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

Ilaria Santi, *_Elisa Carrari_, Pieter De Frenne, Mercedes Valerio, Cristina Gasperini, Marco Cabrucci, Federico Selvi

*Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence

UNIVERSITÀ DEGLI STUDI FIRENZE
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DIPARTIMENTO DI SCIENZE E TECNOLOGIE AGRARIE, ALIMENTARI, AMBIENTALI E FORESTALI

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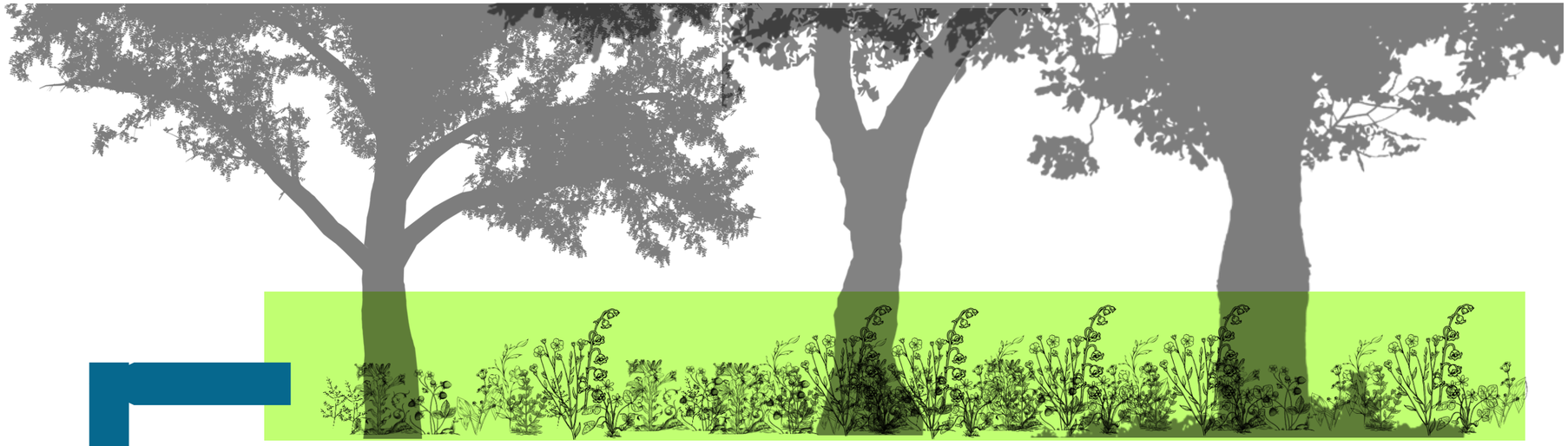
BACKGROUND: understorey



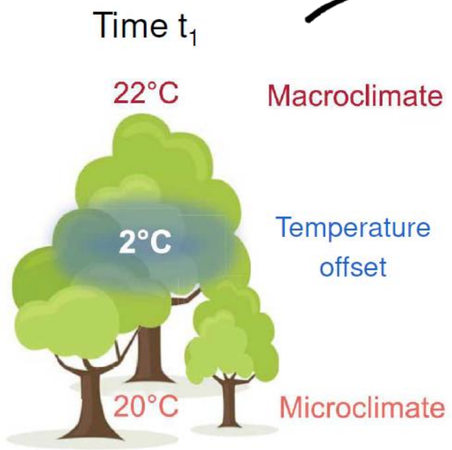
Understorey vegetation (UV) represents the 80% of temperate forest plant diversity (Gilliam 2007)

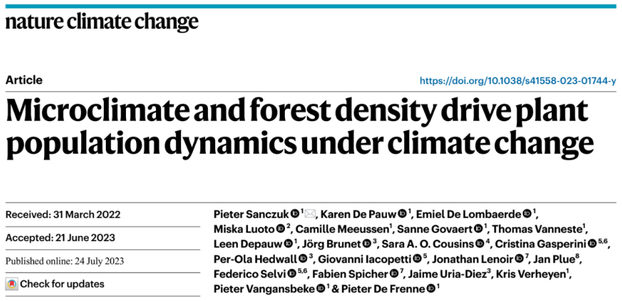
supports several forest ecosystem services

Global warming is causing UV thermophilization!

BACKGROUND: microclimate

The potential of forests to buffer thermophilization





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Microclimate and forest density drive plant population dynamics under climate change

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Check for updates

Pieter Sanczuk[1], Karen De Pauw[1], Emiel De Lombaerde[1], Miska Luoto[2], Camille Meeussen[1], Sanne Govaert[1], Thomas Vanneste[1], Leen Depauw[1], Jörg Brunet[3], Sara A. O. Cousins[4], Cristina Gasperini[5,6], Per-Ola Hedwall[3], Giovanni Iacopetti[5], Jonathan Lenoir[7], Jan Plue[8], Federico Selvi[5,6], Fabien Spicher[7], Jaime Uria-Diez[3], Kris Verheyen[1], Pieter Vangansbeke[1] & Pieter De Frenne[1]

