

# The effect of different forestry treatments on multi-taxon biodiversity in a European oak dominated forest

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Forest Ecology Research Group



IUFRO DIV8 Forests as hubs of biodiversity and ecosystem services in the anthropocene  
March 24-27, Coyhaique, Chile

# Motivation

## Necessity of the integration of timber production and conservation in forest management in Hungary

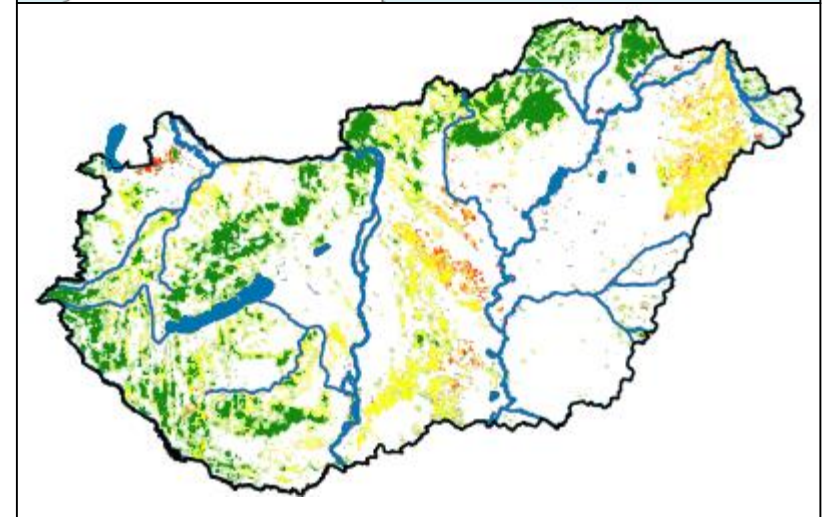
Forest cover in Hungary: ~21%

- Managed forests: 96%
- Unmanaged forests: 4%
- Protected + Natura2000 (management restrictions): 44%

Applied silvicultural systems:

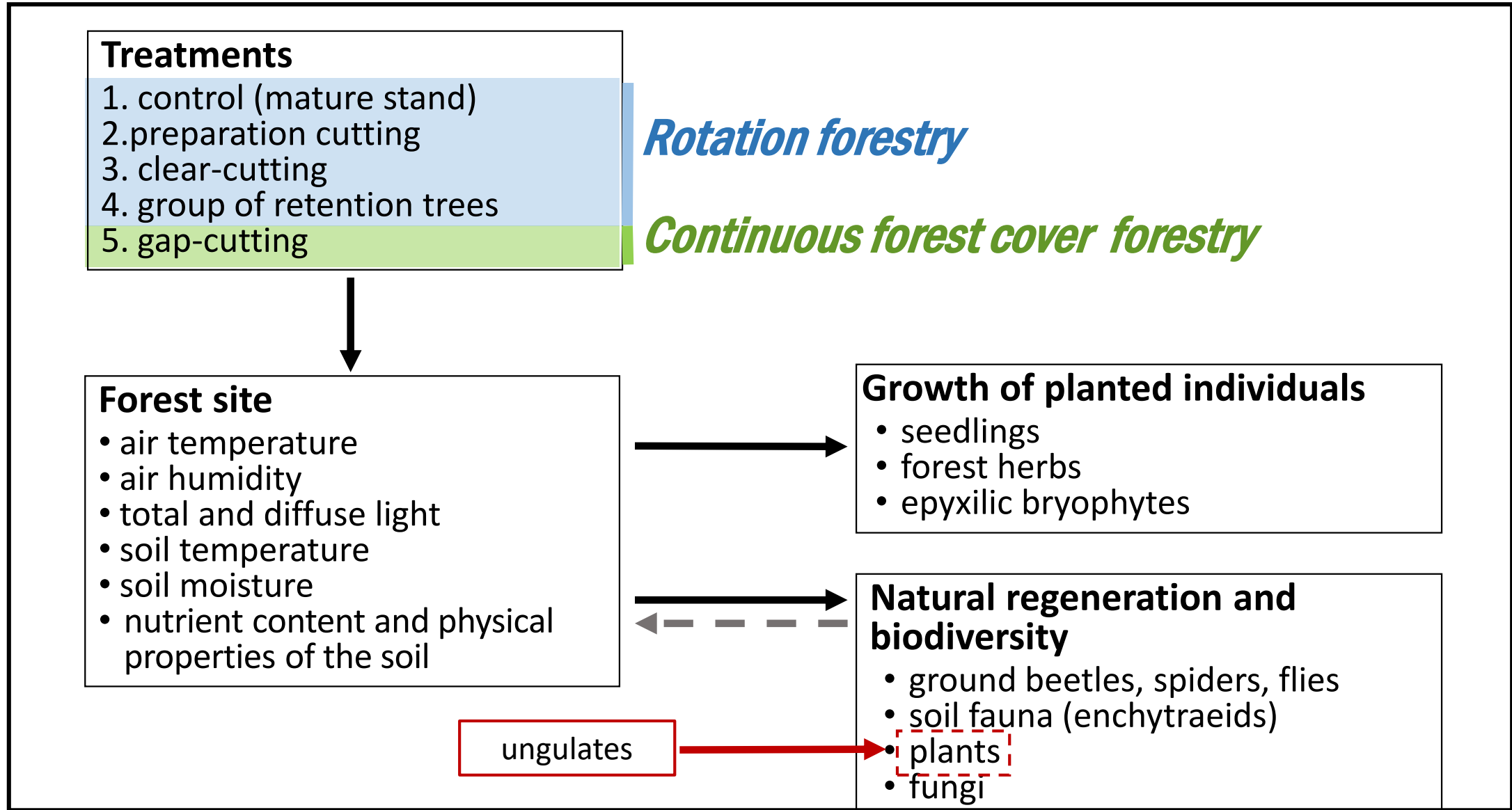
- Rotation forestry: 92%
  - shelterwood system (natural regeneration) → *native submontane forests*
  - clear-cutting system (artificial regeneration) → *lowland forests and plantations*
- Continuous cover forestry, selection system: 4%,

**Important to study the relationships between forest management and biodiversity**



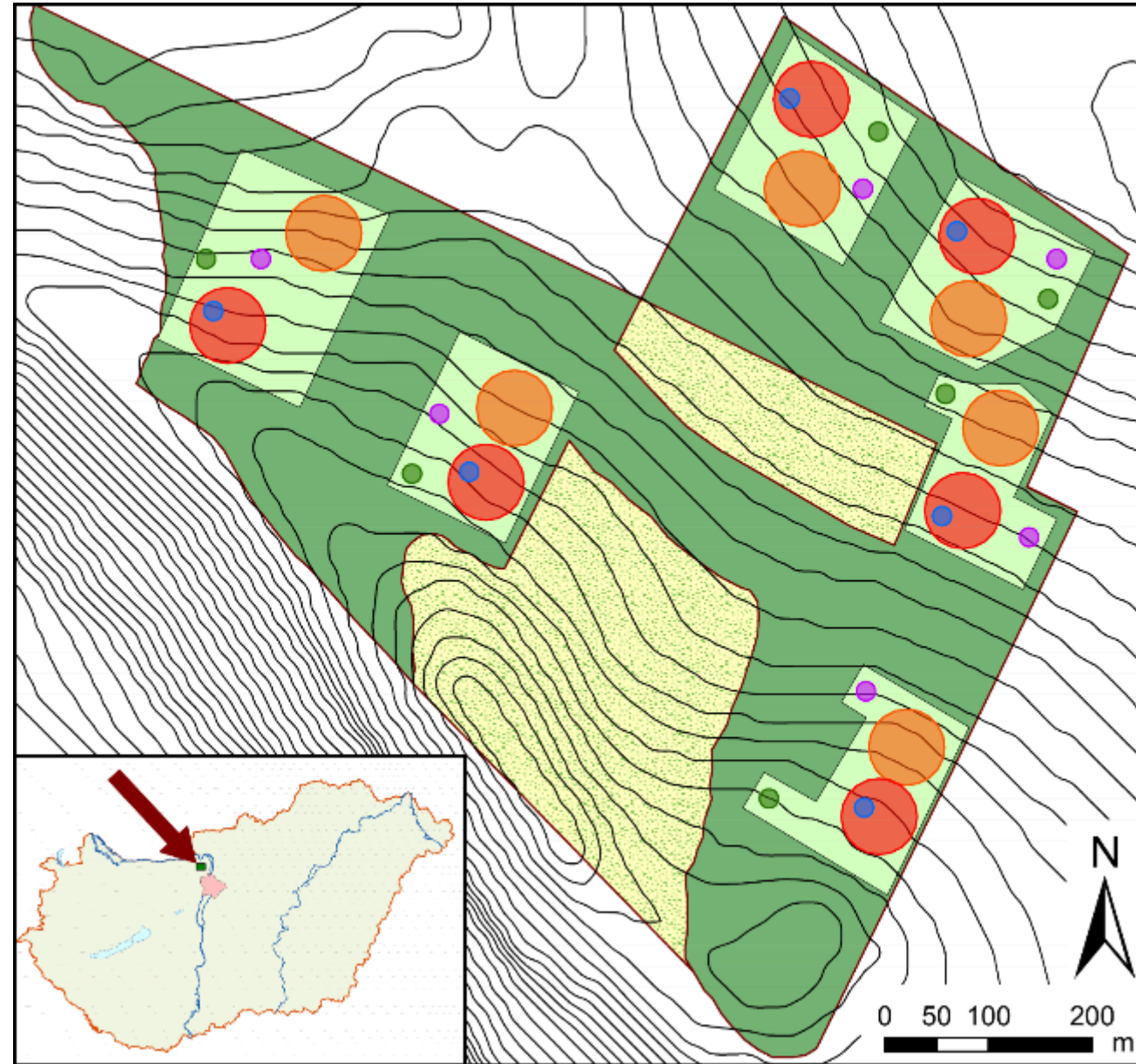
# Framework of the Pilis Forestry Systems Experiment

Mature (85 yr old) oak forest, upper layer *Quercus petraea*, subcanopy layer: *Carpinus betulus*



# Experimental design

- 5 treatments:
  - preparation cutting (d=80 m)
  - gap cutting (d=20 m)
  - clear-cutting (d=80 m)
  - retention tree group (d=20 m)
  - control
- 6 replicates – complete block design
- BACI (Before-After-Control-Impact): all measurements started in 2014



