Waldbau
Silviculture

温带森林幼林中树种多样性对地下根系生产力的影响

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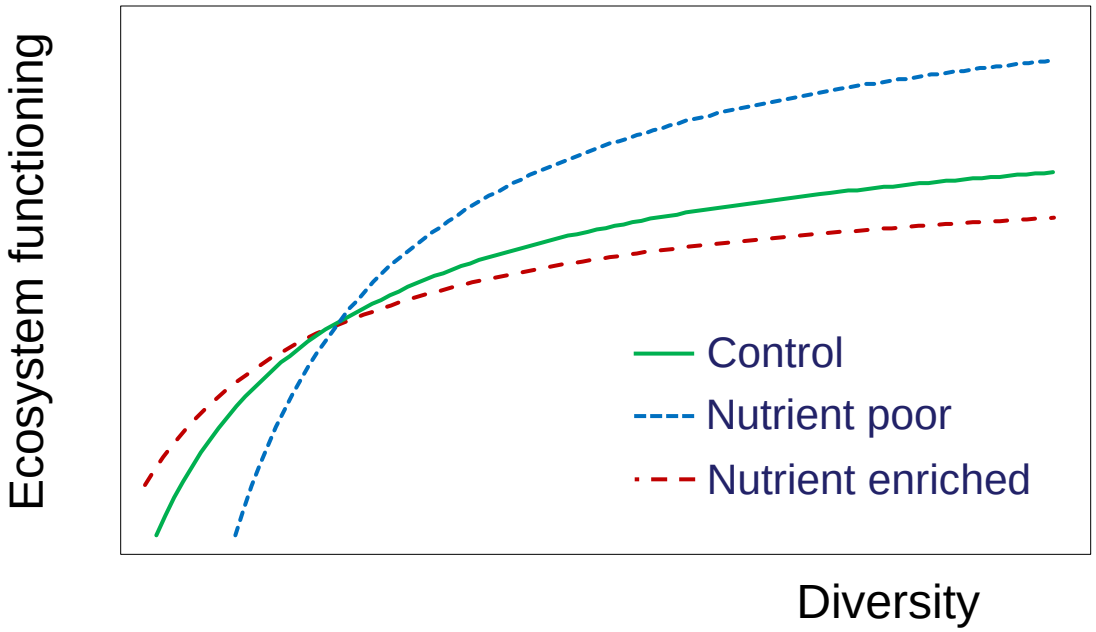
一、研究背景

生物多样性

- 增强生态系统功能

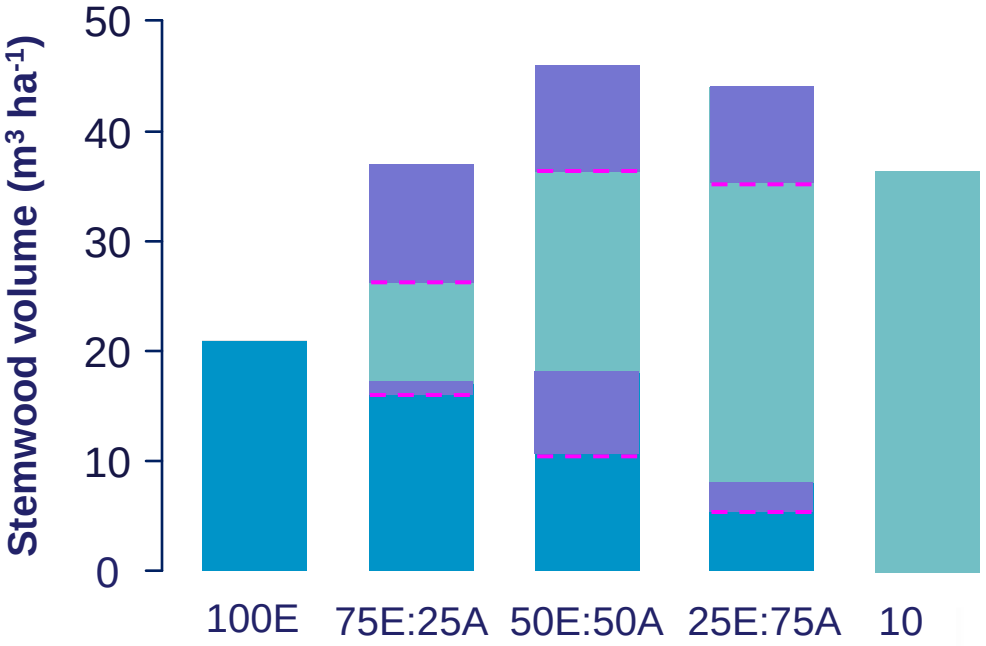


- 稳定性
- 养分截留
- 分解速率
- 养分利用效率
- 生产力

生态位分化及互补效应

- 空间分布
- 生长季节动态
- 养分的选择性利用

一、研究背景



Acacia mearnsii (A)

Eucalyptus globulus (E)

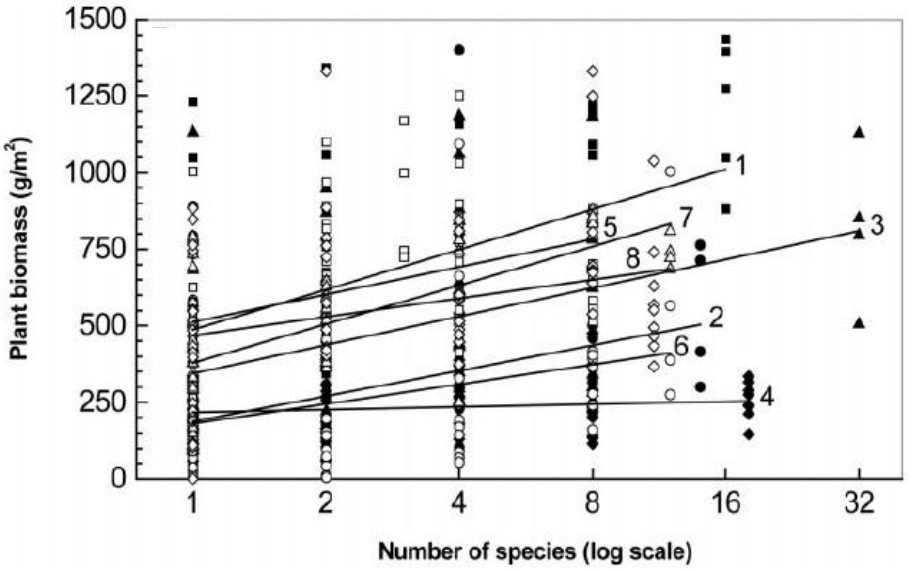
Overyielding part

“超产”

