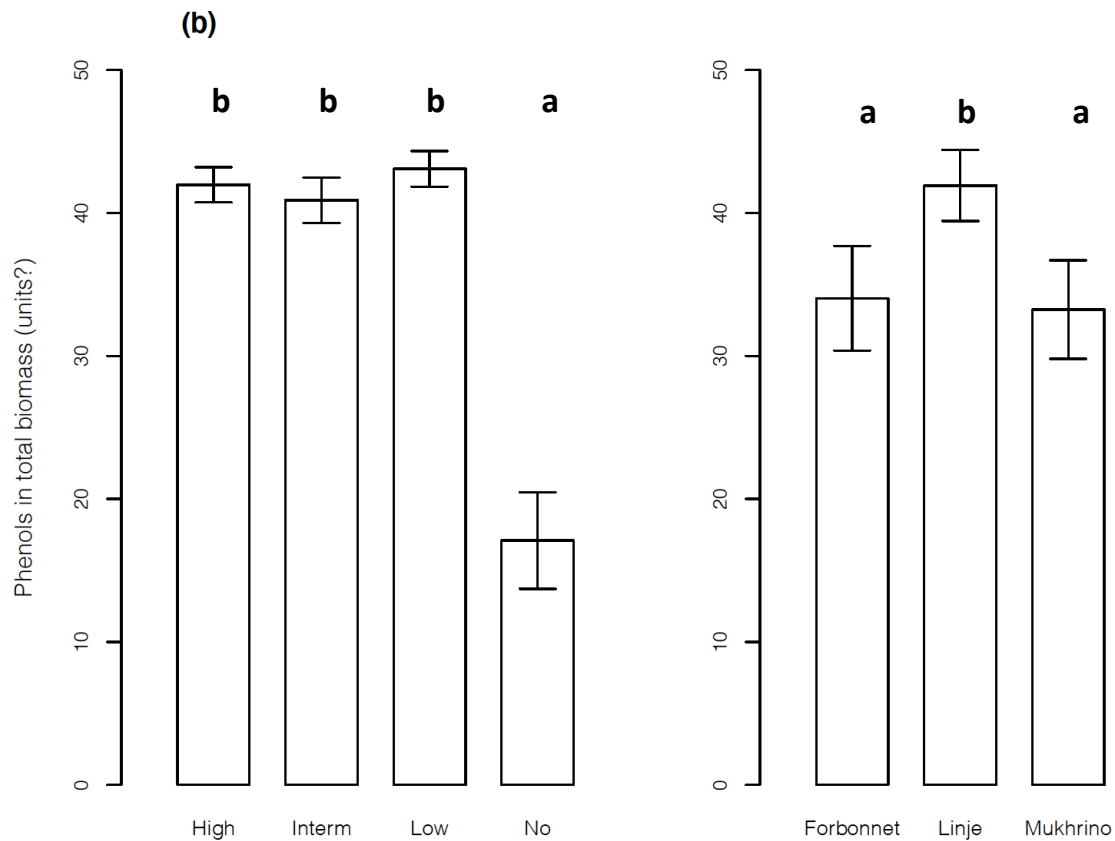
Species and Variables shown in the plot:

- Sphagnum balticum* + fallax
- Carex limosa*
- Eriophorum angustifolium*
- Scheuchzeria palustris*
- Carex rostrata*
- Ledum palustre*
- Betula nana*
- Eriophorum vaginatum*
- Vaccinium oxycoccus*
- Calluna vulgaris*
- Andromeda polifolia*
- Sphagnum magellanicum*
- Drosera rotundifolia*