Control

Clear-cutting

Gap-cutting

Preparation  
cutting

Retention tree  
group

Relative diffuse light 2016

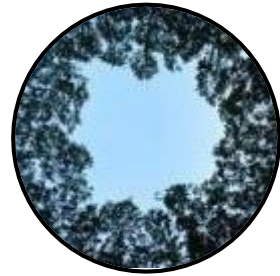
2%<sup>a</sup>

81%<sup>b</sup>

35%<sup>c</sup>

20%<sup>d</sup>

17%<sup>d</sup>



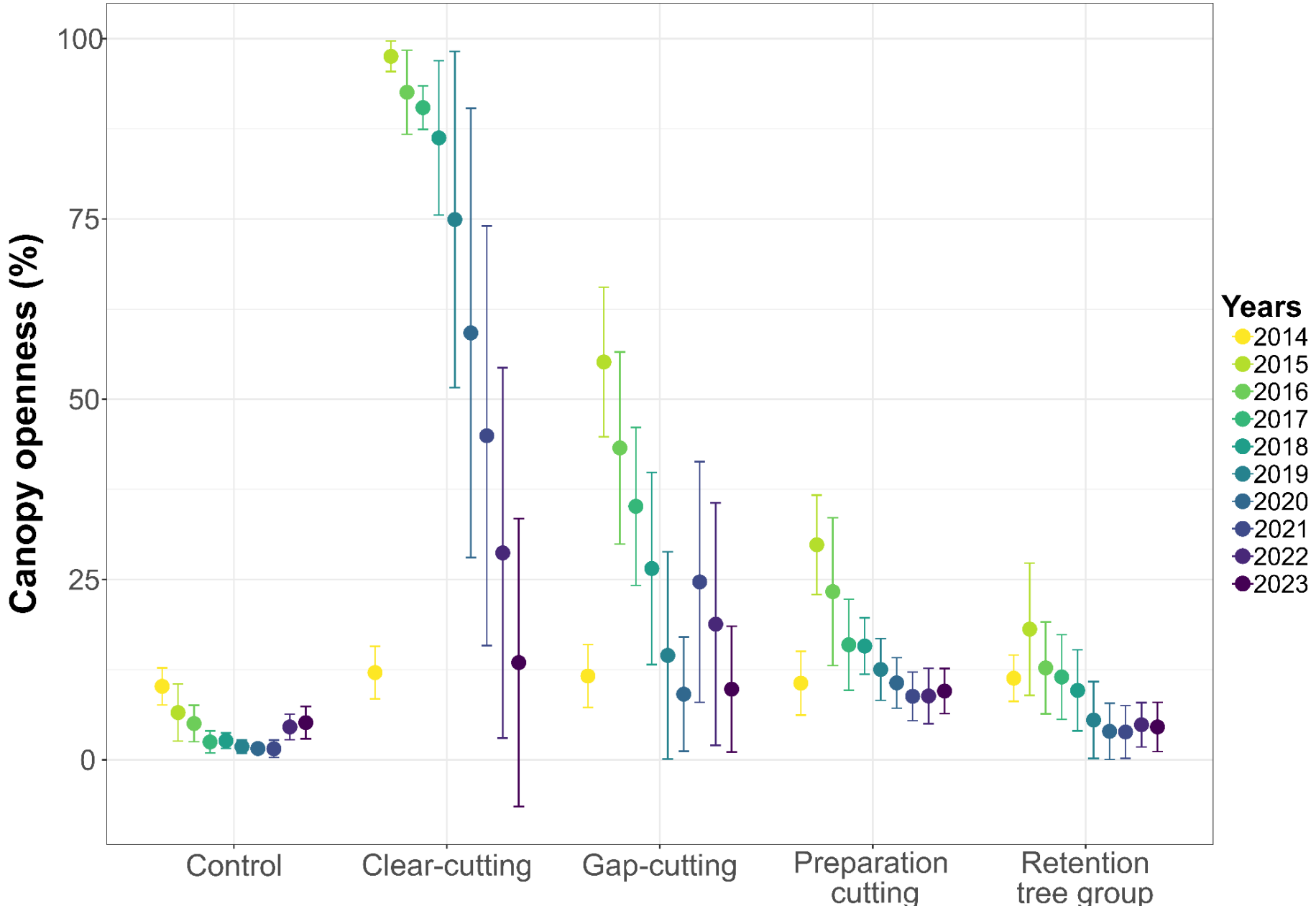
2015



2019



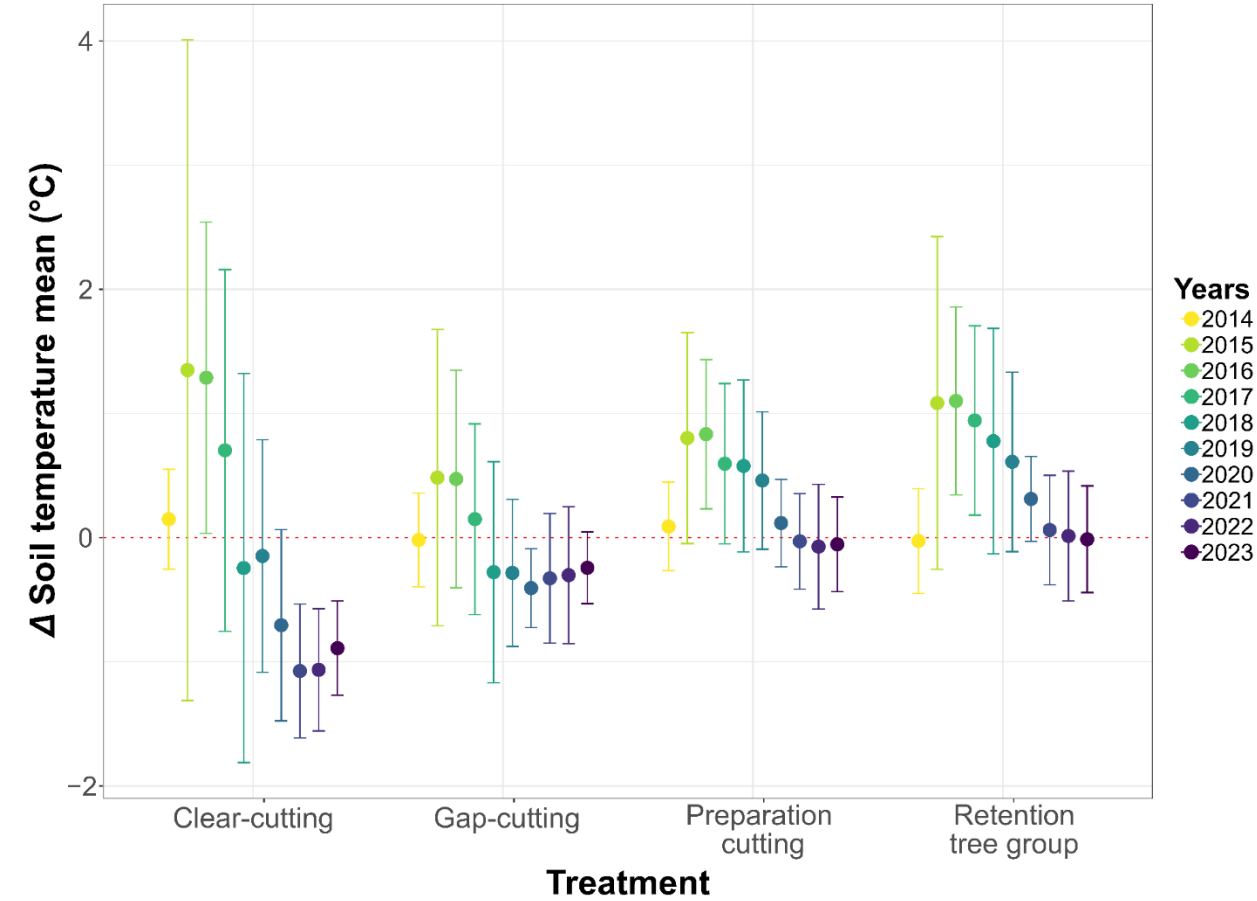
# Microclimate - Light



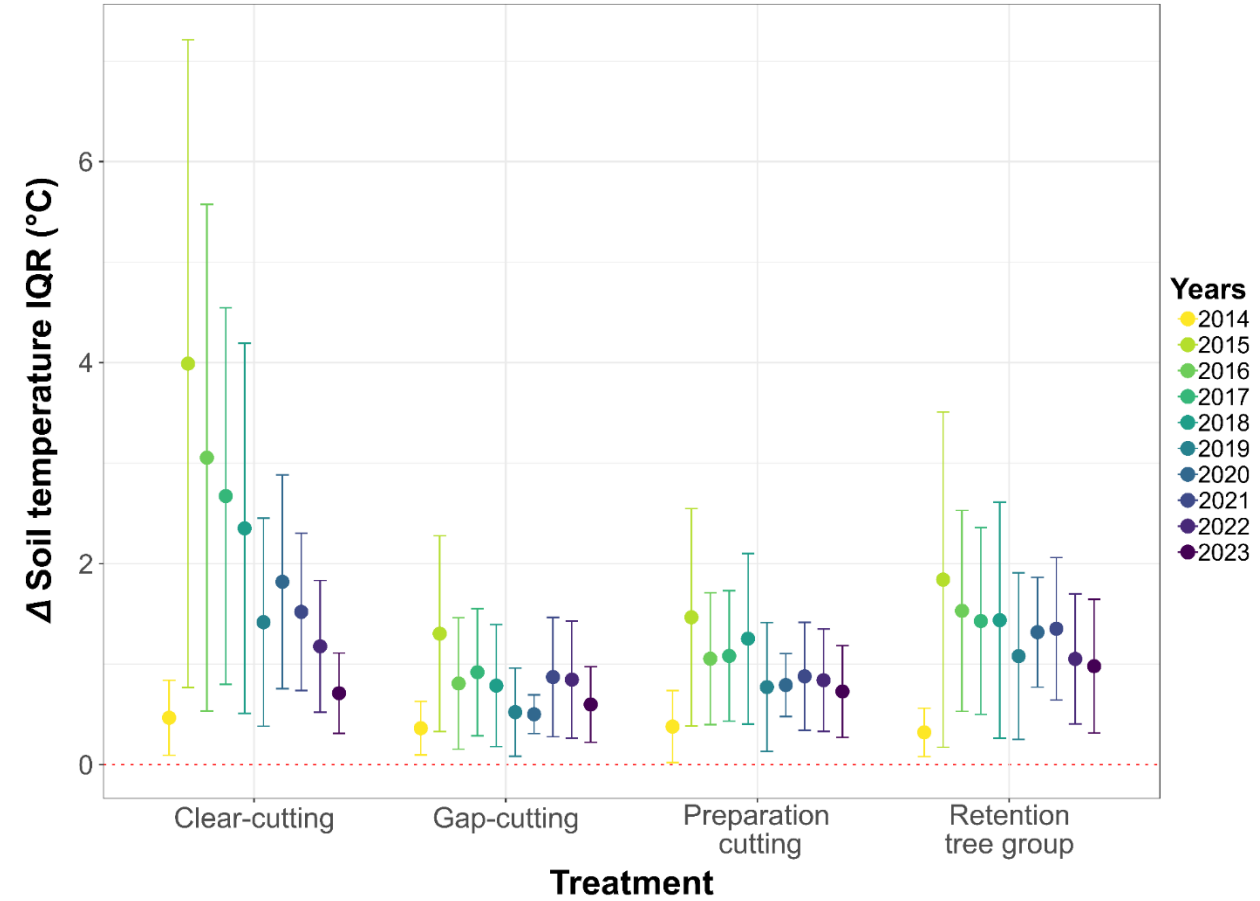
Kovács et al. 2020,  
Ecological  
Applications, 30(2):  
e02043.  
<https://doi.org/10.1002/eap.2043>

