Trait syndromes and intraspecific responses to fire regimes of Mediterranean reseeder and resprouter woody plants

Gianluigi Ottaviani[1,2], Mathieu Millan[3], NBFC Wildfire-Biodiversity WG

[1]Research Institute on Terrestrial Ecosystems (IRET), National Research Council (CNR), Porano, Italy

[2]National Biodiversity Future Center (NBFC), Palermo, Italy

[3]32153 Route de Mende, Montpellier, France

Fire = an eco-evolutionary force

Plant forms & functions

Review TRENDS in Ecology and Evolution Vol.20 No.7 July 2005

Fire as a global 'herbivore': the ecology and evolution of flammable ecosystems

William J. Bond[1] and Jon E. Keeley[2,3]

Opinion

Fire as an evolutionary pressure shaping plant traits

Jon E. Keeley[1,2], Juli G. Pausas[3], Philip W. Rundel[2], William J. Bond[4] and Ross A. Bradstock[5]

A Burning Story: The Role of Fire in the History of Life

JULI G. PAUSAS AND JON E. KEELEY

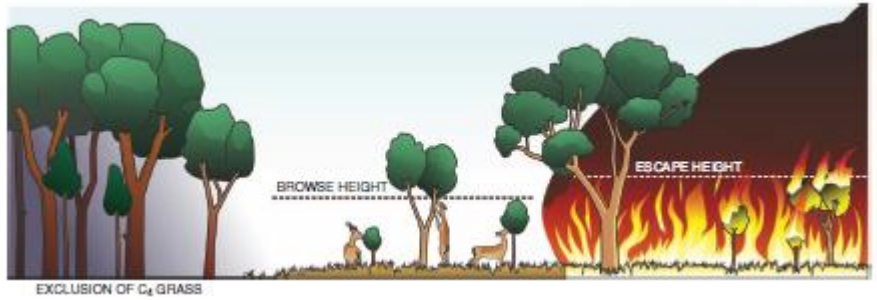
Research New Phytologist

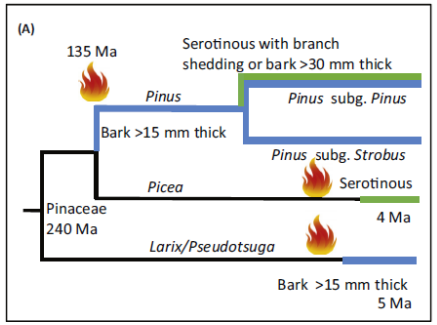
Banksia born to burn

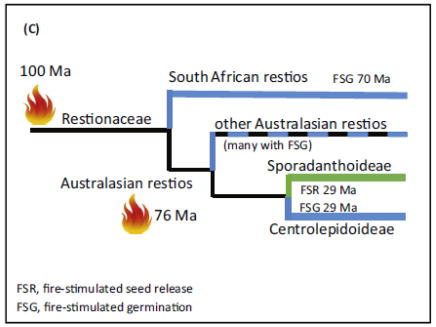
Tianhua He[1,2], Byron B. Lamont[1] and Katherine S. Downes[1]

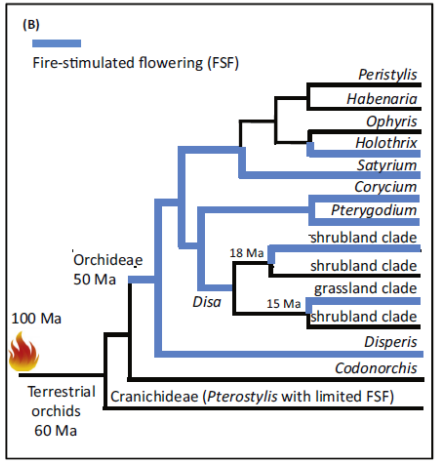
[1]Centre for Ecosystem Diversity and Dynamics, Department of Environment and Agriculture, Curtin University, PO Box U1987, Perth, WA 6845, Australia; [2]School of Plant Biology, The University of Western Australia, Crawley, WA 6009, Australia

