Achievement Report of RJE-3 Program

Popova Diana
ポポワ デイアナ
North-Eastern Federal University
Graduate School of Environmental Science
Sugimoto's Lab

Research Topic: Arctic plant

At Hokkaido University I learned "Arctic ecosystem":

- Effect of global warming;
- Material cycling, using stable Isotope ratios.

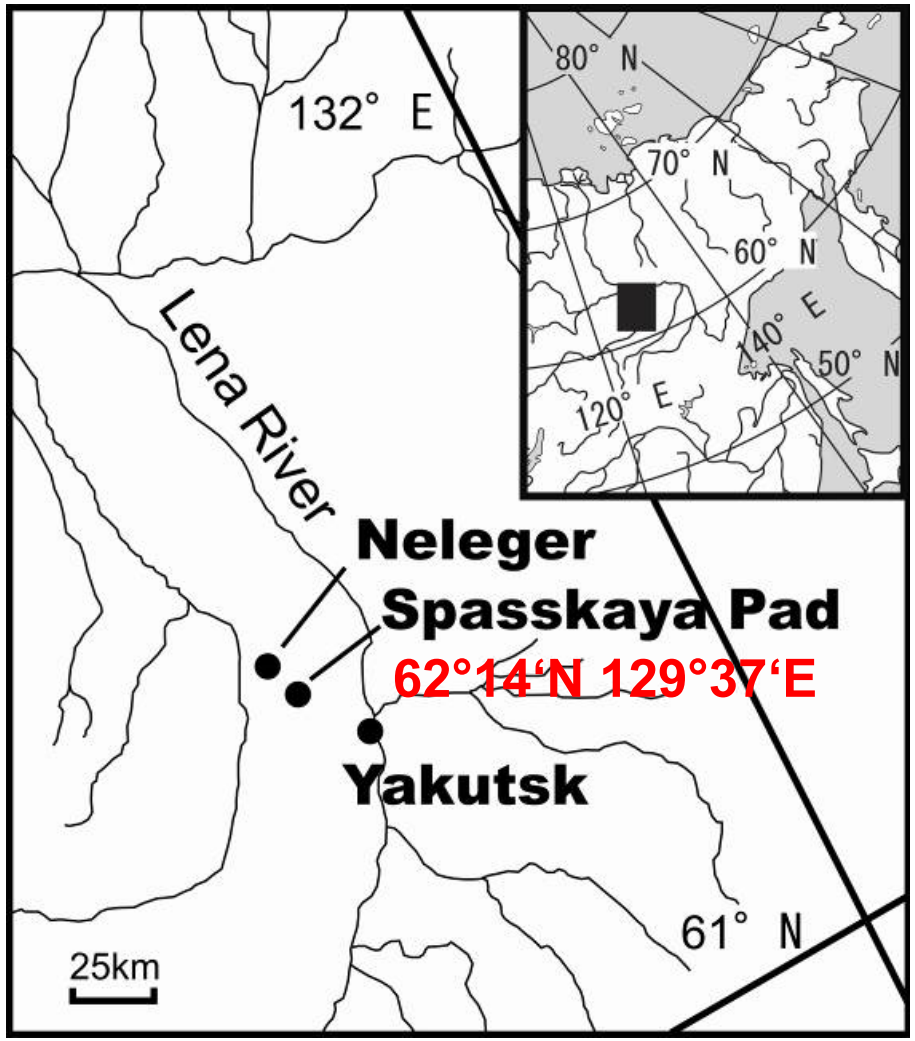
What I did:

- Laboratory short course on stable Isotopes;
- Presentation in Isotope Seminar Reading and introduce paper "Deeper snow alters soil nutrient availability and leaf nutrient status in high Arctic tundra" [Philipp R. Semenchuk et al. 2015, Biogeochemistry];
- Mini research work: N availability at two forest types in Eastern Siberia Taiga.