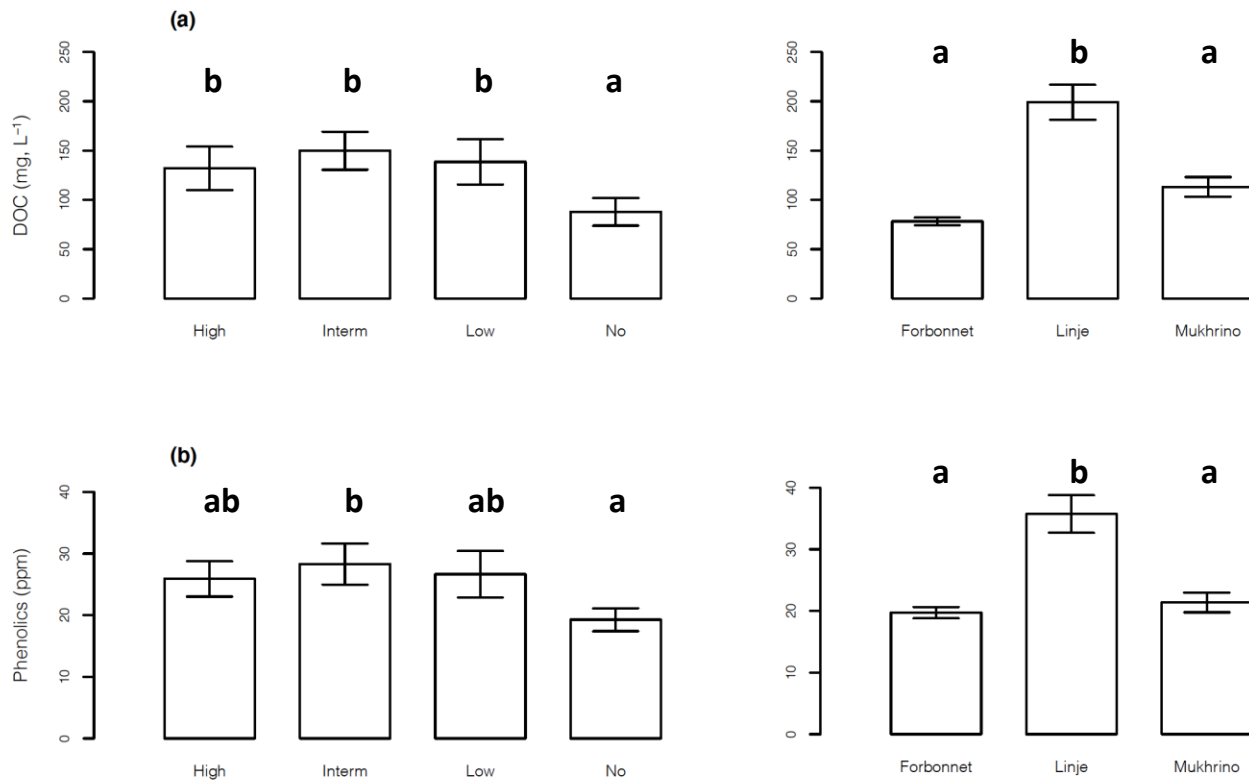
Variables and Parameters shown in the plot:

- Leucine-aminopeptidase
- β -glucosidase
- Acetyl-glucosidase
- ONIN
- Rotifers
- Cyanobacteria
- PO4
- Phenols in vascular plants litter
- Phenolics
- DOC
- NO2
- NO3
- Conductivity
- Total vascular plants biomass
- Phenols in vascular plants biomass
- Litter of vascular plants
- Fungi
- Nematodes
- Microalgae
- Acid phosphatase
- TN
- pH
- NH4
- Testate amoebae
- Ciliates
- E2,E3
- E4,E6

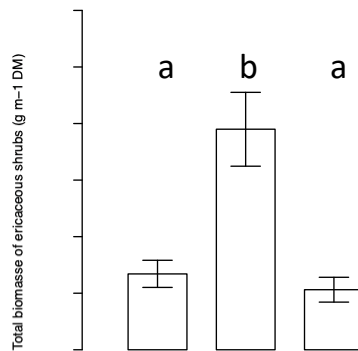
Phenols in total biomass of vascular plants