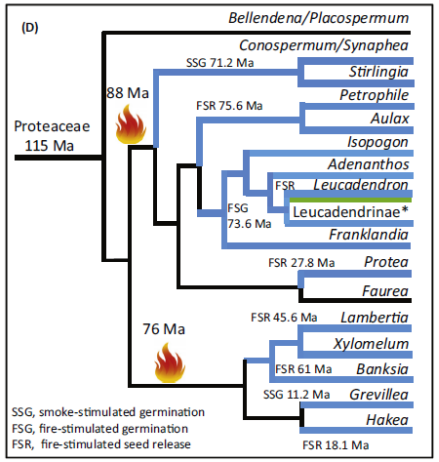
Wigley et al. 2020 Aust J Bot









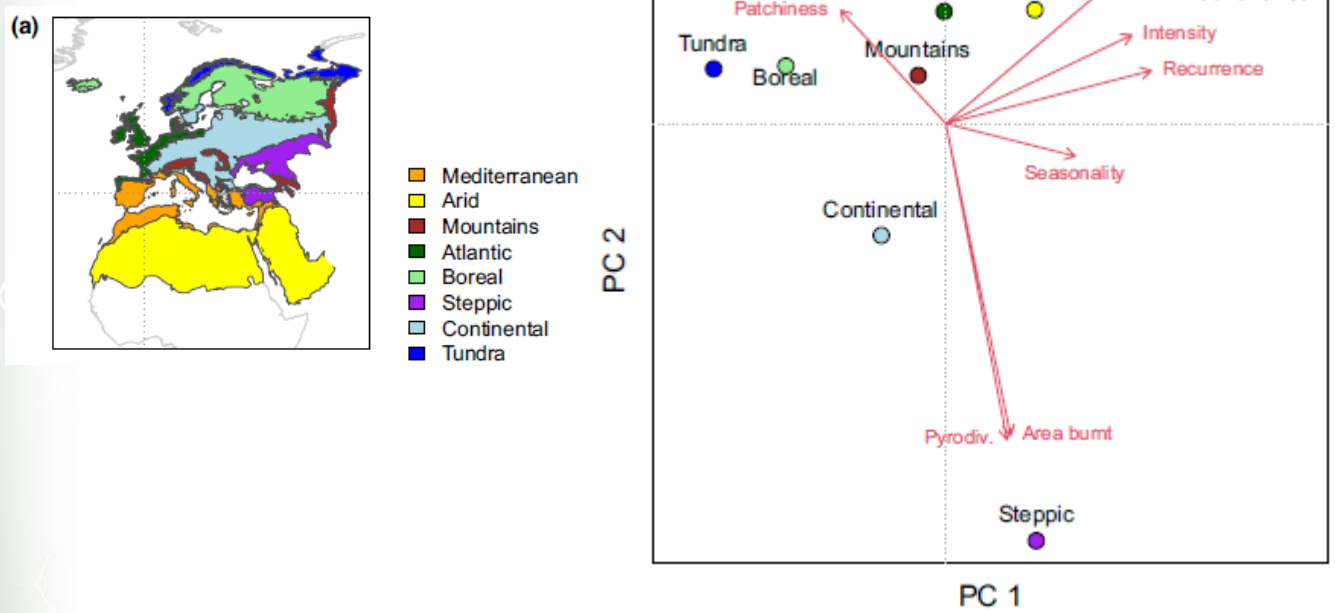


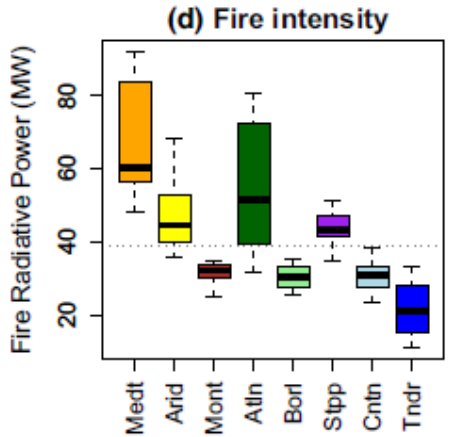
Lamont & He 2017 Trends Plant Sci

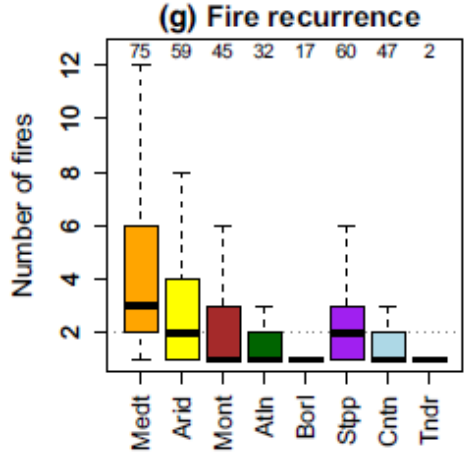
Fire = an eco-evolutionary force

Biome distribution & dynamics

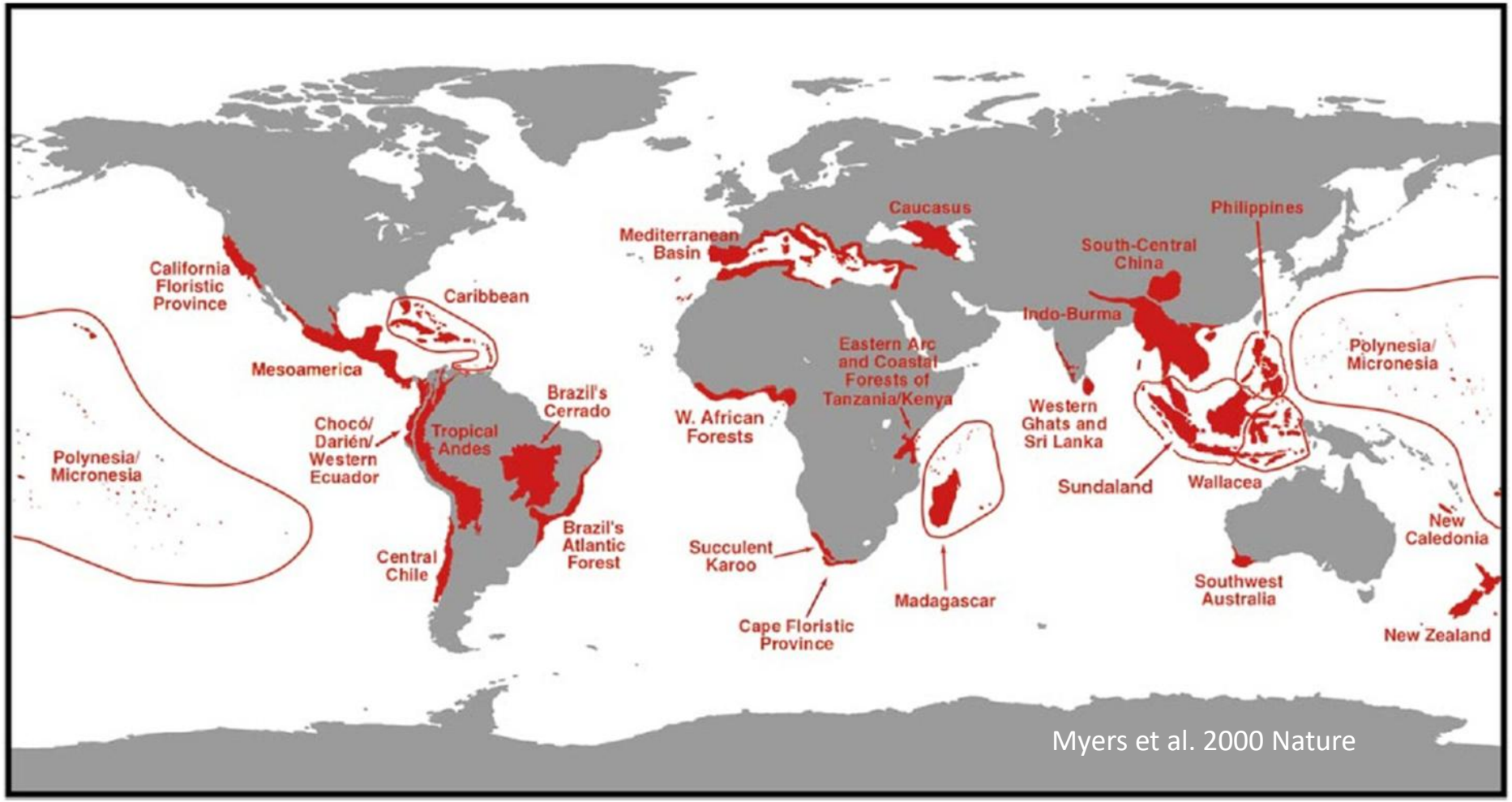
Pausas 2022 Glob Ecol Biogeogr







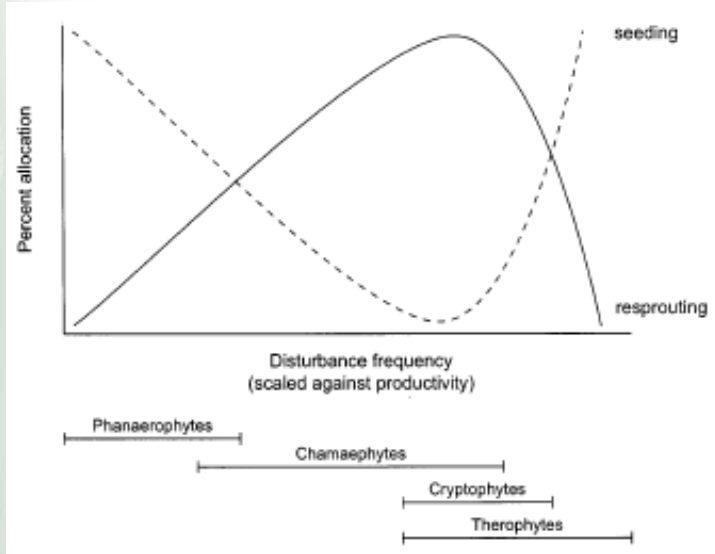
Mediterranean-type ecosystems = hotspots of biodiversity & exacerbating threats