Mini research work: "N availability at two forest types in Eastern Siberia Taiga"

Purpose: To know N dynamics in two typical forest type (Larch forest and Pine forest)

Study site: Experimental forest station "Spasskaya Pad"



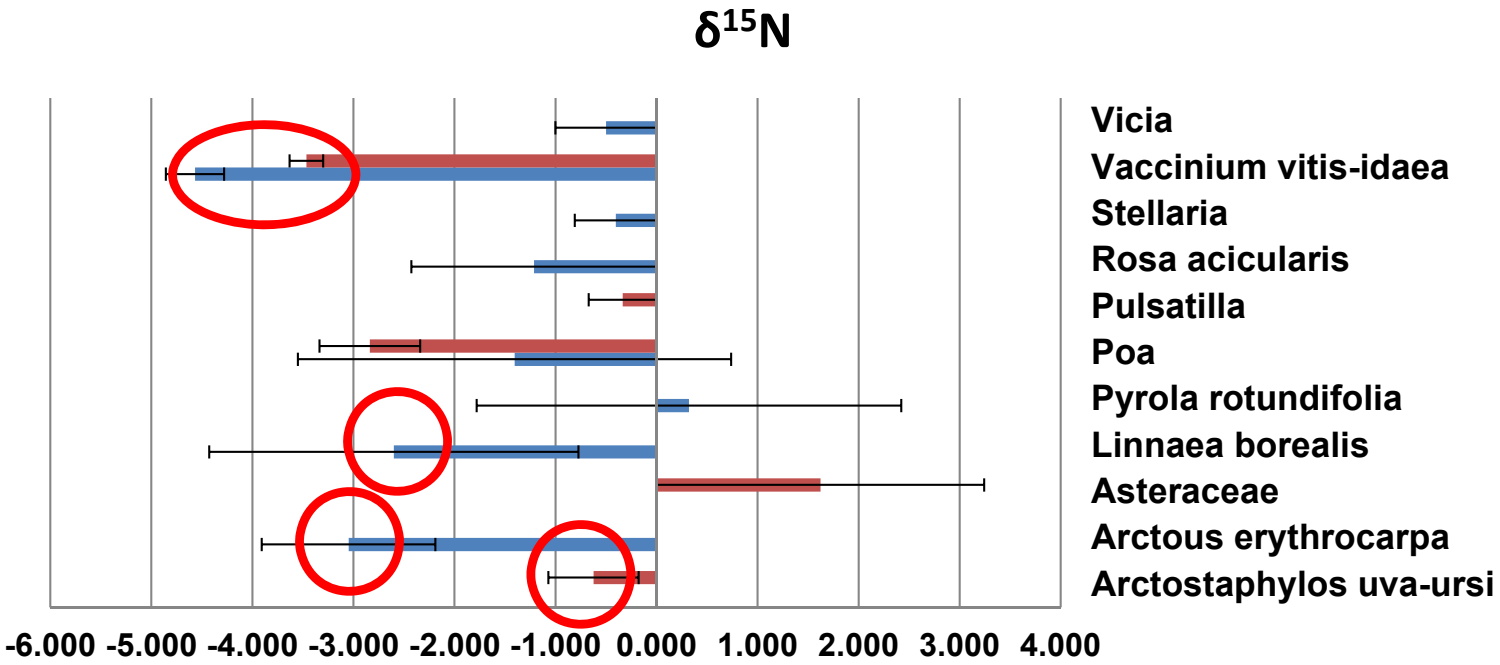
- **Climate zone:** subarctic;
- **Permafrost:** continuous;
- **Mean annual temperature:** (- 9.3°C);
- **Mean temperature in February:** (- 40°C) (January);
- **Mean temperature in July:** (19°C);
- **Mean annual wind speed:** 1.8 m/s;
- **Dominant wind direction:** WNW;
- **Total annual precipitation:** 238 mm;
- **Precipitation type:** rain, snow;
- **Ice break up:** lake (June), river (May-June).