Microclimate is related to forest structure

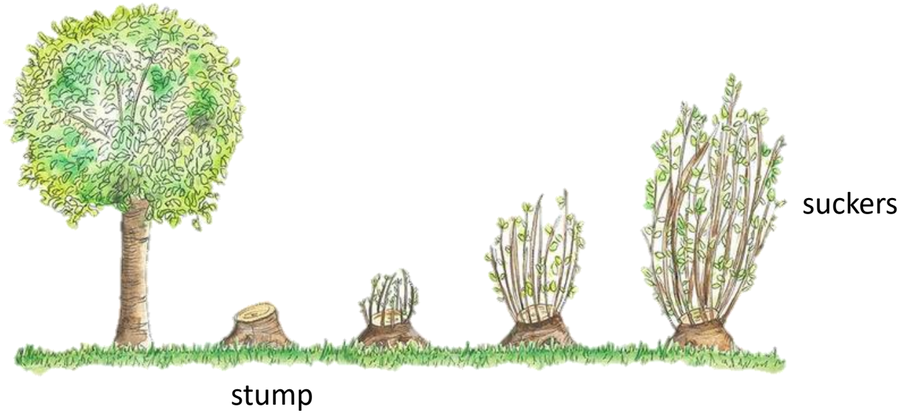
amplifes macroclimate change impacts

mitigates severe warming impacts

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

BACKGROUND: management

COPPICE MANAGEMENT
over 20 million hectares of forests throughout Europe



Lack of evidence about coppice impacts on microclimate

Coppice with standards management

Strong impact on forest structure

possible exacerbation of UV thermophilization processes

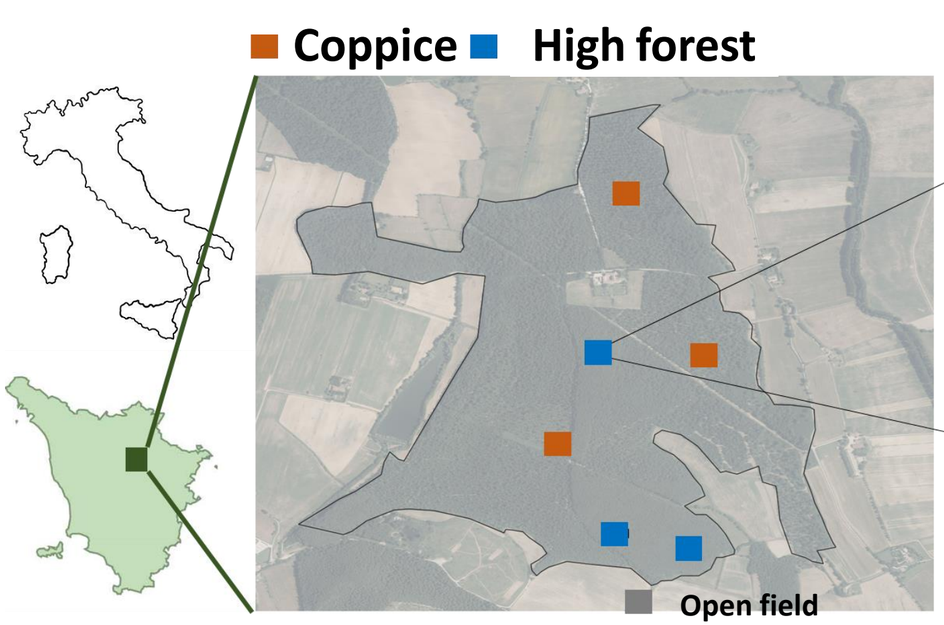
directional shifts in UV diversity, composition and functional profiles…

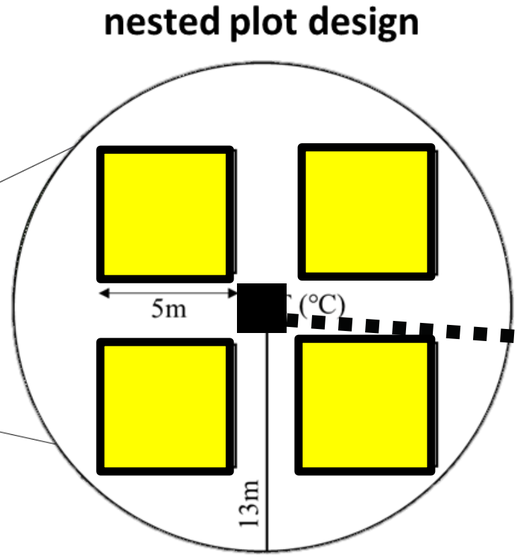
STUDY QUESTIONS

- **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)-Natura2000 site

High forest

Coppice

- AIR AND SOIL TEMPERATURE (2021-2023)
- STRUCTURAL VARIABLES, OVERSTOREY COMPOSITION (6 plots)
- UNDERSTOREY SURVEY (1.3 m) (24 quadrats)