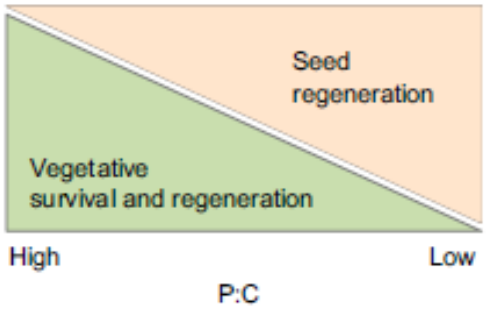
Myers et al. 2000 Nature

Post-fire plant strategies = resprouters & reseeders

Bellingham & Sparrow 2000 Oikos



Pausas & Keeley 2014 New Phytol

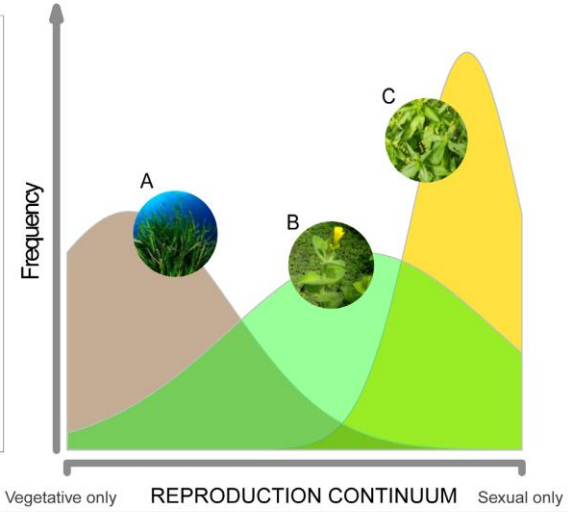


Carta et al. 2024 Funct Ecol

A) *Posidonia oceanica*
Perennial marine herb mainly reproducing vegetatively.

B) *Hypericum elodes*
Perennial soft-water-pool herb reproducing both vegetatively and sexually via mixed mating.

C) *Mercurialis annua*
Annual wind-pollinated dioecious ruderal sexually reproducing with variable outcrossing degree.

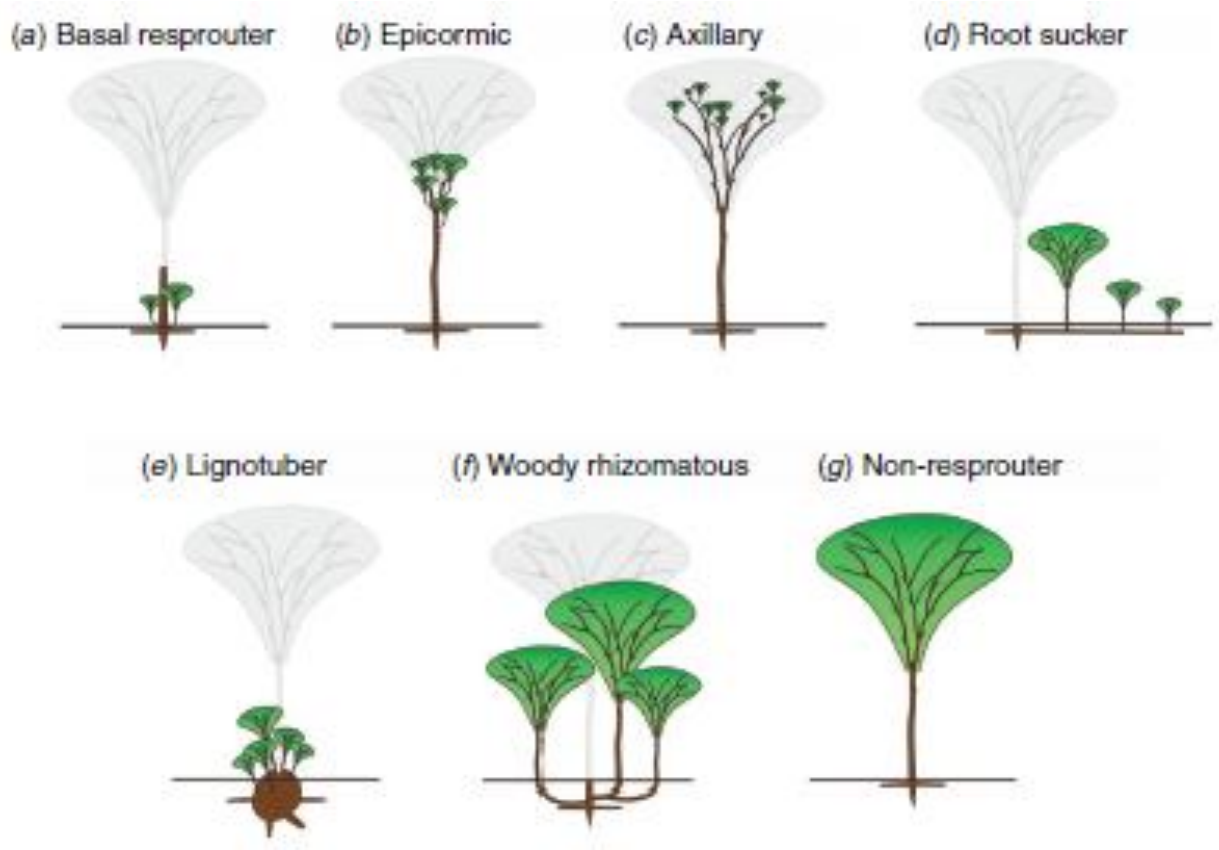


A continuum occurs between obligate resprouters & reseeders, i.e. facultative strategies