# Soil temperature differences

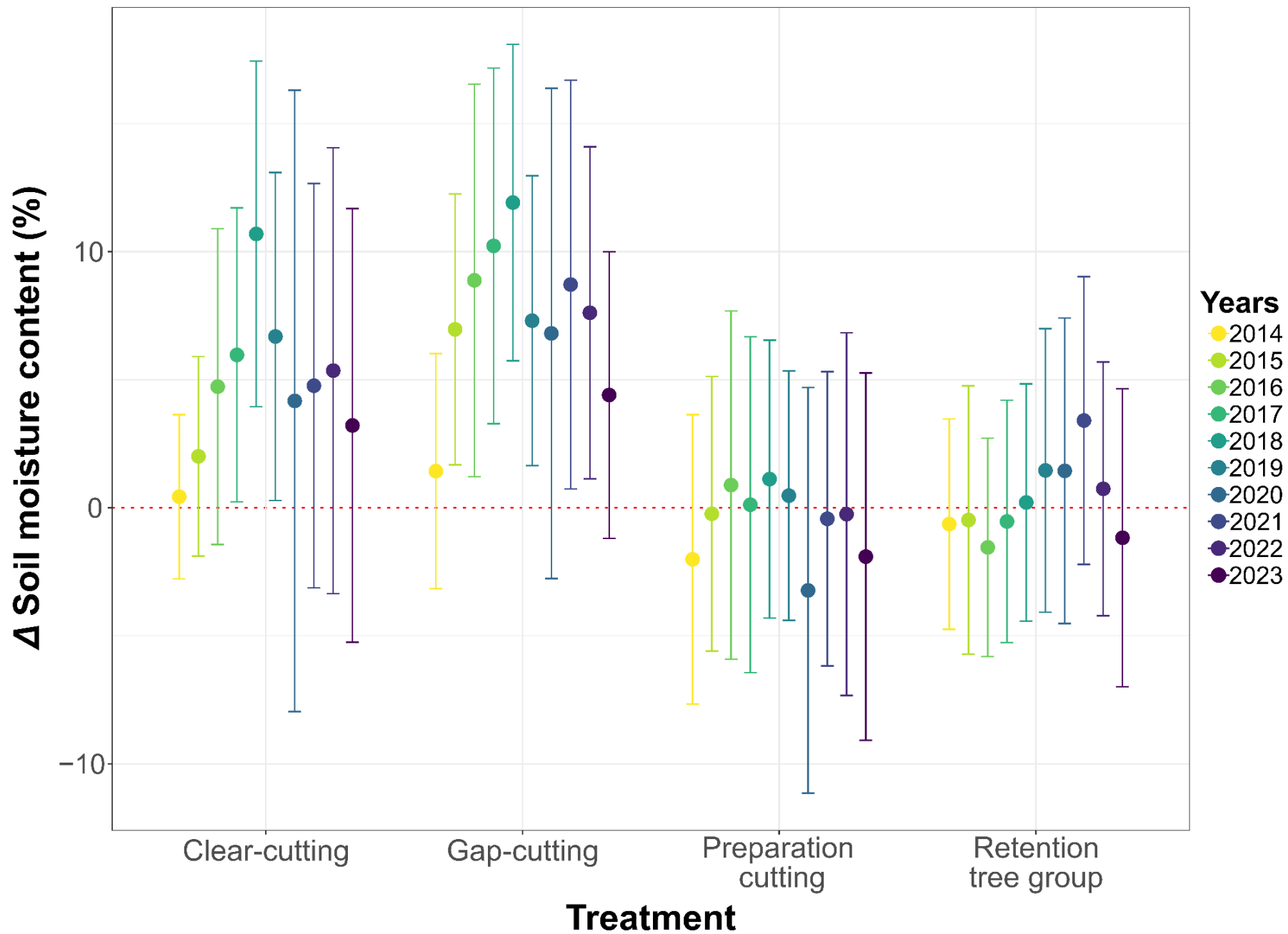
## Daily mean



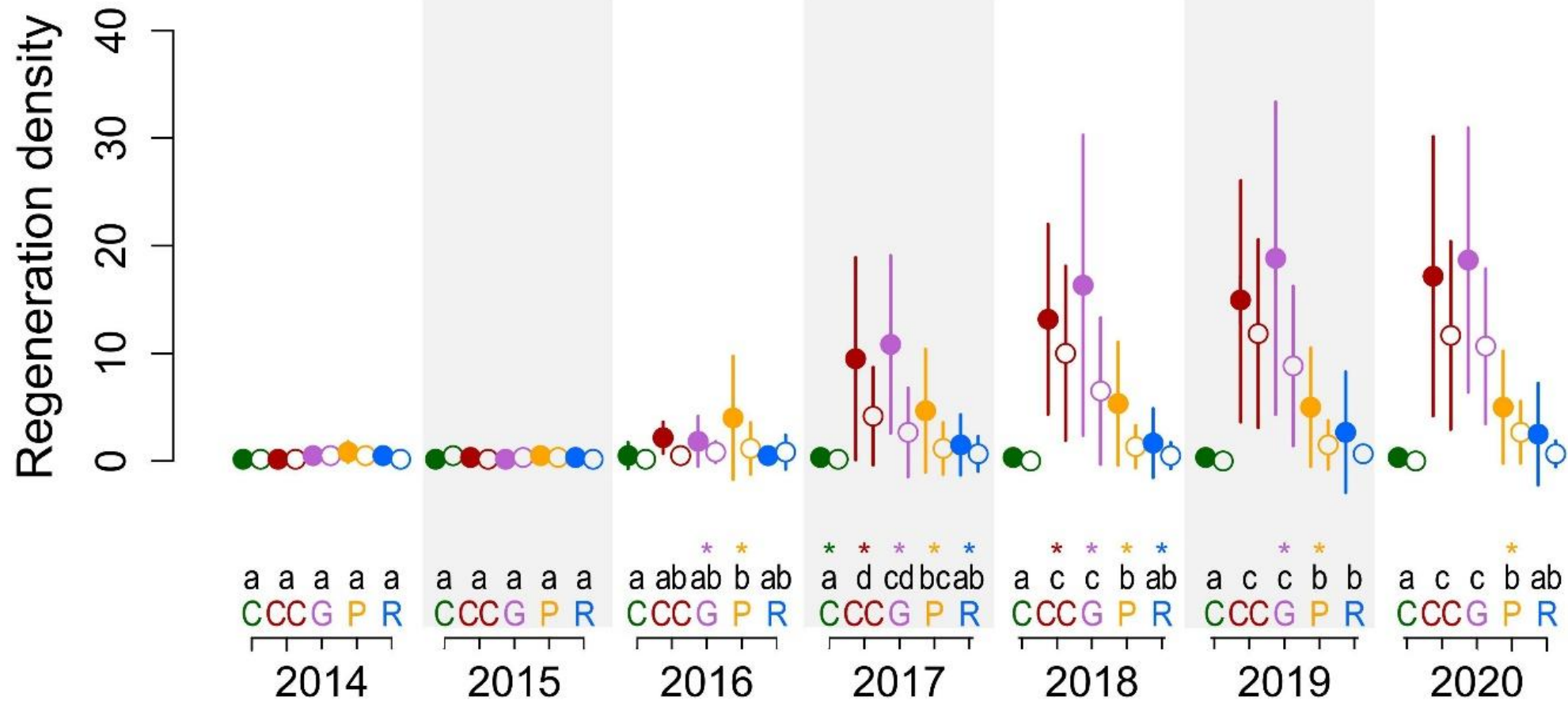
## Daily interquartile range



# Soil moisture differences



# Regeneration

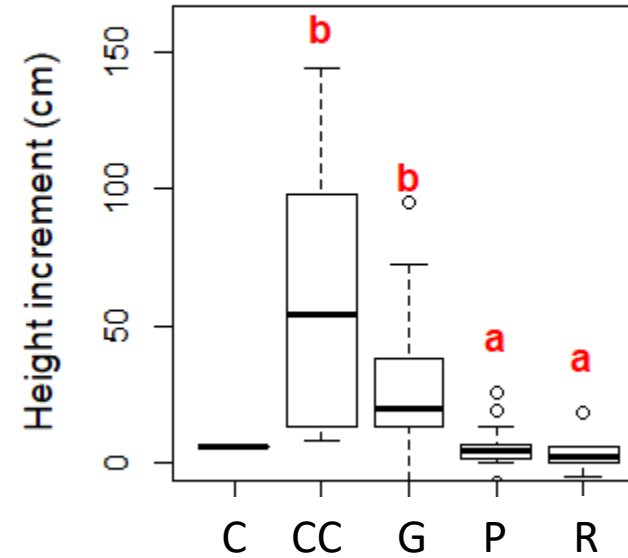


C—Control   CC—Clear-cutting   G—Gap-cutting   ● Full-fenced  
 P—Preparation cutting   R—Retention tree group   ○ Empty-unfenced

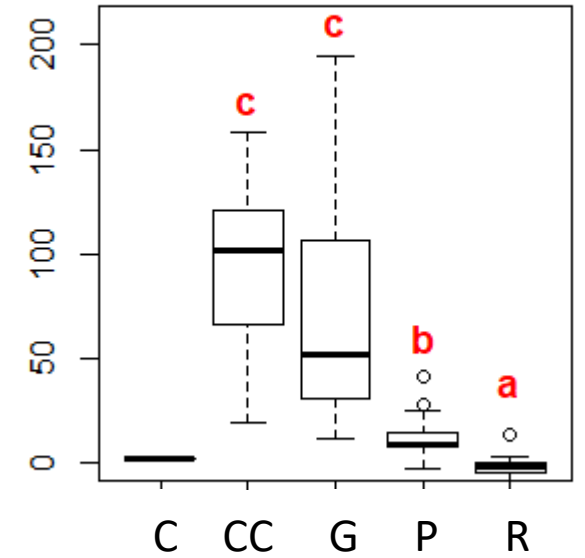
Aszalós et al.  
 2023. *Forest Ecology and Management*  
 549: 121438  
<https://doi.org/10.1016/j.foreco.2023.121438>

