BOTTOMS-UP

# Impact of coppicing on microclimate and understorey vegetation: evidence from an ancient Mediterranean oak forest

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NATIONAL BIODIVERSITY FUTURE CENTER

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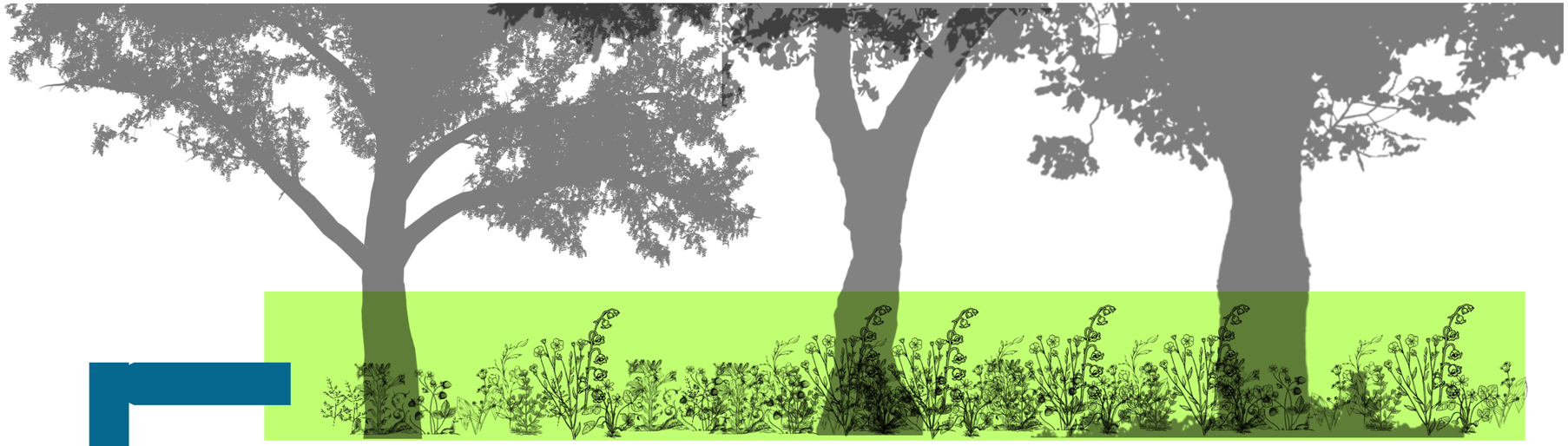
# BACKGROUND: understorey



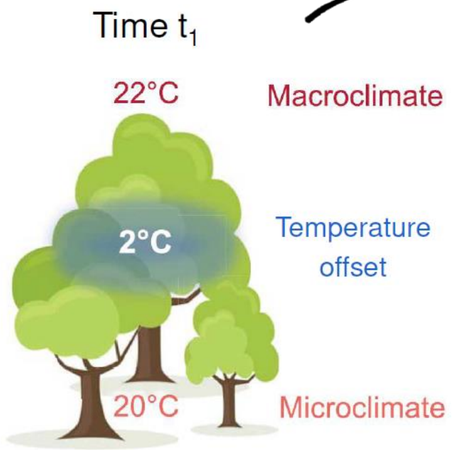
Understorey vegetation (UV) represents the 80% of temperate forest plant diversity (Gilliam 2007)

supports several forest ecosystem services

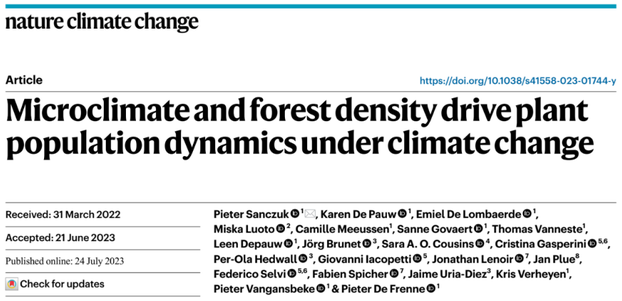
**Global warming is causing UV thermophilization!**

# BACKGROUND: microclimate

**The potential of forests to buffer thermophilization**







nature climate change

Article

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**Microclimate and forest density drive plant population dynamics under climate change**

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Check for updates

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**Microclimate is related to forest structure**

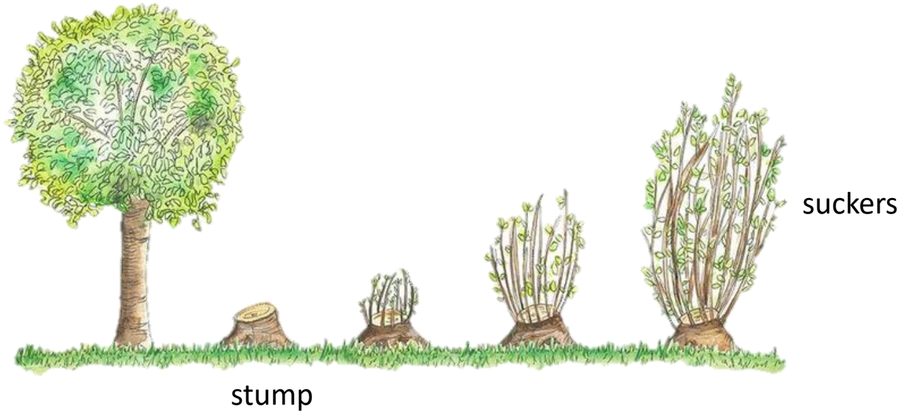

**amplifes macroclimate change impacts**


**mitigates severe warming impacts**

Thermophilization of UV can be mitigated depending on **management type**

# BACKGROUND: management

Traditional coppice-with-standards is still widely used in S Europe for firewood production