Bauhus et al., 2000 *Can. J. For Res.*

物种多样性与生产力的关系

Loreau et al., 2001 *Science*



二、研究问题及假设

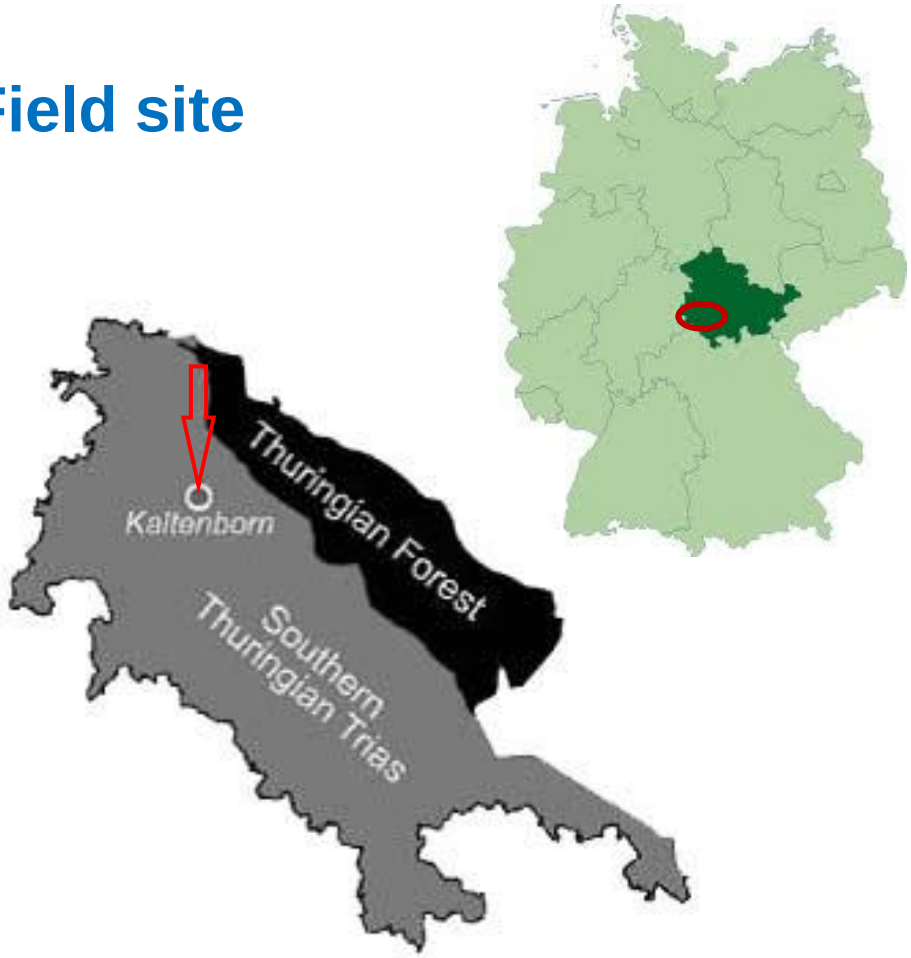
1. 根系对土壤的扩展能力是否随着树种多样性的增加而增强? Soil exploitation by fine roots increases with tree species diversity.

2. 多树种的共存与树种增加是否会产生地下生态位的分化？ Belowground vertical differentiation occurs in mixed species forests.

3. 树种多样性效应是否会随着土壤肥力的提高而有所减弱？Positive diversity effects decrease with enriched soil nutrient on fine root production.