# Height growth of planted seedlings (2015-2018)

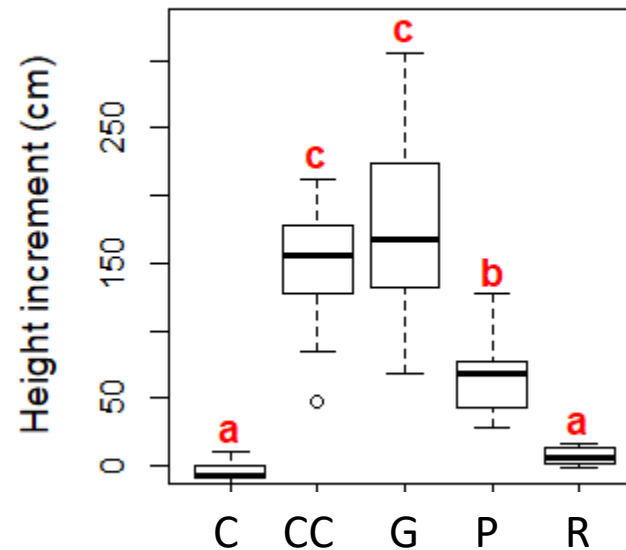
*Quercus petraea*



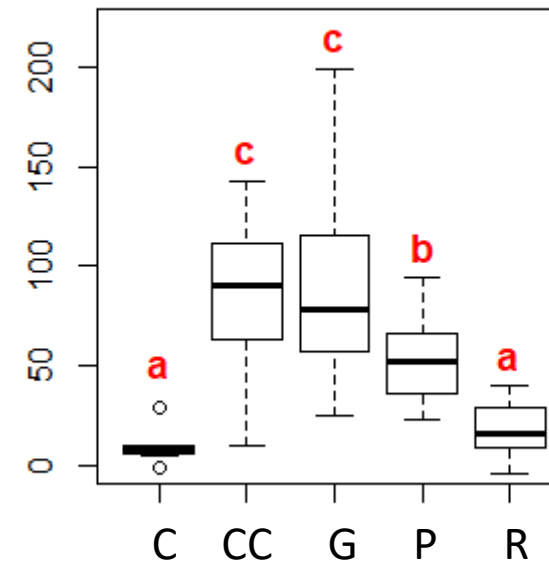
*Quercus cerris*



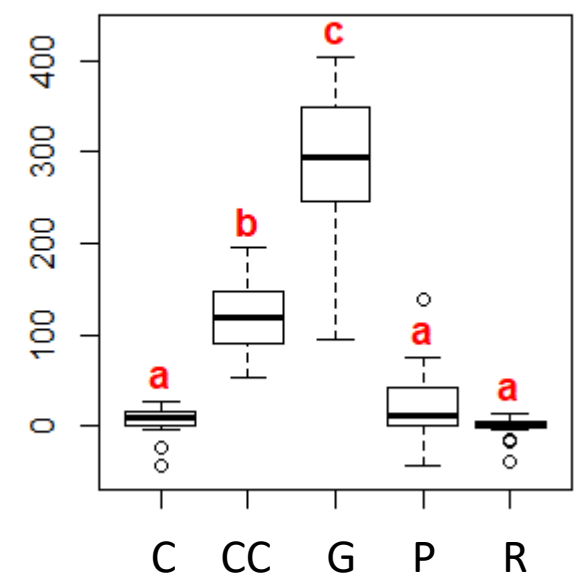
*Carpinus betulus*



*Fagus sylvatica*



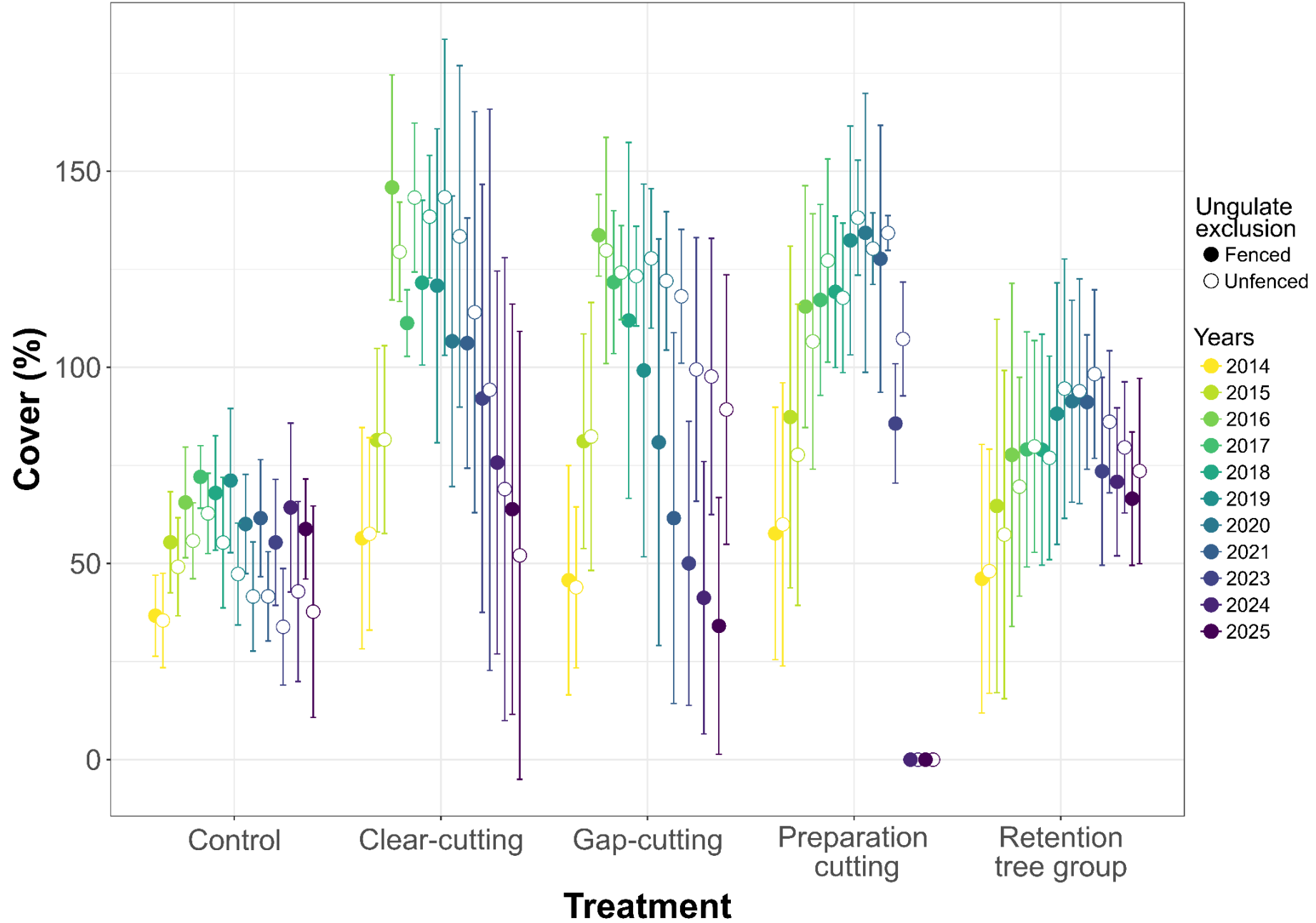
*Fraxinus excelsior*



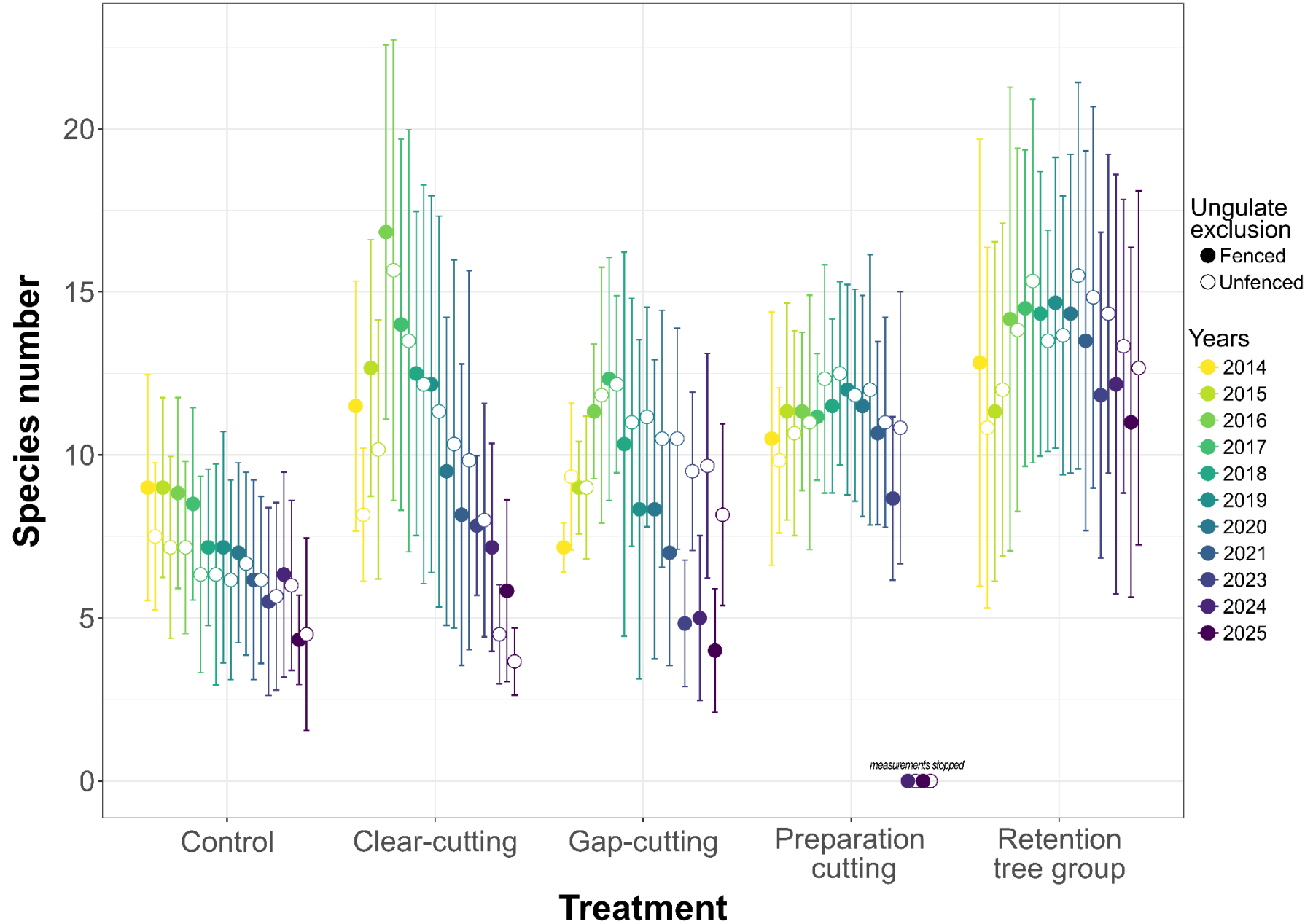
Tinya et al. 2020. Forest Ecology and Management, 433: 720-728.

<https://doi.org/10.1016/j.foreco.2018.11.051>

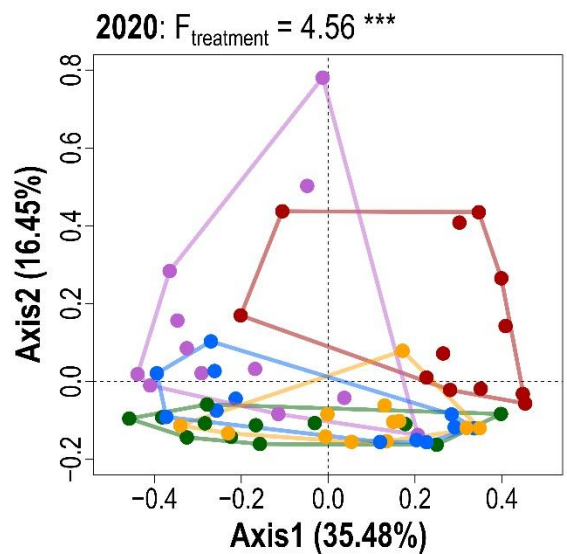
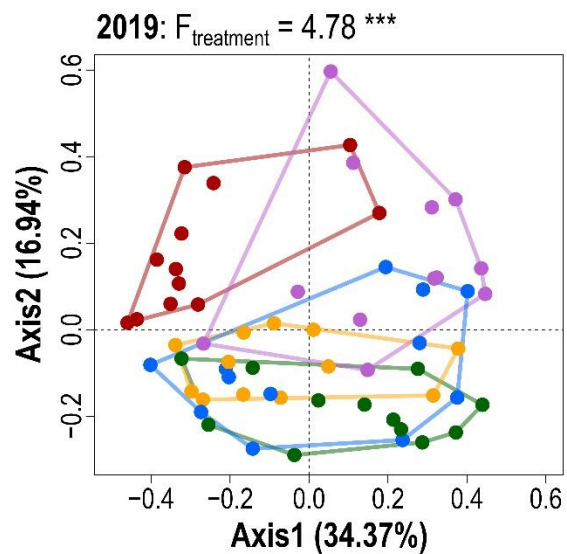
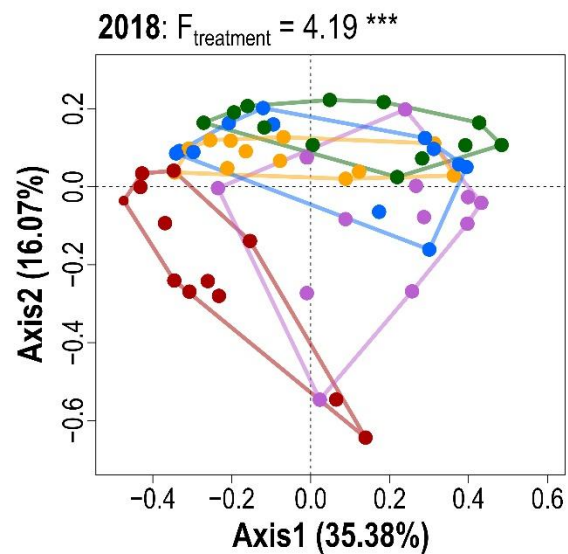
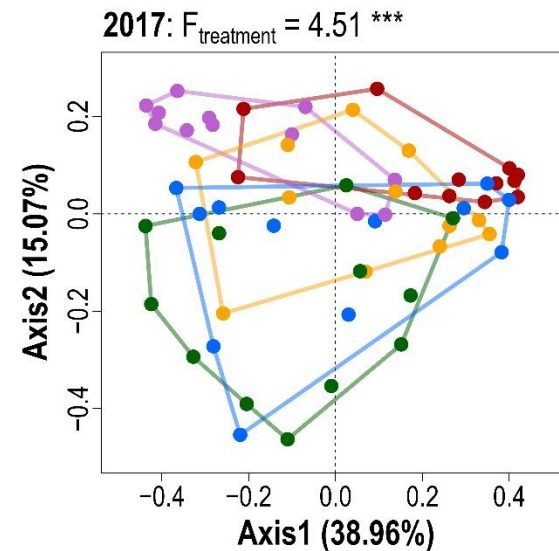
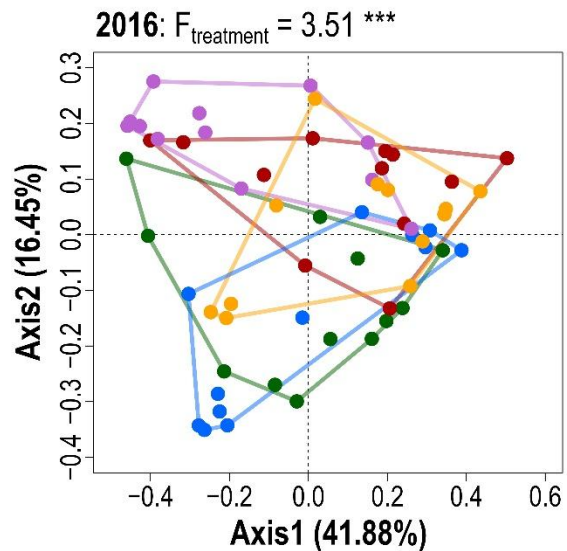
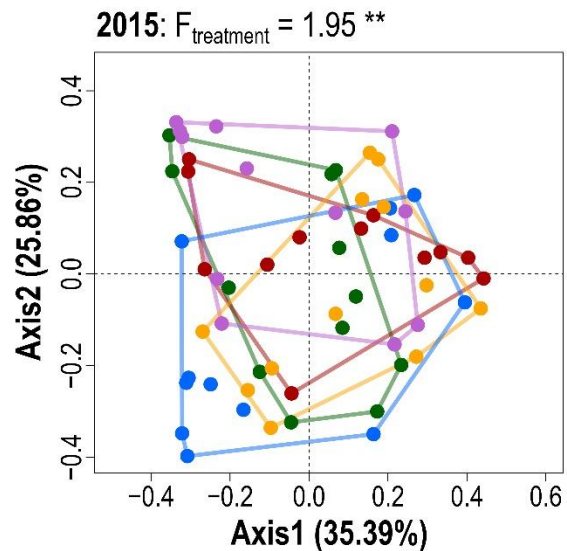
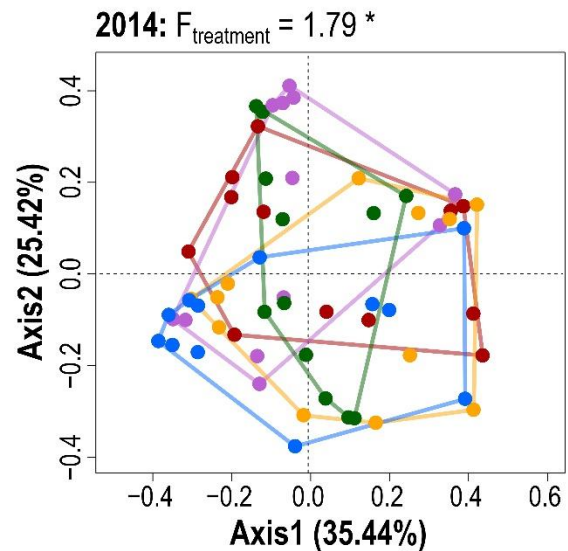
# Understorey - cover