Post-fire plant strategies = resprouters & reseeders

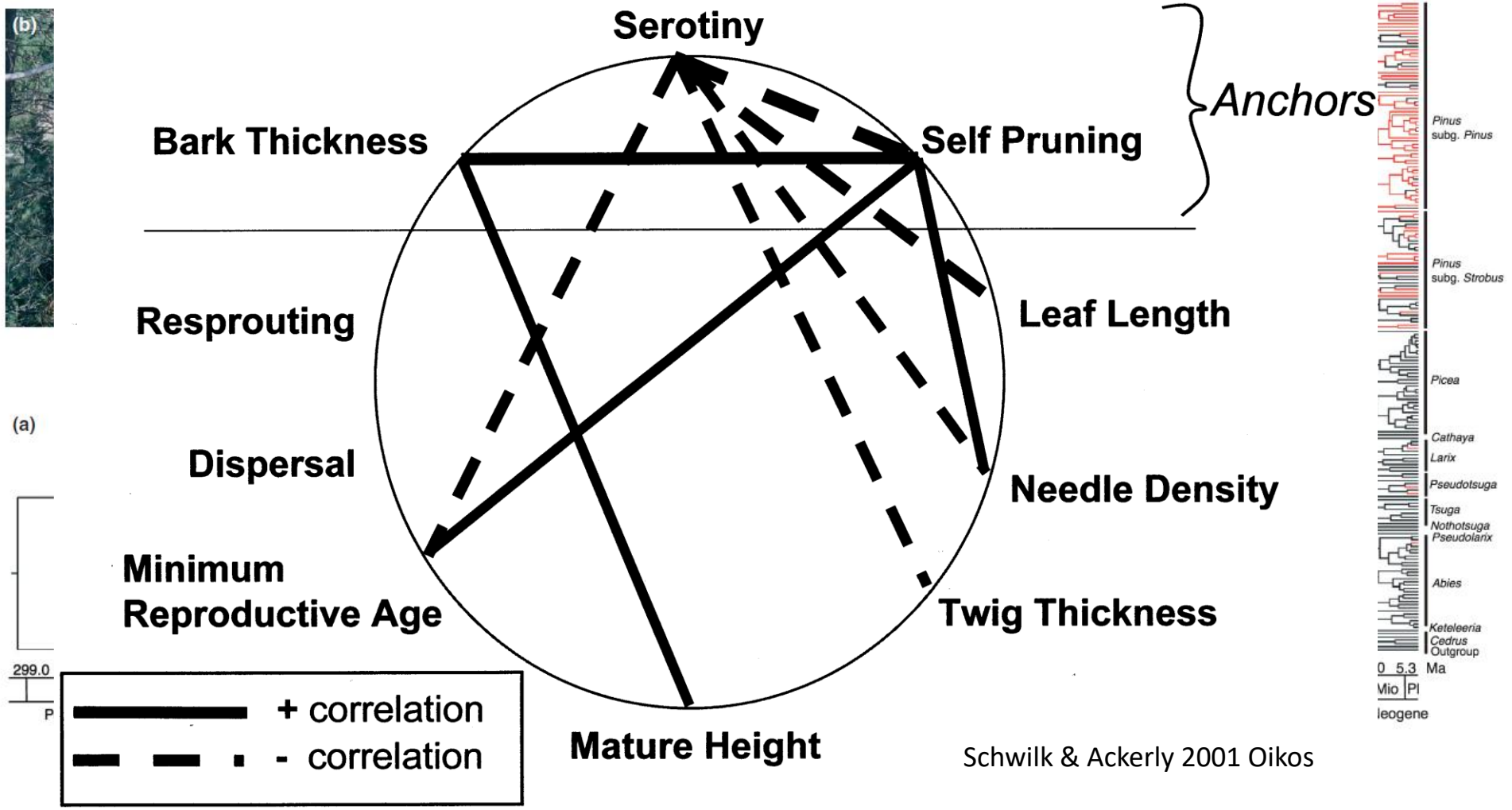
Wigley et al. 2020 Aust J Bot

(modified from Clarke et al. 2013 New Phytol)



