Understanding the response of plant biodiversity to environmental perturbation using Grime's CSR theory

UNIVERSITÀ DEGLI STUDI DI MILANO

UNIVERSITÀ DEGLI STUDI DELL'INSUBRIA, VARESE

Simon Pierce simon.pierce@unimi.it

Department of Agricultural and Environmental Sciences – Production, Landscape, Agroenergy (DiSAA)

Bruno Cerabolini

Department of Theoretical and Applied Sciences

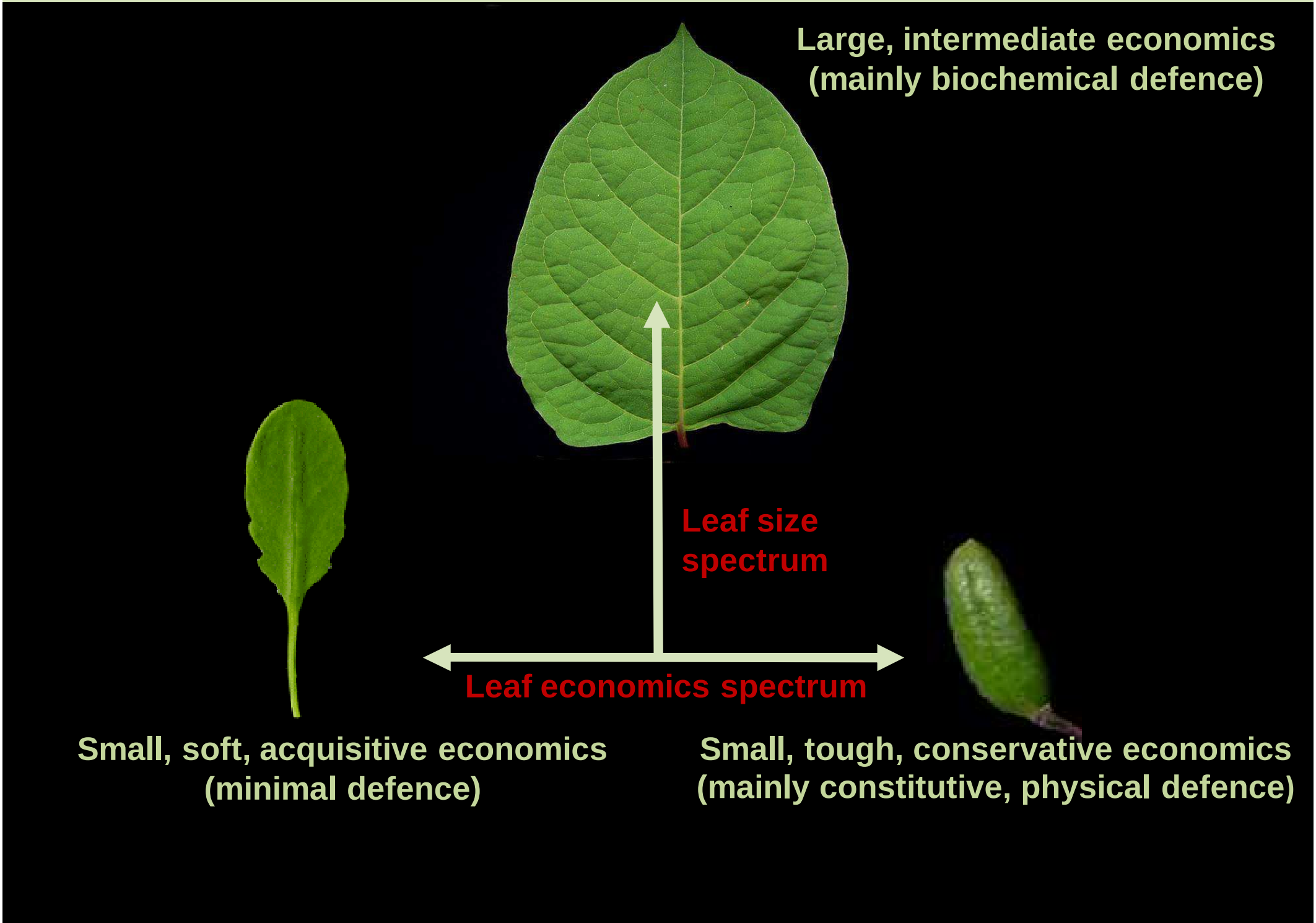
The principal axes of functional variability in the world flora

Leaf economics spectrum

Small, soft, acquisitive economics
(minimal defence)

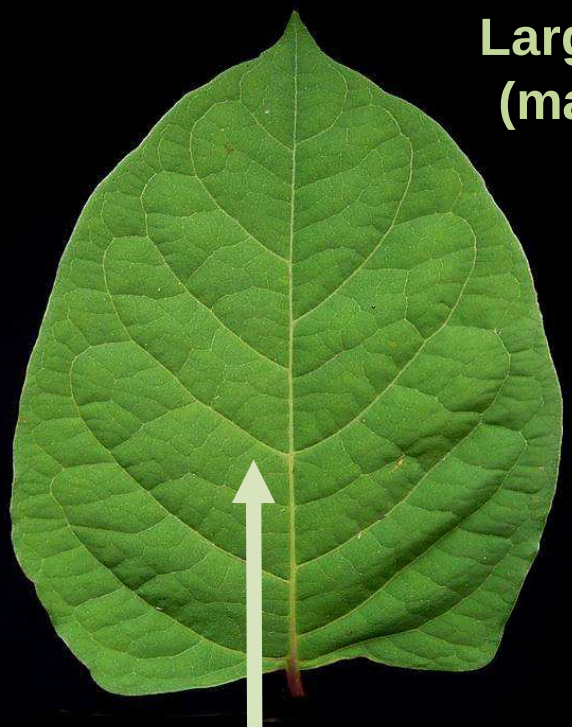
Small, tough, conservative economics
(mainly constitutive, physical defence)

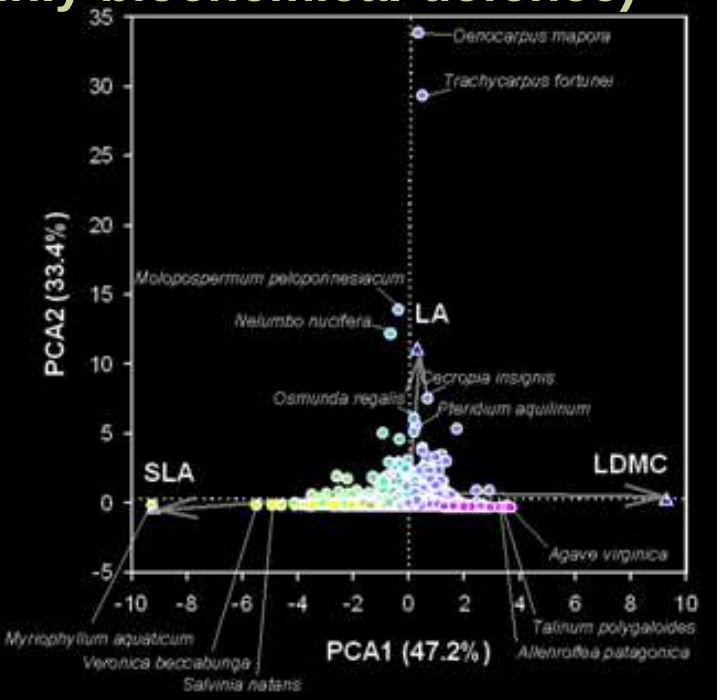
The principal axes of functional variability in the world flora



The principal axes of functional variability in the world flora

Large, intermediate economics (mainly biochemical defence)