# Understorey – species richness



# Understorey – species composition



## Treatment types:

- Control
- Clear-cutting
- Gap-cutting
- Partial cutting
- Retention tree group

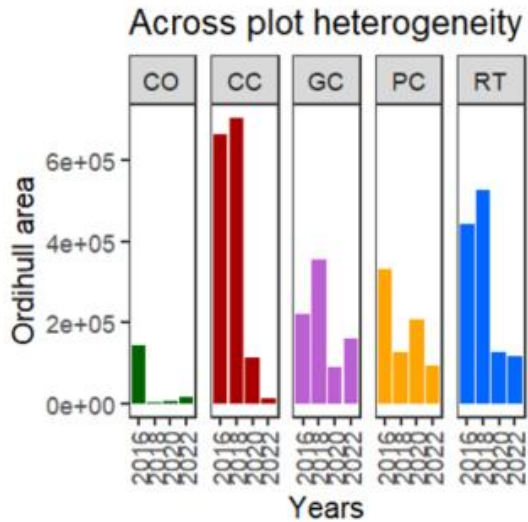
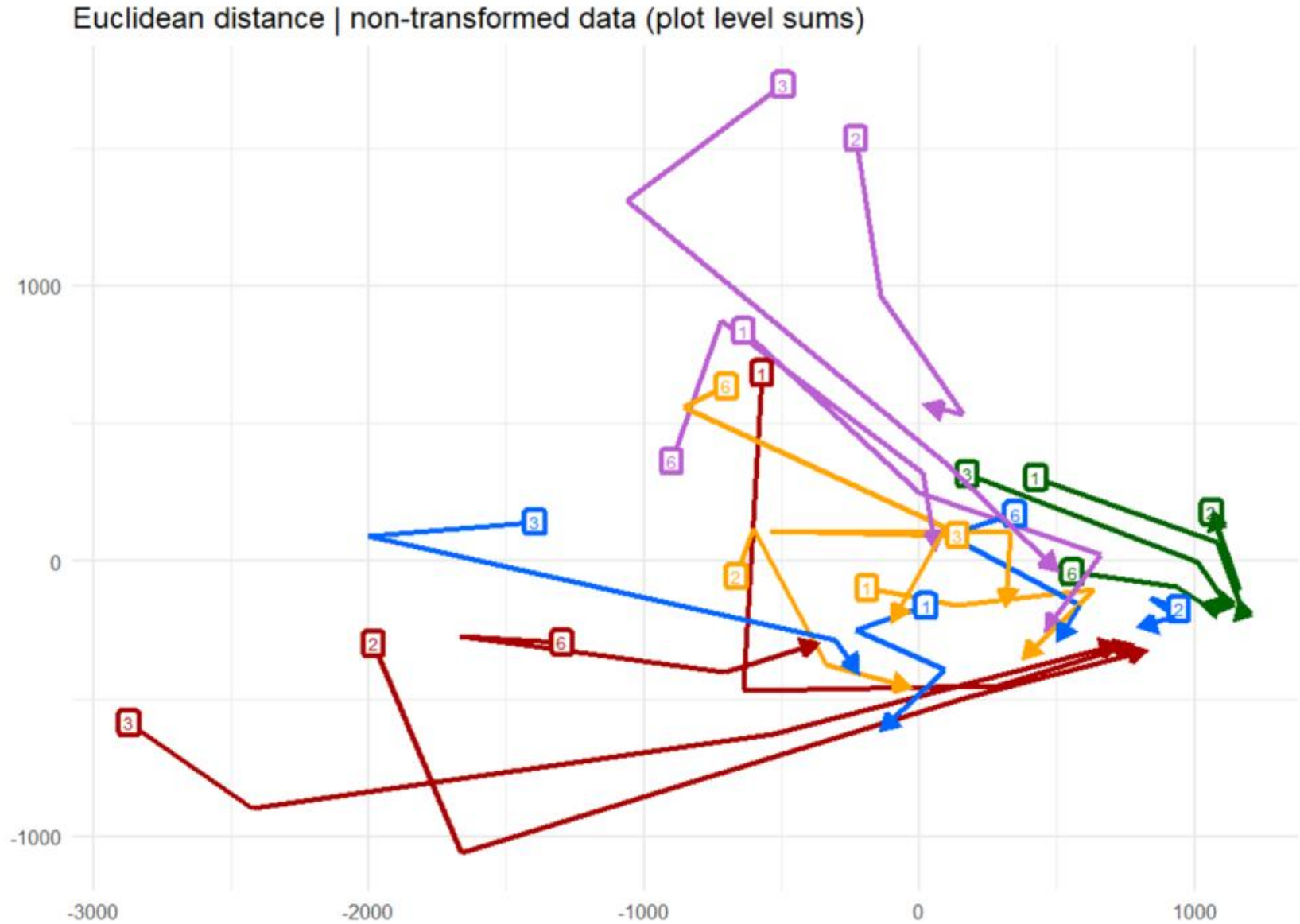
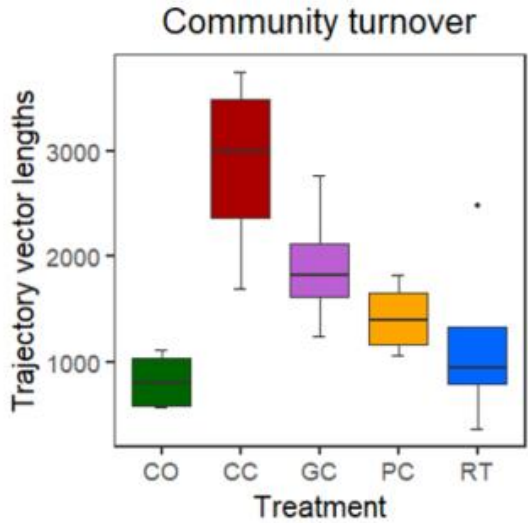
## Significance codes:

- \*\*\*  $\leq 0.001$
- \*\*  $\leq 0.01$
- \*  $\leq 0.05$

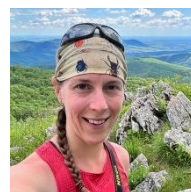
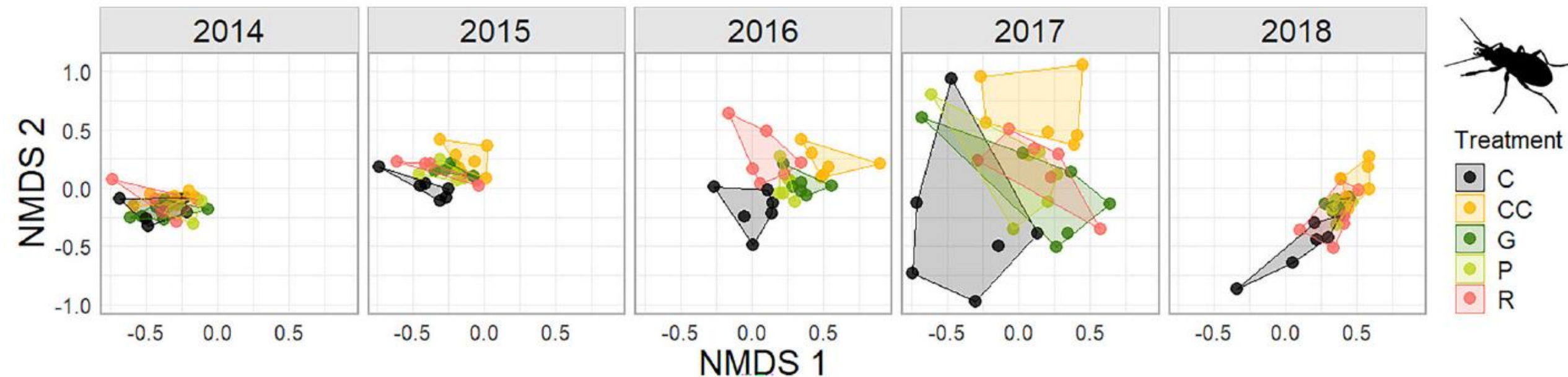


**Réka Aszalós**  
 Forest Ecology and Management  
 549: 121438  
<https://doi.org/10.1016/j.foreco.2023.121438>

# Understorey - composition change (2016-2022)



# Carabidae – species composition



Ruzickova et al. 2025. *Insect Conservation and diversity* 2025:1-13.

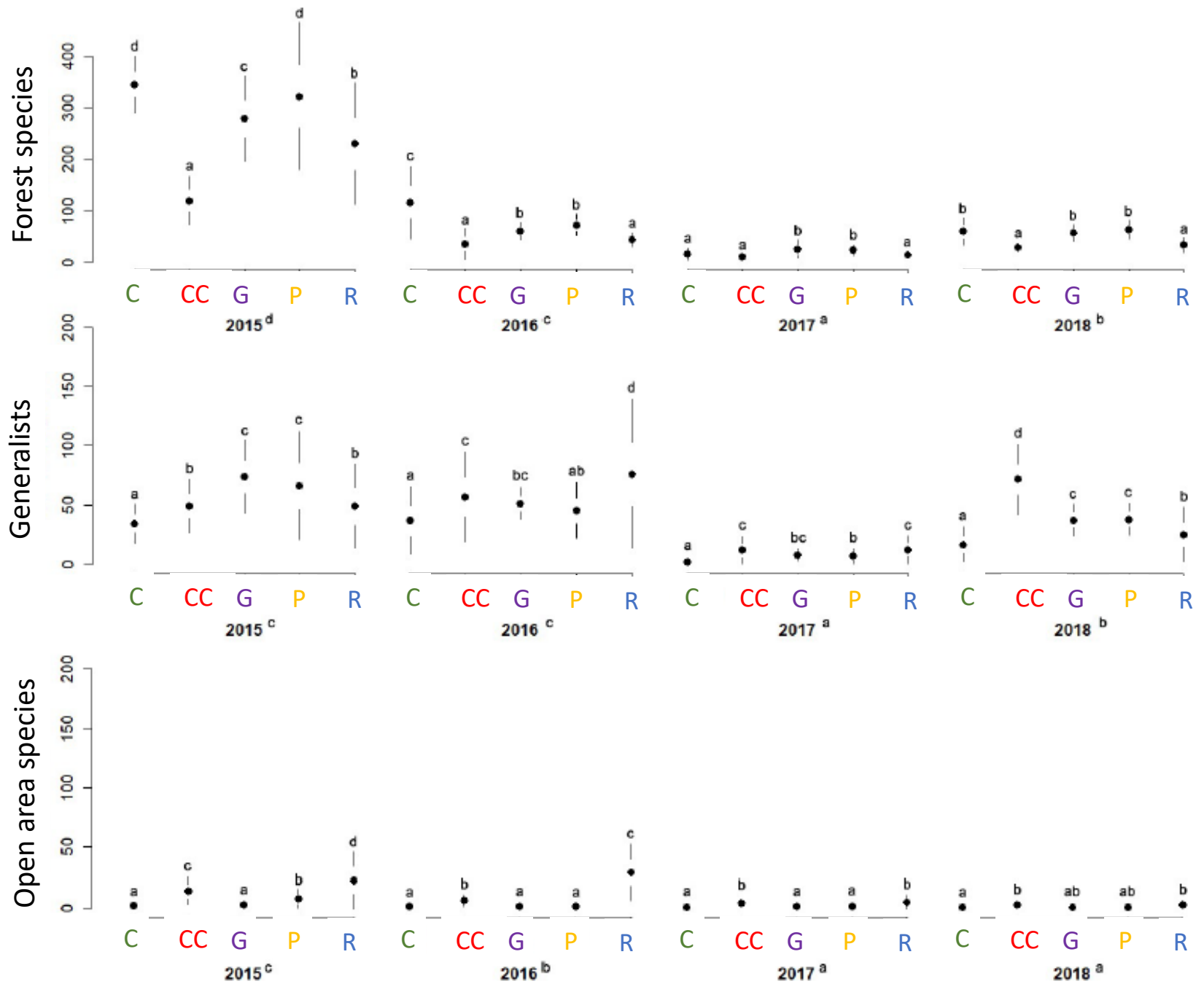
<https://doi.org/10.1111/icad.12849>

# Carabidae - Abundance of functional groups

C – Control  
 CC – Clear-cutting  
 G – Gap-cutting  
 P – Preparation cutting  
 R – Retention tree group