Methods: Comparison of leaf **N** content and **$\delta^{15}N$** ($^{15}N/^{14}N$)

Larch forest and Pine forest

Materials and methods: Sampling procedures and equipment

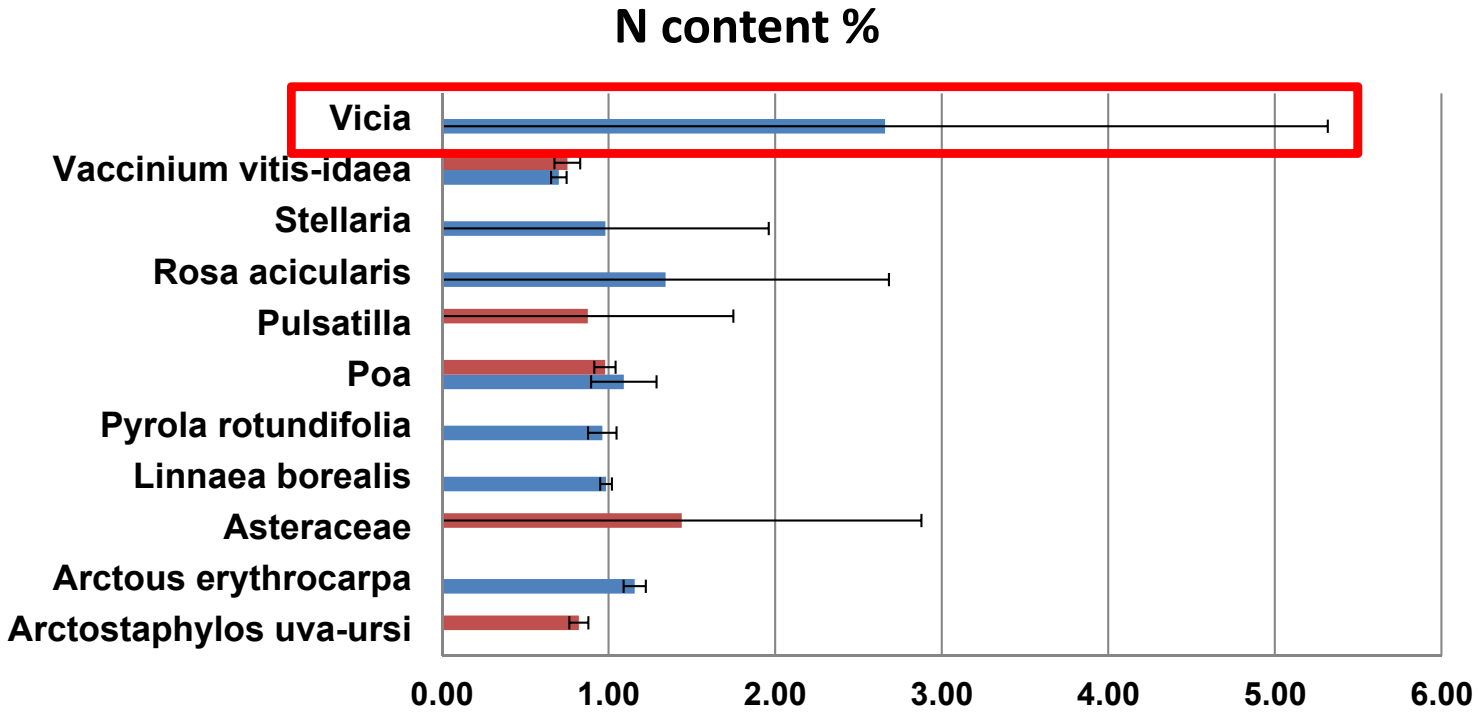
Results: $\delta^{15}N$ and N content % in Pine and Larch forests



Shrubs showed:

- low $\delta^{15}N$

→symbiotic fungi plays an important role for N acquisition.