Leaf size spectrum

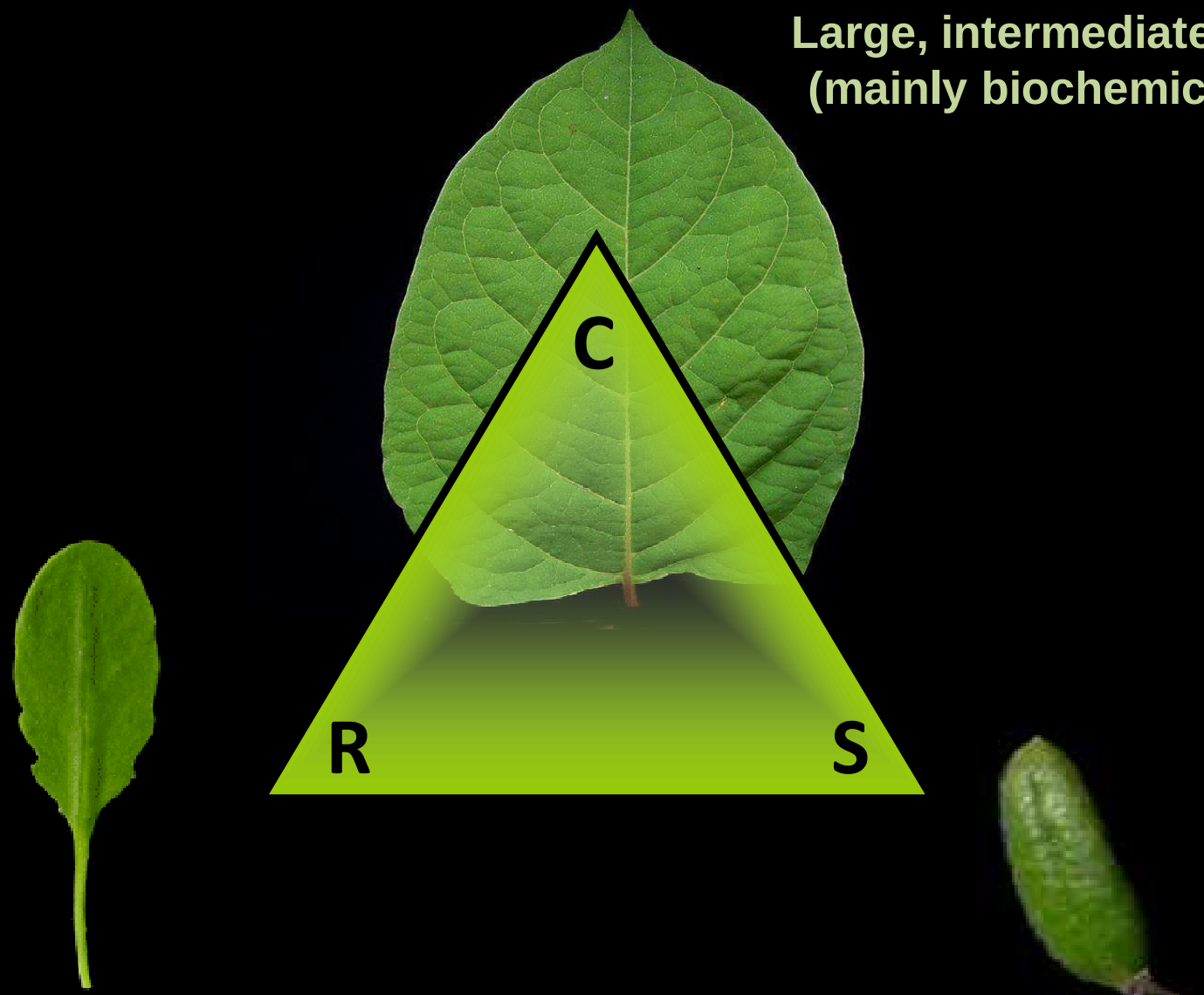
Leaf economics spectrum

Pierce, Cerabolini, Caccianiga, Buffa et al. 2015.
In preparation

Small, soft, acquisitive economics (minimal defence)

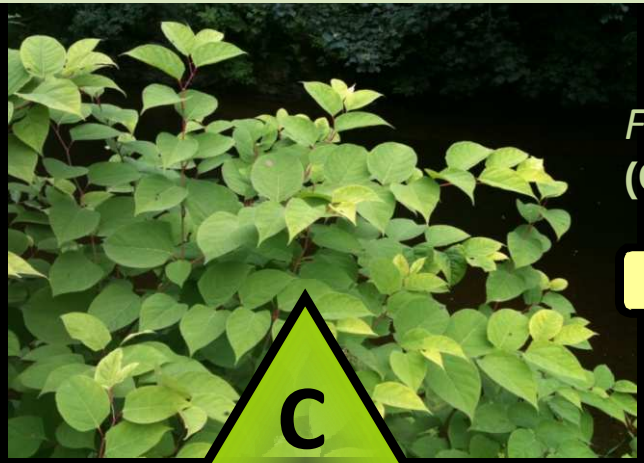
Small, tough, conservative economics (mainly constitutive, physical defence)

The principal axes of functional variability in the world flora



Grime JP. 2001. *Plant Strategies, Vegetation Processes and Ecosystem Properties*. Second Edition. Wiley, Chichester, UK.

CSR theory



Fallopia japonica
(Competitor)

Control of resource capture

C

Kalmia procumbens
(Stress-tolerator)

R

S

Arabidopsis thaliana
(Ruderal)

Regenerative ability (rapid life cycle, survival as seeds)

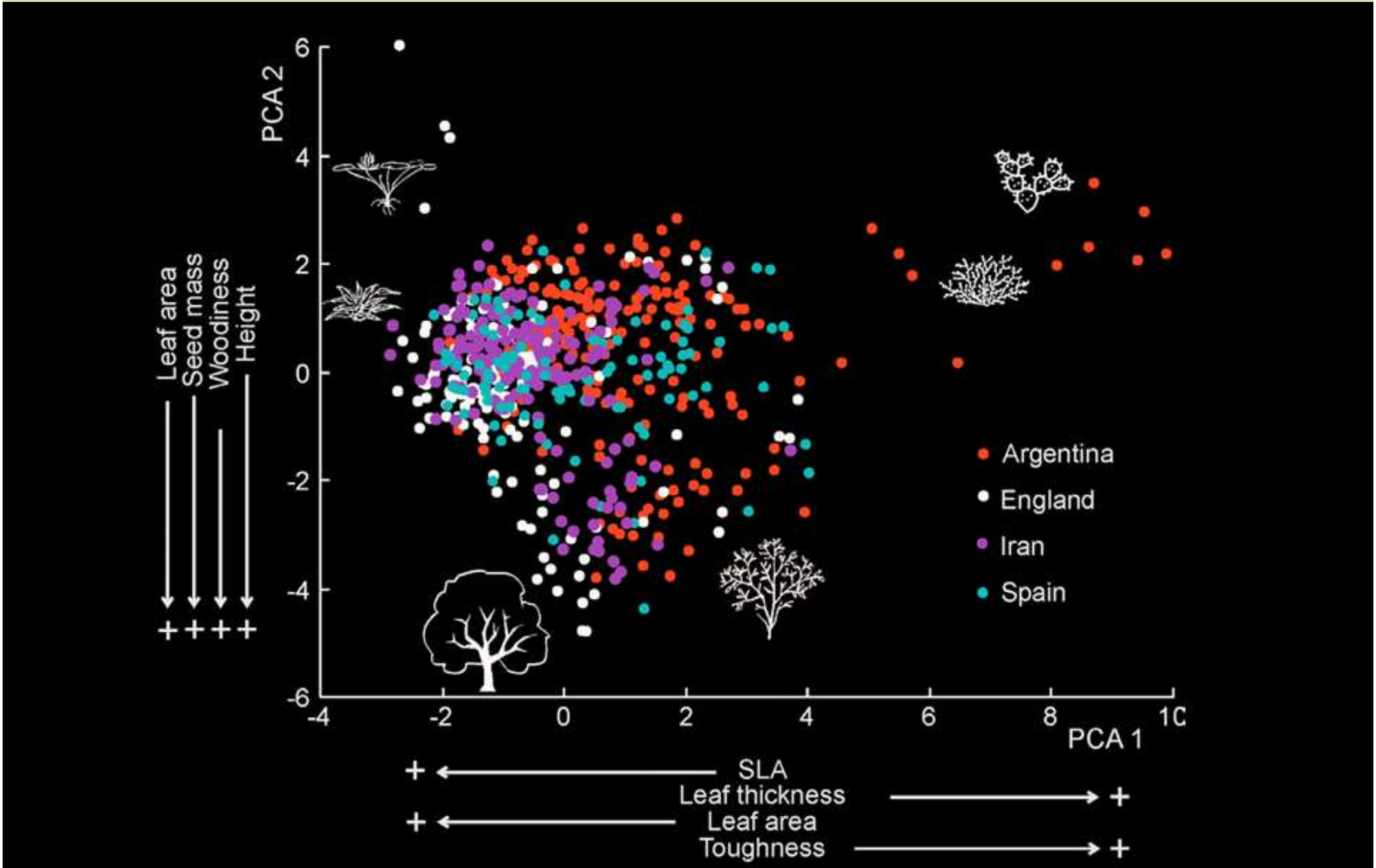
(disturbance = biomass destruction, affected tissues cannot recover)

Resistance of sub-optimal periods for metabolic function

(stress = sub-optimal function, affected tissues can recover)

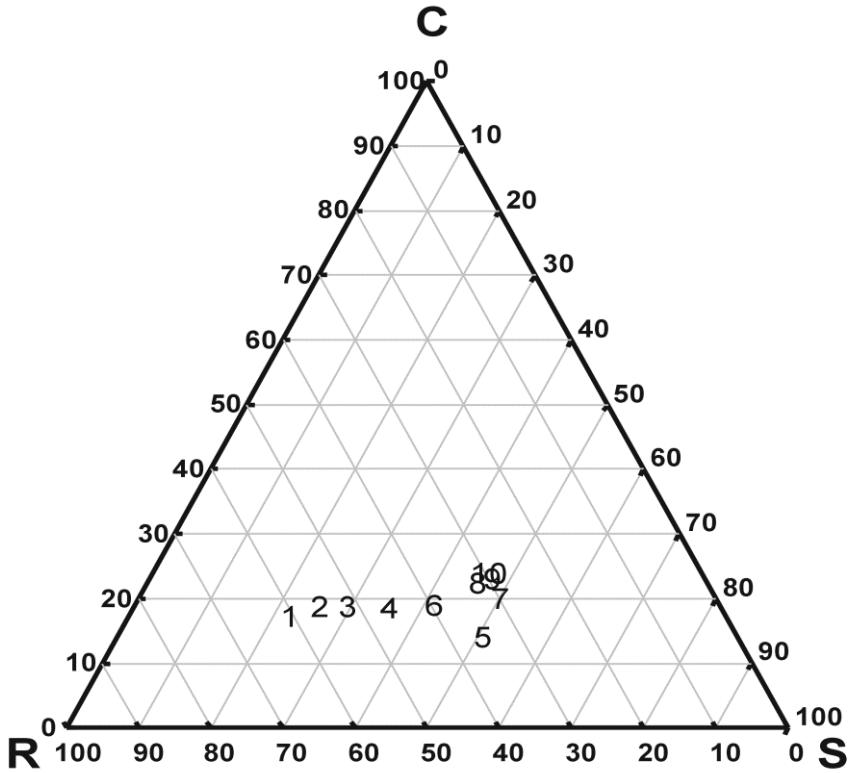
Grime JP. 2001. *Plant Strategies, Vegetation Processes and Ecosystem Properties*. Second Edition. Wiley, Chichester, UK.