Post-fire plant strategies = resprouters & reseeders

Fire-driven evolution of serotiny in *Pinus*



Fire-driven evolution of thick bark in *Pinus*

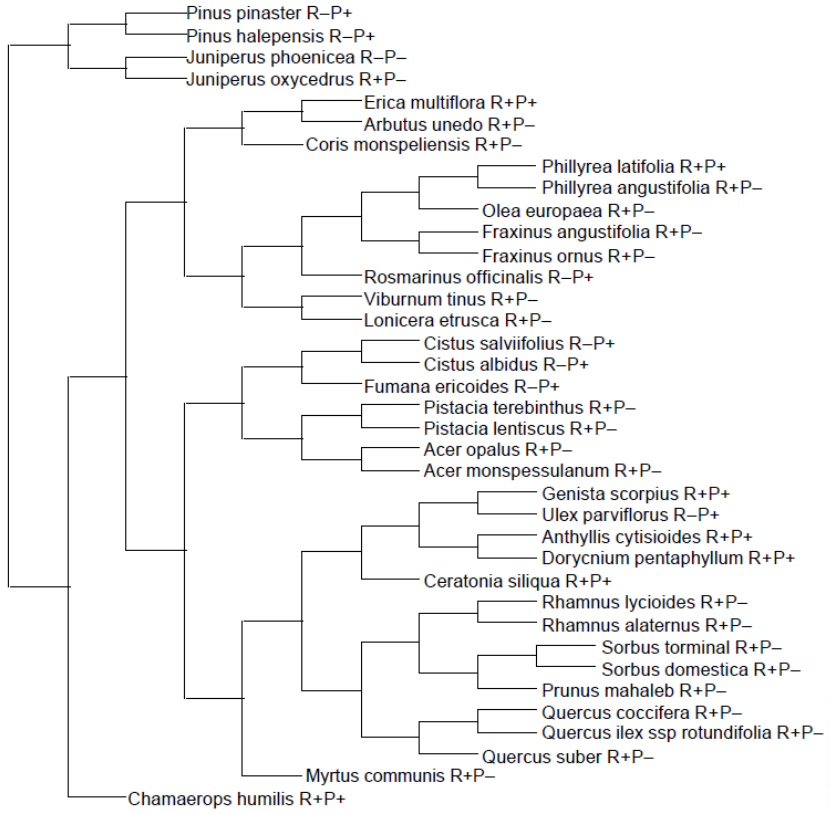
Schwilk & Ackerly 2001 Oikos

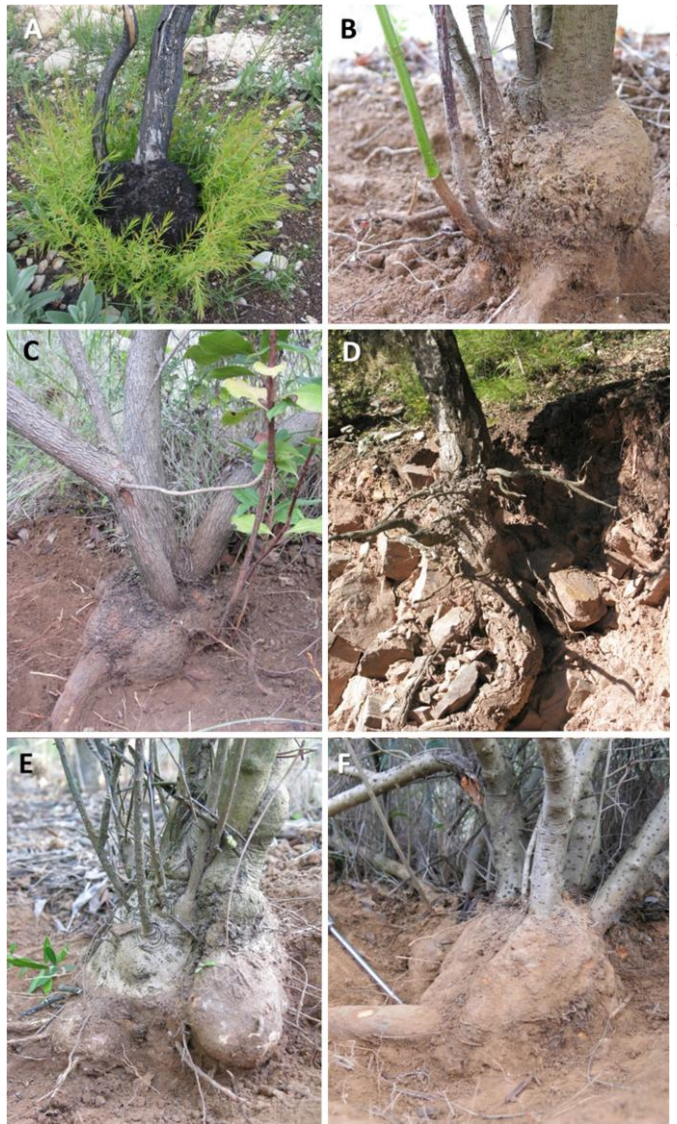
Mediterranean Basin = an aridity- and fire-driven hotspot of biodiversity & exacerbating threats

OIKOS 109: 196–202, 2005

Plant persistence traits in fire-prone ecosystems of the Mediterranean basin: a phylogenetic approach

J. G. Pausas and M. Verdú





Plant Ecol (2016) 217:661–676
DOI 10.1007/s11258-015-0538-9

Lignotubers in Mediterranean basin plants

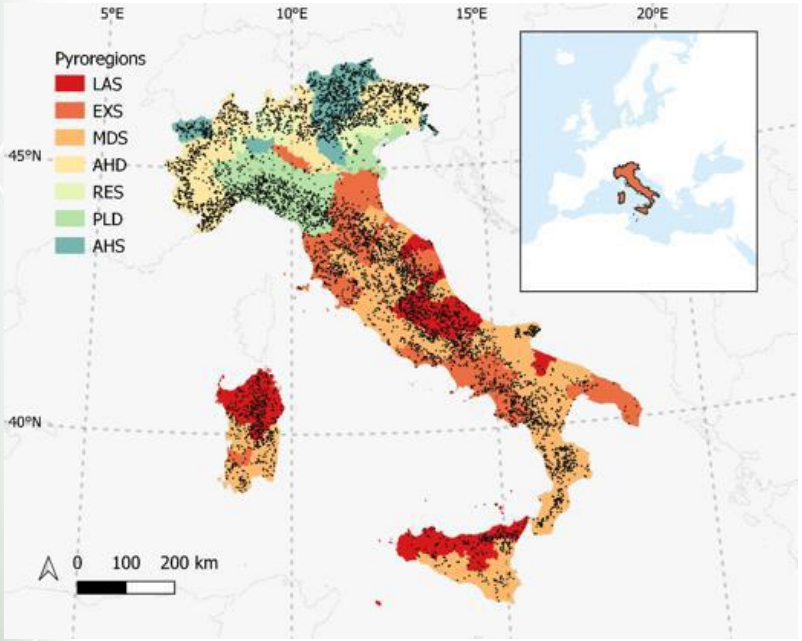
Susana Paula · Paulette I. Naulin · Cristian Arce · Consttanza Galaz · Juli G. Pausas

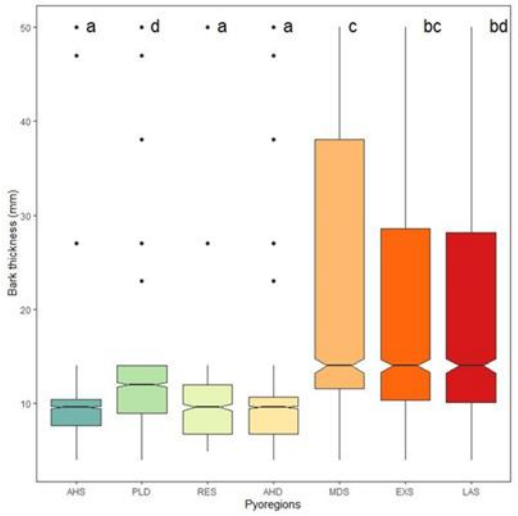
Mediterranean Basin = an aridity- and fire-driven hotspot of biodiversity & exacerbating threats

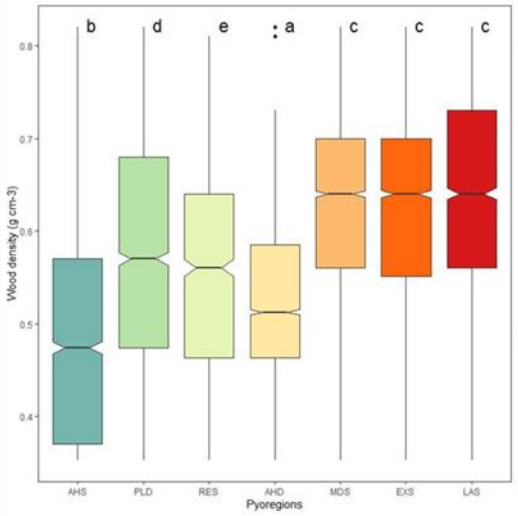
Are trait responses of tree species across pyroregions indicative of fire-modulated plant functional strategies?

