Morphological changes and physiological acclimation alter the photosynthetic responses to temperature in three-year-old grassland communities of different species richness under experimental warming

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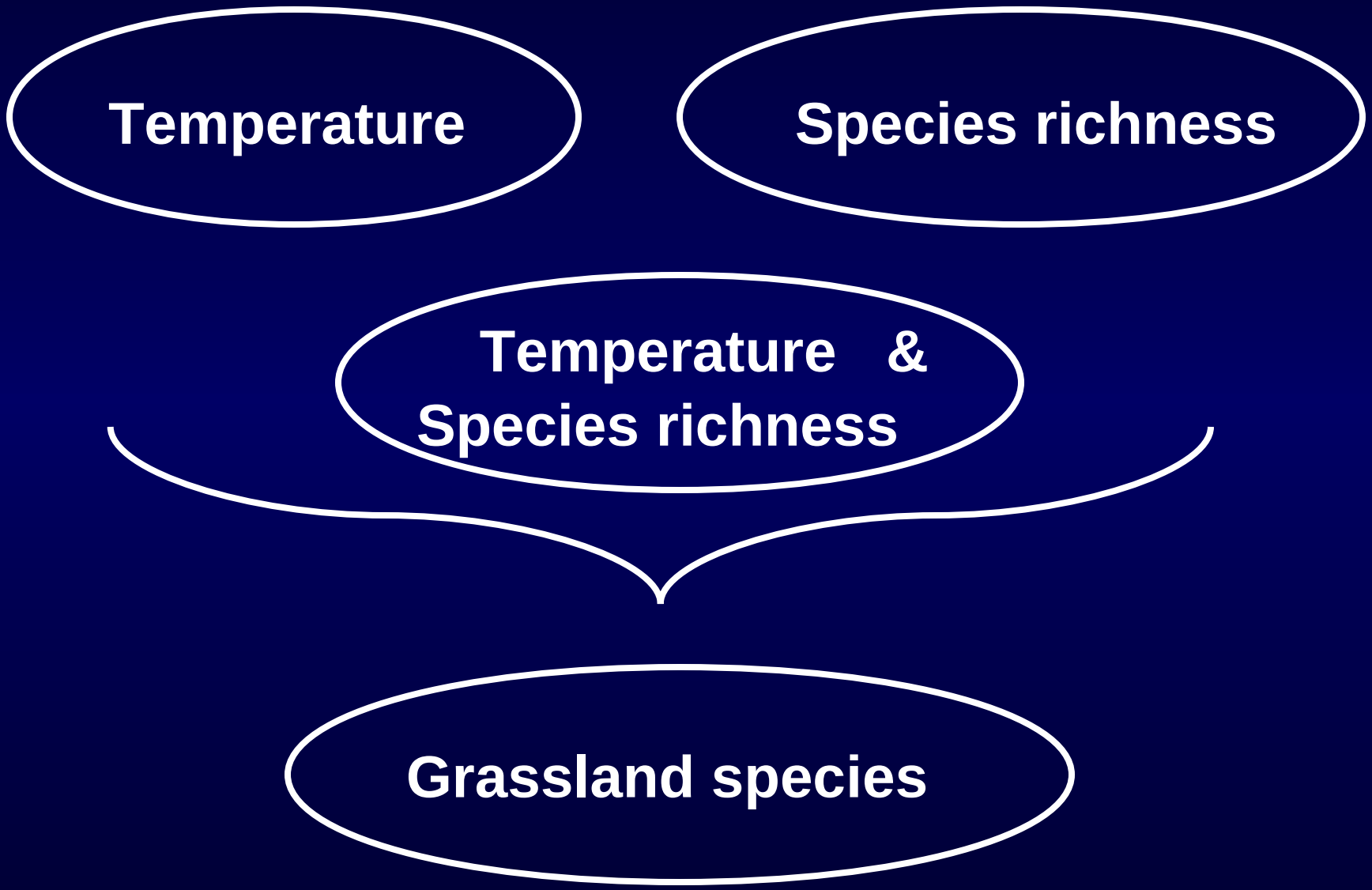
Outline

- Introduction
- Material & Methods
  - Experimental setup
  - Measurements
- Results
- Conclusions


Temperature
Species richness
Temperature & Species richness
Grassland species

12 sunlit,

climate-controlled chambers

2 temperature treatments

6 chambers -> ambient T_{air} (unheated chambers)

6 chambers -> T_{air} + 3 °C (heated chambers)

3 species richness (S) levels

S = 1
S = 3
S = 9
bare soil

24

30 individuals per pot

planted in a hexagonal grid

N-fixers

Trifolium repens L.