The principal axes of trait variation in the world flora



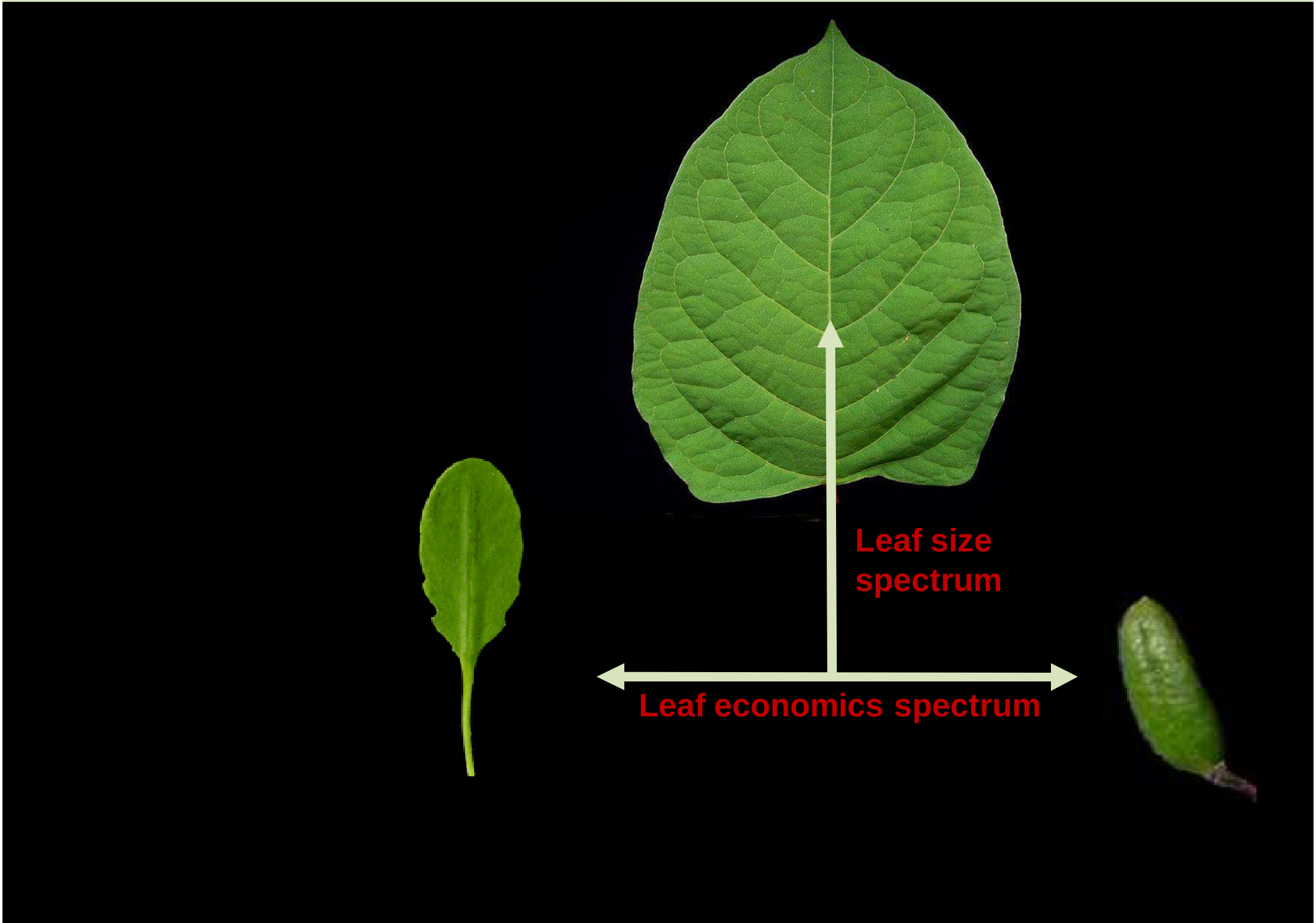
Díaz S. et al. 2004. *Journal of Vegetation Science* 15:295-304

Using CSR theory to understand plant community change

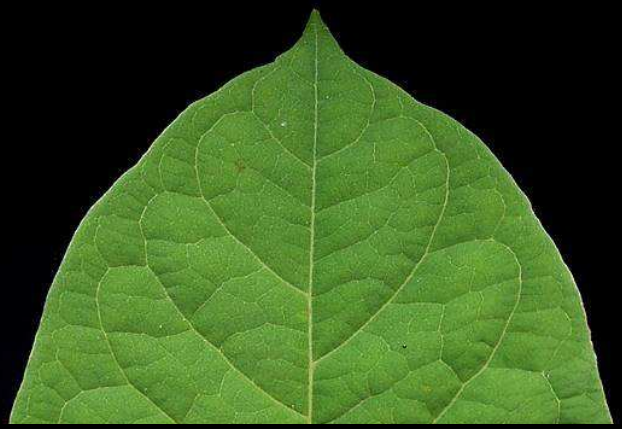


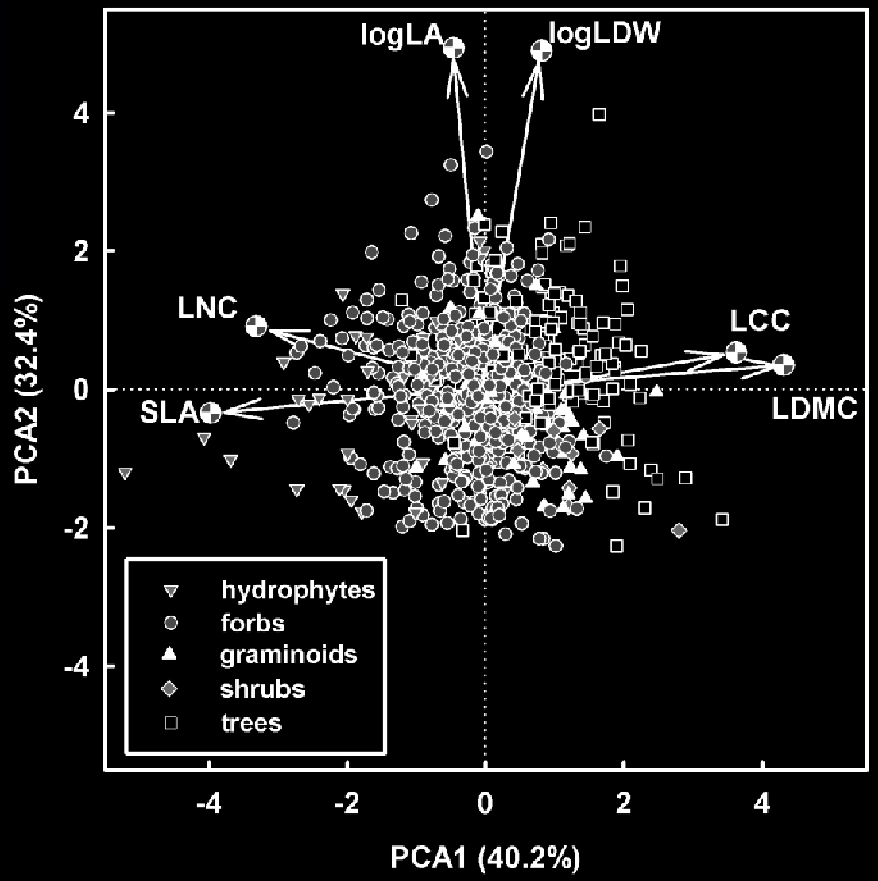
Luzzaro A. et al. 2005. *Informatore Botanico Italiano* 37(1A): 224-225.
Grime JP & Pierce S. 2012. *The Evolutionary Strategies that Shape Ecosystems.* Wiley-Blackwell.