Pine

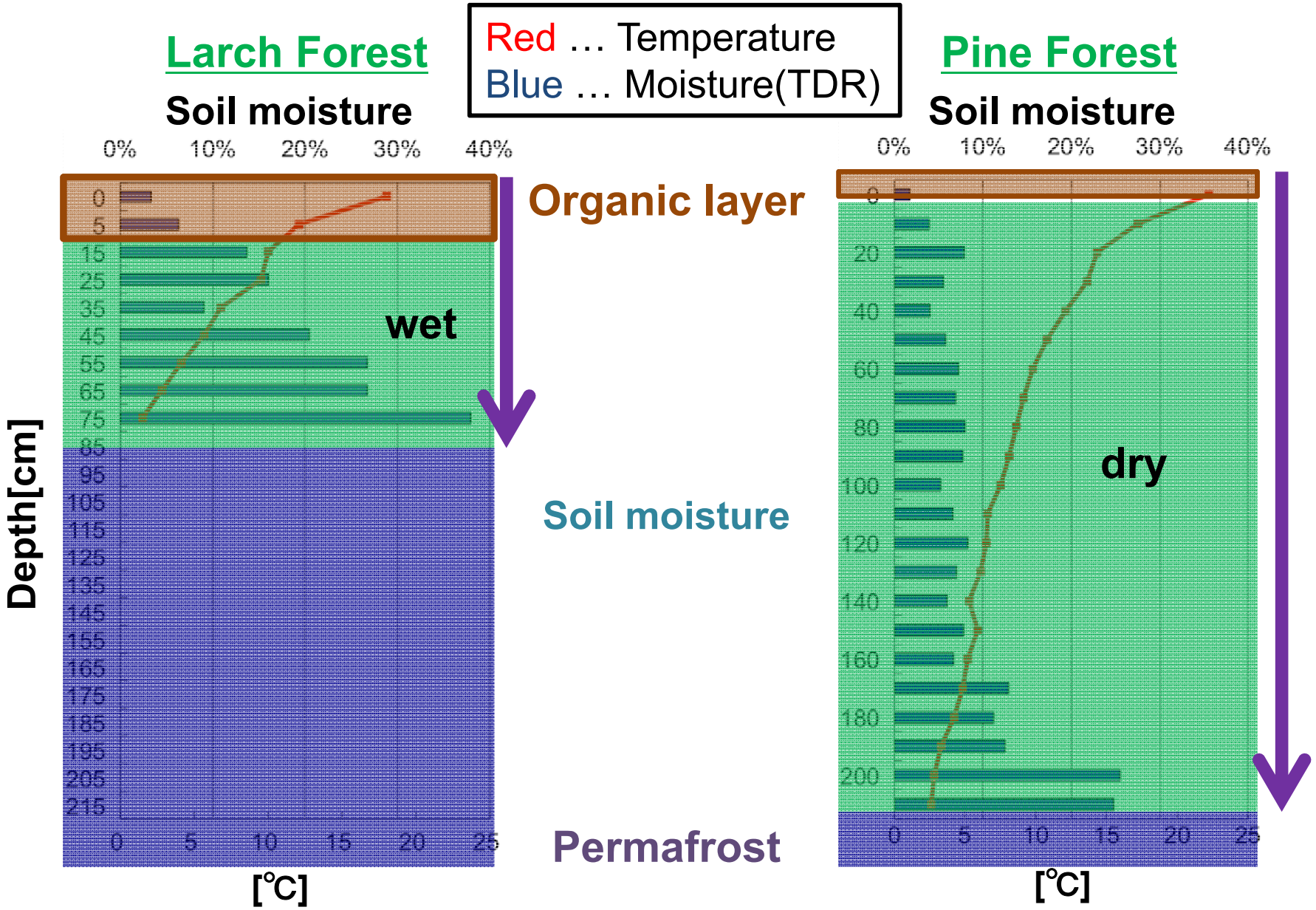
Larch

Vicia showed:

- high leaf N content

→uptake N from Atmosphere.