Elek et al. 2022. Ecological  
 Applications 32(1): e02460,  
<https://doi.org/10.1002/eap.2460>

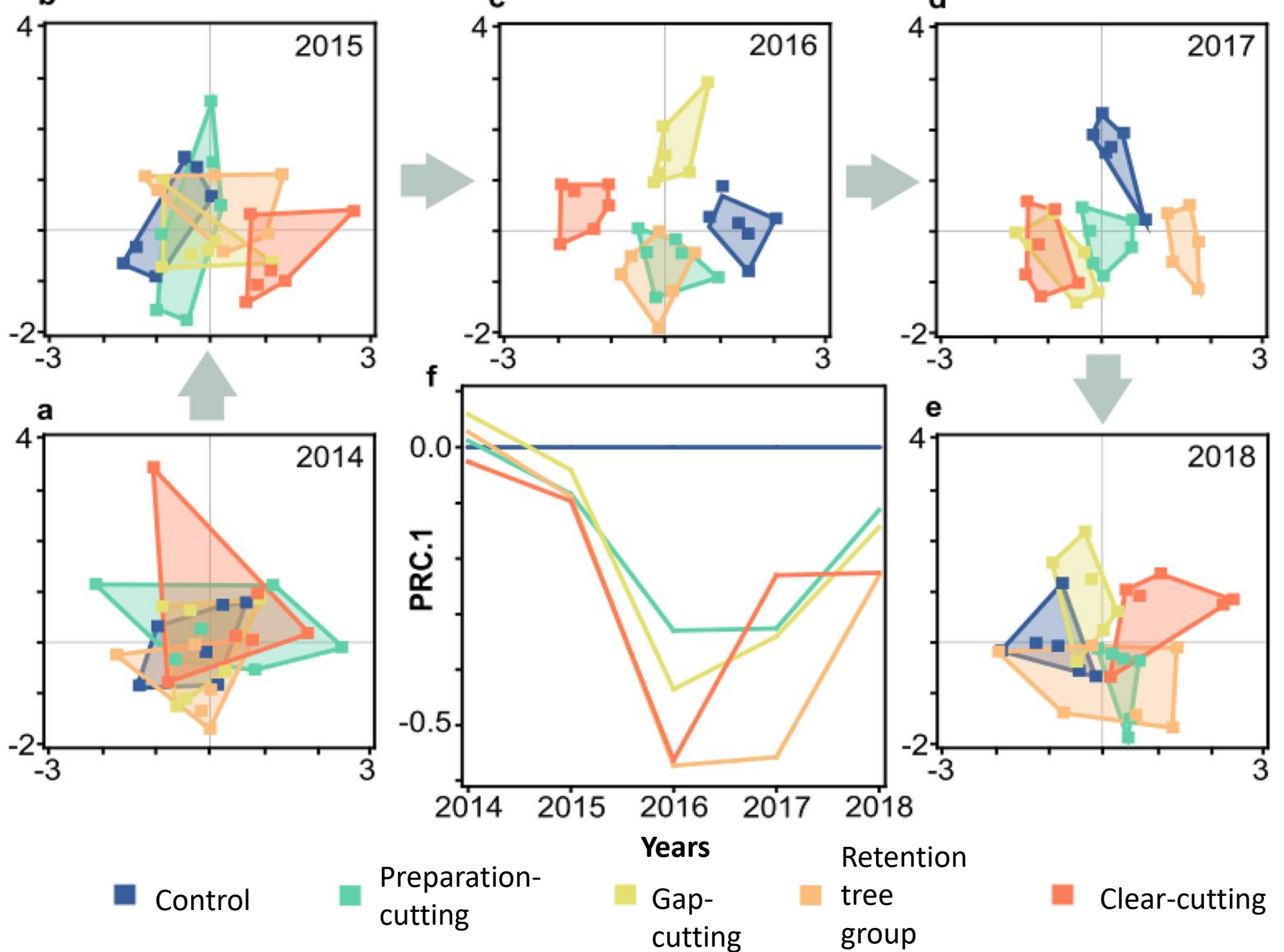


# Spiders Species composition



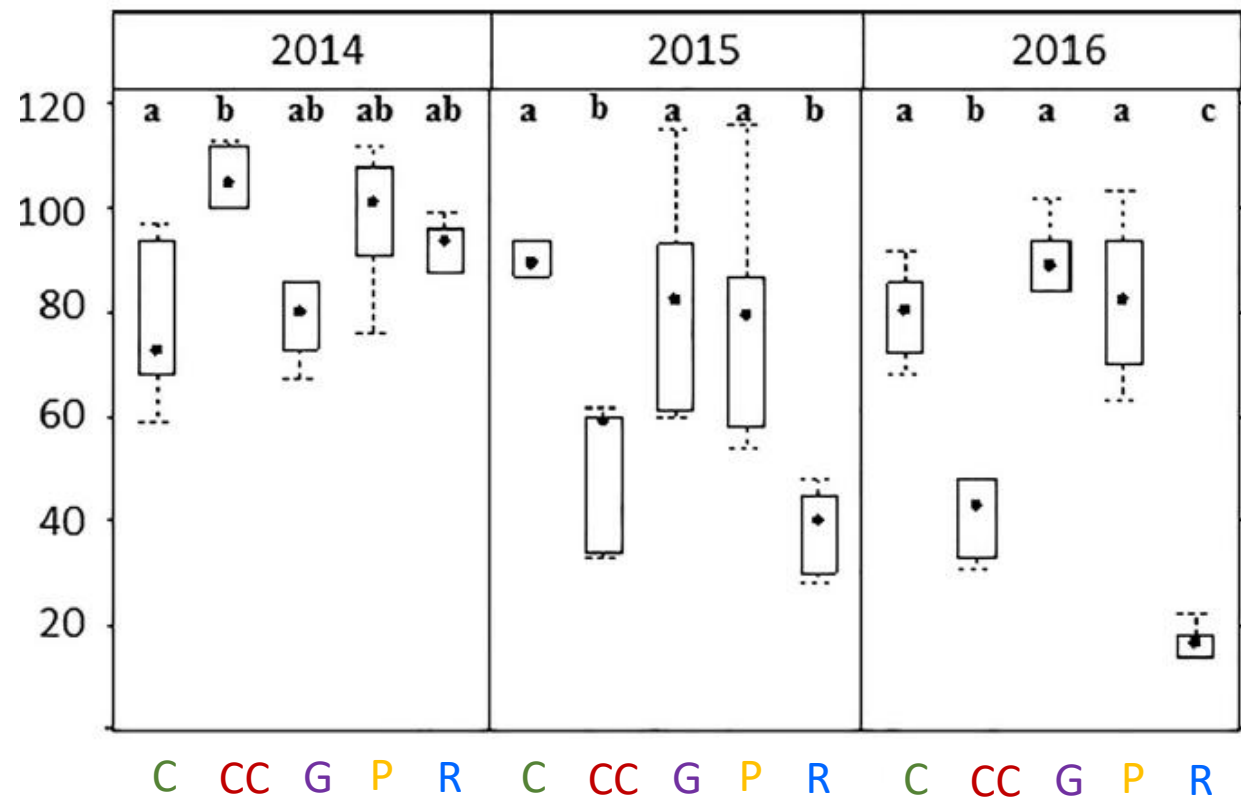
Samu et al. 2021. Scientific Reports 11: 20520