A new CSR classification method



A new CSR classification method



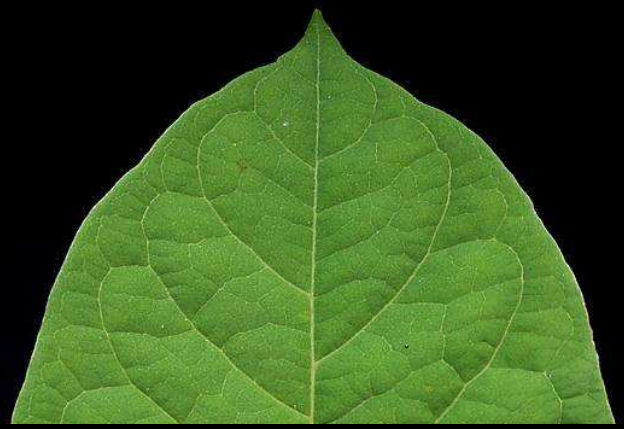


Pierce S, Brusa G, Vagge I & Cerabolini B. 2013. *Functional Ecology* 27(4): 1002-1010

A new CSR classification method

LA = Leaf Area (mm^2)

LDW = Leaf dry weight (mg)

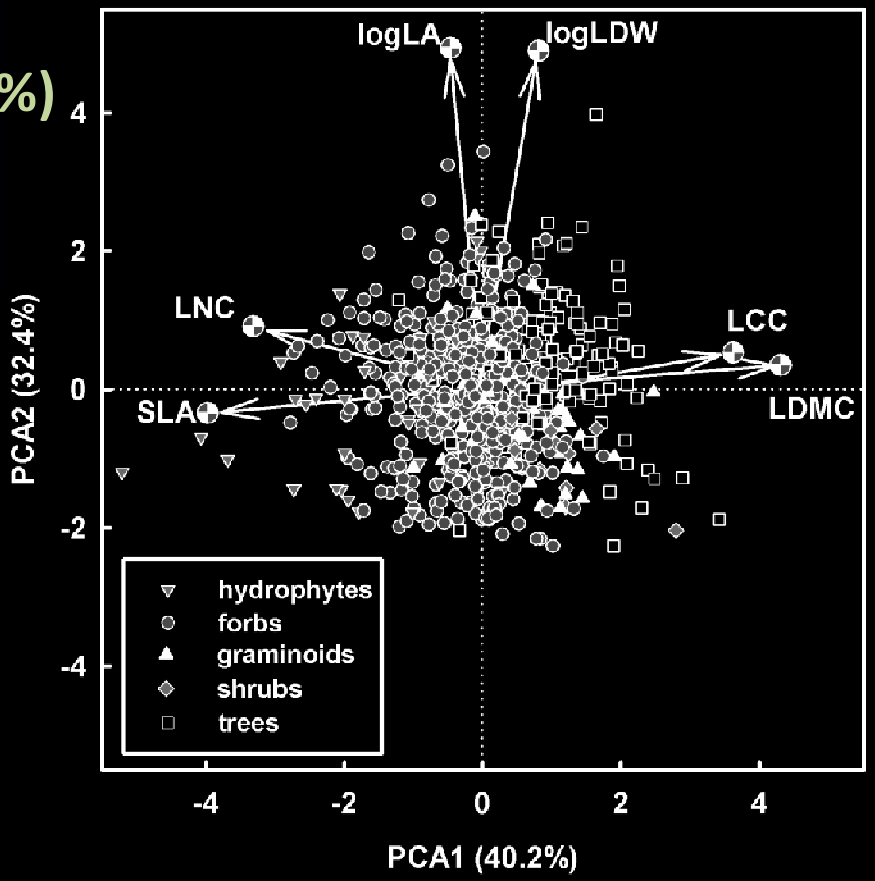


SLA = Specific Leaf Area ($mm^2\ mg^{-1}$)
(~photosynthetic tissue density)

LNC = Leaf Nitrogen Content (%)

LDMC = Leaf Dry Matter Content (%)
(investment of carbon in structural material)

LCC = Leaf Carbon Content (%)



Pierce S, Brusa G, Vagge I & Cerabolini B. 2013. *Functional Ecology* 27(4): 1002-1010

A new CSR classification method

LA = Leaf Area (mm^2)

LDW = Leaf dry weight (mg)

SLA = Specific Leaf Area ($mm^2\ mg^{-1}$)
(~photosynthetic tissue density)

LNC = Leaf Nitrogen Content (%)

LDMC = Leaf Dry Matter Content (%)
(investment of carbon in structural material)

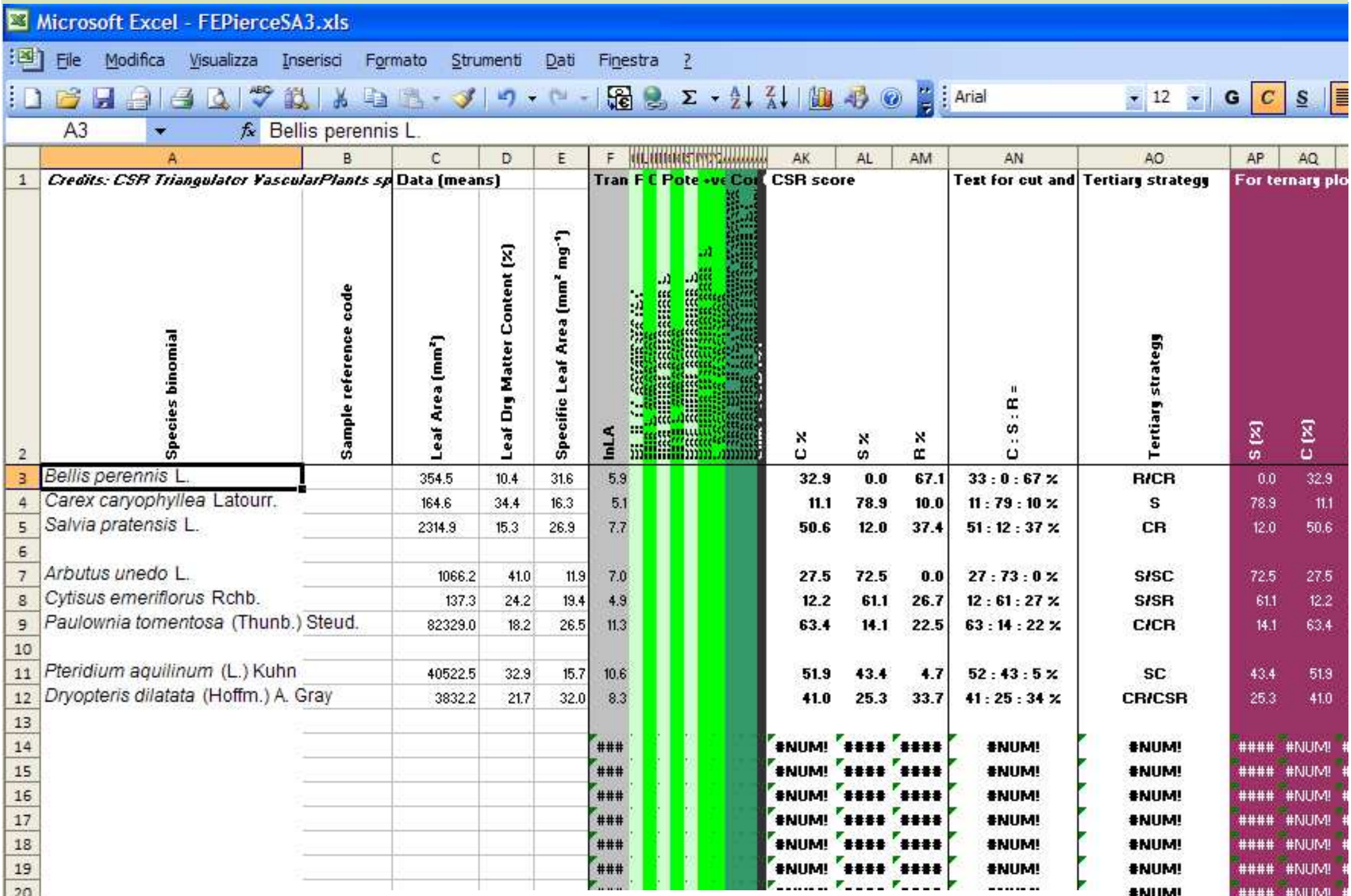
LCC = Leaf Carbon Content (%)

High SLA

High LDMC

Pierce S, Brusa G, Vagge I & Cerabolini B. 2013. *Functional Ecology* 27(4): 1002-1010