Analysis of different aspects of UV diversity

METHODS

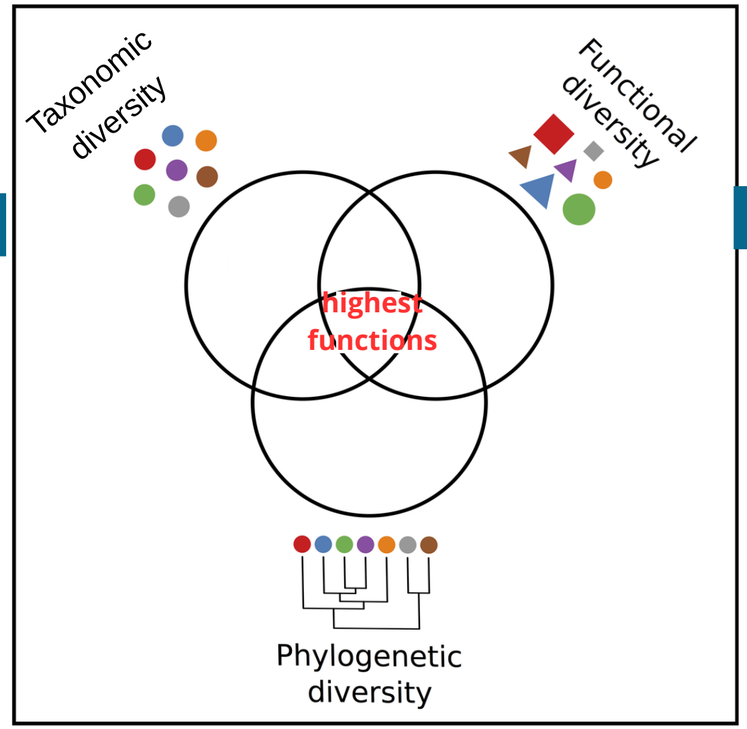
SPECIES RICHNESS (SR), SHANNON INDEX (H'), EVENNESS (J)

COMPOSITION

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

ClimPlant DB

R packages: vegan, Indicspecies

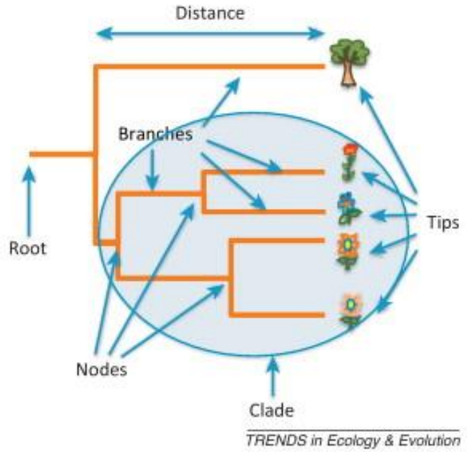


SPECIFIC LEAF AREA INDEX (SLA)
LEAF DRY MATTER CONTENT (LDMC)
VEGETATIVE HEIGHT (VEGH),
REPRODUCTIVE HEIGHT (REPH)
SEEDMASS

collected from TRY DB

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

R package: FD



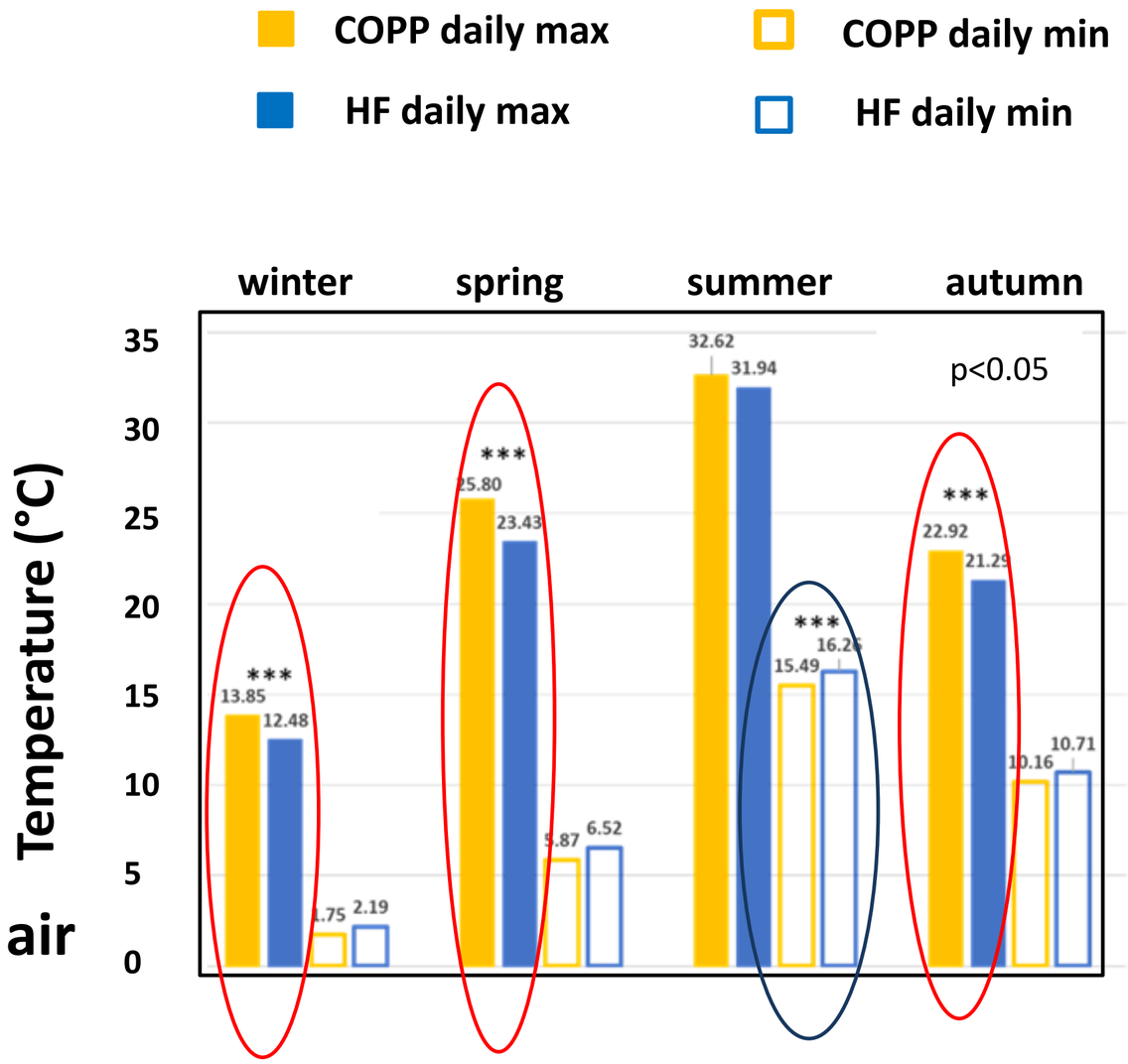
PHYLOGENETIC DIVERSITY (PD), MEAN NEAREST TAXON DISTANCE (MNTD), MEAN PAIRWAISE DISTANCE (MPD)