<https://doi.org/10.1038/s41598-021-99884-8>

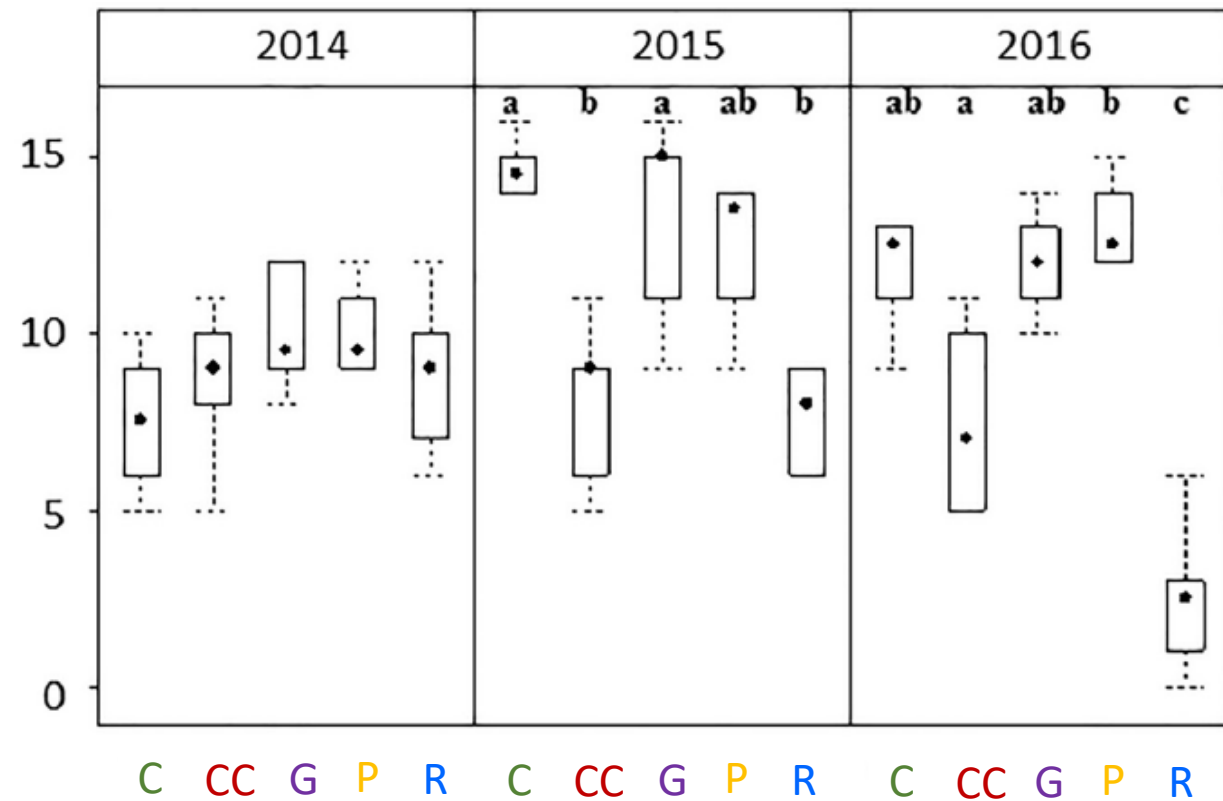


# Enchytraeid worms

Abundance



Species richness

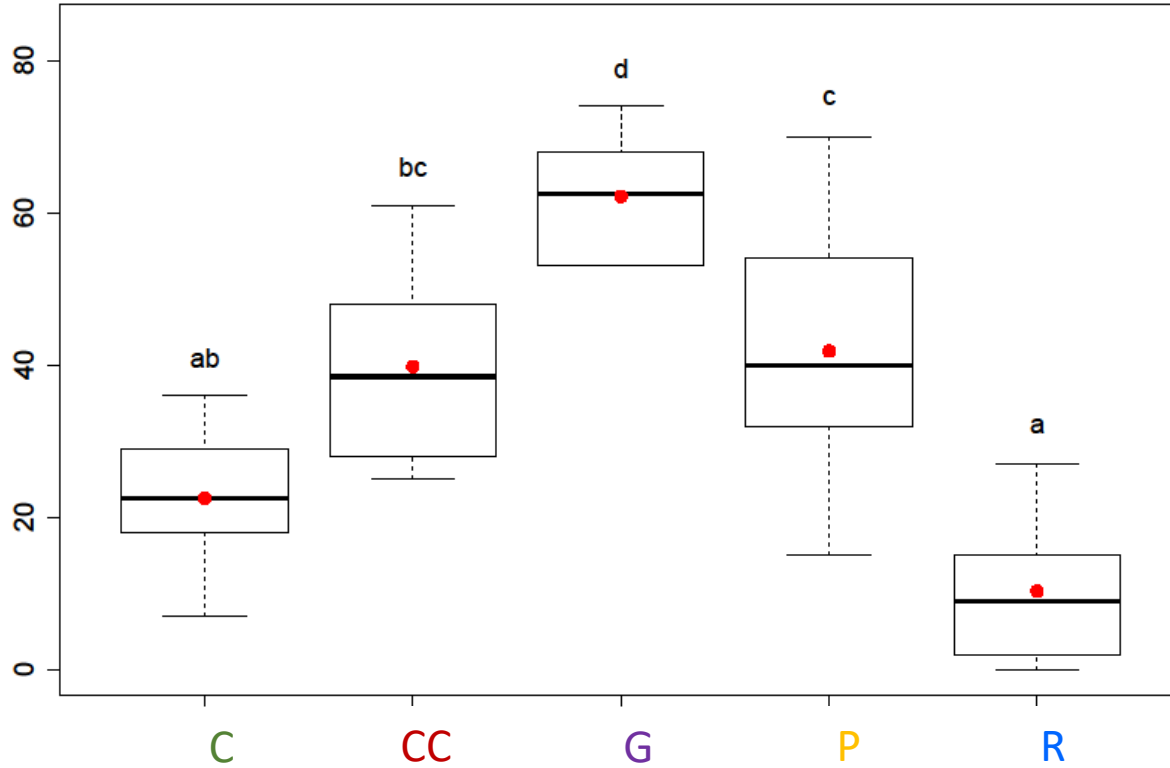


- C – Control
- CC – Clear-cutting
- G – Gap-cutting
- P – Preparation cutting
- R – Retention tree group

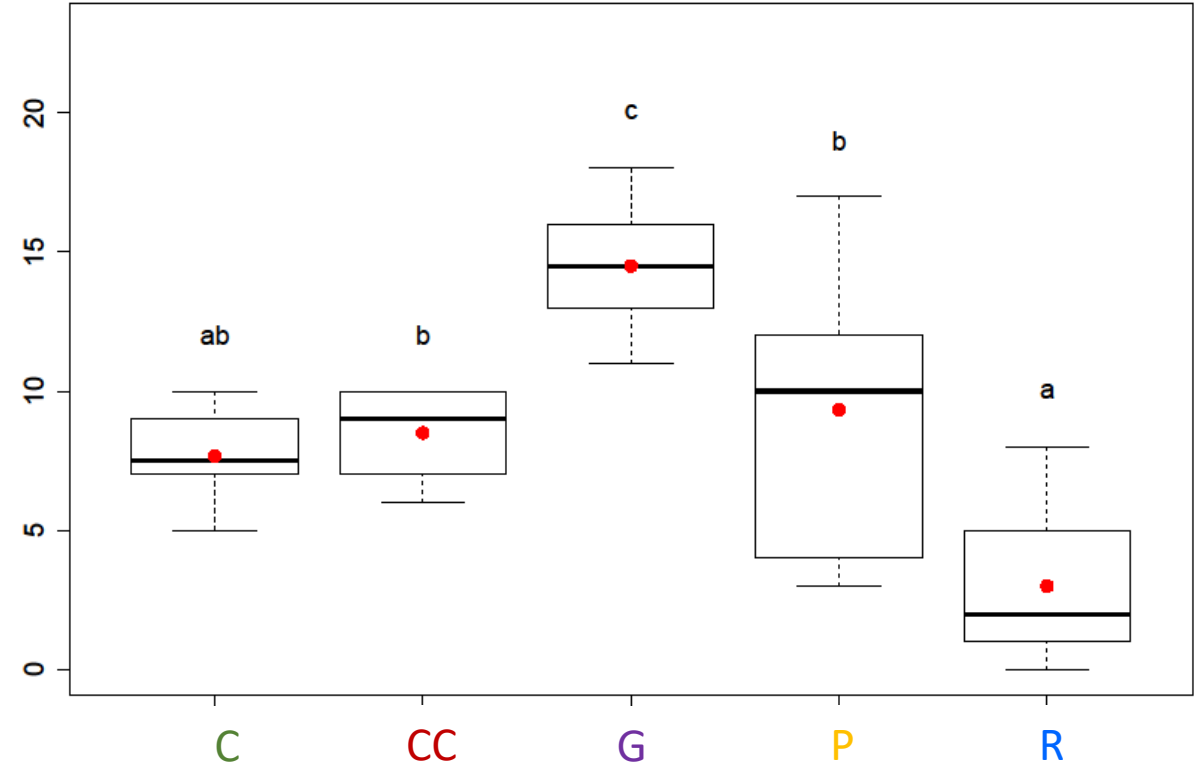


# Crane flies (Tipulidae) 2017

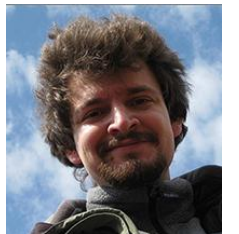
Abundance



Species richness



- C – Control
- CC – Clear-cutting
- G – Gap-cutting
- P – Preparation cutting
- R – Retention tree group

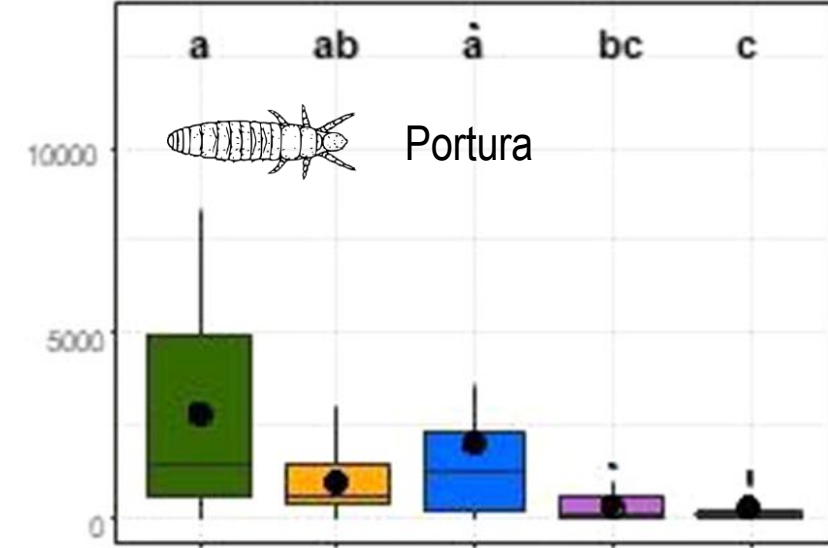
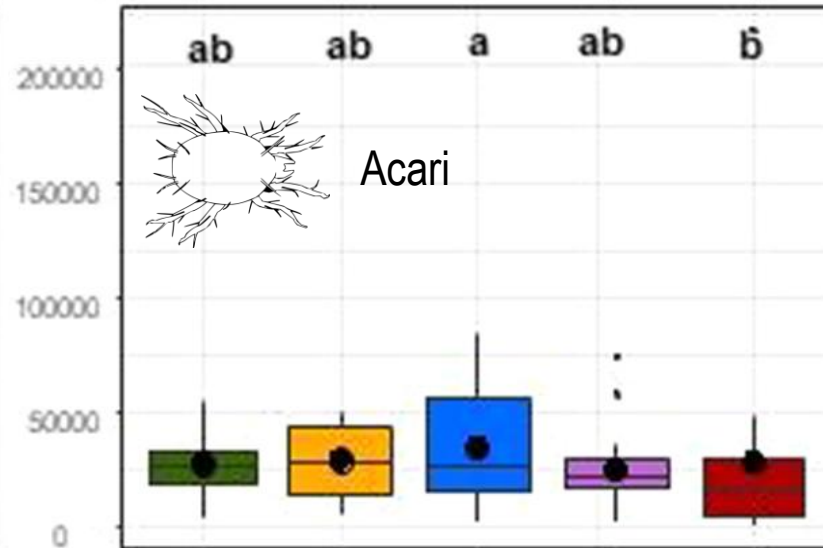
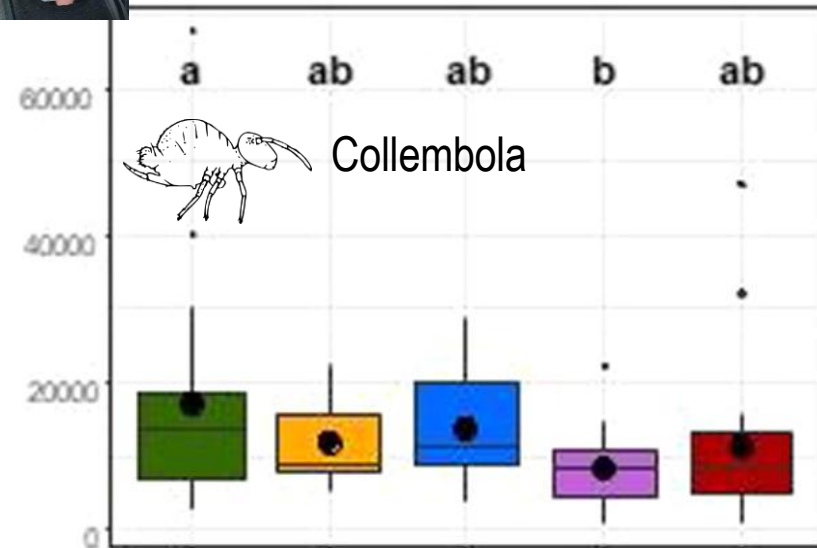


Zoltán Soltész in prep.