A new CSR classification method



Microsoft Excel - FEPierceSA3.xls

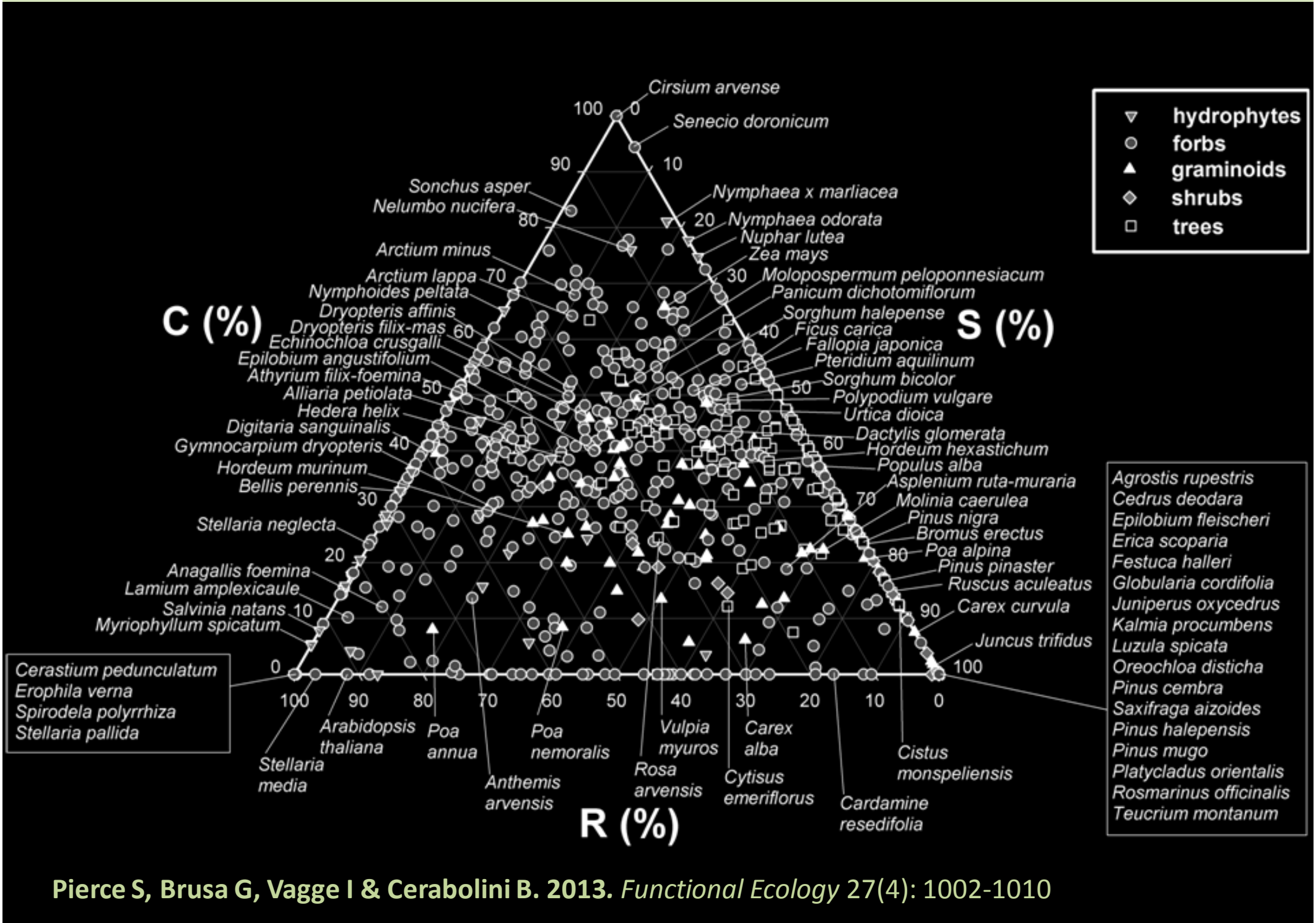
File Modifica Visualizza Inserisci Formato Strumenti Dati Finestra ?

A3 Bellis perennis L.

	A	B	C	D	E	F	AK	AL	AM	AN	AO	AP	AQ
1	Credits: CSR Triangulator VascularPlants sp		Data (means)			Tran	CSR score			Text for cut and	Tertiary strategy	For ternary plo	
2	Species binomial	Sample reference code	Leaf Area (mm²)	Leaf Dry Matter Content (%)	Specific Leaf Area (mm² mg⁻¹)	lnLA	C %	S %	R %	C : S : R =	Tertiary strategy	S (%)	C (%)
3	*Bellis perennis* L.		354.5	10.4	31.6	5.9	32.9	0.0	67.1	33 : 0 : 67 %	R/CR	0.0	32.9
4	*Carex caryophyllea* Latourr.		164.6	34.4	16.3	5.1	11.1	78.9	10.0	11 : 79 : 10 %	S	78.9	11.1
5	*Salvia pratensis* L.		2314.9	15.3	26.9	7.7	50.6	12.0	37.4	51 : 12 : 37 %	CR	12.0	50.6
6													
7	*Arbutus unedo* L.		1066.2	41.0	11.9	7.0	27.5	72.5	0.0	27 : 73 : 0 %	S/SC	72.5	27.5
8	*Cytisus emeriflorus* Rchb.		137.3	24.2	19.4	4.9	12.2	61.1	26.7	12 : 61 : 27 %	S/SR	61.1	12.2
9	*Paulownia tomentosa* (Thunb.) Steud.		82329.0	18.2	26.5	11.3	63.4	14.1	22.5	63 : 14 : 22 %	C/CR	14.1	63.4
10													
11	*Pteridium aquilinum* (L.) Kuhn		40522.5	32.9	15.7	10.6	51.9	43.4	4.7	52 : 43 : 5 %	SC	43.4	51.9
12	*Dryopteris dilatata* (Hoffm.) A. Gray		3832.2	21.7	32.0	8.3	41.0	25.3	33.7	41 : 25 : 34 %	CR/CSR	25.3	41.0
13													
14						###	#NUM!	####	####	#NUM!	#NUM!	####	#NUM!
15						###	#NUM!	####	####	#NUM!	#NUM!	####	#NUM!
16						###	#NUM!	####	####	#NUM!	#NUM!	####	#NUM!
17						###	#NUM!	####	####	#NUM!	#NUM!	####	#NUM!
18						###	#NUM!	####	####	#NUM!	#NUM!	####	#NUM!
19						###	#NUM!	####	####	#NUM!	#NUM!	####	#NUM!
20											#NUM!	####	#NUM!
21											#NUM!	####	#NUM!
22											#NUM!	####	#NUM!

Pierce S, Brusa G, Vagge I & Cerabolini B. 2013. *Functional Ecology* 27(4): 1002-1010

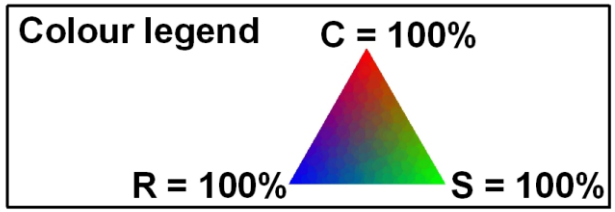
A new CSR classification method

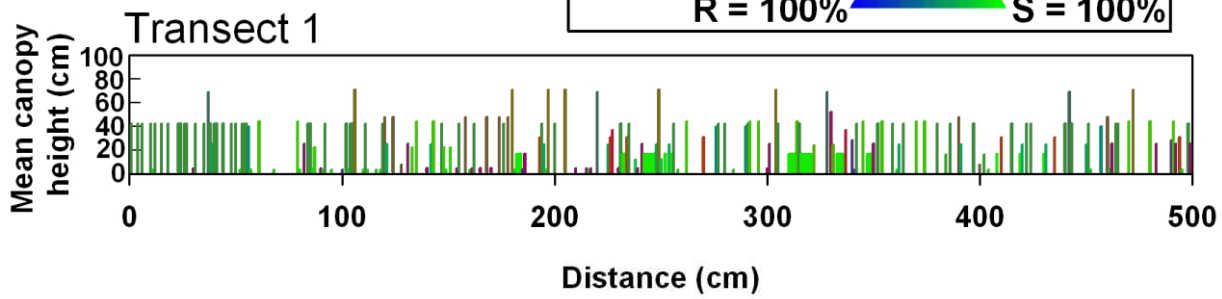


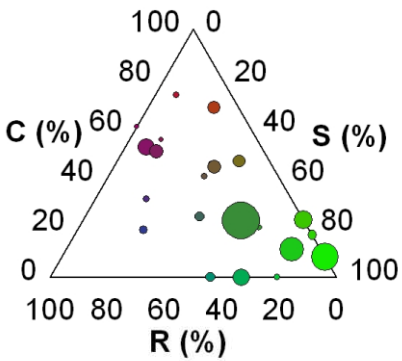
Pierce S, Brusa G, Vagge I & Cerabolini B. 2013. *Functional Ecology* 27(4): 1002-1010

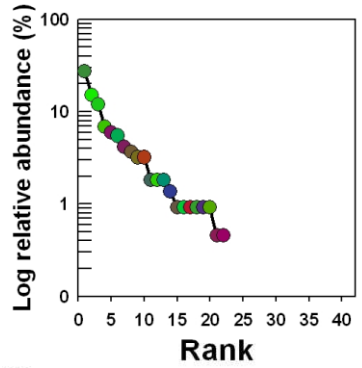
Investigating species coexistence at the centimetre scale