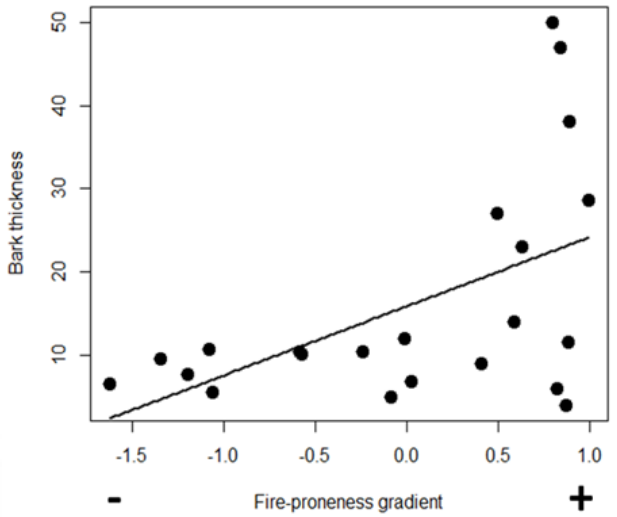
Authors' list

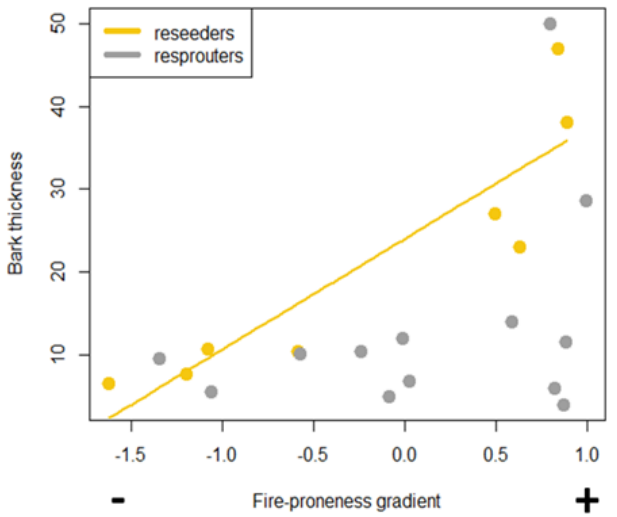
José Maria Costa-Saura, Gabriele Midolo, Carlo Ricotta, Mara Baudena, Carlo Calfapietra, Mario Elia, Paolo Fiorucci, Simone Mereu, Costantino Sirca, Donatella Spano, Gianna Vivaldo, Gianluigi Ottaviani











Study goal: Examining trait syndromes & post-fire intraspecific responses of Mediterranean reseeder and resprouter woody plants

Q1. Do resprouter and reseeder species differ in their trait coordination?

Q2. Do trait patterns indicate fire-modulated plant responses to changes in fire regime?

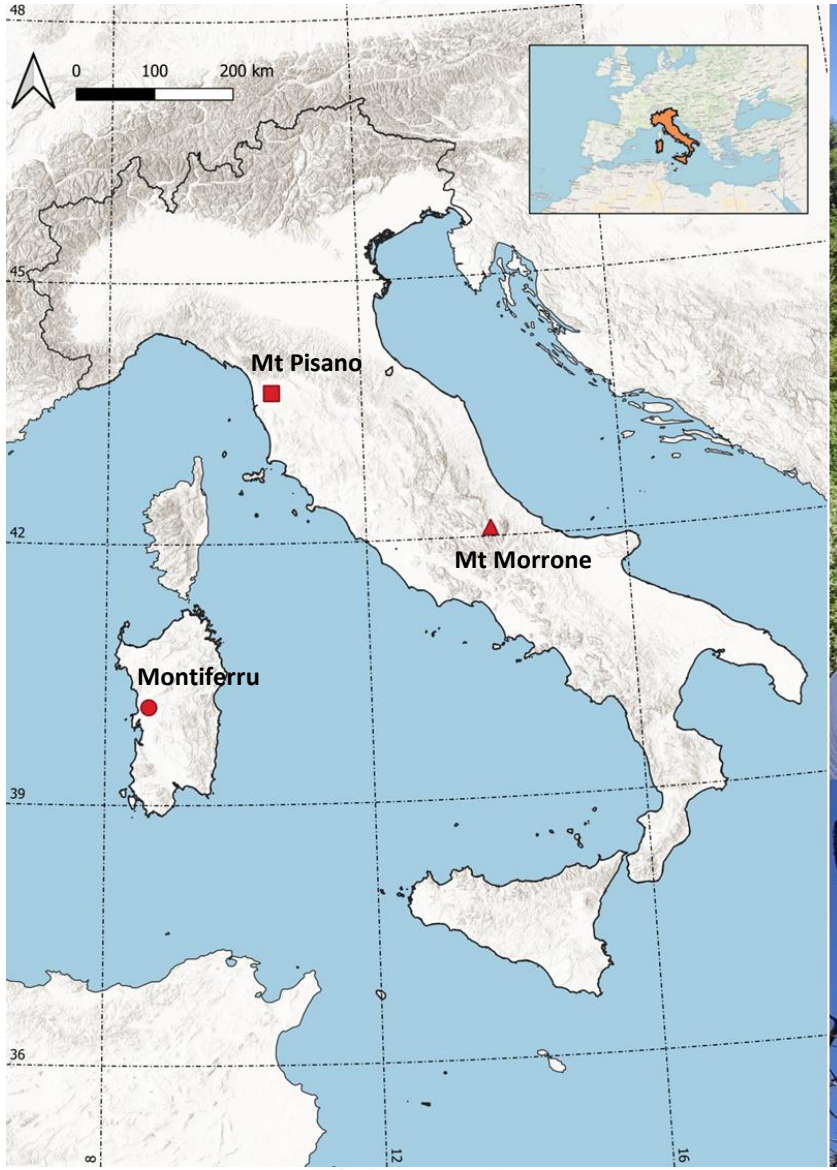
Q3. Does fire regime affect trait coordination relationships?

Study system

Sites

Species

Post-fire strategies



Study system

Plant functional traits (some): informing on fire-related strategies & fitness

TRAIT	MAIN PLANT & ECOSYSTEM FUNCTION(S)	ORGAN
Bark thickness (mm)	Protection from disturbance (mainly fire); Resource storage	Stem base
Belowground coarse organ dry matter content [BDMC] (mg g^{-1})	Resource (water) conservation; Plant lifespan	Thick root, lignotuber
Leaf dry matter content [LDMC] (mg g^{-1})	Resource (water) conservation; Leaf and plant lifespan; Resistance to herbivory; Flammability; Litter decomposability	Leaf
Plant height (cm)	Aboveground biomass allocation & vertical space occupancy; Light capture; Escape from disturbance trap(s)	Stem
Ratio between generative and vegetative stems (%)	Main reproduction type; Generative vs vegetative reproduction effort	Stem bearing flowers and/or fruits
Ratio between dead and alive stems (%)	Disturbance damage; Mortality/vitality	Stem
Stem dry matter content [SDMC] (mg g^{-1})	Resource (water) conservation; Plant lifespan; Flammability; Structural support	Stem
Stem diameter (cm)	Response to aridity, Aboveground biomass allocation	Stem base