**Lack of evidence about coppice impacts on microclimate**

strong impact on forest structure

**possible exacerbation of UV thermophilization processes**

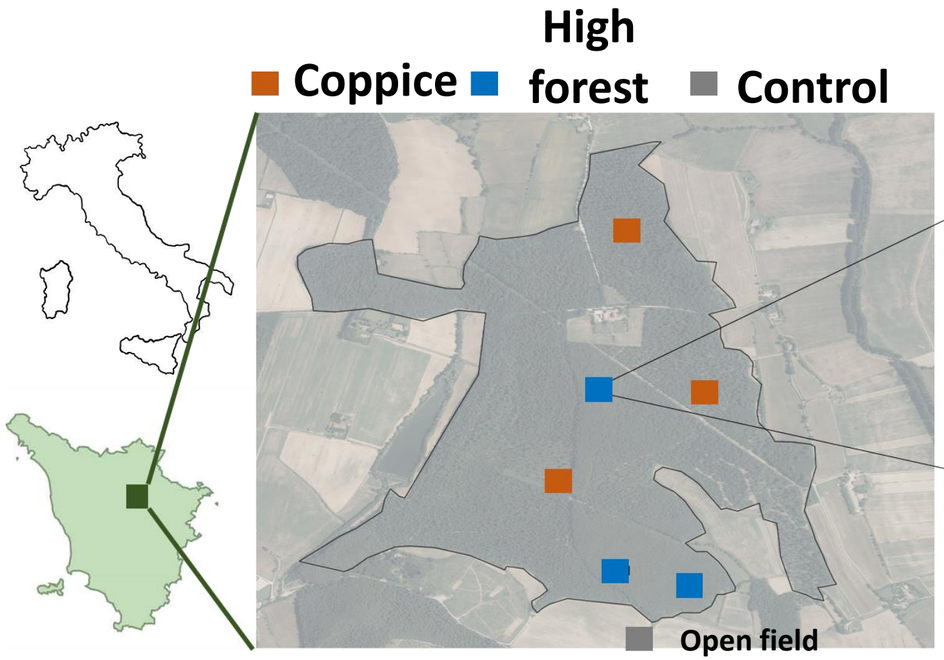
**directional shifts in UV diversity, composition and functional profiles…**

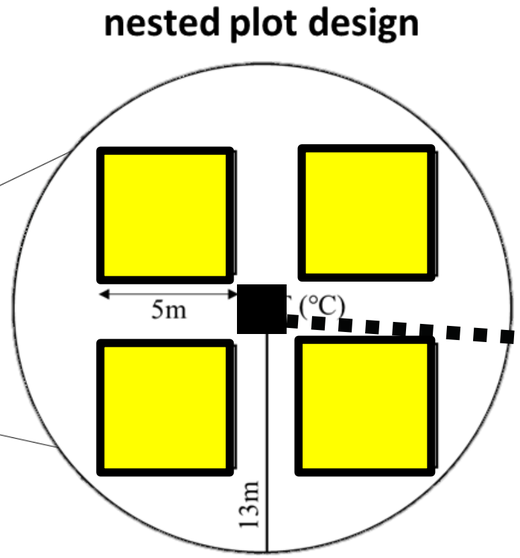
# STUDY QUESTIONS

- HOW IS THE OAK FOREST MICROCLIMATE IMPACTED BY COPPICING ?

- WHAT ARE THE EFFECTS ON UV COMPOSITION and DIVERSITY (TAXONOMIC, FUNCTIONAL, PHYLOGENETIC)?

# SAMPLING DESIGN





**Deciduous mixed oak forest (*Q.cerris* and *Q. petraea*) of central Tuscany (Italy)**

High forest

Coppice


- AIR AND SOIL TEMPERATURE (2021-2023)
- STRUCTURAL VARIABLES, OVERSTOREY COMPOSITION
- UNDERSTOREY SURVEY (1.3 m)

# Analysis of different aspects of UV diversity

METHODS

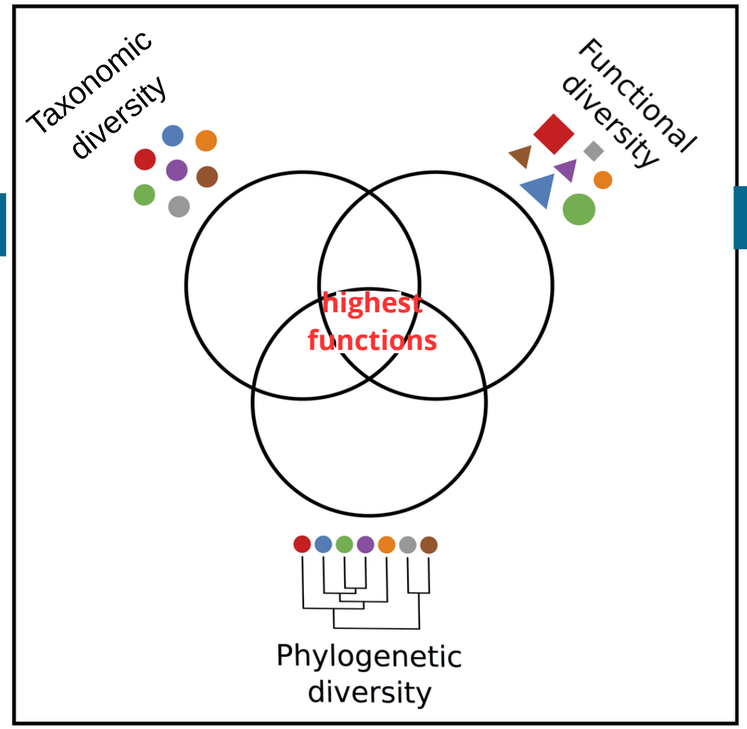
**SPECIES RICHNESS (SR), SHANNON INDEX (H'), EVENNESS (J)**

**COMPOSITION**

- Indicator species,
- forest guilds (Heinken 2022), community thermal niches (Vangansbeke 2021)