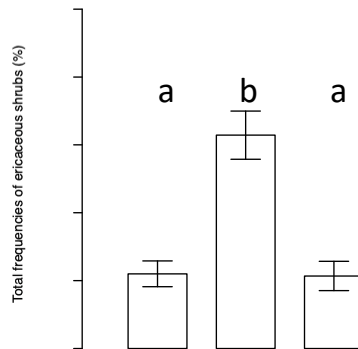
Phenolics and DOC in pore-water



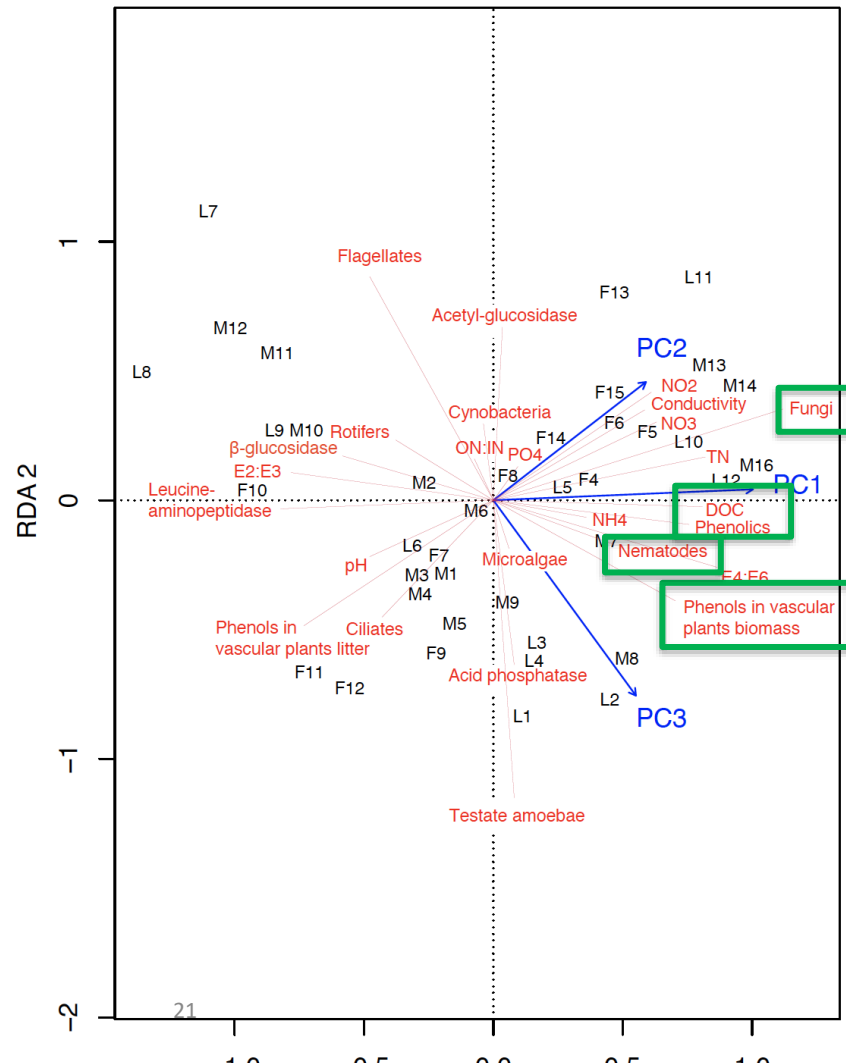
Linje has significantly more ericaceous shrubs (other than *Andromeda*) ...