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)



2.CHANGES IN UV COMPOSITION AND TAXONOMIC DIVERSITY

High forest


Malus florentina


Anemone nemorosa


Physospermum cornubiense


Pyrus pyraster


Carpinus betulus


Ruscus aculeatus

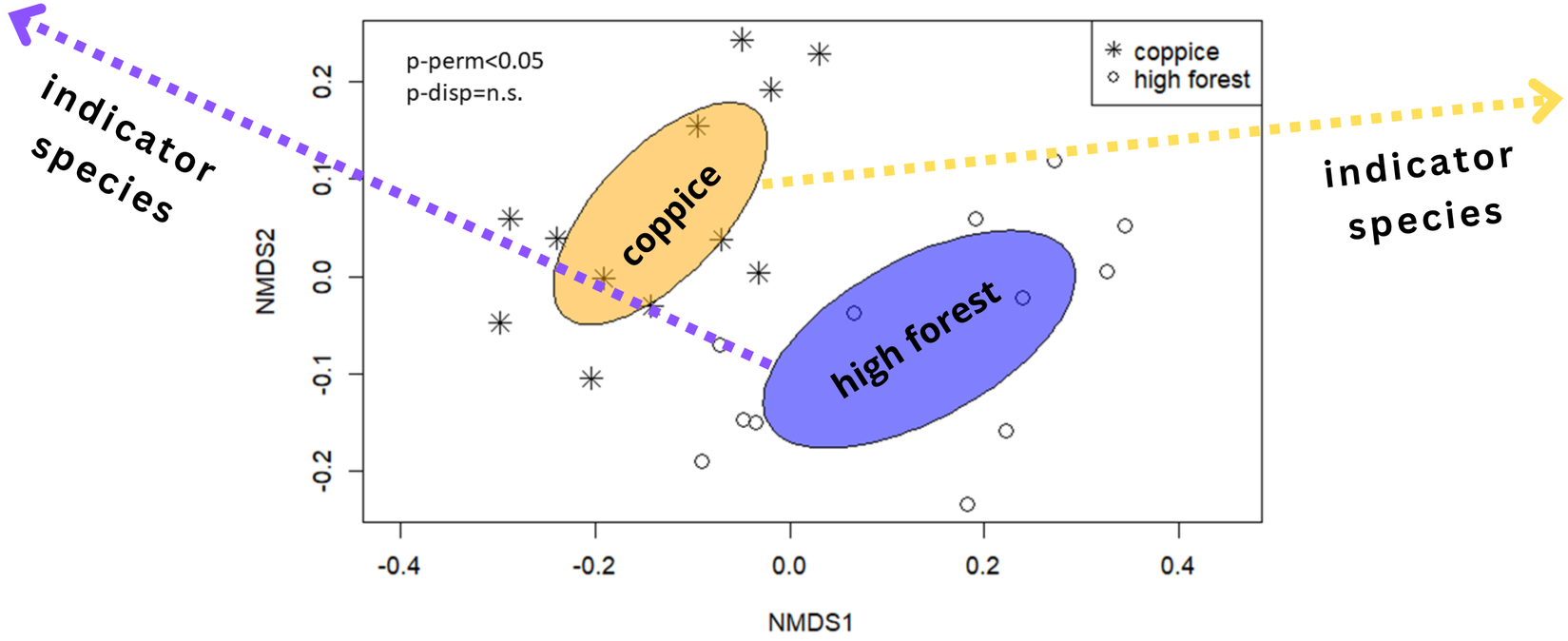
mixed model results:
y~forest management+1|plot