ClimPlant DB

R packages: vegan, Indicspecies

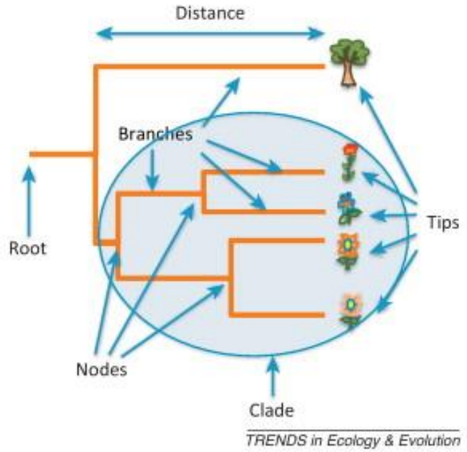



**SPECIFIC LEAF AREA INDEX (SLA)**
**LEAF DRY MATTER CONTENT (LDMC)**
**VEGETATIVE HEIGHT (VEGH),**
**REPRODUCTIVE HEIGHT (REPH)**
**SEEDMASS**

collected from TRY DB

community weighted value: CWM
value standardized on SR: RAO.ses

R package: FD




**PHYLOGENETIC DIVERSITY (PD), MEAN NEAREST TAXON DISTANCE (MNTD), MEAN PAIRWAISE DISTANCE (MPD)**

value standardized on SR: PD.ses, Mntd.ses, mpd.ses

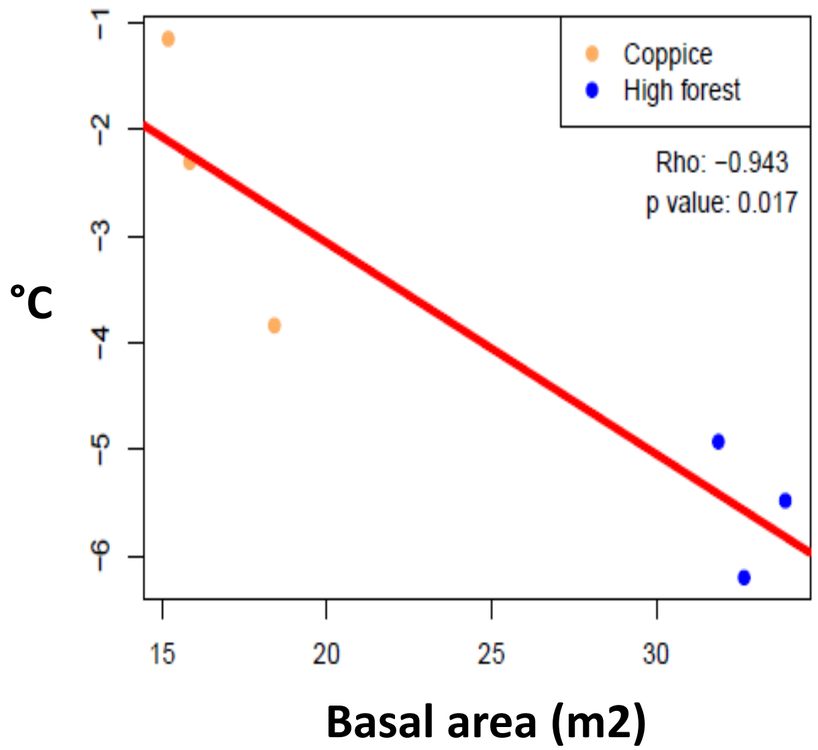