Medicago sativa L.

Lotus corniculatus L.

Grasses

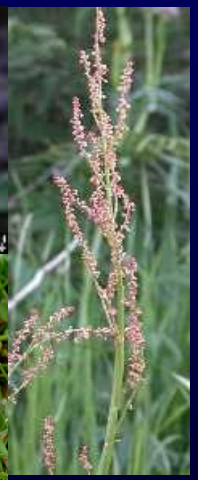
Lolium perenne L.

Festuca arundinacea Schreb.

Dactylis glomerata L.

Non-N-fixers

Plantago lanceolata L.



Rumex acetosa L.

Bellis perennis L.

Physiological acclimation, morphological & biochemical changes

- **Physiological acclimation**: shifts of T_{opt} & P_{sat} (Gunderson et al. 2000)

- **Morphological changes**: leaf size and thickness (Lichtenthaler 1996; Atkin et al. 2006)

- **Biochemical changes**: N & C concentrations (Lichtenthaler 1996; Loveys et al. 2002)

Physiological acclimation

Li-Cor 6400

P_{sat} measured at 7 air temperatures:

4 °C intervals between 14 & 38 °C

(14 – 18 – 22 – 26 – 30 – 34 – 38 °C)

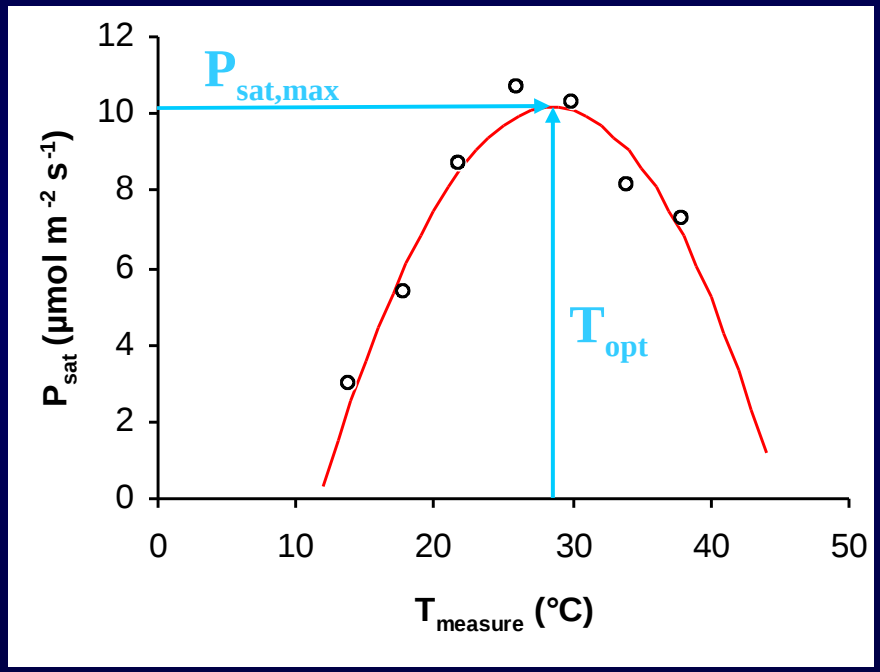
Morphological & biochemical changes

- SLA (leaf area/dry leaf mass)

Biochemical changes

- C, N, C/N
- NUE ($P_{sat,max}$/N)

Curve fitting to determine T_{opt} & $P_{sat,max}$



× 2 (temperature)

× 3 (S)

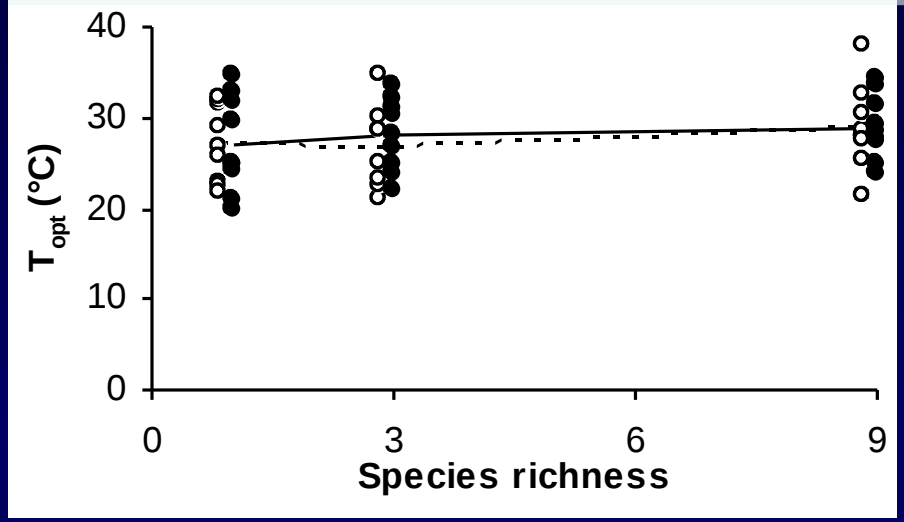
× 9 (species)