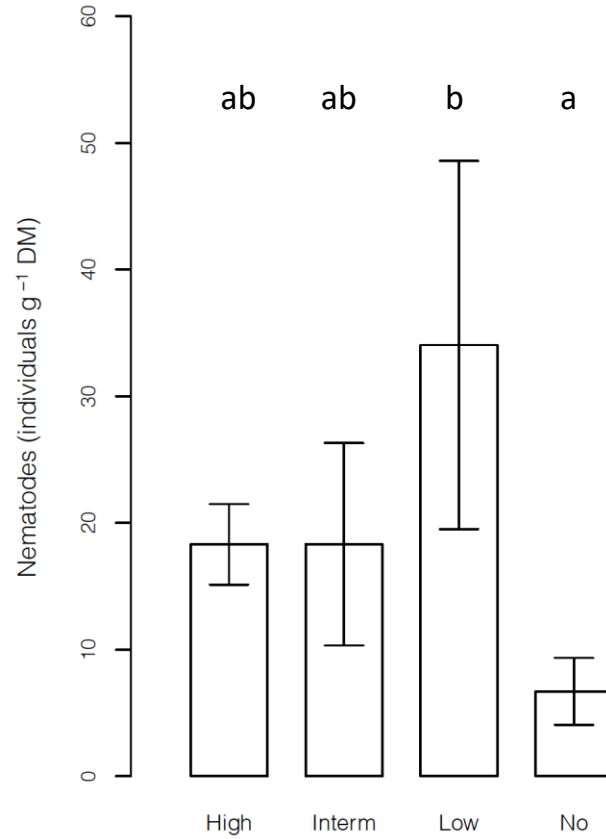
therefore it is wise to remove the effect of the general climate so as to be able to focus on the *Andromeda* gradient only, across all sites



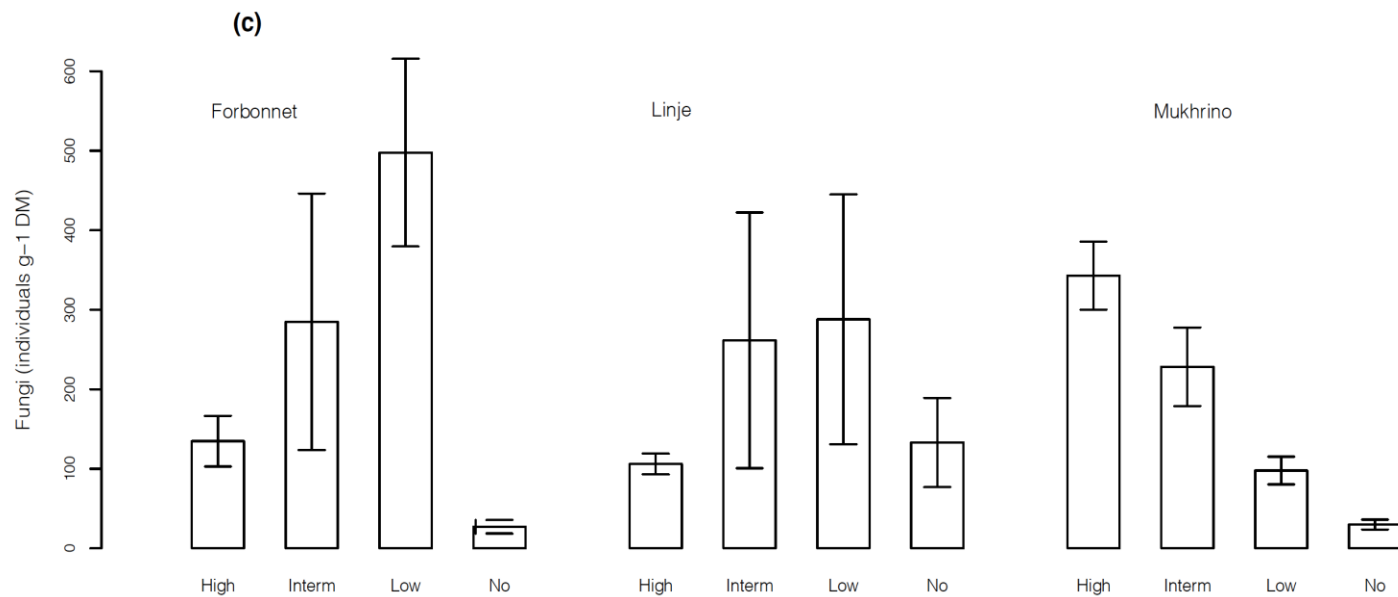
Redundancy analysis (RDA) of biogeochemical variables explained by the vegetation gradient (PCA axes), after having removed the effect of the general climate