R packages: V.PhyloMaker2, Picante

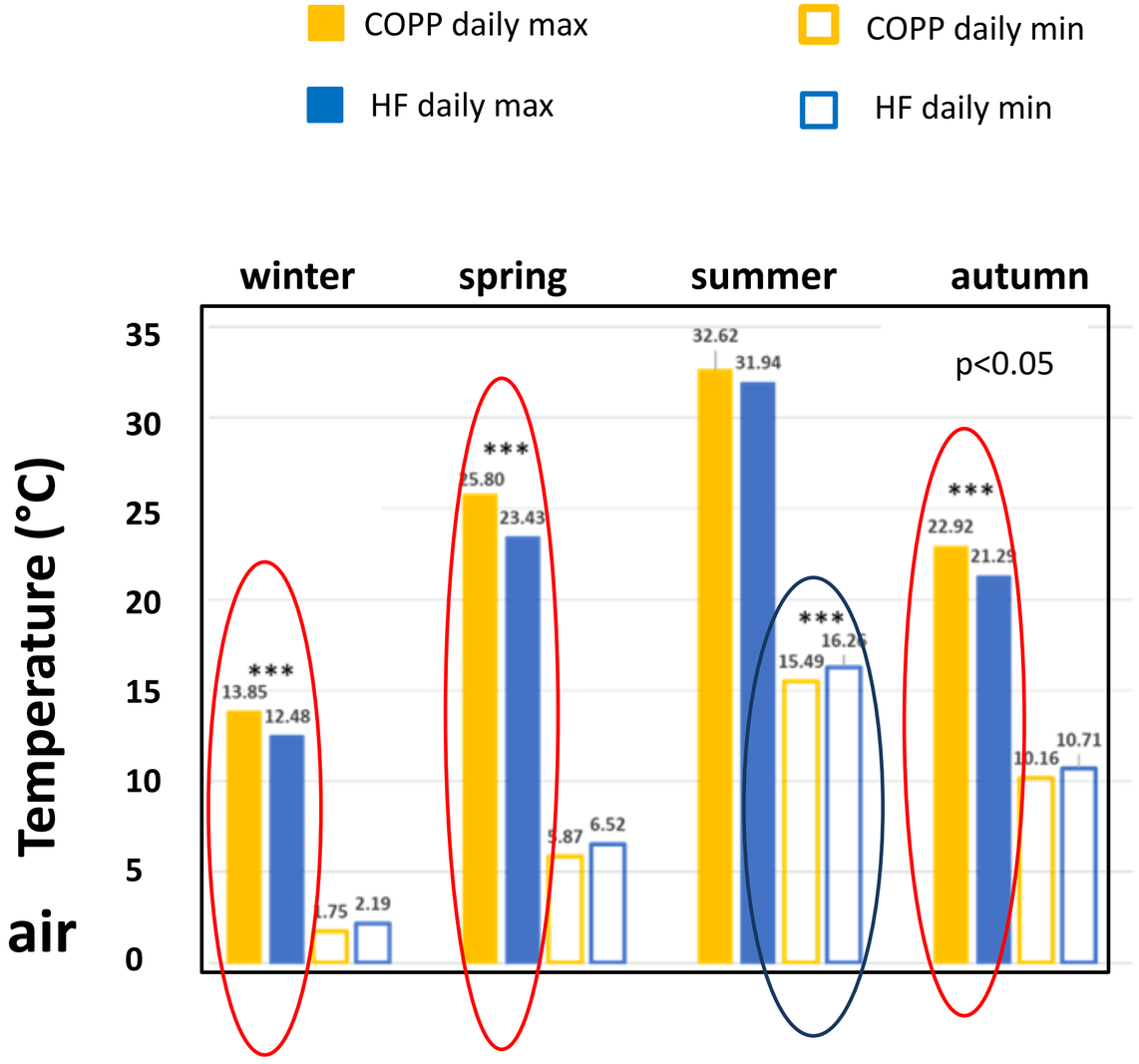
# 1.REDUCED TEMPERATURE BUFFERING IN COPPICE STANDS



**Tmax:** 1.45 °C higher in coppice stands (3 yrs average)

**Offset: T max forest - Tmax open field**



# 2.CHANGES IN UV COMPOSITION AND TAXONOMIC DIVERSITY

## High forest


*Malus florentina*


*Anemone nemorosa*


*Physospermum cornubiense*


*Pyrus pyraster*


*Carpinus betulus*


*Ruscus aculeatus*

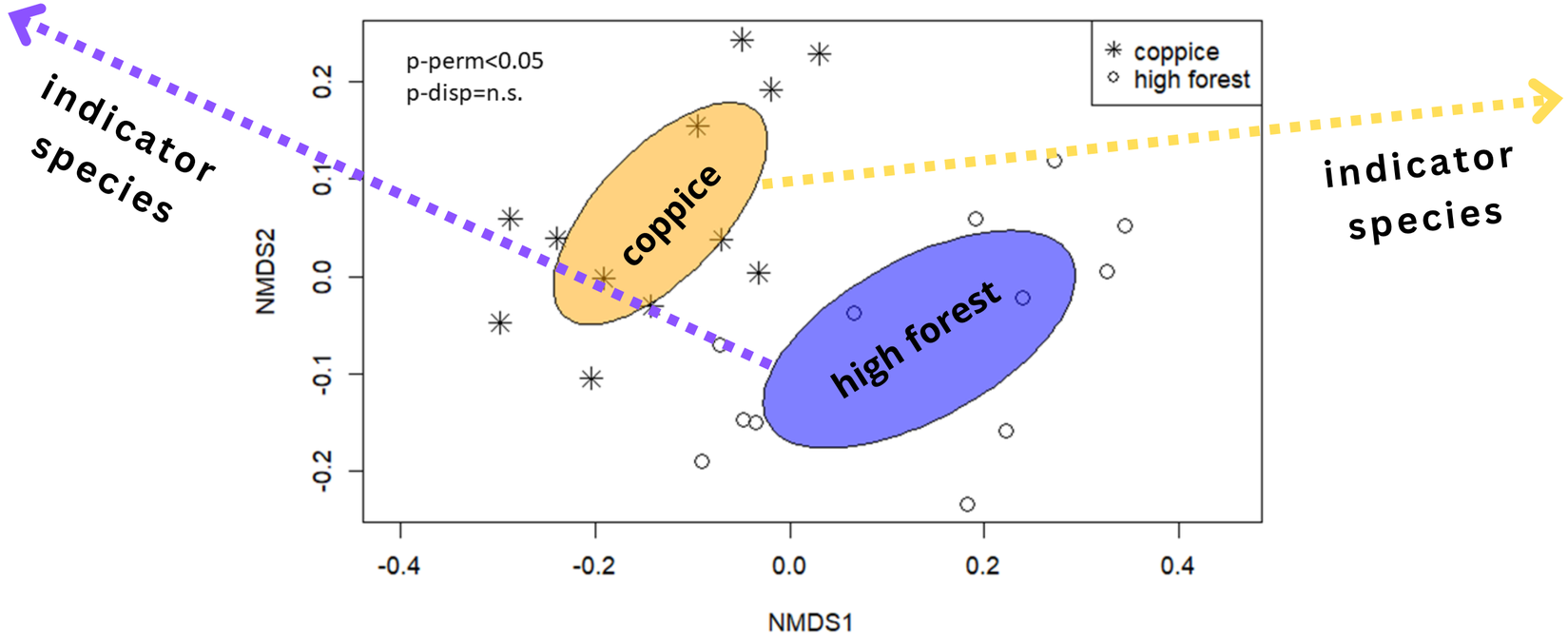
**mixed model results:**
**y~forest management+1|plot**