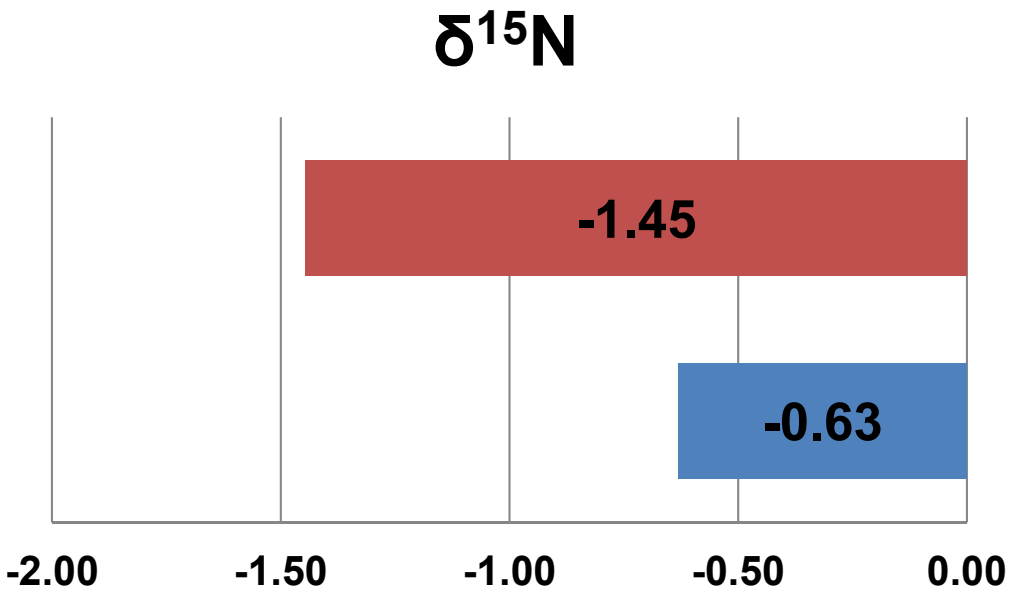
Results: Soil profiles of Larch and Pine forest

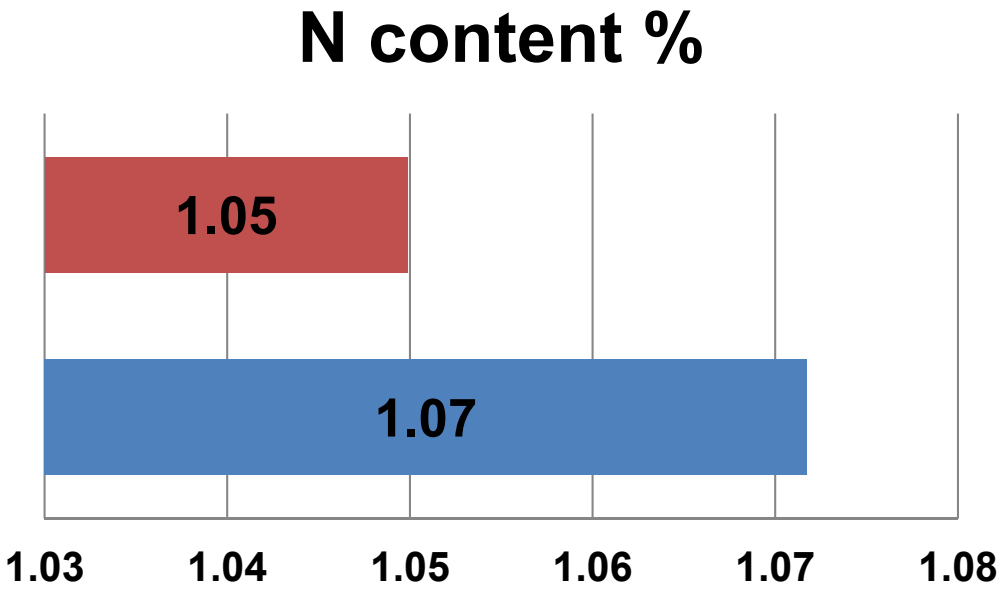


- **Temperature depends on soil moisture.**
- **The deeper soil is, the wetter and colder it is.**

[Data from RJE-3 Summer school Group A]

Discussion: $\delta^{15}N$ and N content % in Pine and Larch forests





Pine

Larch

Excluding: *Vicia* and shrubs.