TOTAL SPECIES RICHNESS ↓

↑ **+4.6** ***

*** **+80%** ↑

FOREST SPECIALISTS (NUMBER AND ABUNDANCE) ↓



Coppice


Poa nemoralis


Carex pallescens


Calluna vulgaris

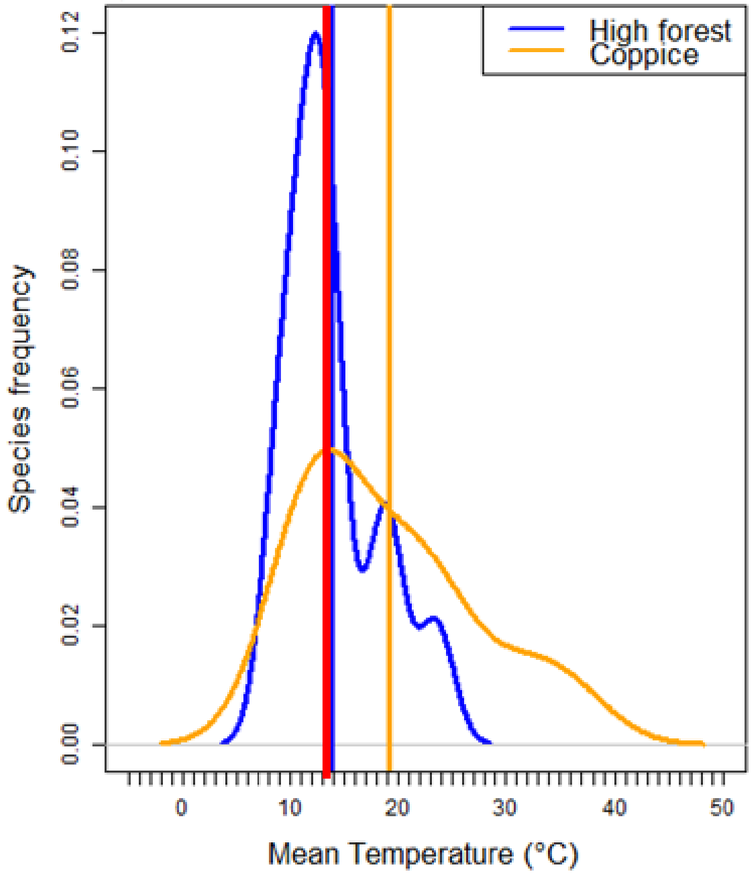

Genista pilosa


Cruciata glabra

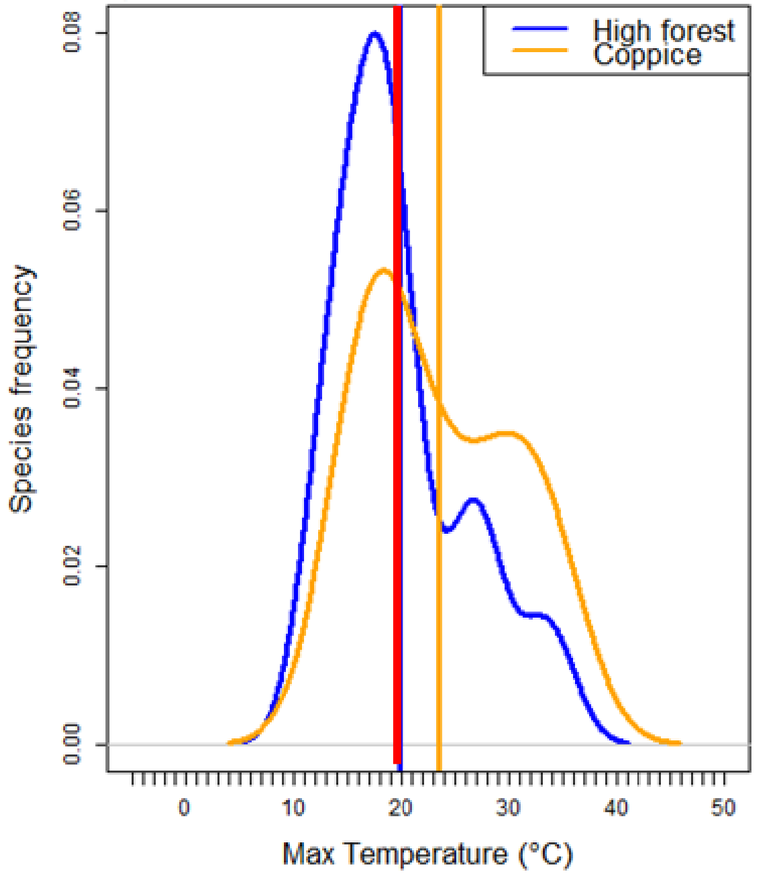

Viola alba

3. Shift towards more thermophilous UV communities in coppice

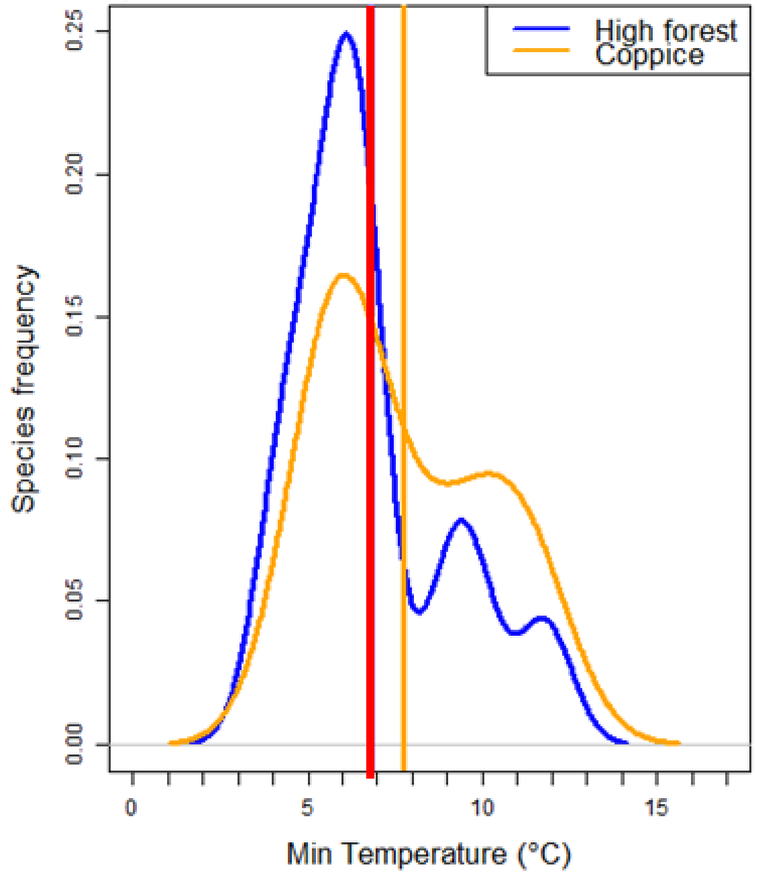
Coppice effect