**TOTAL SPECIES RICHNESS** ↓

↑ **+4.6** ***

*** **+80%** ↑

**FOREST SPECIALISTS (NUMBER AND ABUNDANCE)** ↓




## Coppice


*Poa nemoralis*


*Carex pallescens*


*Calluna vulgaris*

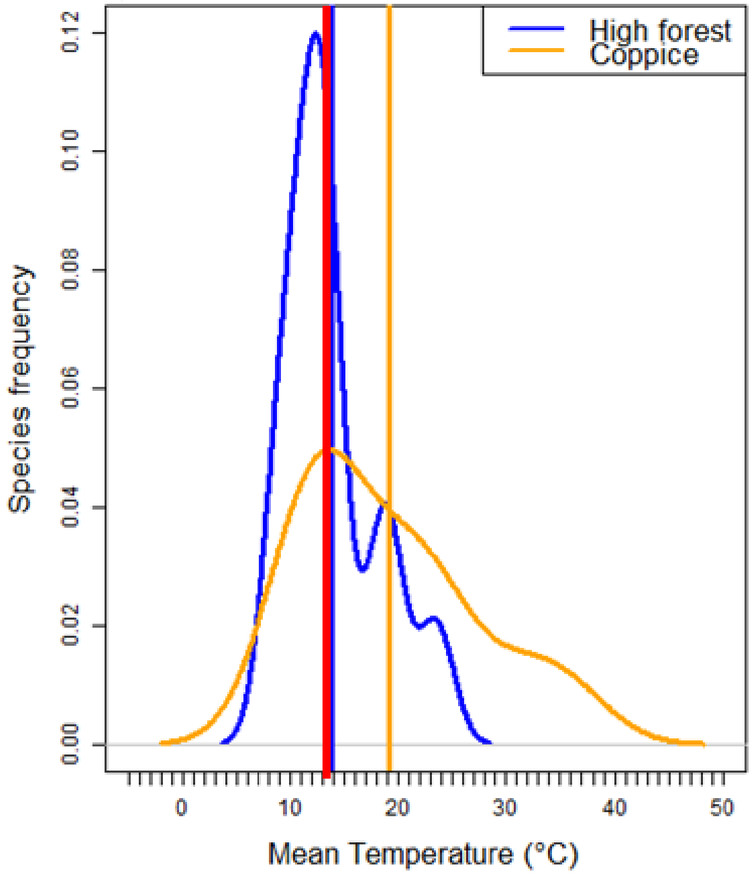

*Genista pilosa*


*Cruciata glabra*

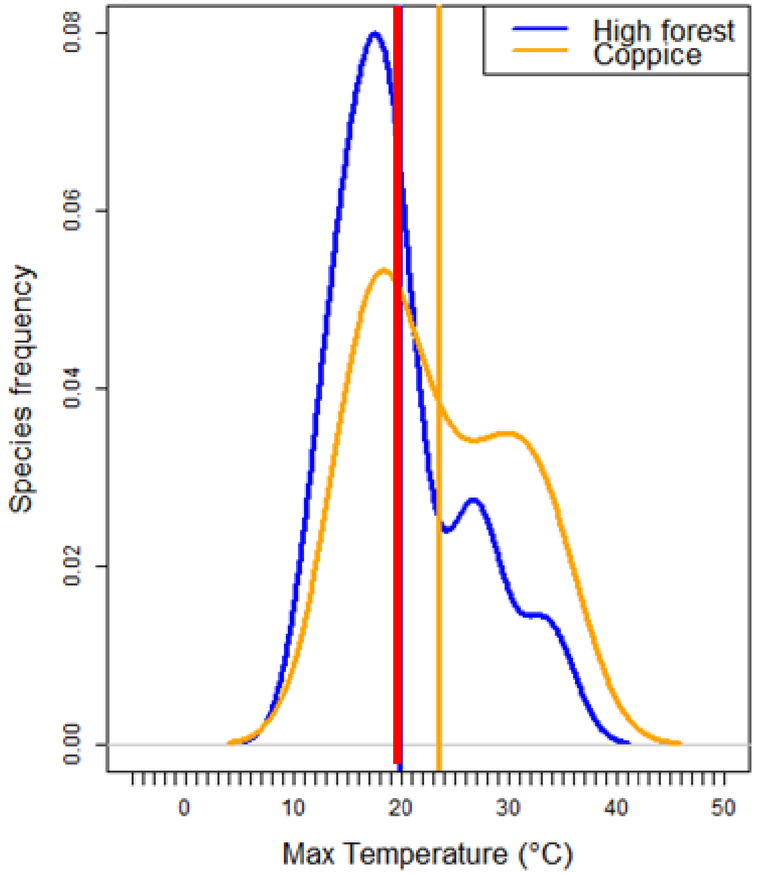

*Viola alba*

# 3. Shift towards more thermophilous UV communities in coppice

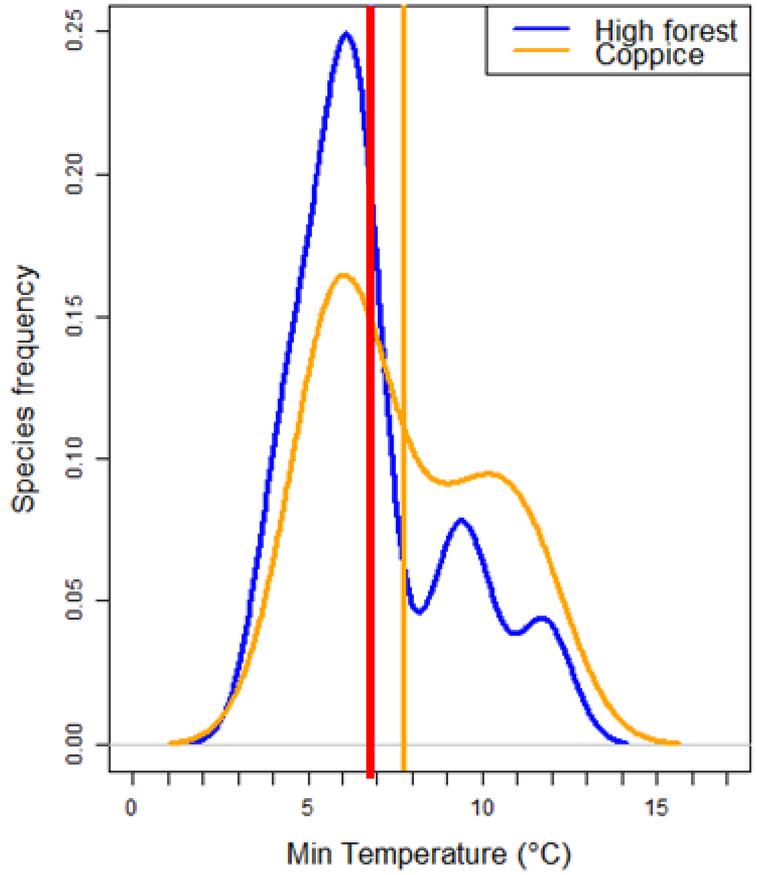
Coppice effect




Coppice effect



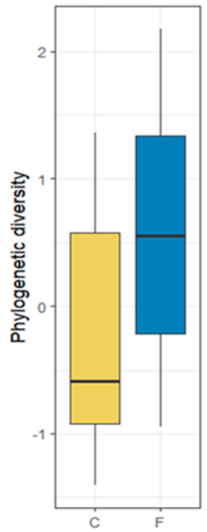

Coppice effect



# 4. LOSS OF PHYLOGENETIC DIVERSITY AND EVENNESS IN COPPICE



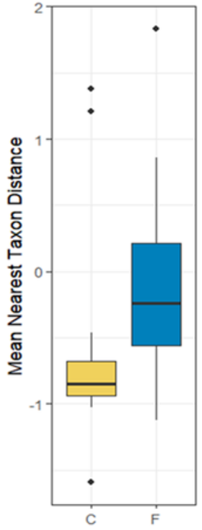
## High forest




* +0.72 STANDARDIZED PHYLOGENETIC DIVERSITY

+0.11 STANDARDIZED MEAN PAIRWISE DISTANCE

+0.46 STANDARDIZED MEAN NEAREST TAXON INDEX




+0.41 STANDARDIZED MEAN PAIRWISE DISTANCE

*** +0.99 STANDARDIZED MEAN NEAREST TAXON INDEX

mixed model results:
y~forest management+1|plot

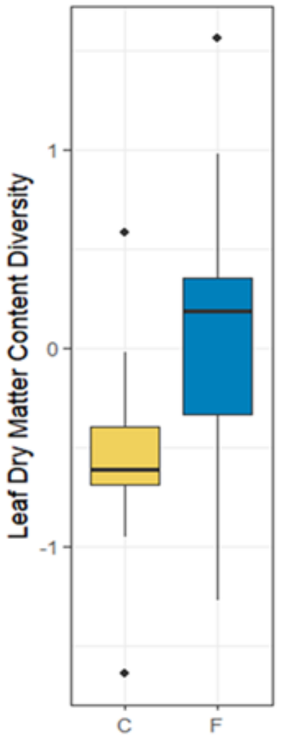
## Coppice

**Phylogenetic clusterization (by habitat filtering)**

# 5. CHANGES IN CWM and DIVERSITY(LDMC)



## High forest




mixed model results:
y~forest management+1|plot

## Trait CWM

| | | |
|---|---|---|
| SPECIFIC LEAF AREA | ↑ | +0.96 |
| LEAF DRY MATTER CONTENT | ↑ | +12.32 |
| VEGETATIVE HEIGHT | ↓ | +1.74 |
| REPRODUCTIVE HEIGHT | | +0.22 |
| SEEDMASS | | +10.69 |