三、试验设计与方法

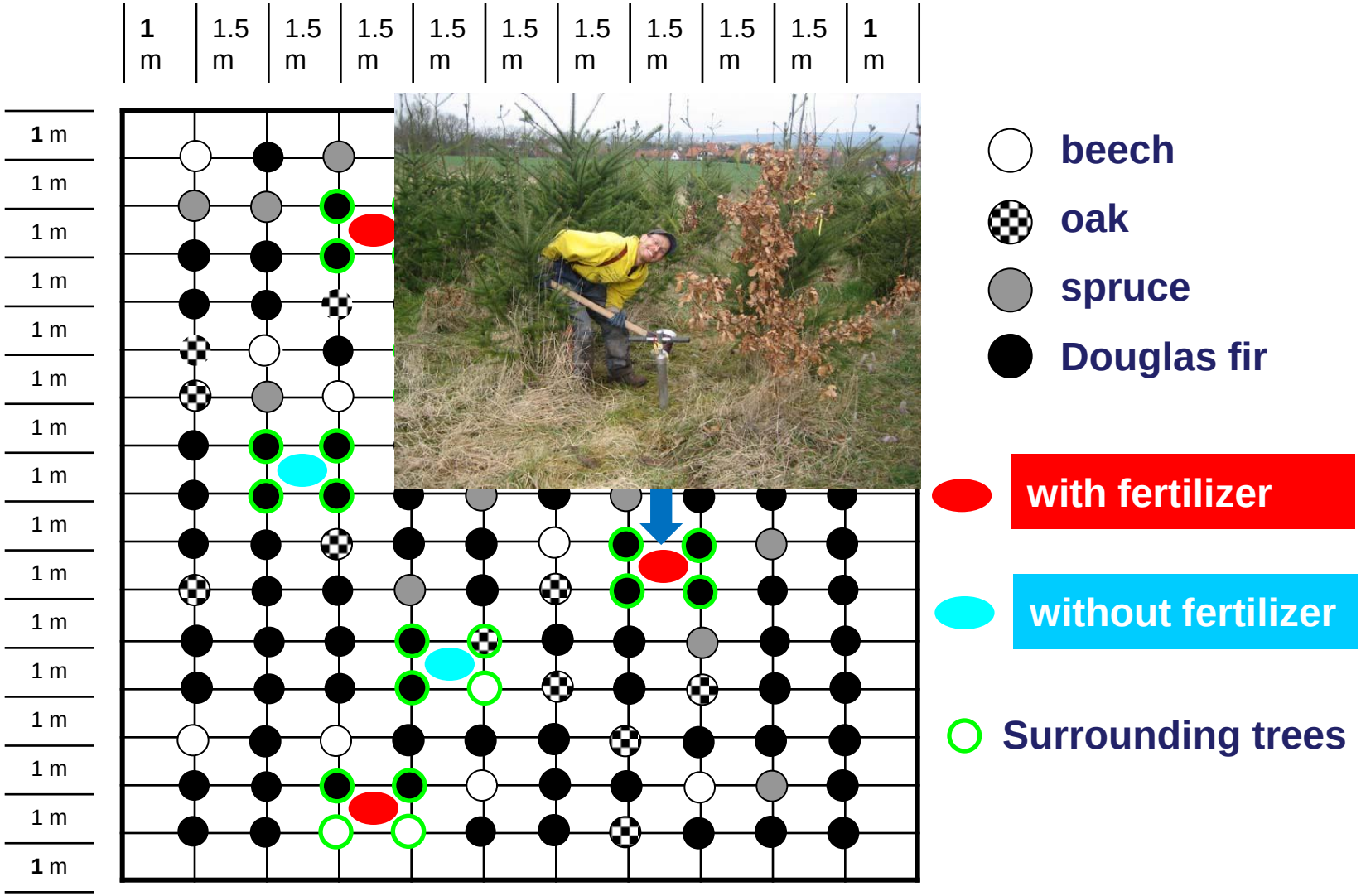
Field site



SIMPLEX site

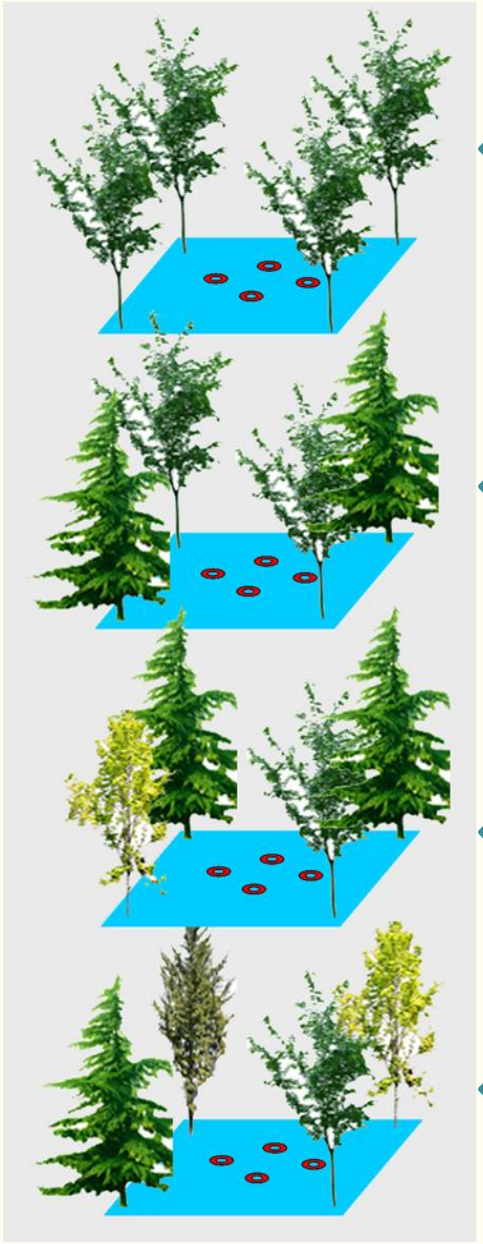
BIOTREE experiment site Kaltenborn, Germany (Scherer-Lorenzen, 2007)

三、试验设计与方法



Plantation pattern of the BIOTREE-species in plot 36

三、试验设计与方法



1 species
- BBBB
- OOOO
- SSSS
- DDDD

2 species
- BBOO
- BBSS
- BBDD
- OOSS
- OODD
- SSDD

3 species
- BOSS
- BODD
- BBSD
- OOSD

4 species
- BOSD

Species

- B - beech
- O - oak
- S - spruce
- D - Douglas fir

- ✓ 15 combinations
- ✓ 2 depths (0-15 and 15-30 cm)
- ✓ 2 treatments (with or without fertilizer)
- ✓ 6 replicates
- ✓ 3 sampling occasions
- ✓ with soil cores or ingrowth cores

三、试验设计与方法

Soil cores

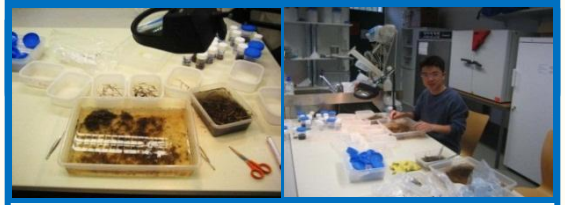
Mar. 2008

Ingrowth cores

Oct. 2008; Oct. 2009

Fine root analyses

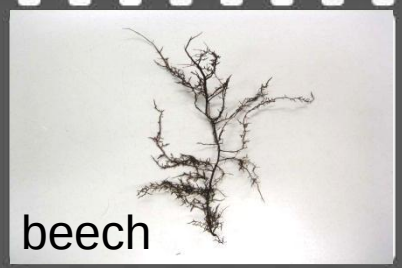
Fine root mass

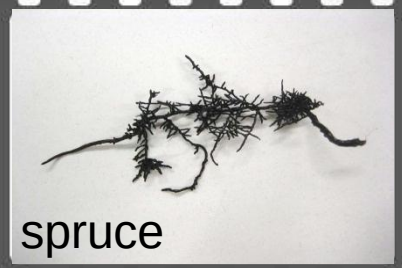


- Biomass
- Necromass
- Production
- Stratification
- Growth rate

Fine root morphology

- Length
- Surface area
- Specific root length
- Lateral root order
- Root diameter





三、试验设计与方法

Aboveground stand structure

Mar. 2008	Jun. 2008	Oct. 2008	Oct. 2009

- Diameter at 10 cm height
- Height
- Space occupation (crown area)
- Leaf area & leaf area index
- Growth rate (basal area)

四、结果与分析

4.1 Aboveground structure

Stand characteristics		oak	beech	Spruce	Douglas fir
Oct. 2009	Height (m)	2.51 a	2.90 b	**3.33 c**	**4.86 d**
	D10 (cm)	3.45 a	3.83 b	**6.78 c**	**8.92 d**
	Basal area (m^2 ha^{-1})	1.72 a	2.02 a	**6.25 b**	**10.87 c**
	LAI	2.06 a	2.30 b	**3.54 c**	**3.33 c**