$\delta^{15}N$
Larch>Pine

N content %
Larch>Pine

Discussion: Inorganic N pool in Pine and Larch forests

Larch Forest

Organic matter

N cycle
(NH_4^+)
(NO_3^-)

Pine Forest

N cycle
(NH_4^+)
(NO_3^-)

Conclusion of mini research work

- Diversity of vegetation: Larch>Pine
- **Soil moisture:** Larch>Pine
- **$\delta^{15}N$:** Larch>Pine
- **Leaf N content:** Larch>Pine
- **N** storage in the soil has important role for **N** availability.

Seminar on "Deeper snow alters soil nutrient availability and leaf nutrient status in high Arctic tundra"
Philipp R. Semenchuk, Bo Elberling, Cecilie Amtorp et al.
(2015, Biogeochemistry)

Introduction: Carbon cycle and Nitrogen in Arctic ecosystem

Current Arctic condition:

Low nutrient availability

- low primary production

Under warming climate:

Nutrient availability will increase

- faster plants growth
- more C uptake

More Litter production

More decomposition (respiration)

Introduction: Purpose

To test the hypothesis:

Deeper snow → Warmer cold-season soil conditions

→ More N availability in the soil

→ High litter quality (high N content)

→ More growth of plant (more C uptake)

Objectives: ***Snow manipulation experiment and Measurement***

Soil inorganic N pool (NH_4^+, NO_3^-)

Total dissolved organic carbon (DOC)

Total dissolved organic nitrogen (TON)

Plant C, N, $\delta^{15}N$ and chlorophyll content in *Salix polaris* leaves

Leaf sizes of *Salix, Bistorta vivipara*, and *Luzula arcuata* at peak season.