## Trait diversity (Rao.ses)

| | | |
|---|---|---|
| SPECIFIC LEAF AREA | | +0.23 |
| LEAF DRY MATTER CONTENT | ↑ ** | +0.63 |
| VEGETATIVE HEIGHT | ↓ | +0.62 |
| REPRODUCTIVE HEIGHT | | +0.64 |
| SEEDMASS | | +0.04 |

## Coppice

ongoing adaptation processes

# Conclusions

## In coppice stands:

- The **temperature buffering capacity** of the forest is reduced, especially of Tmax during spring.
- UV was more **species-rich**, but with a lower number of **forest specialist**.
- UV consisted of more **warm-adapted** species (thermophilization).
- We observed a loss of **phylogenetic evenness** and shifts in diversity and CWM of **LDMC**, pointing to habitat filtering and acclimation processes.

# Take home message

Need to consider negative effects on microclimate and all facets of diversity for a holistic understanding of coppicing impacts and a more conscious application of this practice in Mediterranean oak woodlands affected by climate warming

ELSEVIER

Science of The Total Environment

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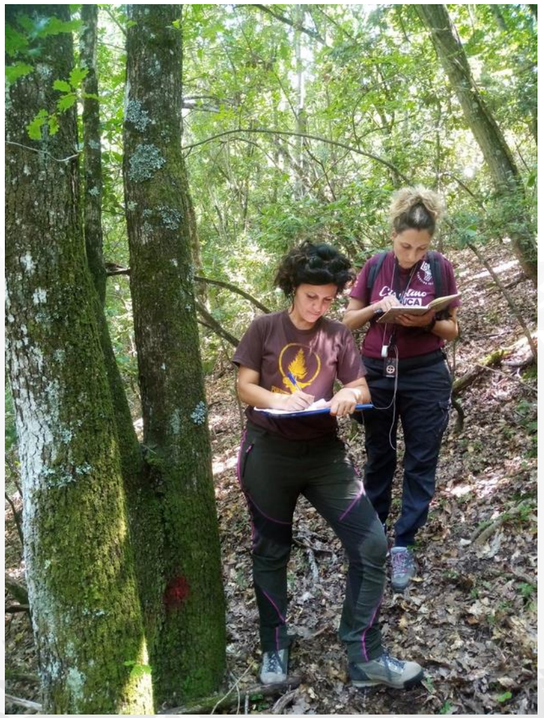
## Impact of coppicing on microclimate and understorey vegetation diversity in an ancient Mediterranean oak forest

Ilaria Santi [a], Elisa Carrari [a], Pieter De Frenne [b], Mercedes Valerio [a, c], Cristina Gasperini [a], Marco Cabrucci [a], Federico Selvi [a]