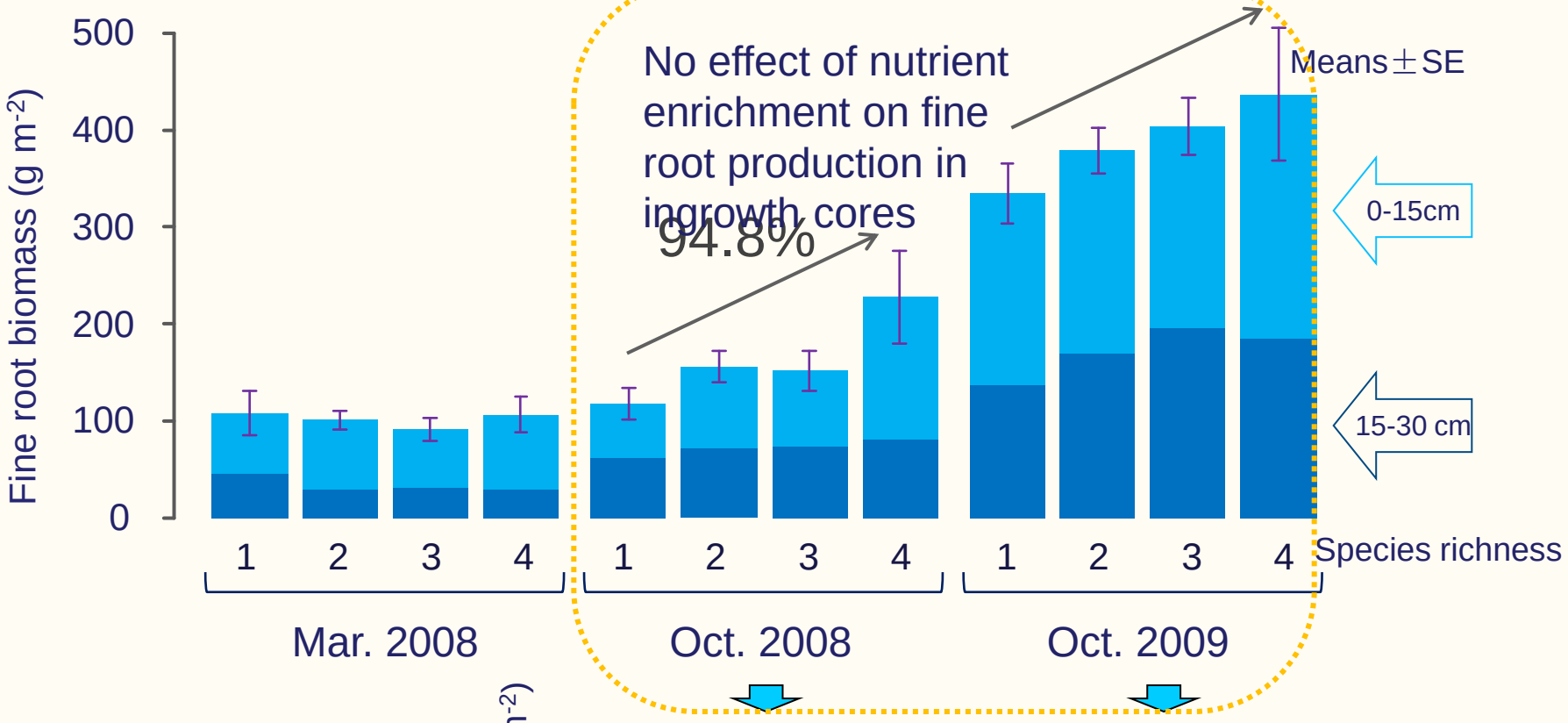
四、结果与分析

4.2 Over-yielding

The effect of tree species diversity on fine-root production in a young temperate forest

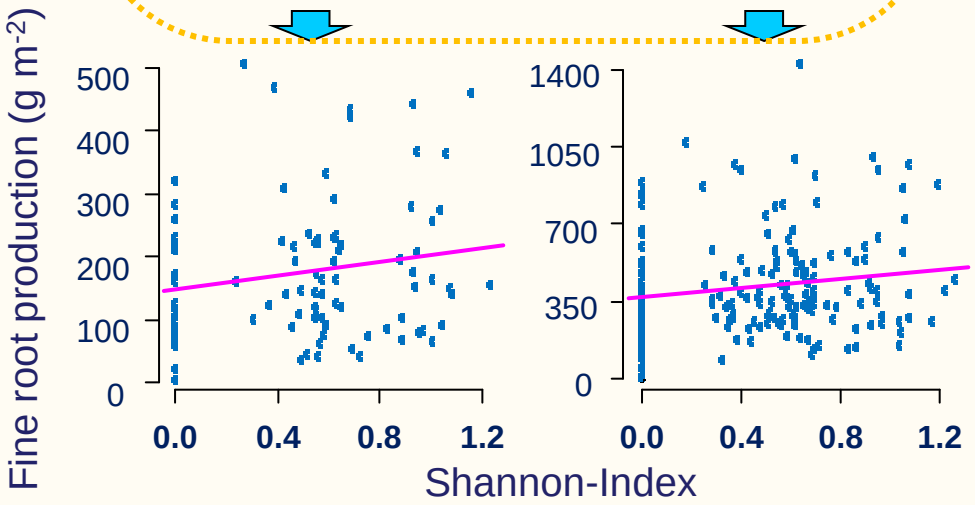
Oecologia 2012

4.2.1 Fine root biomass and production

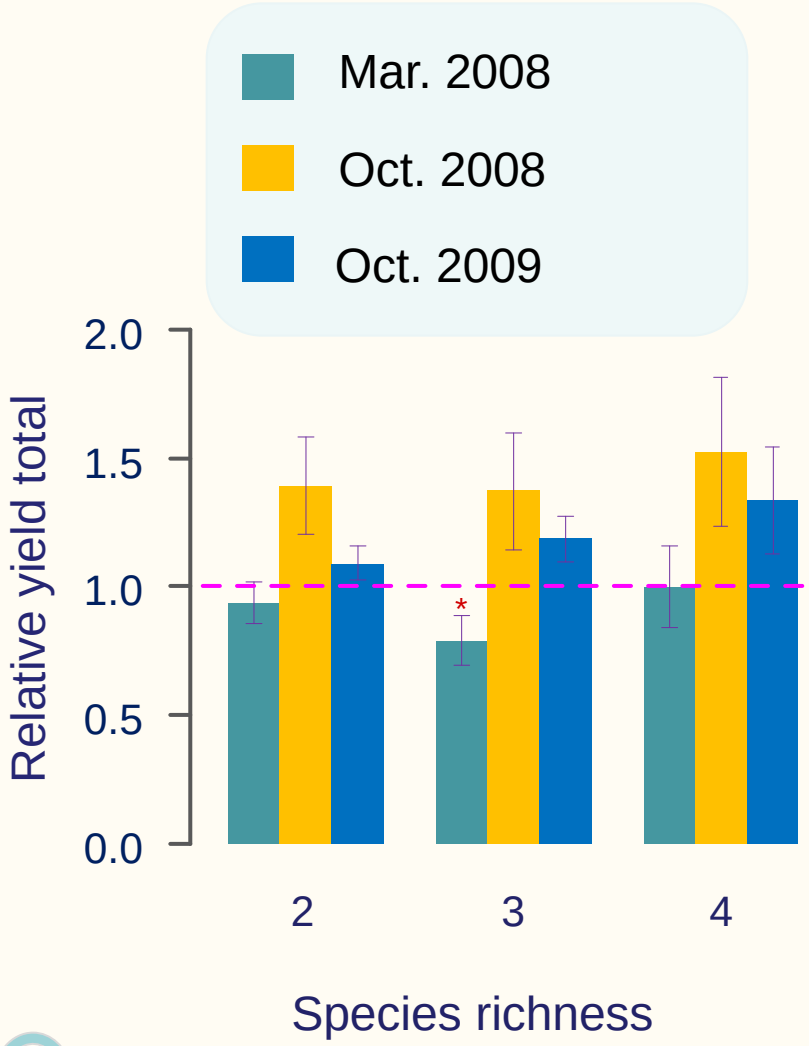


Regression:

Production vs diversity



4.2.2 Overyielding and Relative yield total

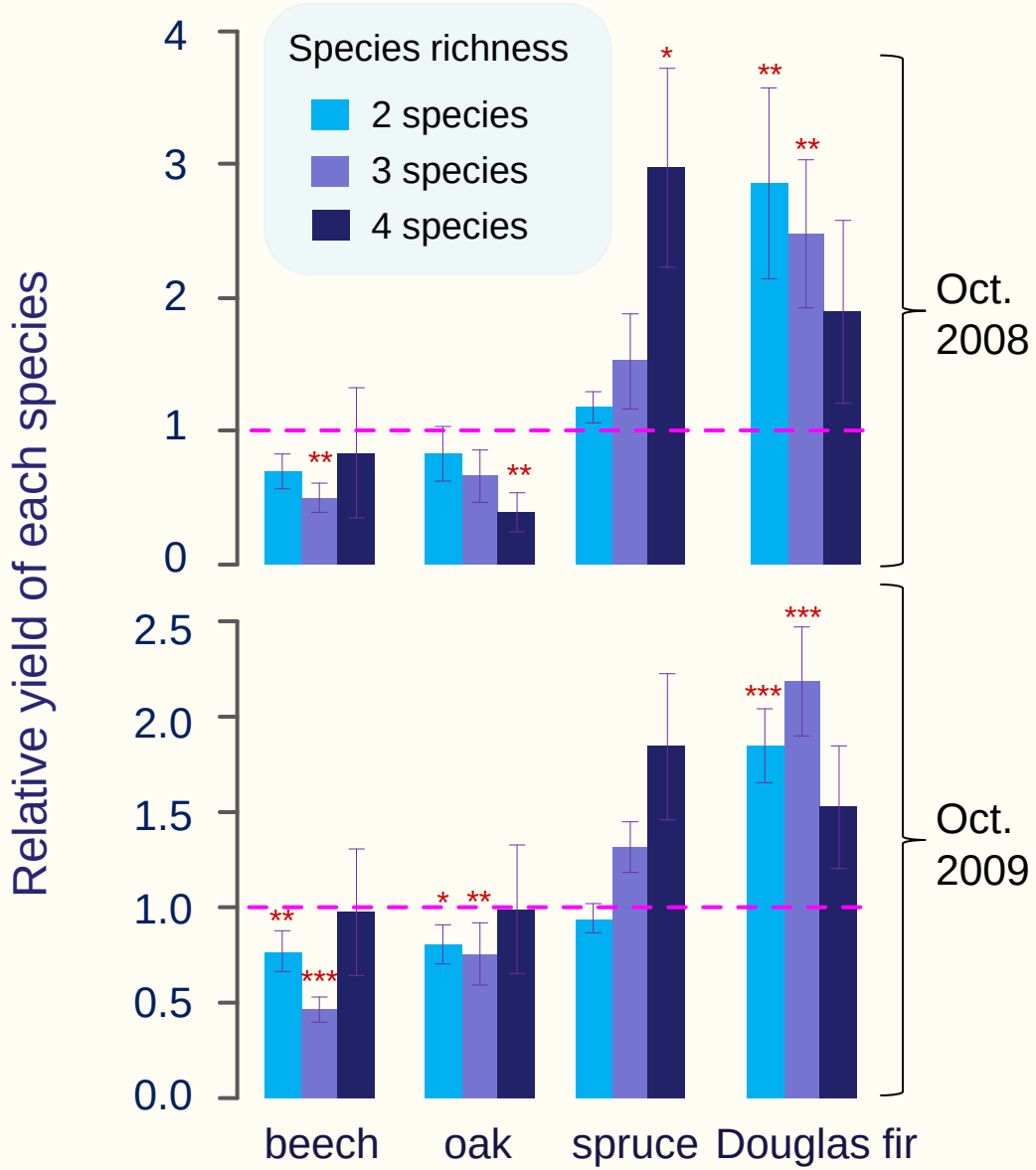


Relative yield total (RYT) was calculated by summing up the relative yields of all species in mixture.

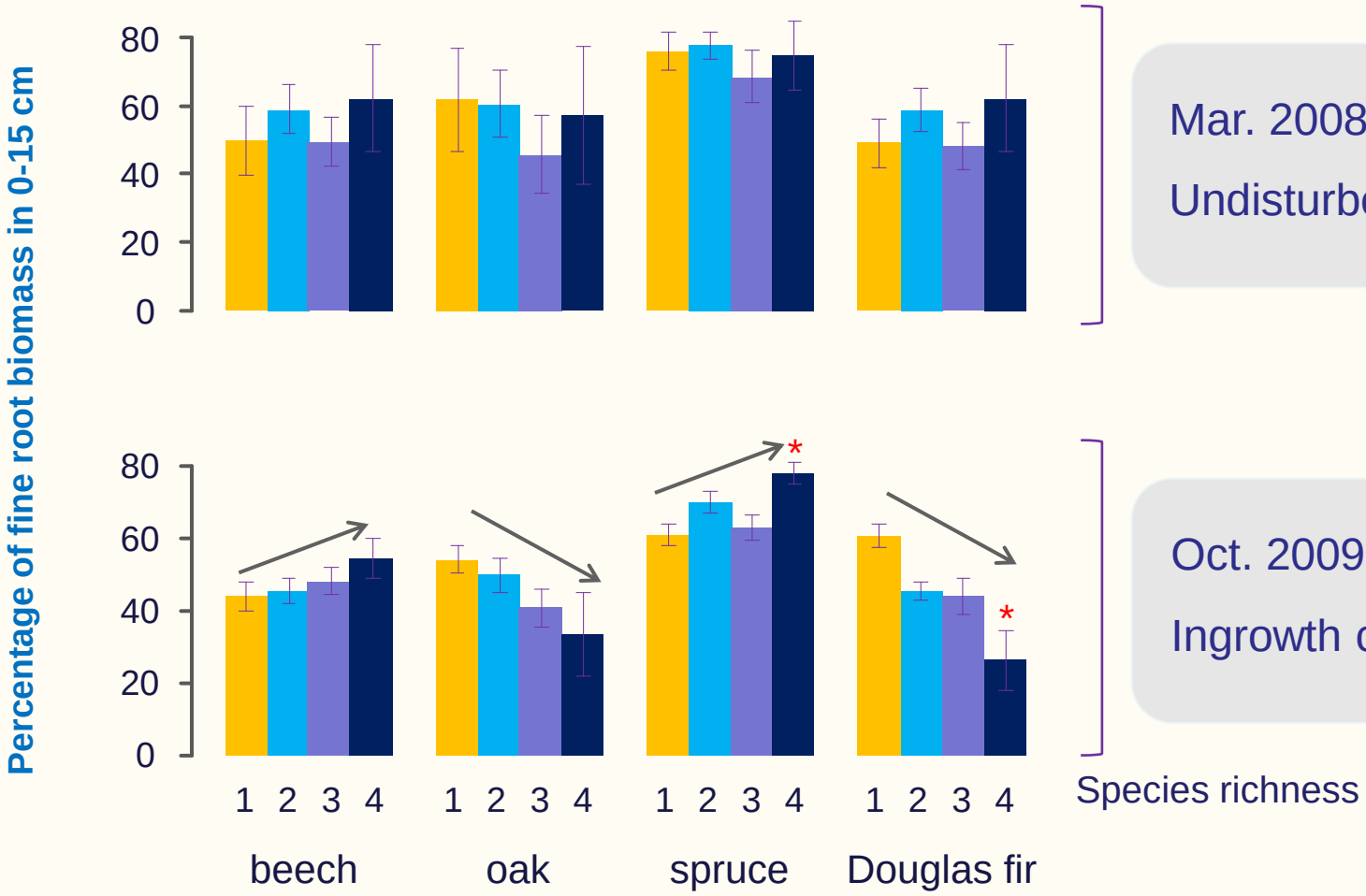
RYT>1, indicate overyielding;