Coppice effect

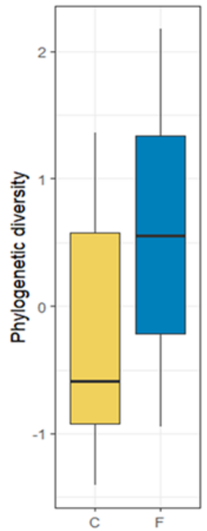


Coppice effect



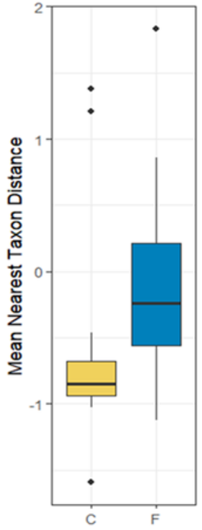
4. LOSS OF PHYLOGENETIC DIVERSITY AND EVENNESS IN COPPICE

High forest



* +0.72 ↑ STANDARDIZED PHYLOGENETIC DIVERSITY ↓

+0.41 STANDARDIZED MEAN PAIRWISE DISTANCE



*** +0.99 ↑ STANDARDIZED MEAN NEAREST TAXON INDEX ↓

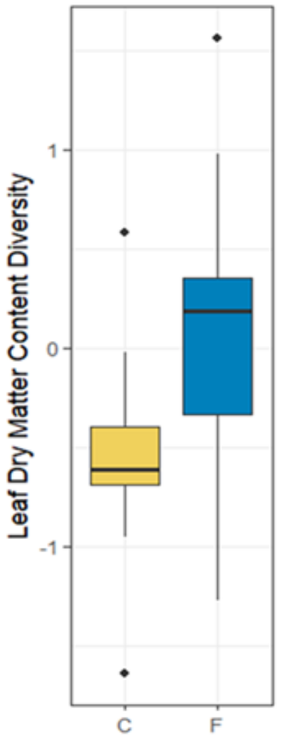
mixed model results:
y~forest management+1|plot