Show more



# Thank you

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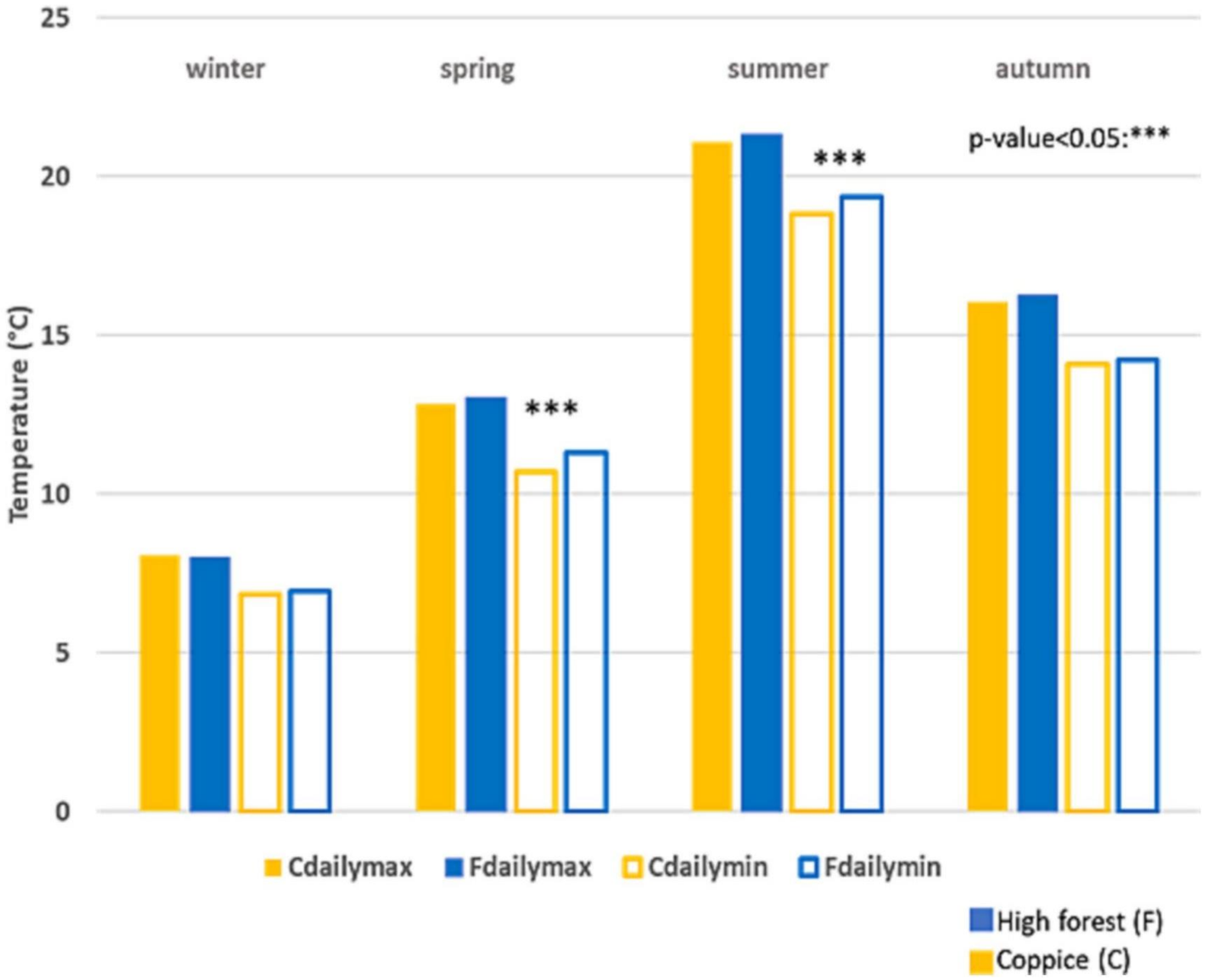
# DATA ANALYSIS

| variable | measure | statistic |
|---|---|---|
| **•Microclimate buffering** | •Max and min T offsets | ANOVA of offset comparisons (n=6) |
| **•Taxonomic diversity and composition** | •SR, H', J; % of different forest guilds (Heinken), Thermal niches | Linear mixed model (n=24; biomass n=48): y~ forest management + 1\|plot (*lme* function with Gaussian distribution; SR *lmer* function with Poisson distribution) |
| **•Phylogenetic structure and diversity** | •PD, MNTDses, MPDses | |
| **•Functional trait diversity** | •SLA, LDMC, vegH, repH, seedmass (cwm, rao, ses) | |
| **•Biomass productivity** | •Herb, woody and total biomass | Ordinary least squares regression analysis between SR and productivity |