RYT<1, indicate underyielding

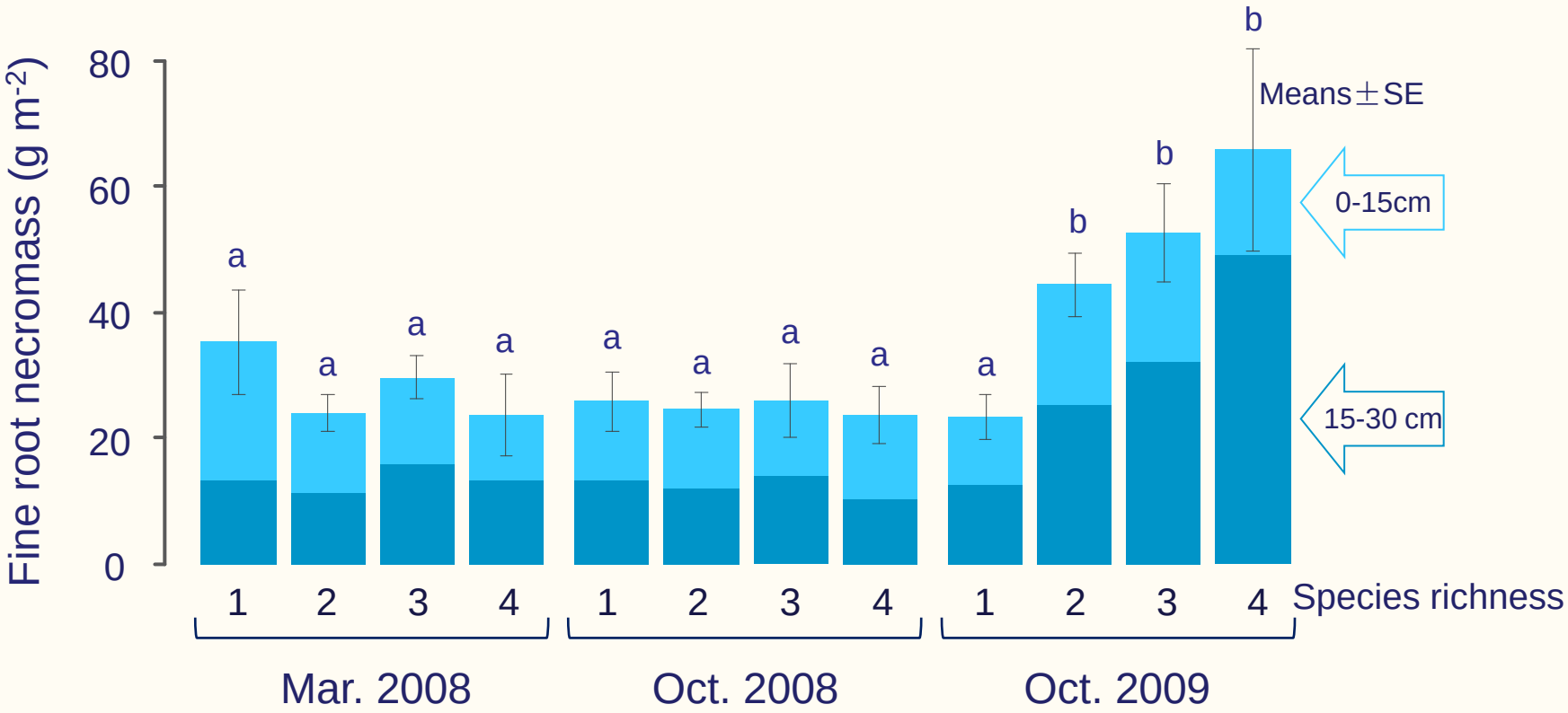
4.2.2 Relative yield of each species



4.2.3 Vertical niche differentiation



4.2.4 Tree fine root mortality

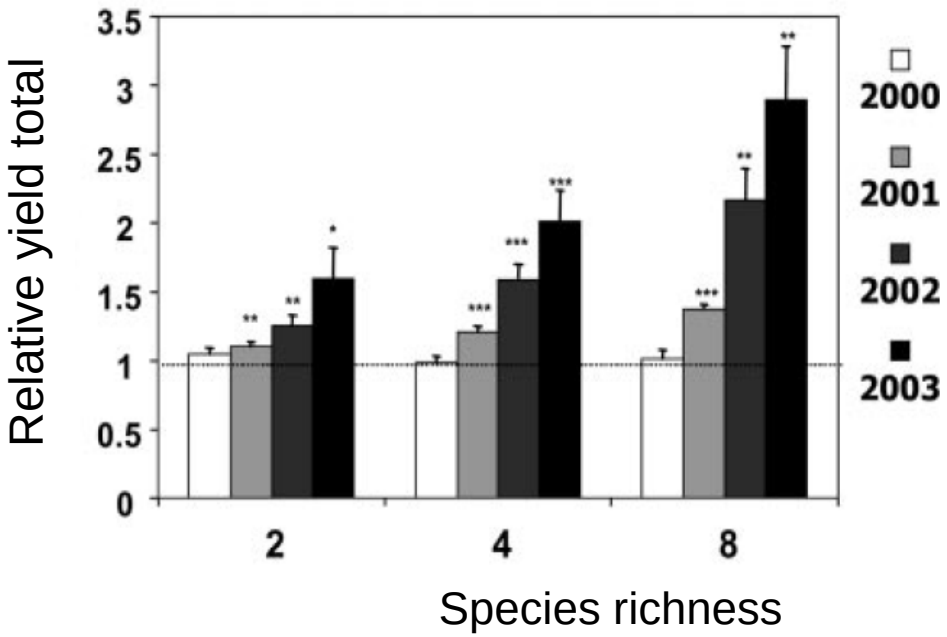


4.2.5 Main findings

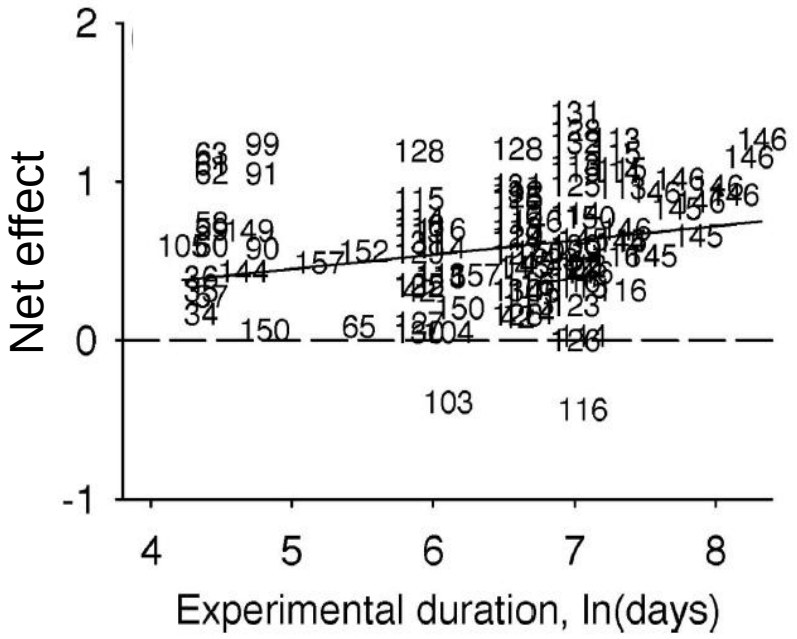
1. Initial fine-root production increased slightly with species richness and diversity.
2. Belowground over-yielding was mainly attributable to the strong performance of the dominant coniferous species.
3. Belowground vertical differentiation may commence early in this forest stand.
4. Fine root mortality increased with species diversity.
5. Nutrient enrichment did not affect fine root production.