After 6 years snow manipulation

Materials and methods: Study site

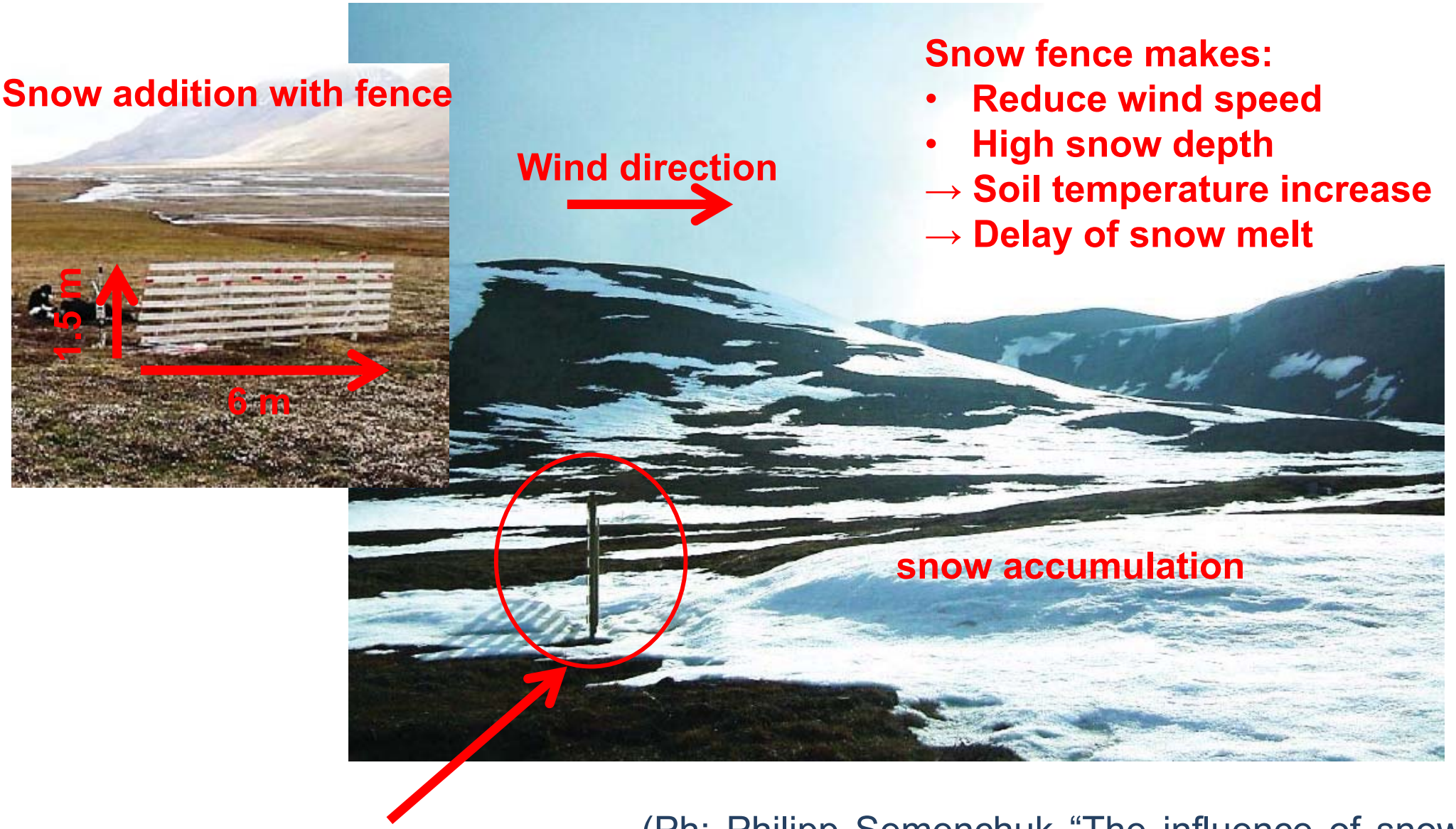
Svalbard, Adventdalen

- **Soil** development poor
- **Permafrost:** active layer depth 80-100 cm
- **Mean Temperature:**
  - July (+6.4˚C)
  - March (-13.7˚C)
- **Annual precipitation:** 190 mm (120 mm in snow)
- **Winter wind direction** – SE

(Morgner et al. 2010)