} 54 fittings

$$P_{sat} = P_1 + P_2(T_{measure} - 25) - P_3(T_{measure} - 25)^2 - P_4(T_{measure} - 25)^3$$

Kirschbuam & Farquhar 1984

○, -- Unheated ●, ▬ Heated



No T-effect:

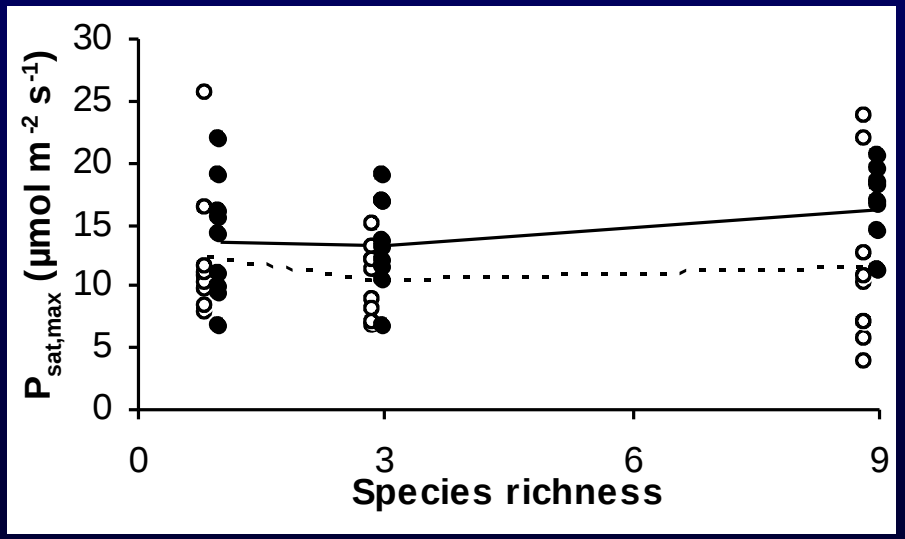
no shift in T_{opt}

No S-effect

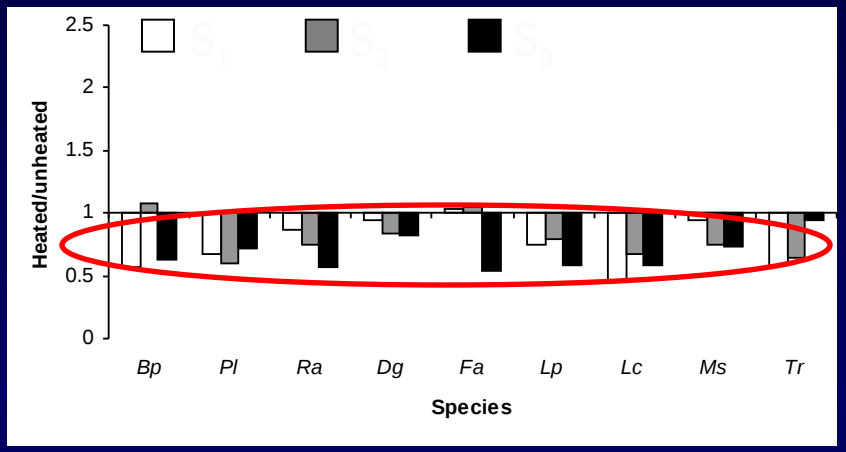
T-effect:

heated > unheated

No S-effect



SLA

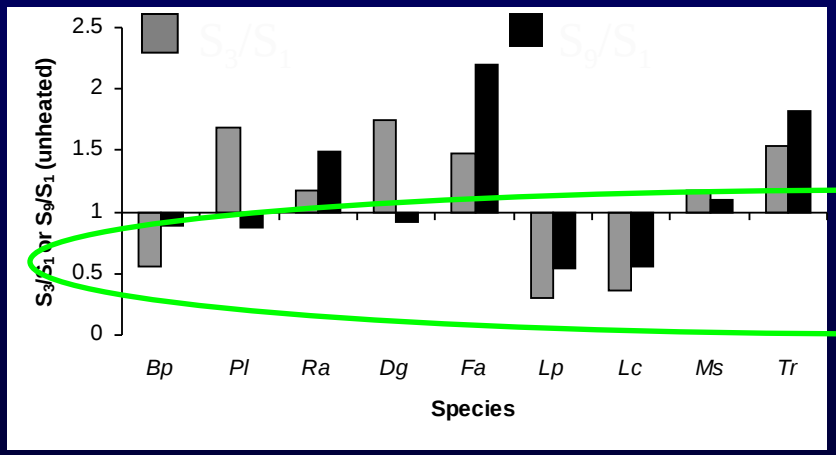


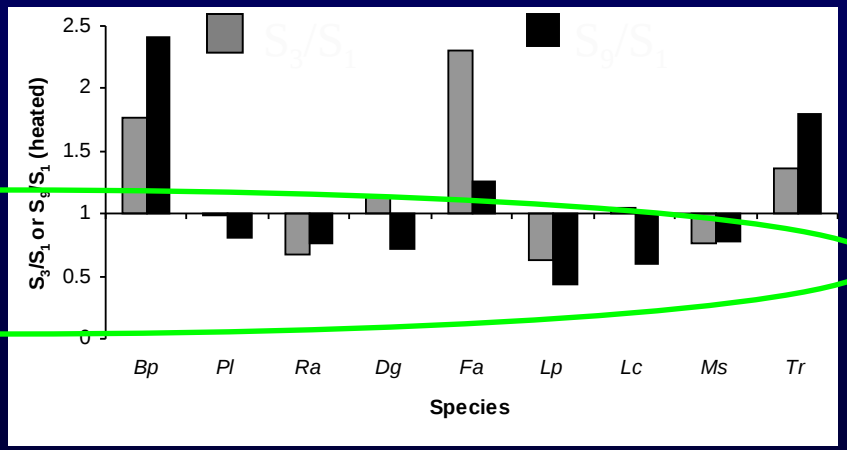
T effect:

heated < unheated

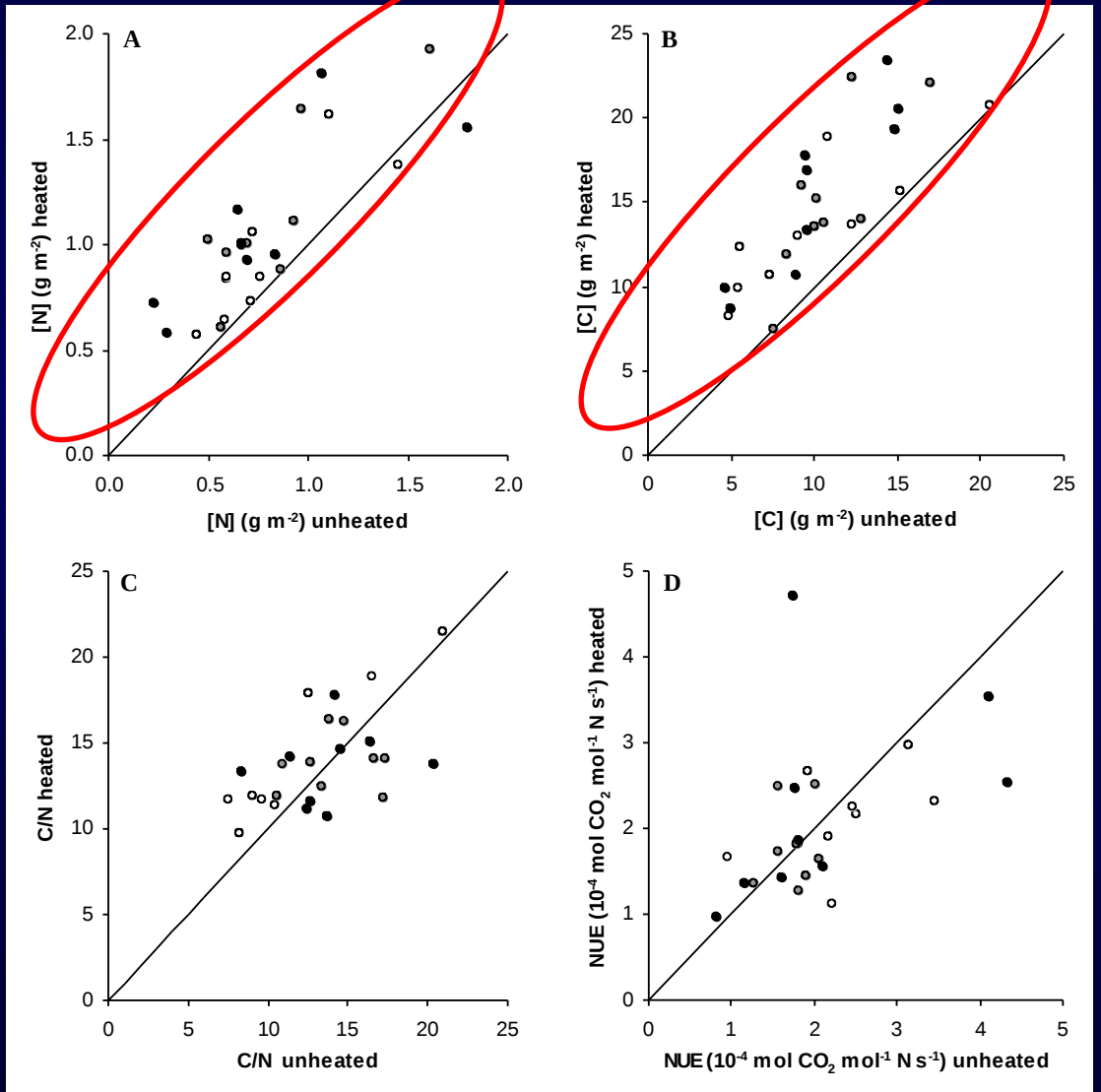
S effect:

S_3 & S_9 < S_1





C, N, C/N & NUE



S_1 S_3 S_9

T effect: on N & C

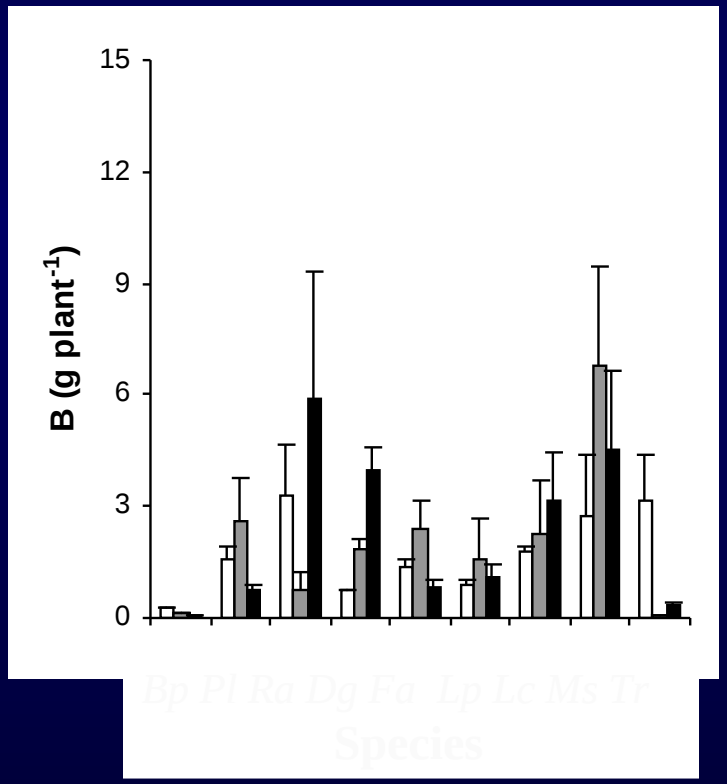
heated > unheated

No S effect

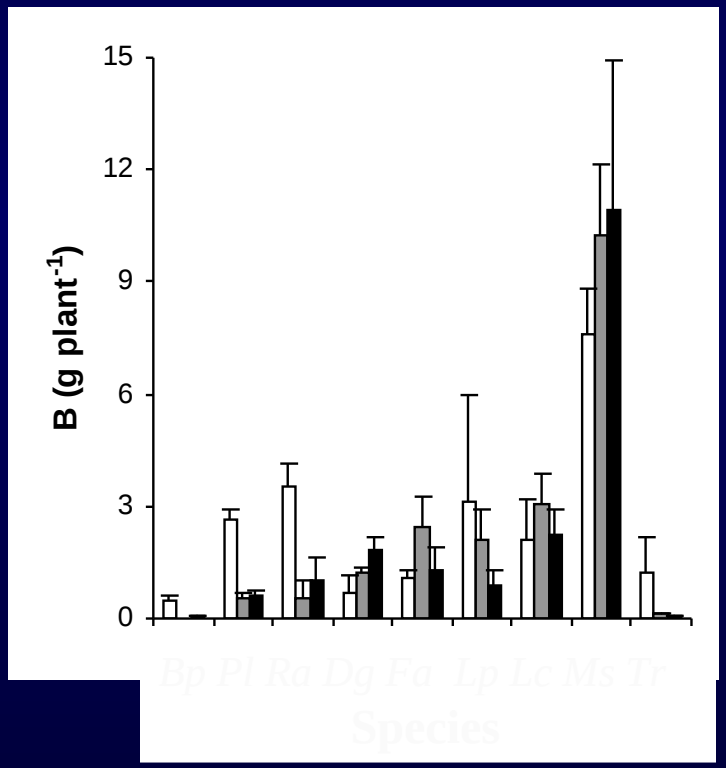
Above-ground biomass – plant level

S_1 S_3 S_9

Unheated



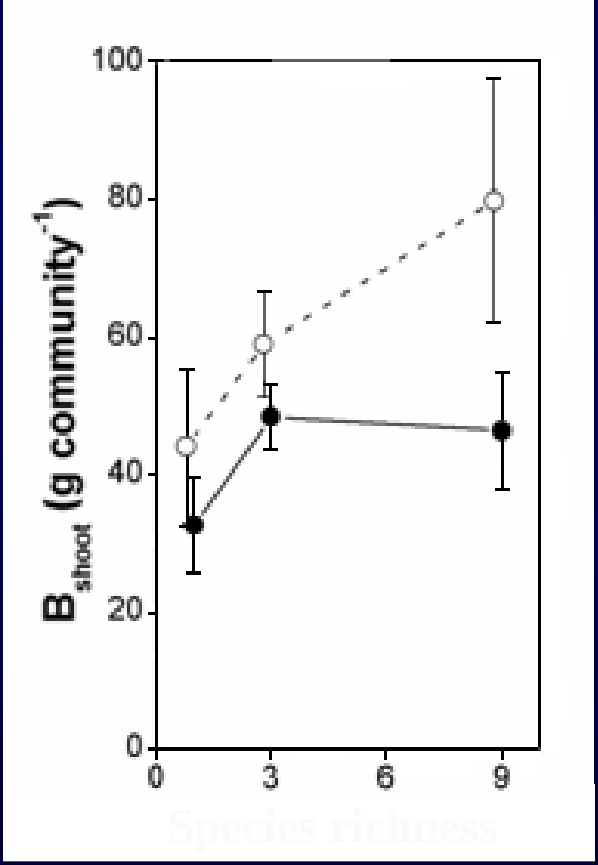
Heated



No T or S effect

Above-ground biomass – community level

○, -- Unheated ●, ▬ Heated



T effect:

heated < unheated

S effect:

S_3 & S_9 > S_1

De Boeck H.

Conclusions

- T effect - in heated chamber:

  higher P_{sat} & $P_{sat,max}$ but no shifts in T_{opt}

  higher [N] & [C] in the leaves

  reduced SLA
- S effect - at S_3 & S_9:

  higher SLA
- similar above-ground plant biomass at each T & S treatment

•Gielen et al.(2005) Grassland species will not necessarily benefit from future elevated air temperatures: a chlorophyll fluorescence approach to study autumn physiology. Physiol.Plant. 125: 52-63.

•Lemmens et al.(2006) End-of-season effects of elevated temperature on ecophysiological processes of grassland species at different species richness levels. Env.Exp.Bot. 56: 245-254.

•De Boeck et al.(2006) How do climate warming and plant species richness affect water use in experimental grasslands? Plant Soil 288: 249-261.

•Vicca et al.(2007) Effects of climate warming and declining species richness in grassland model ecosystems: acclimation of CO_2 fluxes. Biogeosciences 4: 27-36.

•De Boeck et al.(2007) Combined effects of climate warming and plant diversity loss on above- and below-ground grassland productivity. Env.Exp.Bot. 60: 95-104.

•De Boeck et al.(2007) How do climate warming and species richness affect CO_2 fluxes in experimental grasslands? New Phytol. in press.