五、研究展望

物种多样性与生产力的关系在时间上的存在性？



van Ruijven et al. 2005 *PNAS*



Cardinale et al. 2007 *PNAS*

森林生态系统、特别是不同生长发育阶段地下部分如何改变生物多样性与生产力关系格局及相互竞争关系？

谢　谢！

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German Academic Exchange Service

4. Results

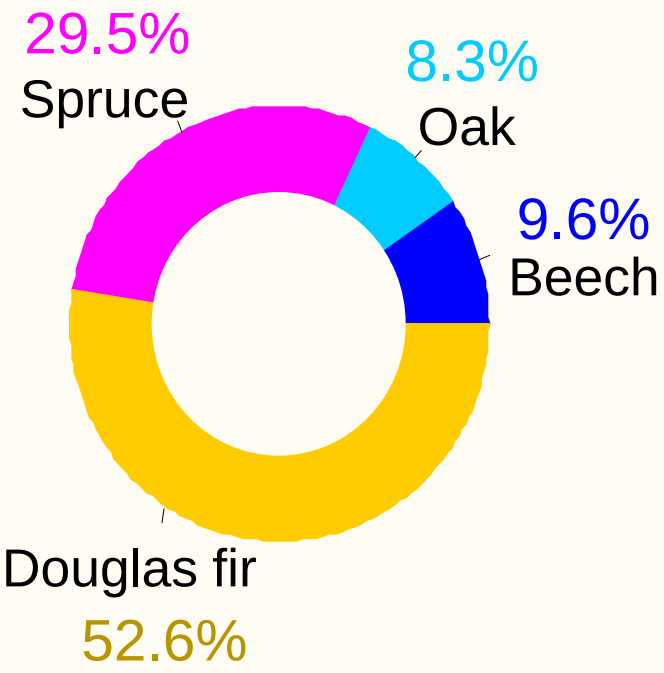
4.3 Competition

Belowground facilitation and competition in young tree species mixtures

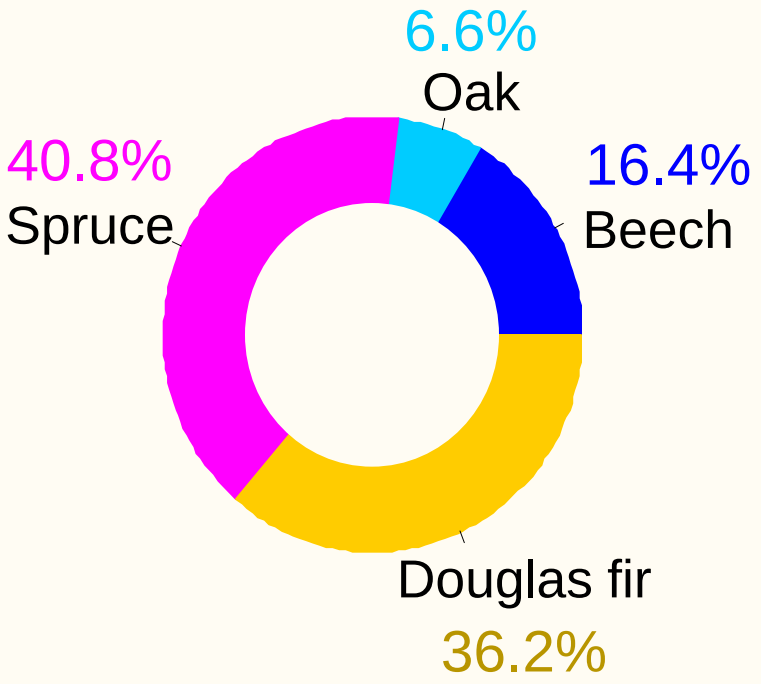
Forest Ecology and management 2012

4.3.1 Interactions between above and belowground

Basal area



Live fine root mass

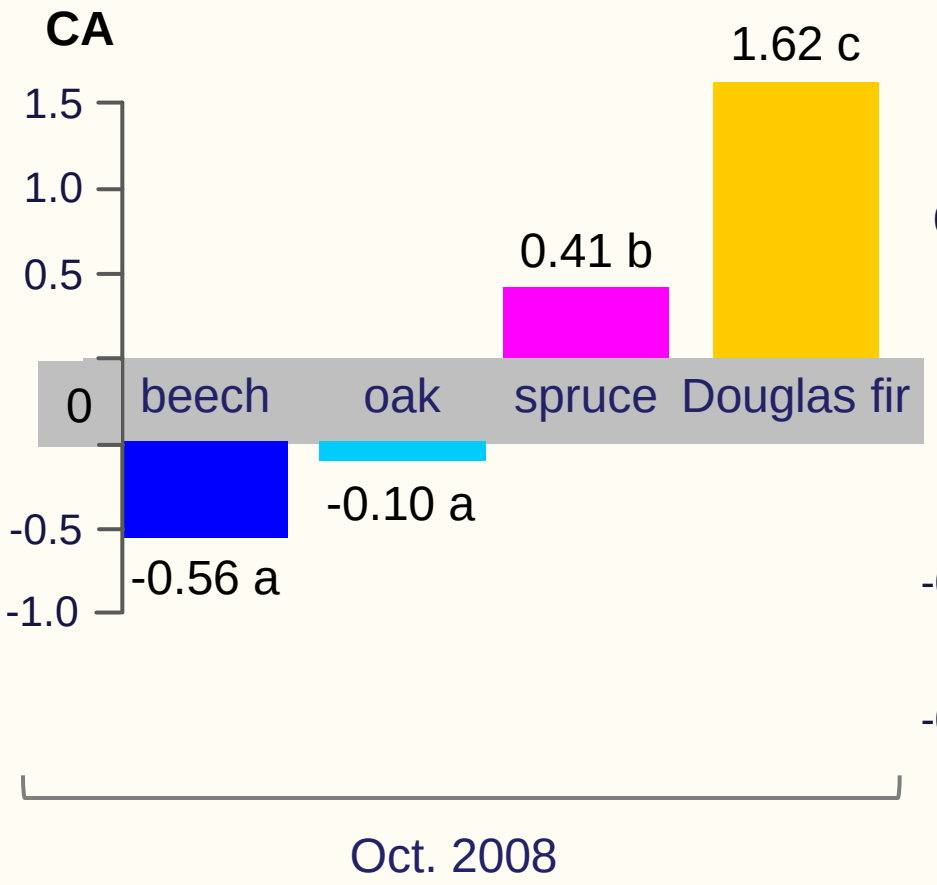


RAI/LAI	Beech	Oak	Spruce	Douglas fir
Monocultures	2.71	1.33	1.81	0.69
Mixtures	2.29 ↓	1.01 ↓	1.93 ↑	0.82 ↑