Materials and methods: Experimental setup and design

Snow manipulation experiment



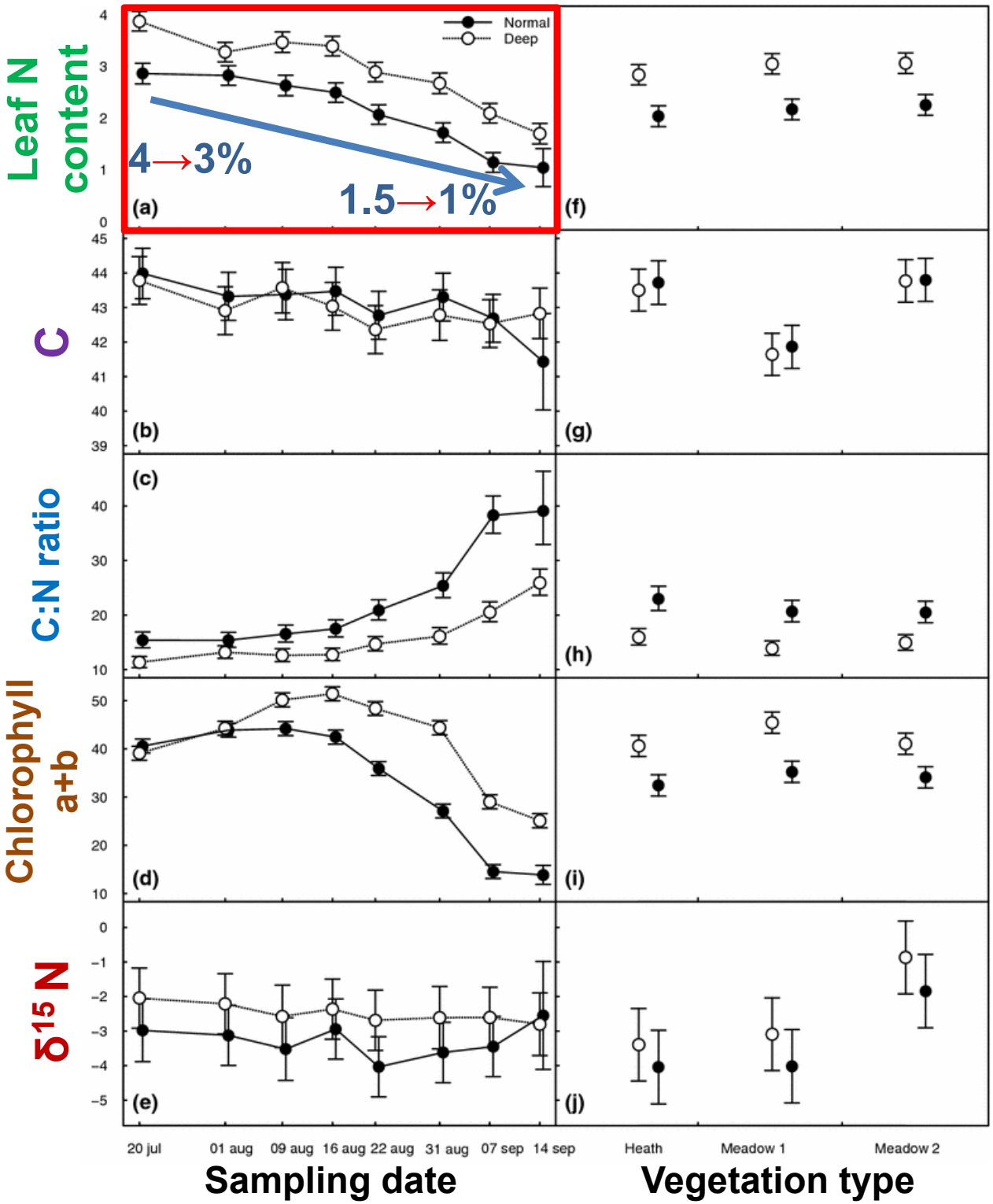
(Ph: Philipp Semenchuk "The influence of snow cover and cold-season temperatures on growing-season processes" 2013)

Materials and methods: Experimental setup and design

Two snow depth regimes were compared:

- ***Normal*** *snow(control) plots, without fence* (ambient unmanipulated snow cover 10–35 cm);
- ***Deep*** *snow plots, using snow fence* (experimentally increased snow cover approximately 150 cm deep, 3–12 m behind fences), in eight replicates.

After 6 years snow manipulation. Then measurement conducted.



Results and Discussion:
S. Polaris leaf chemistry

Normal

Deep

Leaf N content:

Deep **>**Normal

Deep snow pack

↓

High soil temperature in cold-season

↓

Enhancement decomposition of Organic matter

↓

More **NH_4^+** produced

↓

Increase in **N** availability

Conclusion

Multi-year increased snow depth:

- Lead N availability increased;
- Through warming soil temperature in winter;
- Increase in plant N content;

Future studies seem crucial to verify to which extent an increased N cycling can be linked to the C cycle.

Conclusion: How would I use my results/experience?

- Similar study site (Arctic ecosystem):
  - same species diversity;
  - climate condition;
  - influence of global warming.
- In Sugimoto's Lab I more depth understood about global warming and stable Isotope etc.

Thank you for attention!!!

ご清聴ありがとうございました