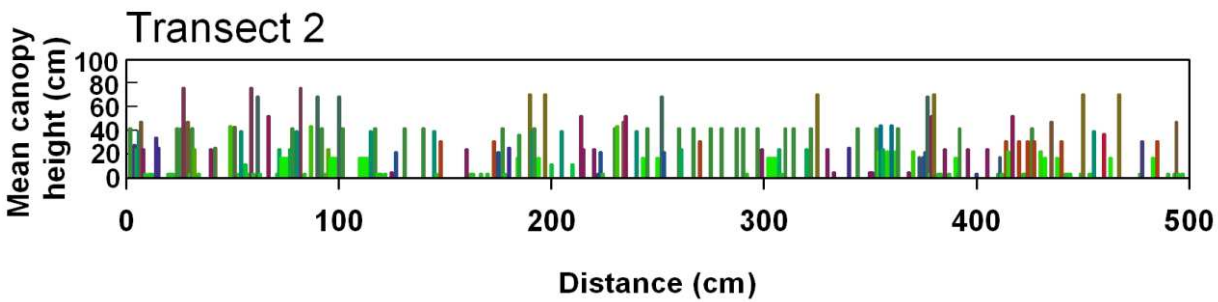
6210* Xeric sand calcareous grassland

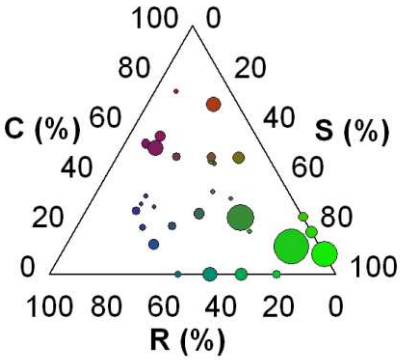


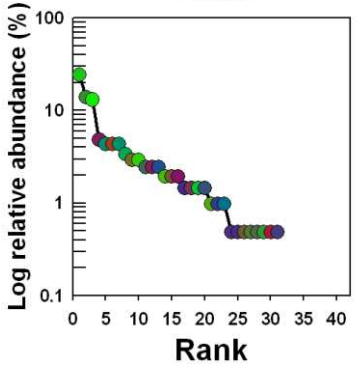


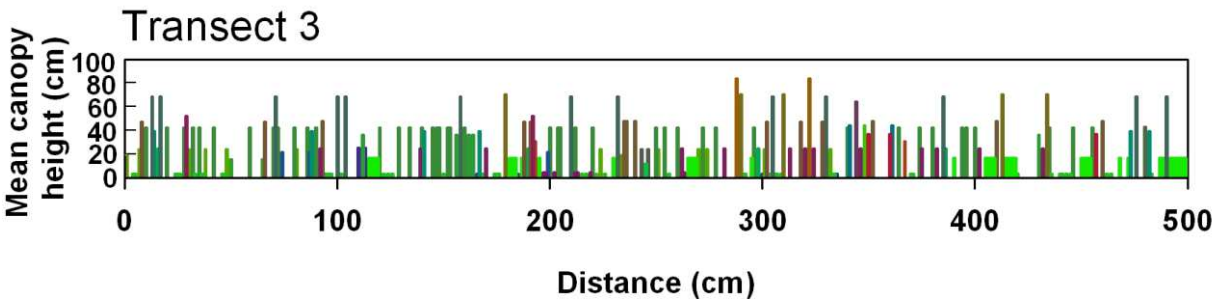


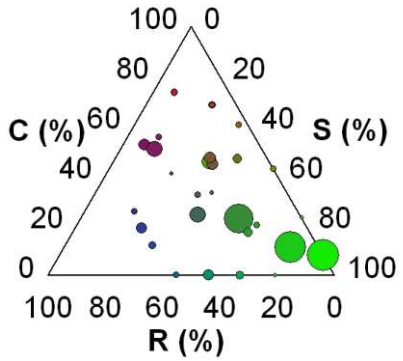


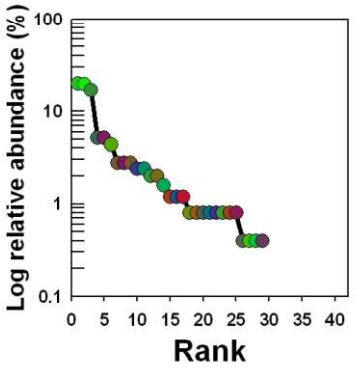








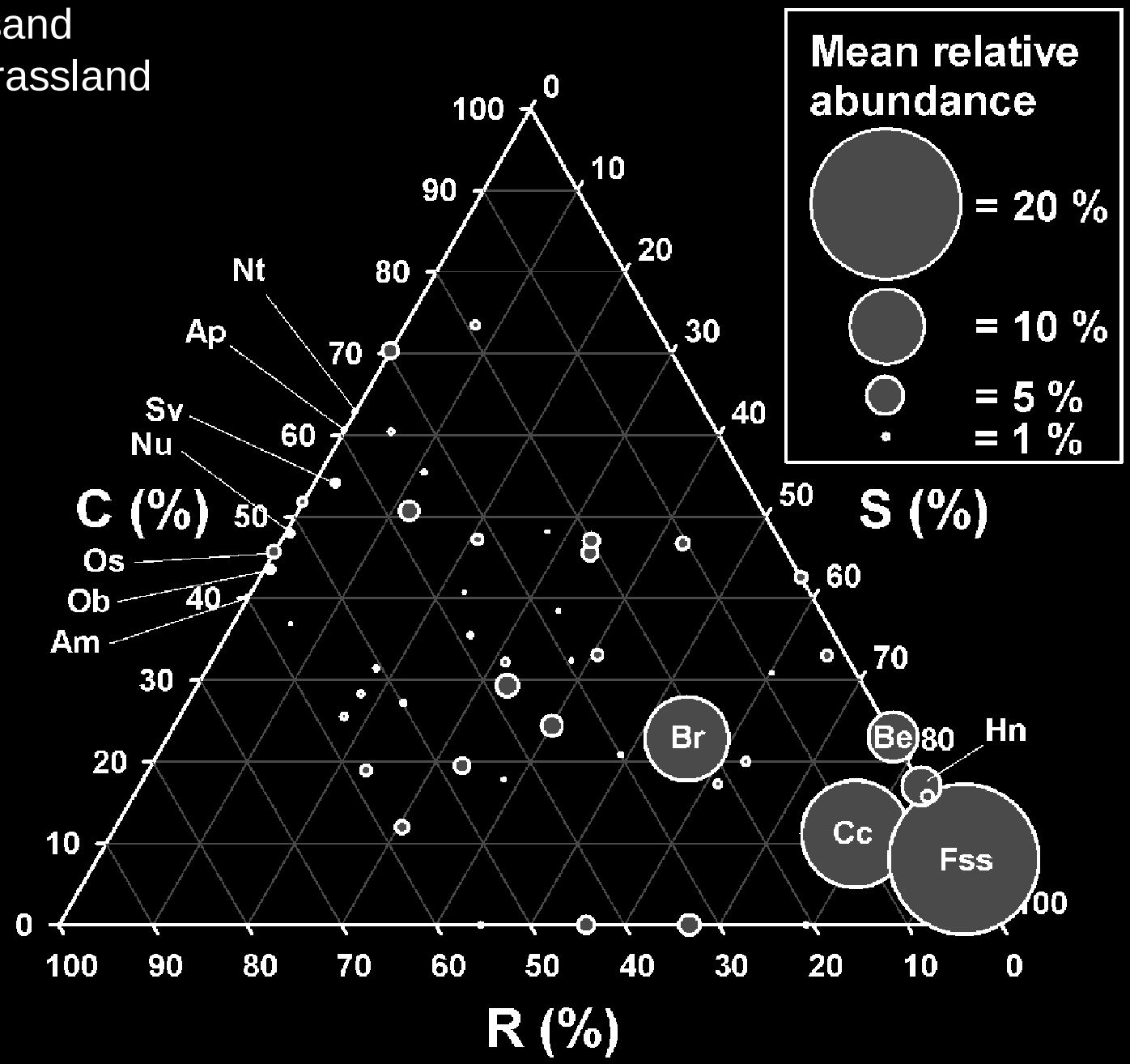




Pierce S, Vagge I, Brusa G & Cerabolini B. 2014. *Plant Ecology* 215: 495-505

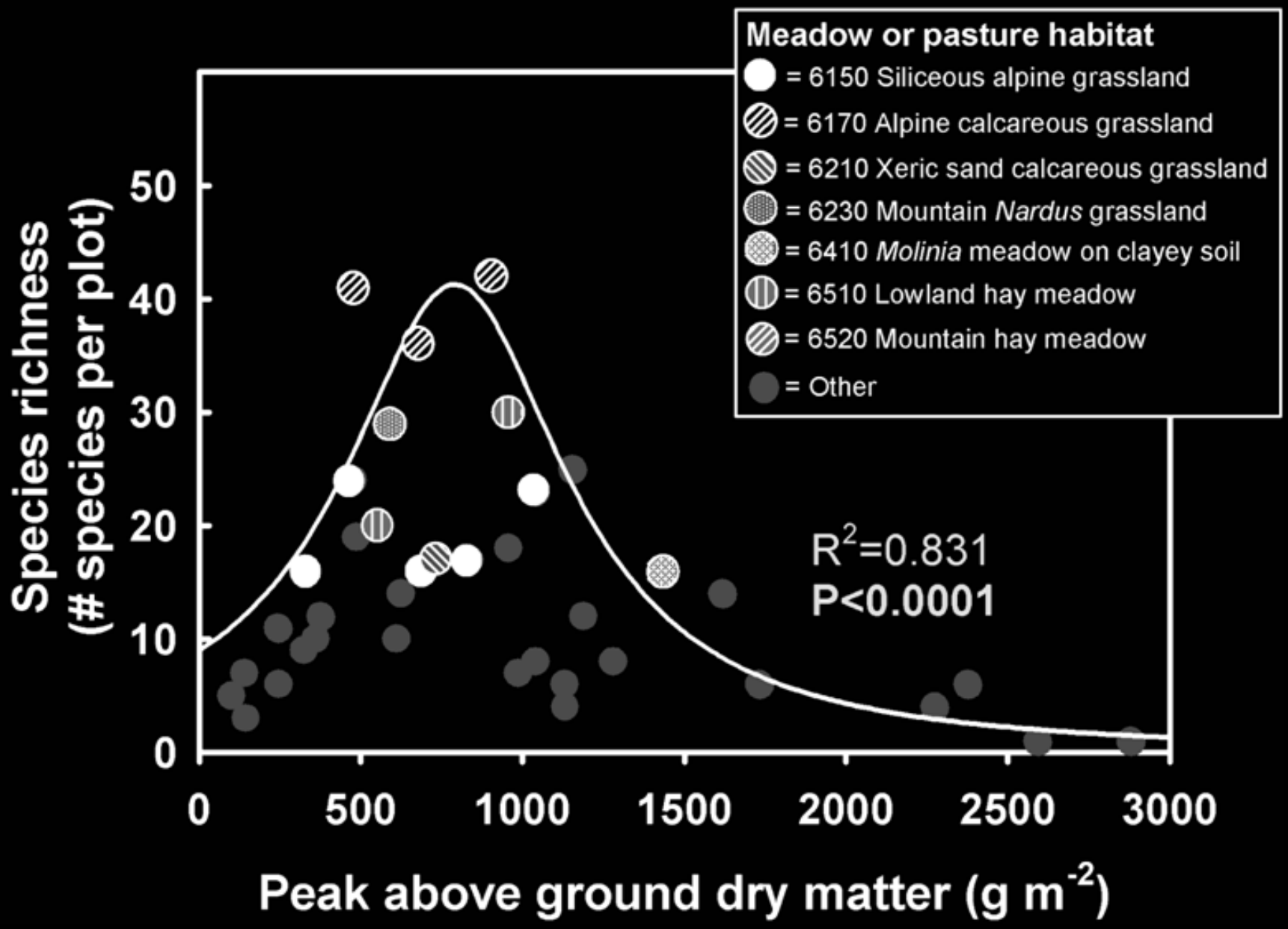