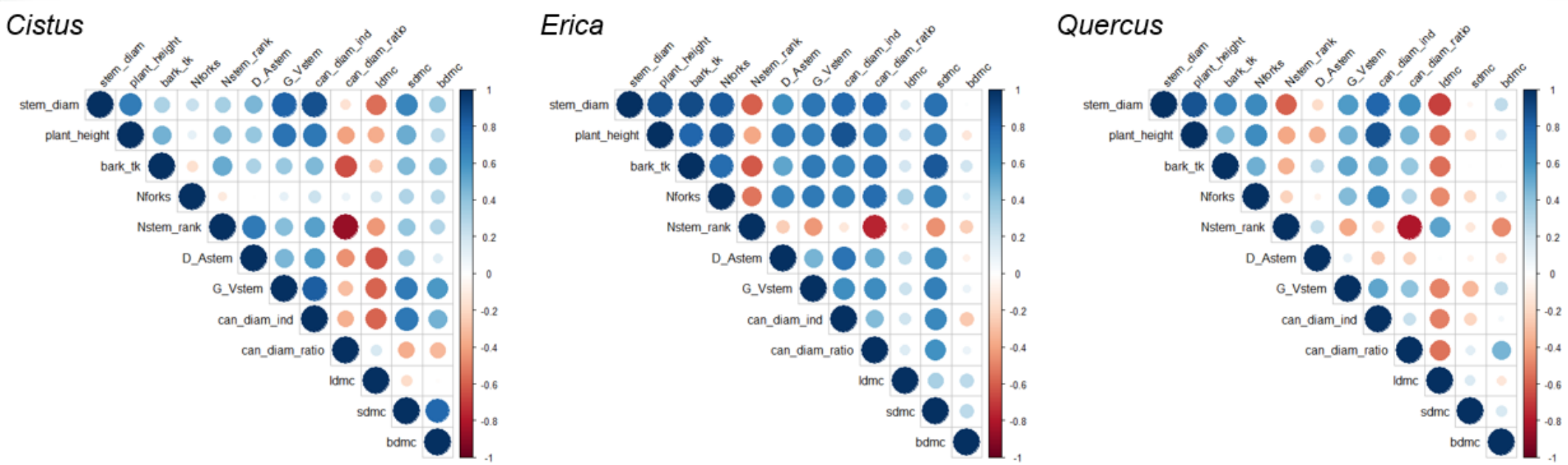
Study system & sampling design

Fire regimes

Site	Plot type	Year Burnt	Time since last fire (yrs)	Number of fires	Fire return interval (=yrs/(#fires+1))	Species		
						Resprouter		Reseeder
						Q. ilex (n=50)	*E. arborea* (n=40)	*C. salviifolius* (n=30)
Montiferru	Control – Holm oak	<1970	54	0	54	10		5
	Control – Mix	<1970	54	0	54	10		
	2 Fires	1994, 2021	3	2	18	5	10	10
	3 Fires	1983, 1994, 2021	3	3	13.5	10	5	
Mt Morrone	1 fire	2017	7	1	27	10		
	2 Fires	2017, 2023	1	2	18	5		
Mt Pisano	Control – Pine	<1970	54	0	54		10	
	1 fire	1998	26	1	27		10	5
	2 Fires	1998, 2023	1	2	18		5	10

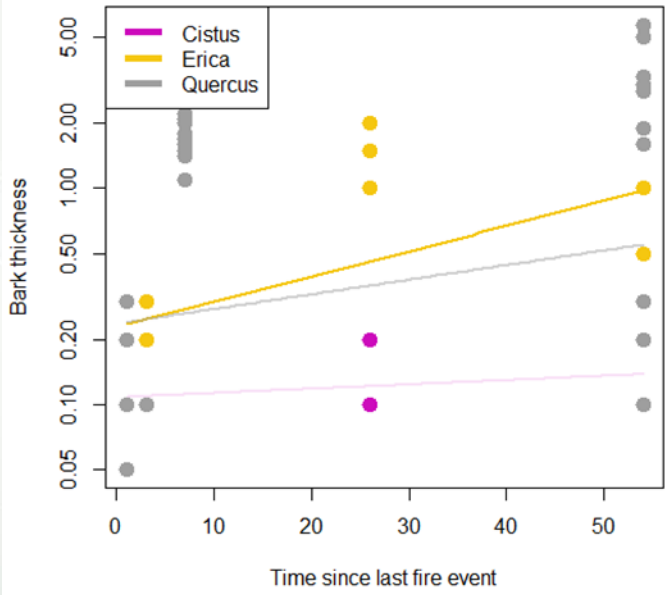
Q1. Do resprouter and reseeder species differ in their trait coordination?

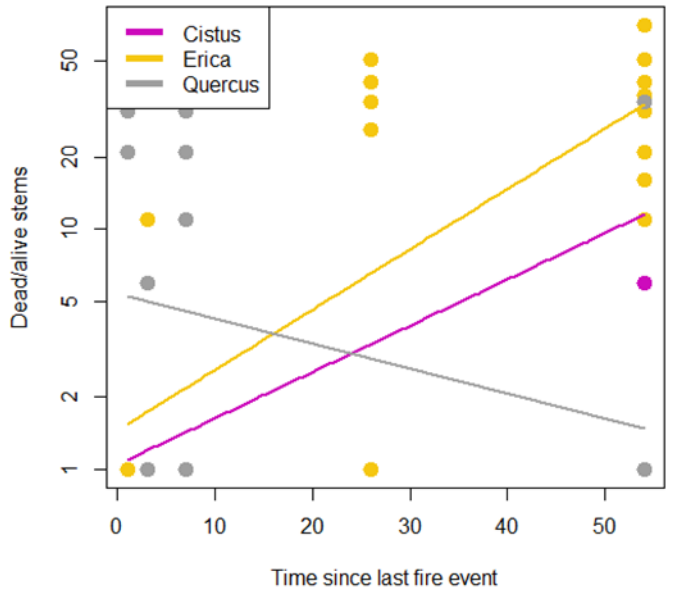
A1. Yes they do differ, as there are differences between resprouters

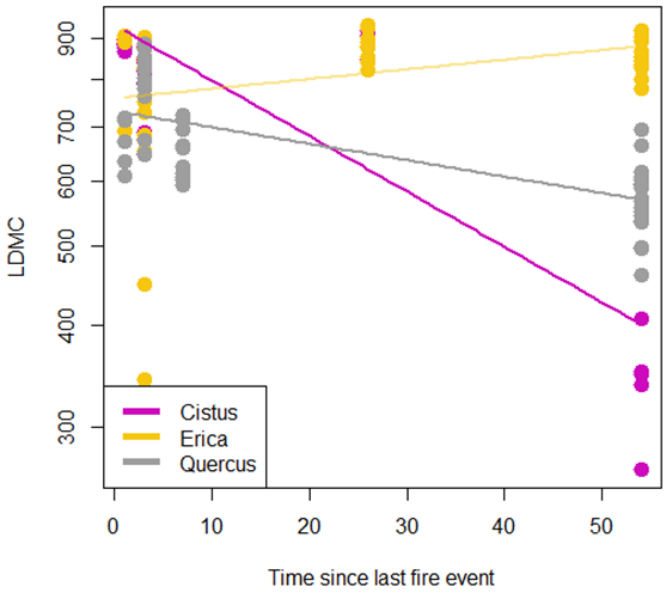


Q2. Do trait patterns indicate fire-modulated plant responses to changes in fire regime?