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

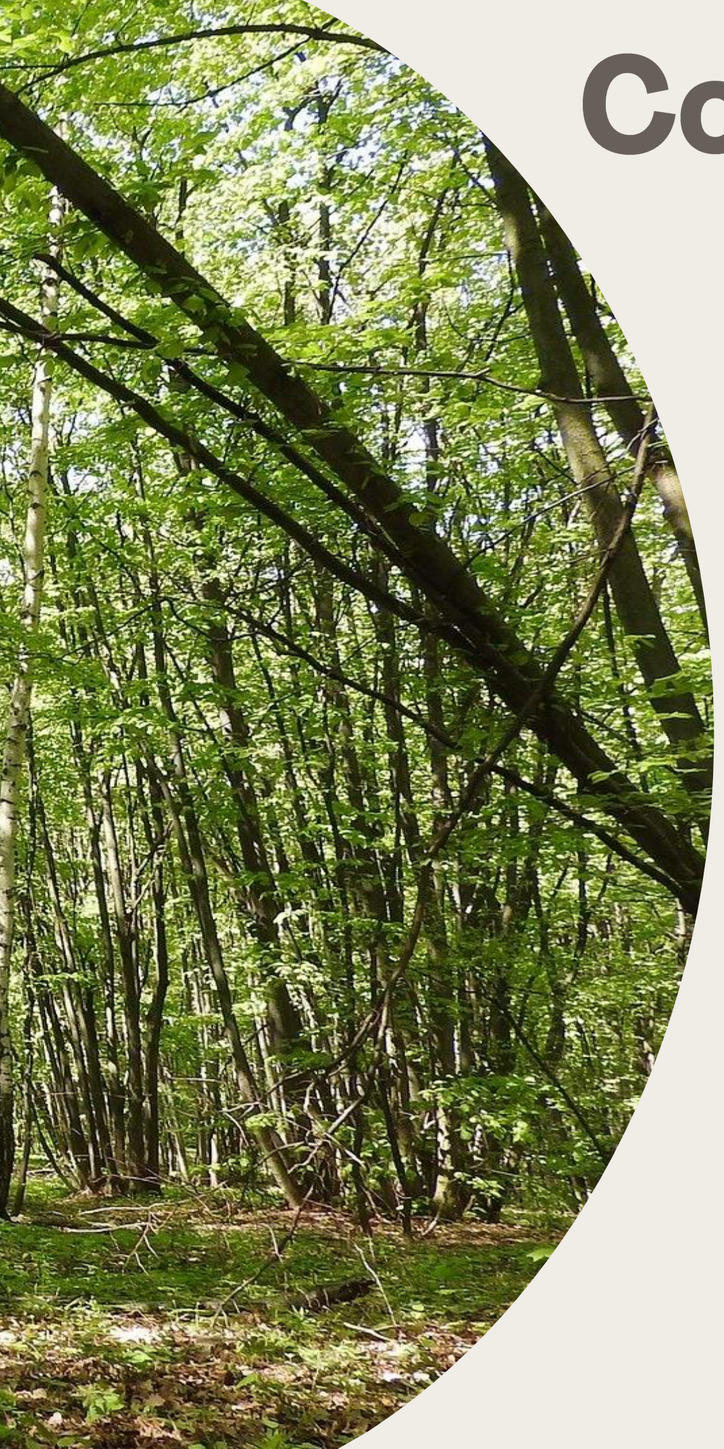
SPECIFIC LEAF AREA	↑	+0.96
LEAF DRY MATTER CONTENT	↑	+12.32
VEGETATIVE HEIGHT	↓	+1.74
REPRODUCTIVE HEIGHT		+0.22
SEEDMASS		+10.69