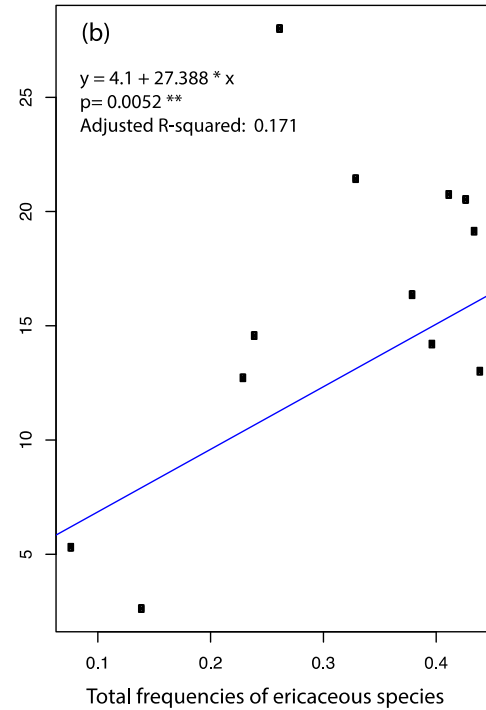
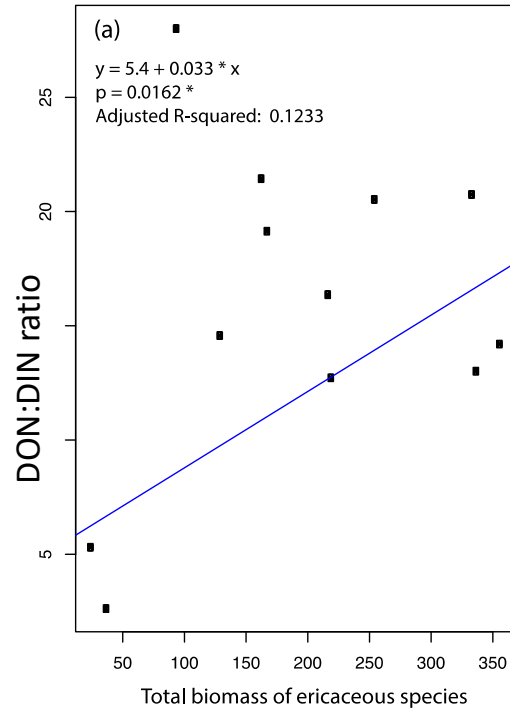
Nematodes



Fungi



Relationship between DON:DIN and ericaceous species in Linje



DON = dissolved organic N
DIN = dissolved inorganic N

Allgemeine Schlussfolgerung

- Mehr Gefäßpflanzen, insbesondere Ericaceen Sträucher, bestrafen nicht nur die *Sphagnum* Moosen, indem sie sie unterdrücken, sondern verursachen auch irreparable Veränderungen im Boden
- Einerseits sichern sich diese Gefäßpflanzen einen Vorteil durch die Qualität ihrer Streu (Phenols) und ihre Fähigkeit zur Mykorrhiza-Symbiose
- Andererseits setzen Gefäßpflanzen mehr Rhizodeposition frei (labiles OM, Zucker), was die mikrobielle Aktivität und die Zersetzung von frischem OM stimuliert (Arbeiten von Jassey et al., Global Change Biology, 2018)
- Auch Priming-Effekt bei alten OM wird möglich (Arbeiten von Gavazov et al, Global Change Biology, 2018)

Schlussfolgerung für die Praxis

- Erwärmung von Torfmooren erhöht das Feinwurzelwachstum stark (PNAS, 2020)
- Positive Wechselwirkungen zwischen Sträuchern und Bäumen erleichtern das Eindringen von Gehölzen in borealen Moorgebieten (J. Ecology, 2015)
- Sorgen um die Entwicklung der Sträucher

Vielen Dank für Ihre Aufmerksamkeit