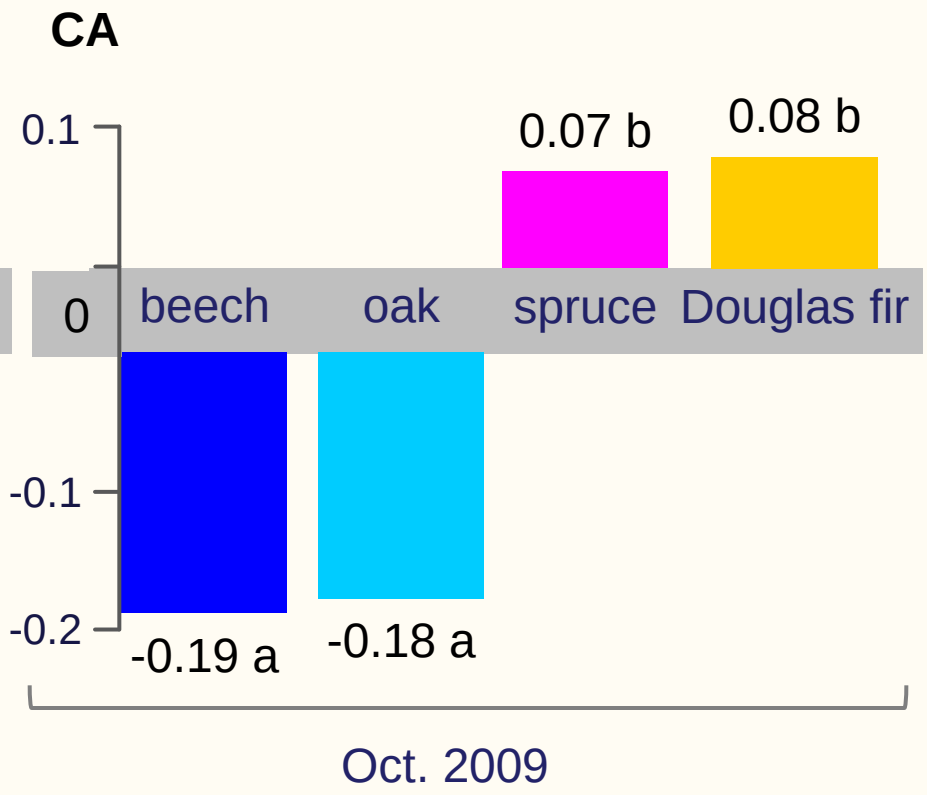
4.3.2 Competitive ability index (CA)

$$CA = (FRL_{mix} - FRL_{mono}) / FRL_{mono}$$

FRL: fine root length per unit basal area

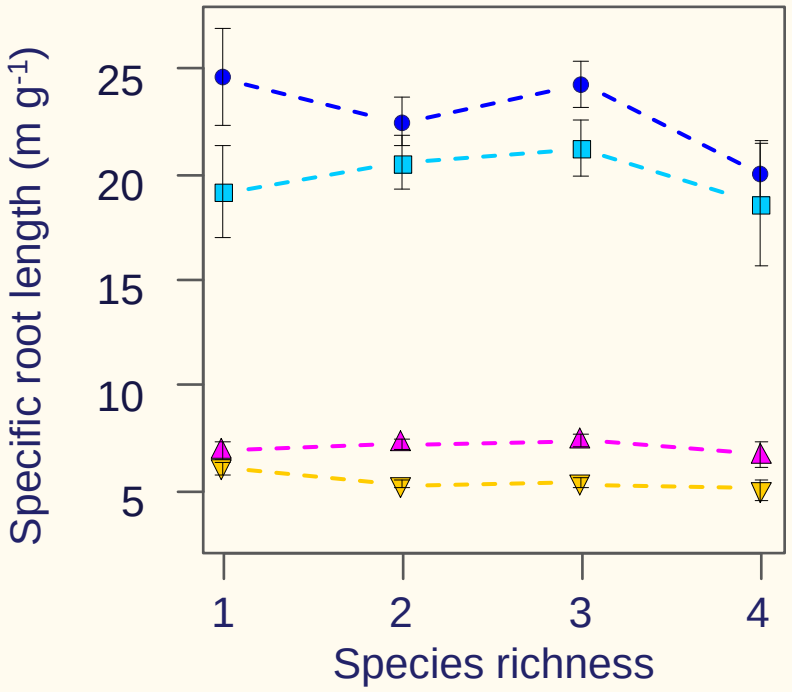


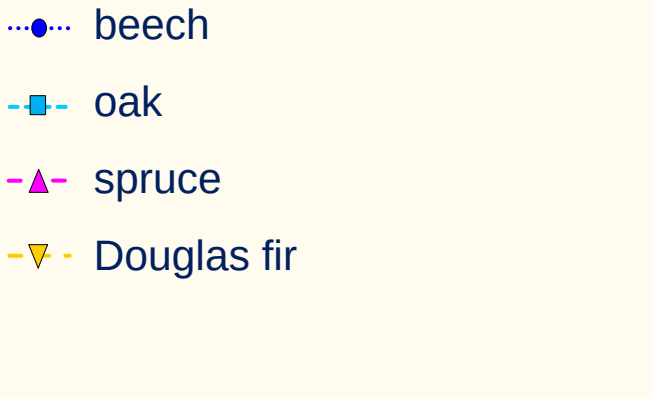
Oct. 2008

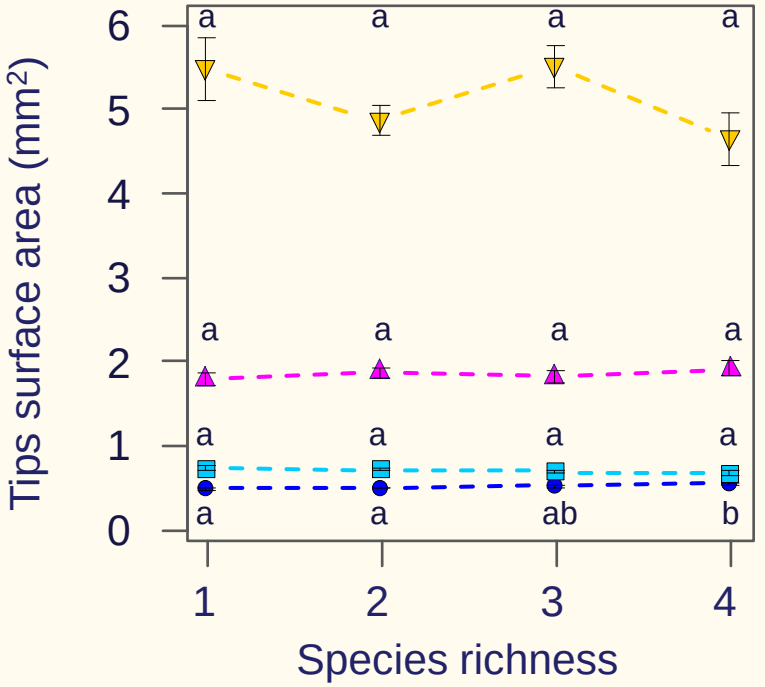


Oct. 2009

4.3.3 Fine root morphological plasticity







4.3.4 Main findings

1. Belowground competition was size-asymmetric.

2. Fine root morphology did not change with neighbouring tree species richness.

5. Objectives and Hypotheses _Summary

1. Overall level of soil exploitation of fine roots increases with tree species diversity.

2. Soil nutrient enrichment decreases diversity effects on fine root production.

3. Belowground competitive ability is size-symmetric.

5. Conclusions

1. Overall level of soil exploitation of fine roots increased very little with tree species diversity.

2. Vertical niche differentiation of fine root system occurred in this young stand.

3. Soil nutrient enrichment did not decrease diversity effects on fine root production.

4. Belowground competitive ability was size-asymmetric.

Thanks for your attention!

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