# SOIL TEMPERTAURE



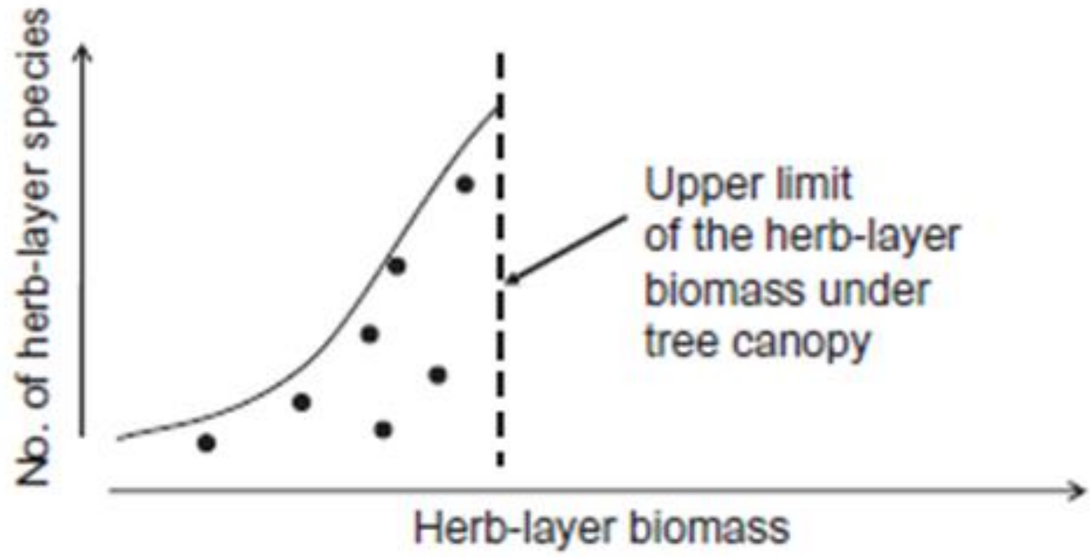
# 1. BACKGROUND

*Global Ecology and Biogeography, (Global Ecol. Biogeogr.)* (2012) **21**, 657–667

RESEARCH PAPER

## The species richness–productivity relationship in the herb layer of European deciduous forests

Irena Axmanová[1]*, Milan Chytrý[1], David Zelený[1], Ching-Feng Li[1], Marie Vymazalová[1], Jiří Danihelka[1,2], Michal Horsák[1], Martin Kočí[1], Svatava Kubešová[1,3], Zdeňka Lososová[1,4], Zdenka Otýpková[1], Lubomír Tichý[1], Vasiliy B. Martynenko[5], El'vira Z. Baisheva[5], Brigitte Schuster[6] and Martin Diekmann[6]




THE ALTERED FOREST STRUCTURE CAUSED BY COPPICE INCREASES LIGHT AVAILABILITY

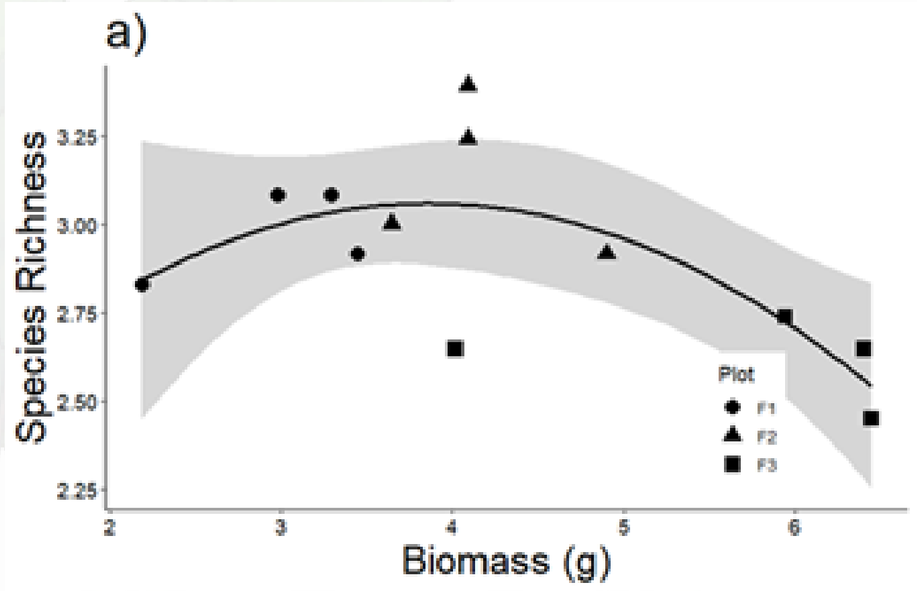
THIS MAY AFFECT THE EXPECTED RELATIONSHIP BETWEEN SR AND PRODUCTIVITY

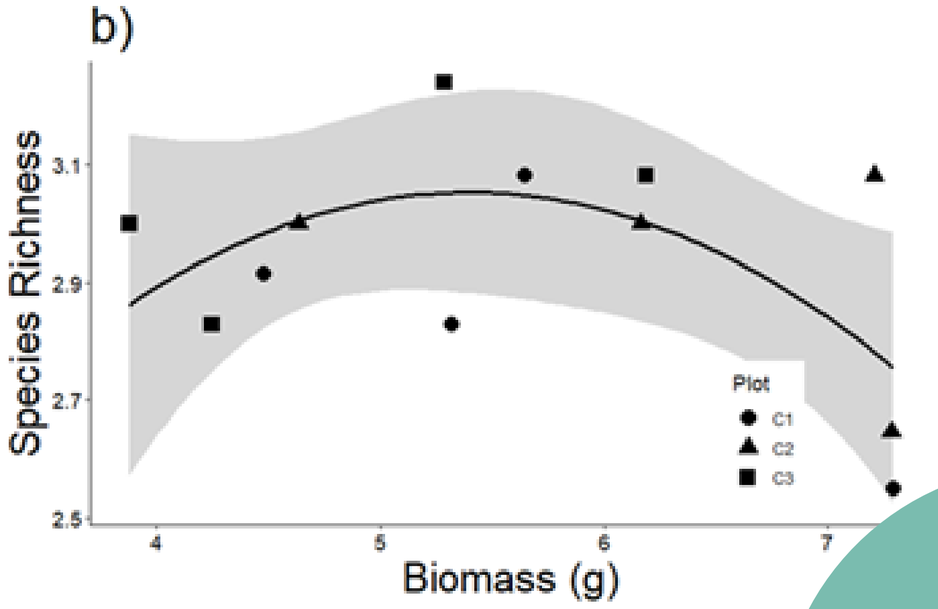
# 4. RESULTS WHAT ARE THE EFFECTS ON UV PRODUCTIVITY?

## High forest

## Coppice

**TOTAL BIOMASS** **+60%** ***




$R^2$=0.44 p<0.001

$R^2$<0.3 p=n.s.

**Not monotonic linear as in central Europe but unimodal humped-back model (different light regime)**

**large SR variation at the higher productivity levels**