A2. Yes they do, and responses are species-specific & not necessarily aligning with post-fire strategy (life history classification)

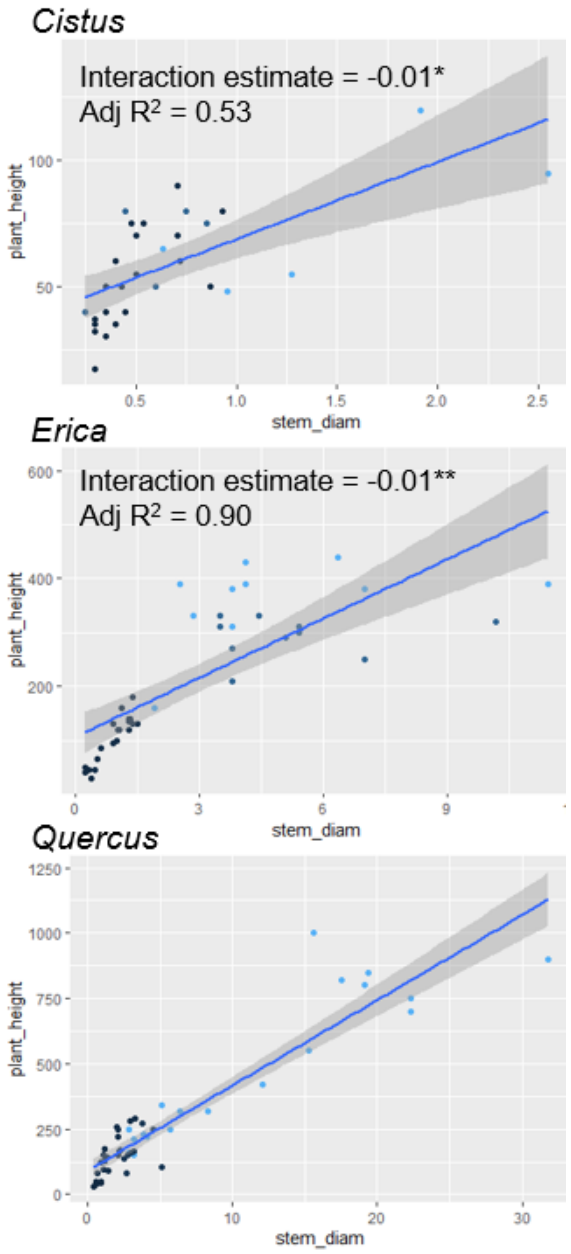






Q3. Does fire regime affect trait coordination relationships?

A3. Yes for *C. salviifolius* (reseeder) and *E. arborea* (resprouter) – e.g. weakening the size-related allometric link – but not for *Q. ilex* (resprouter)



Takeaways

1. Plant species are not homogeneous entities, even less so are life histories; the dichotomy between reseeder and resprouter plant strategies is more nuanced – when including intraspecific variability (being trait- and context-dependent)

2. *A priori* classifications of life histories, including post-fire strategies (e.g. reseeders vs resprouters, life forms), can constitute powerful tools to examine species and functional patterns at coarser scales. At finer scales considering species-specific patterns and intraspecific variability can refine our understanding of how plants may cope with changes in the environment (e.g. fire disturbance) – useful information to estimate cascading effects on ecosystem functioning & for restoration purposes

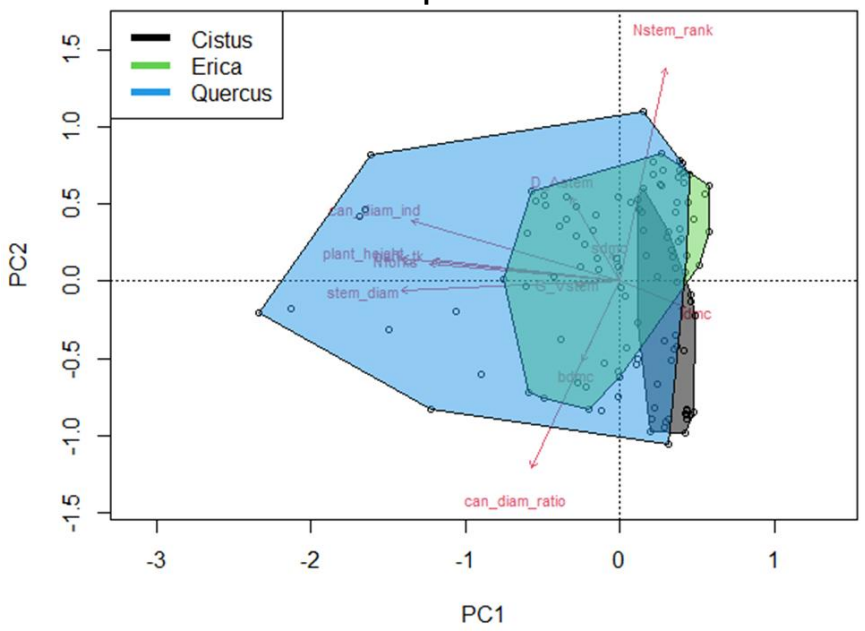
This research is supported by NBFC (National Biodiversity Future Center) funded by the Italian Ministry of University and Research, P.N.R.R., Missione 4 Componente 2, “Dalla ricerca all'impresa”, Investimento 1.4, Project CN00000033 (financed by the European Union – NextGenerationEU).

A special thank goes to Mara Baudena (CNR-ISAC), Heath Beckett (Stellenbosch Uni, SA), José Maria Costa-Saura, Costantino Sirca, Mauro Lo Cascio (UniSS), Marta Magnani (CNR-IGG), Silvia Portarena, Ettore D’Andrea (CNR-IRET) for conceptually contributing to the study or helping with field- & lab-work.

Extensions of this trait-based research are undergoing with 2 students (1 Master @ UniTO, 1 PhD @ UniGE & CIMA).

Thanks for your attention!

Species



Site