Investigating species coexistence at the centimetre scale

6210* Xeric sand calcareous grassland



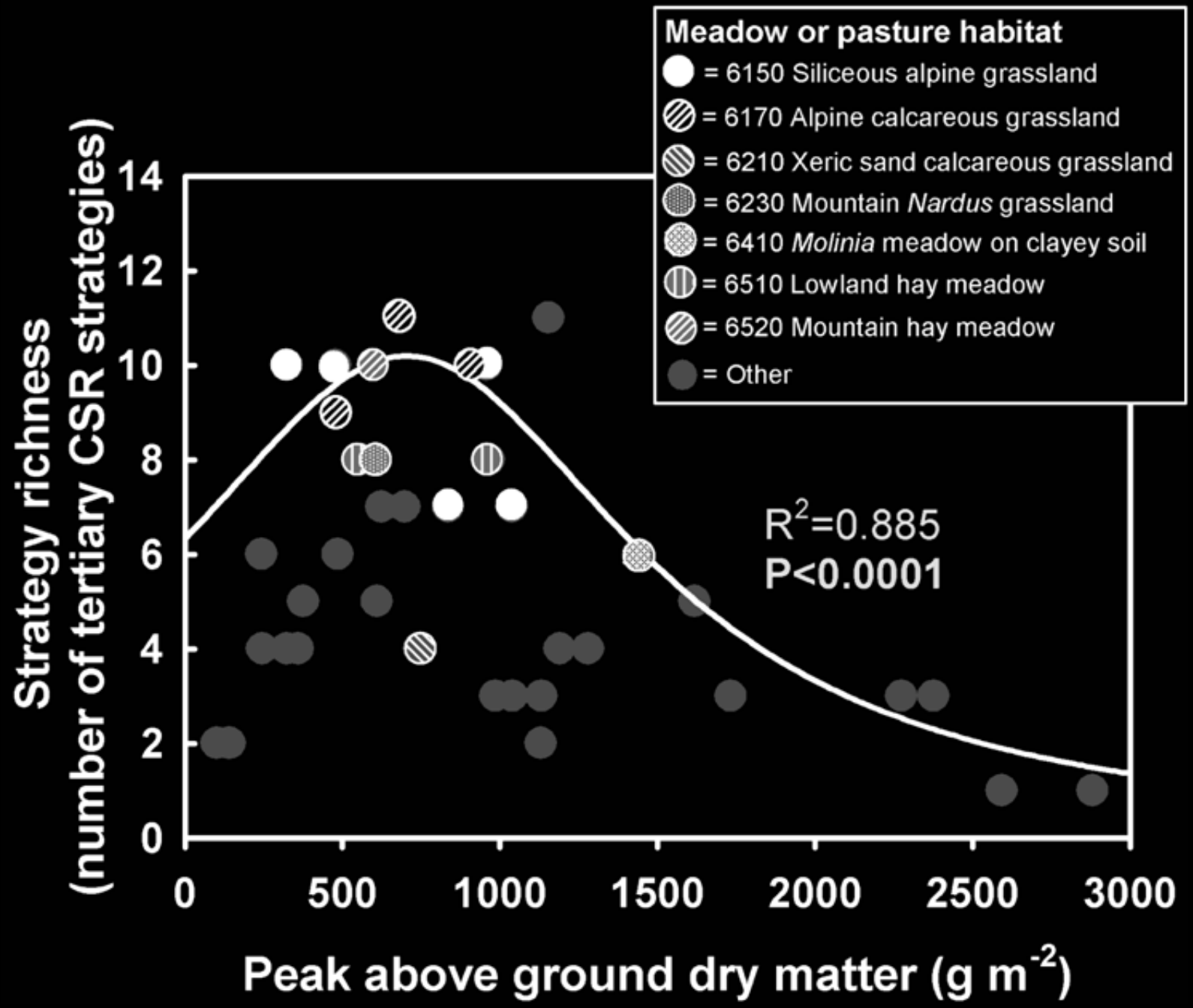
Pierce S, Vagge I, Brusa G & Cerabolini B. 2014. *Plant Ecology* 215: 495-505

Does greater species richness correspond with greater diversity in CSR strategies?



Cerabolini *et al.* 2014. *Plant Biosystems* (in press)

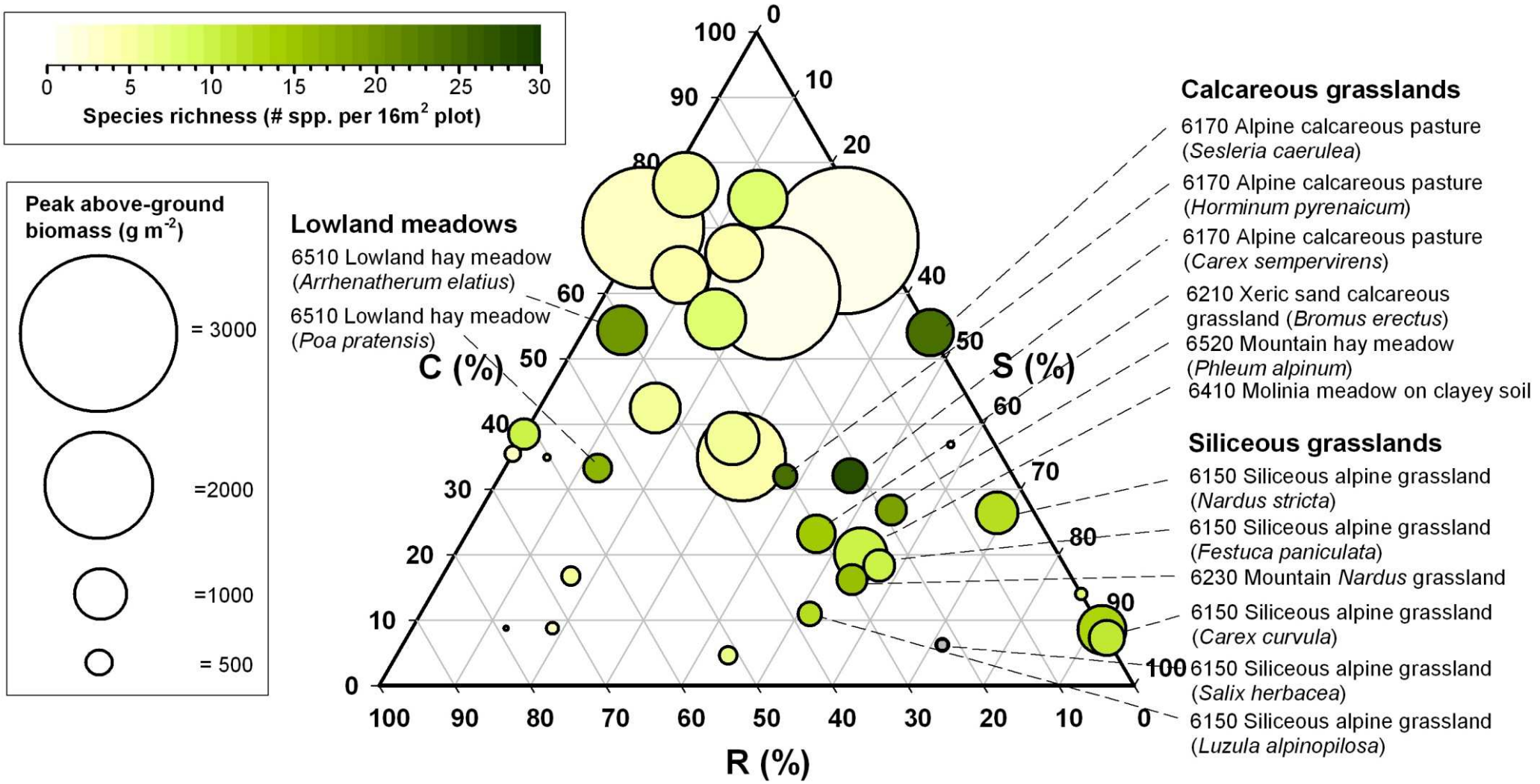
Does greater species richness correspond with greater diversity in CSR strategies? YES