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

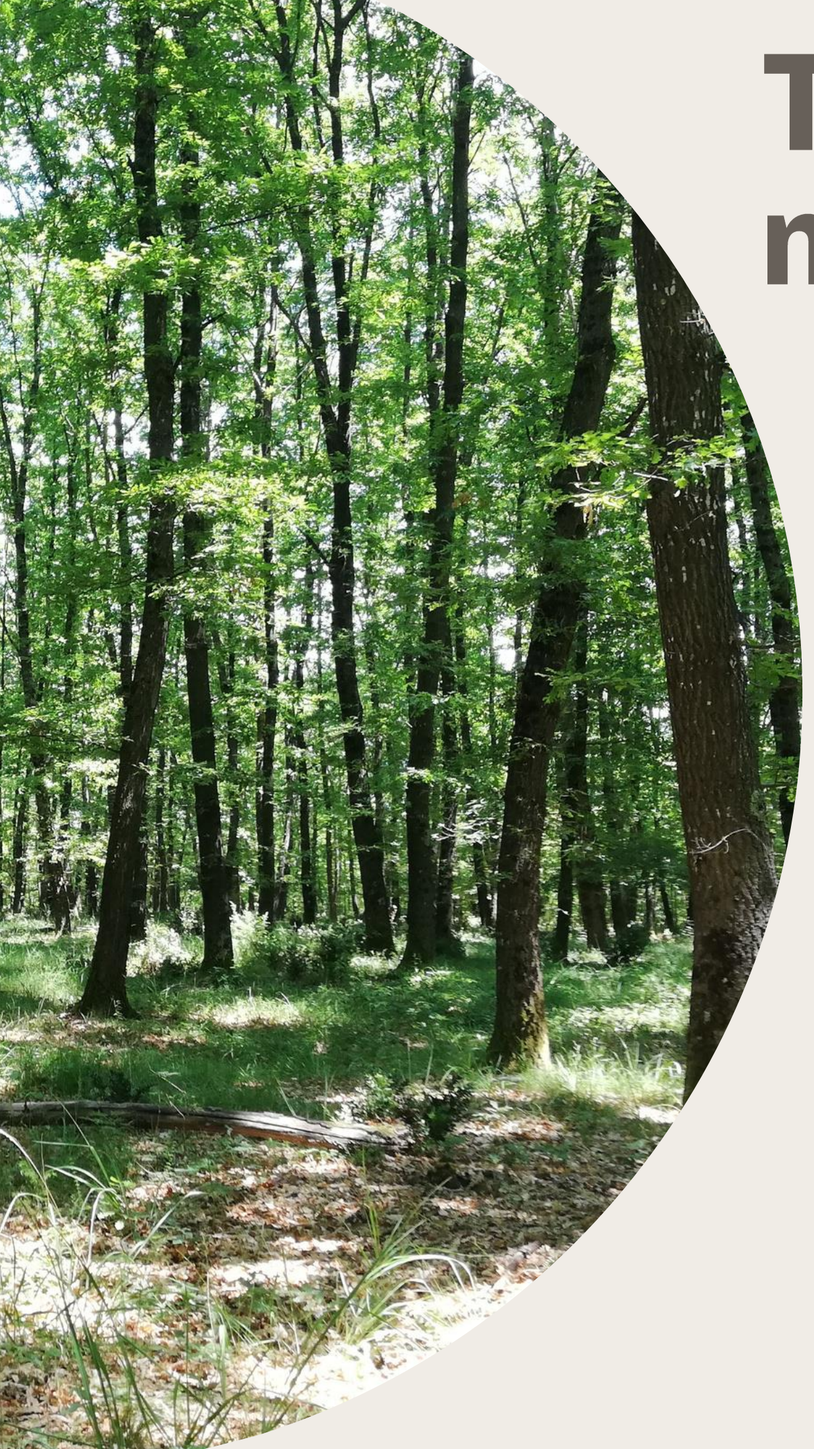
ongoing adaptation processes



Conclusions

In coppice stands:

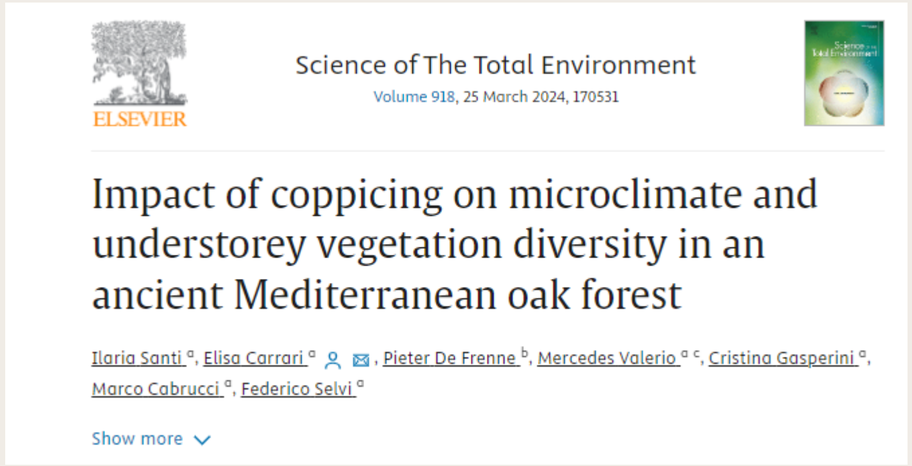
- The **temperature buffering capacity** of the forest is reduced, especially of Tmax during spring.
- UV was more **species-rich**, but with a lower number of **forest specialists**.
- UV consisted of more **warm-adapted** species (thermophilization).
- We observed a loss of **phylogenetic evenness**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



Take home message

Need to consider all facets of diversity for a holistic understanding of disturbances (e.g. coppicing);

More conscious application of coppice management in Mediterranean oak woodlands affected by climate warming.



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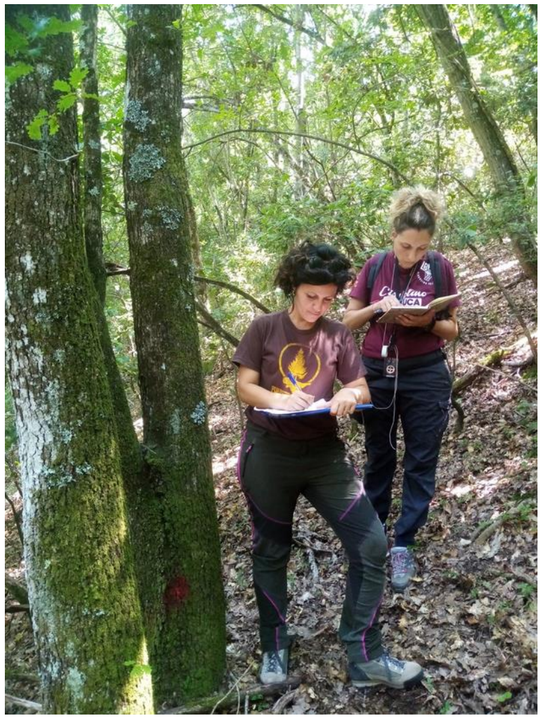

Thank you

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DIPARTIMENTO DI SCIENZE TECNOLOGIE AGRARIE, [illegible]MENTARI, AMBIENTALI E FOR

NATIONAL BIODIVERSITY FUTURE CENTER

UNIVERSITEIT GENT

elisa.carrari@unifi.it

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