# Densities of soil mesofauna groups in 2023

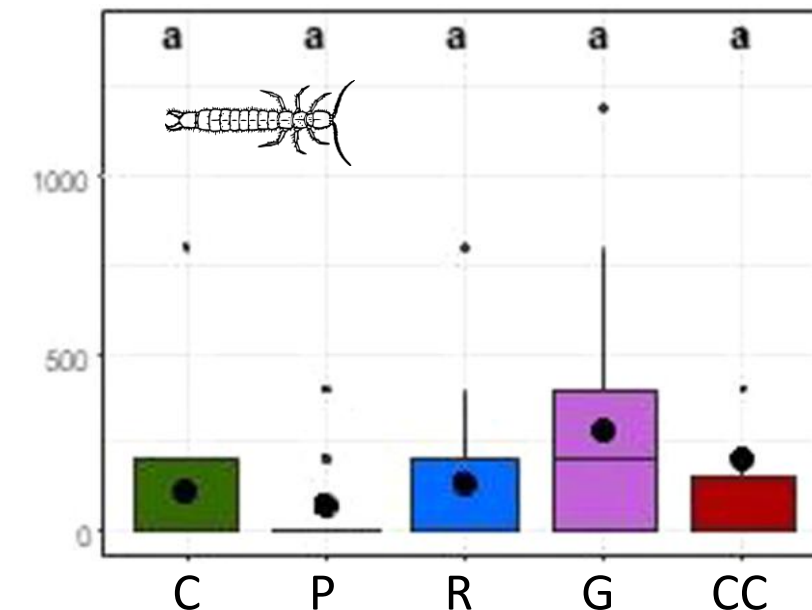
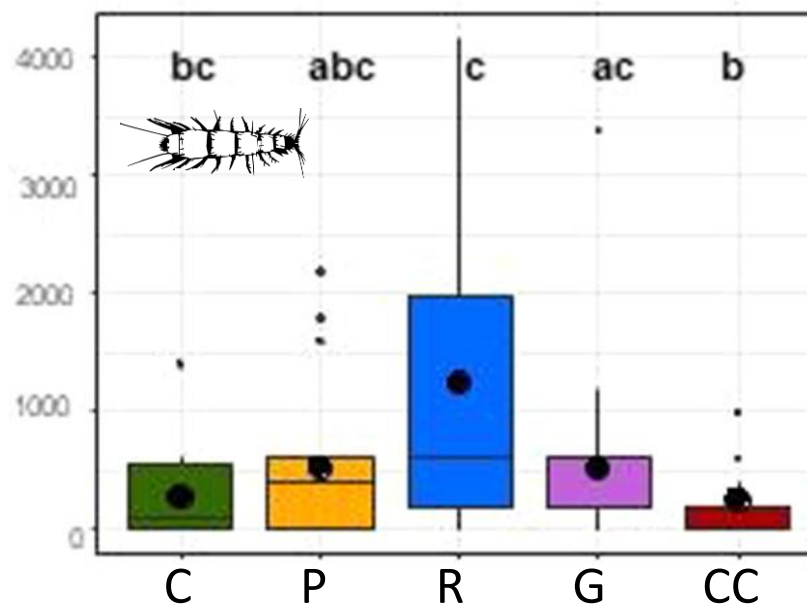
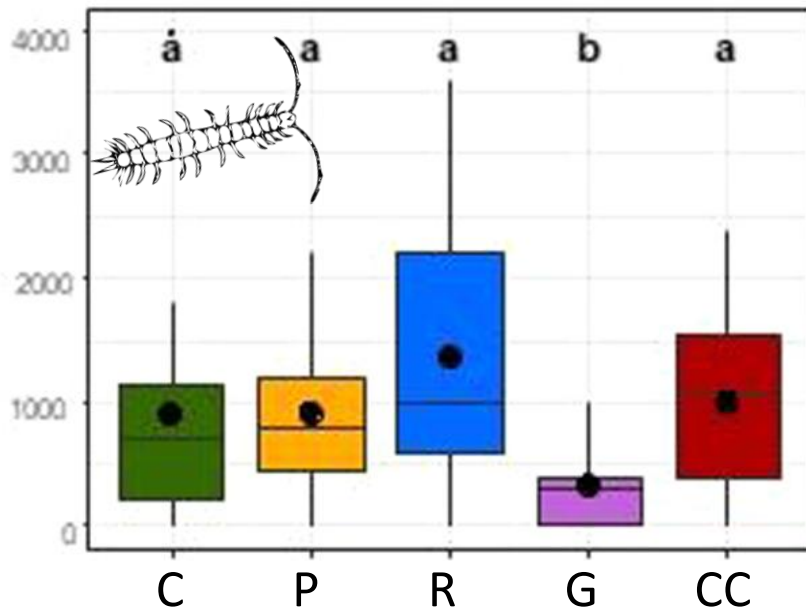
Flórián et al. 2025. Forest Ecology and Management 593: 122857, <https://doi.org/10.1016/j.foreco.2025.123196>



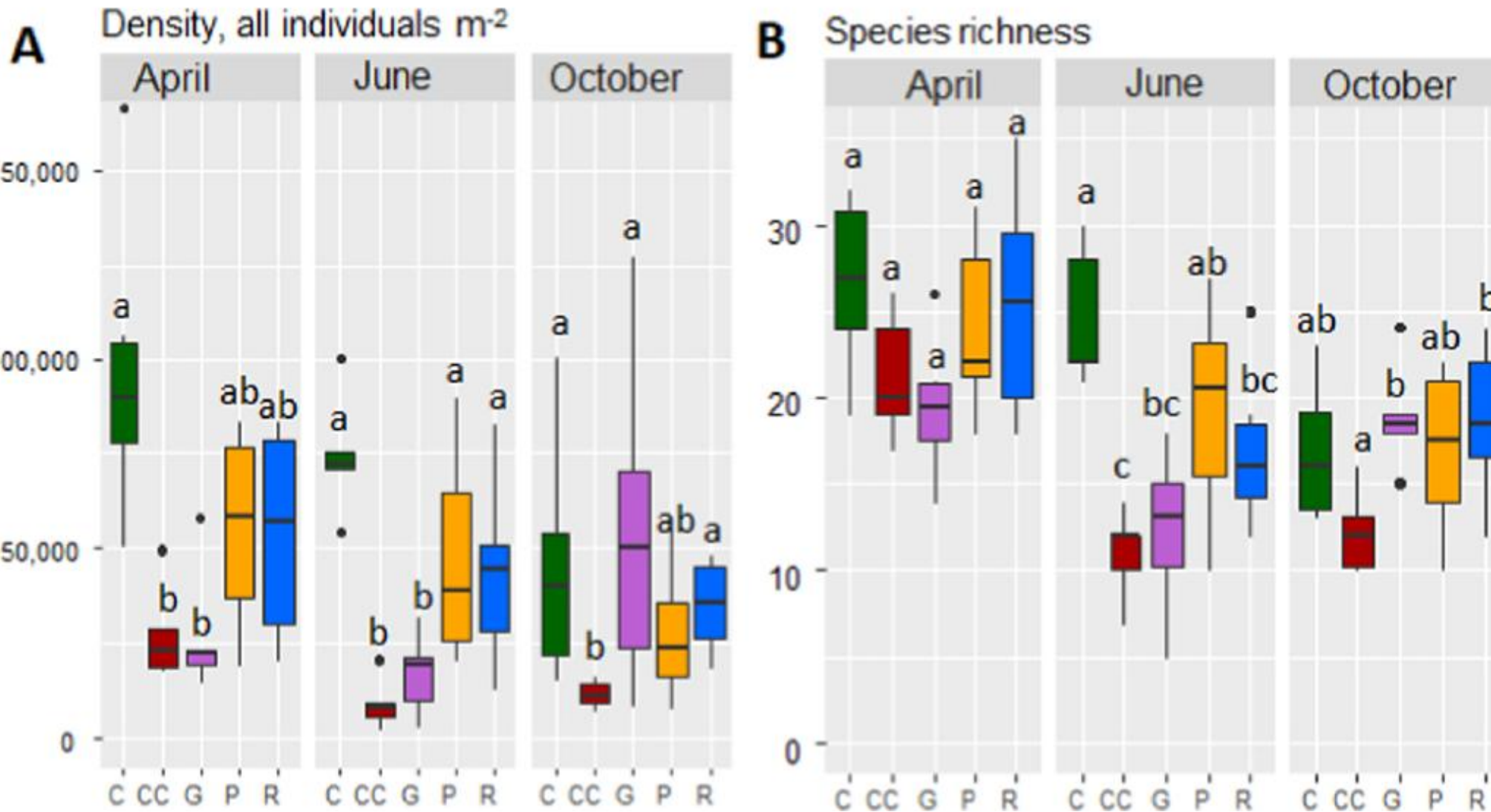
Symphyla

Pauropoda

Diplura



# Oribatid mites (Acari: Oribatides) in 2020

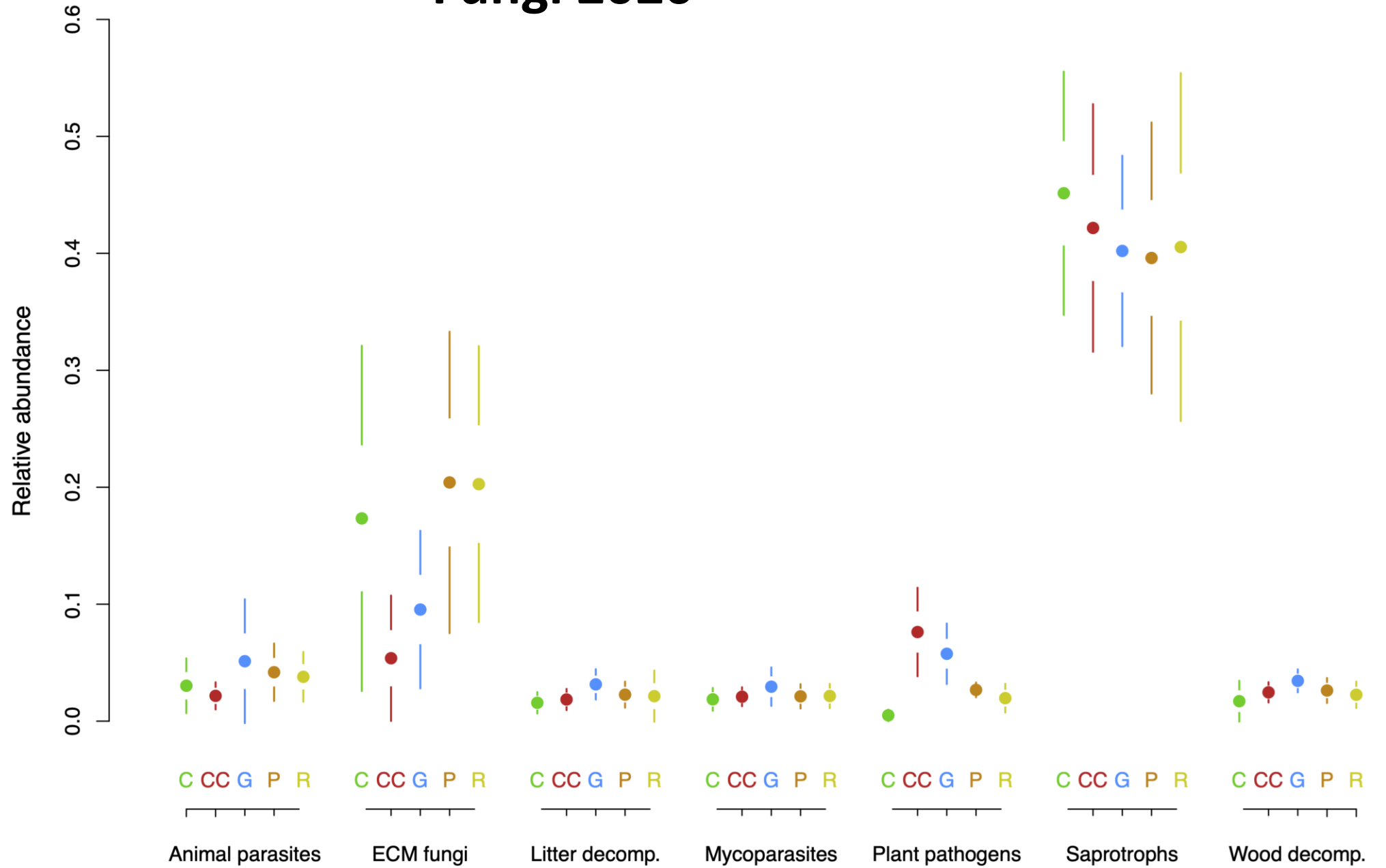


Gergőcs-Winkler et al.  
2025. *Journal of Soil Biology* 127: 103790.  
<https://doi.org/10.1016/j.ejsobi.2025.103790>

# Fungi 2020



József Geml in prep.



# Conclusions

- Clear-cutting: extreme microclimate, good for regeneration, non-forest understory species, unfavorable for soil organisms, non-forest carabids, fungi composition changed.
- Gap: balanced microclimate, soil moisture increment, good for regeneration, light-flexible forest species in understory, favorable for soil organisms, forest carabids, fungi composition changed.
- Preparation cutting: Microclimate similar to control, moderate regeneration, increased understory cover with forest species, animal and fungi community similar to control.
- Retention tree group: warmer and drier microclimate, low soil moisture, no regeneration, understory similar to control more species from forest edges, unfavorable for soil organisms but later regeneration, non-forest carabids.
  
- Treatment of continuous cover forestry as gap-cutting, partial cutting, thinning provide regeneration but more favorable for microclimate and forest biodiversity than treatment of rotation forestry.
- In case of rotation forestry large retention tree groups are necessary to compensate the effect of final cuttings.
- Soil organisms were the most sensitive groups
- Composition and functional groups better indicators than general species richness or abundance.



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Csaba Németh

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