Cerabolini *et al.* 2014. *Plant Biosystems* (in press)

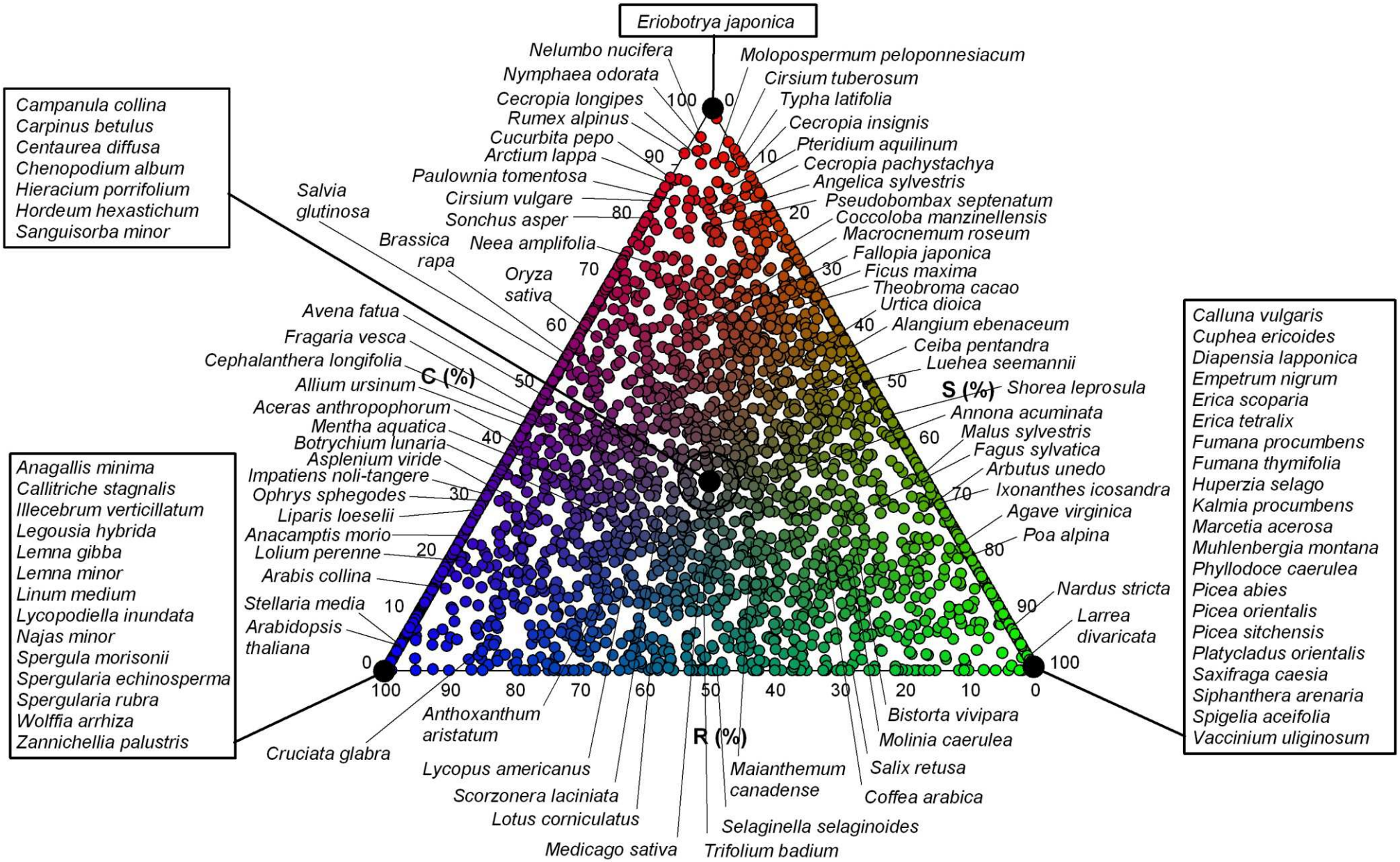
Does greater species richness correspond with particular CSR strategies?

Community weighted mean CSR strategies



Cerabolini *et al.* 2014. *Plant Biosystems* (in press)

The future – a globally calibrated CSR classification (3052 spp. from around the world)



Pierce, Cerabolini, Caccianiga, Buffa et al. 2015. *(in preparation)*

CSR classification is:

1). mechanistic

(it demonstrates the evolutionary basis of plant communities)

CSR classification is:

1). mechanistic

(it demonstrates the evolutionary basis of plant communities)

2). transferable between regional and national floras

(a primary succession on an Alaskan glacier foreland should be functionally similar to that on an Italian or Japanese glacier foreland)

CSR classification is:

1). mechanistic
(it demonstrates the evolutionary basis of plant communities)

2). transferable between regional and national floras
(a primary succession on an Alaskan glacier foreland should be functionally similar to that on an Italian or Japanese glacier foreland)

3). well integrated with established phytosociological knowledge
(it provides an extra and complementary investigative tool)

CSR classification is:

1). mechanistic
(it demonstrates the evolutionary basis of plant communities)

2). transferable between regional and national floras
(a primary succession on an Alaskan glacier foreland should be functionally similar to that on an Italian or Japanese glacier foreland)

3). well integrated with established phytosociological knowledge
(it provides an extra and complementary investigative tool)

4). predictive and allows hypothesis testing

Hypothesis: plant communities dominated by stress-tolerators exhibit greater latency in response to climatic change

Understanding the response of plant biodiversity to environmental perturbation using Grime's CSR theory

UNIVERSITÀ DEGLI STUDI DI MILANO

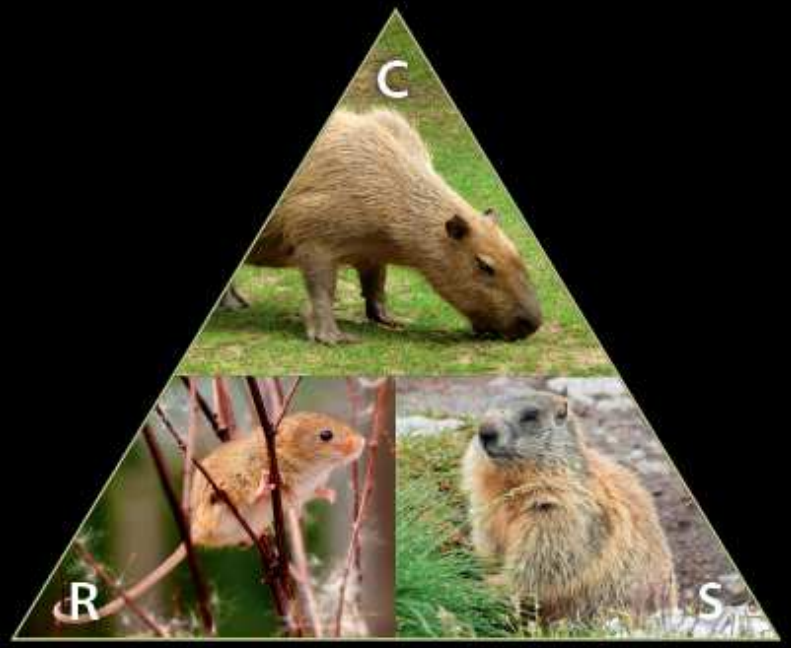
UNIVERSITÀ DEGLI STUDI DELL'INSUBRIA, VARESE

Simon Pierce simon.pierce@unimi.it

Department of Agricultural and Environmental Sciences – Production, Landscape, Agroenergy (DiSAA)

Bruno Cerabolini

Department of Theoretical and Applied Sciences



THE EVOLUTIONARY STRATEGIES THAT SHAPE ECOSYSTEMS

J. Philip Grime and Simon Pierce

WILEY-BLACKWELL