Soil biota and innovative forest management: a Life Project

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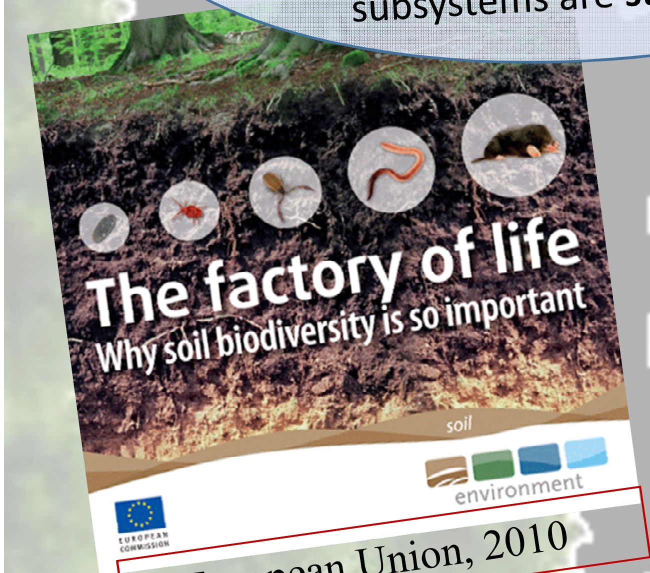
FUNGAL CONSERVATION
IN A CHANGING EUROPE

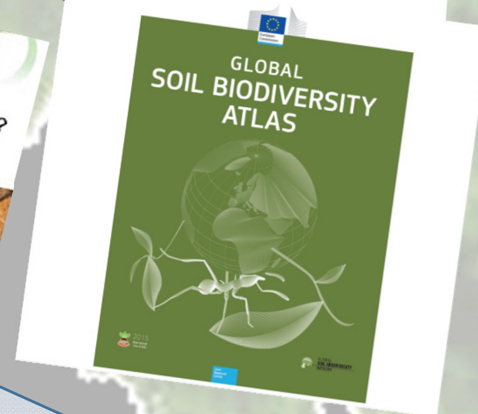
The Challenges Ahead

Ohrid, Former Yugoslav Republic of Macedonia [FYROM]
Sunday 1 to Friday 6 October 2017

SOIL BIOTA play a fundamental role for supplying the environment with a number of important ecological processes and interactions. Soil hosts approximately a quarter of Earth's biodiversity. This biodiversity provides a vital habitat, regulating the dynamics of soil cycles of essential elements modifying soil physical structure and water regimes, enhancing fertility and plant growth.

Effects of soil biota changes on ecosystem processes are mostly **unknown**! Researches investigating the many **interactions** between above and below ground subsystems are **still lacking**.





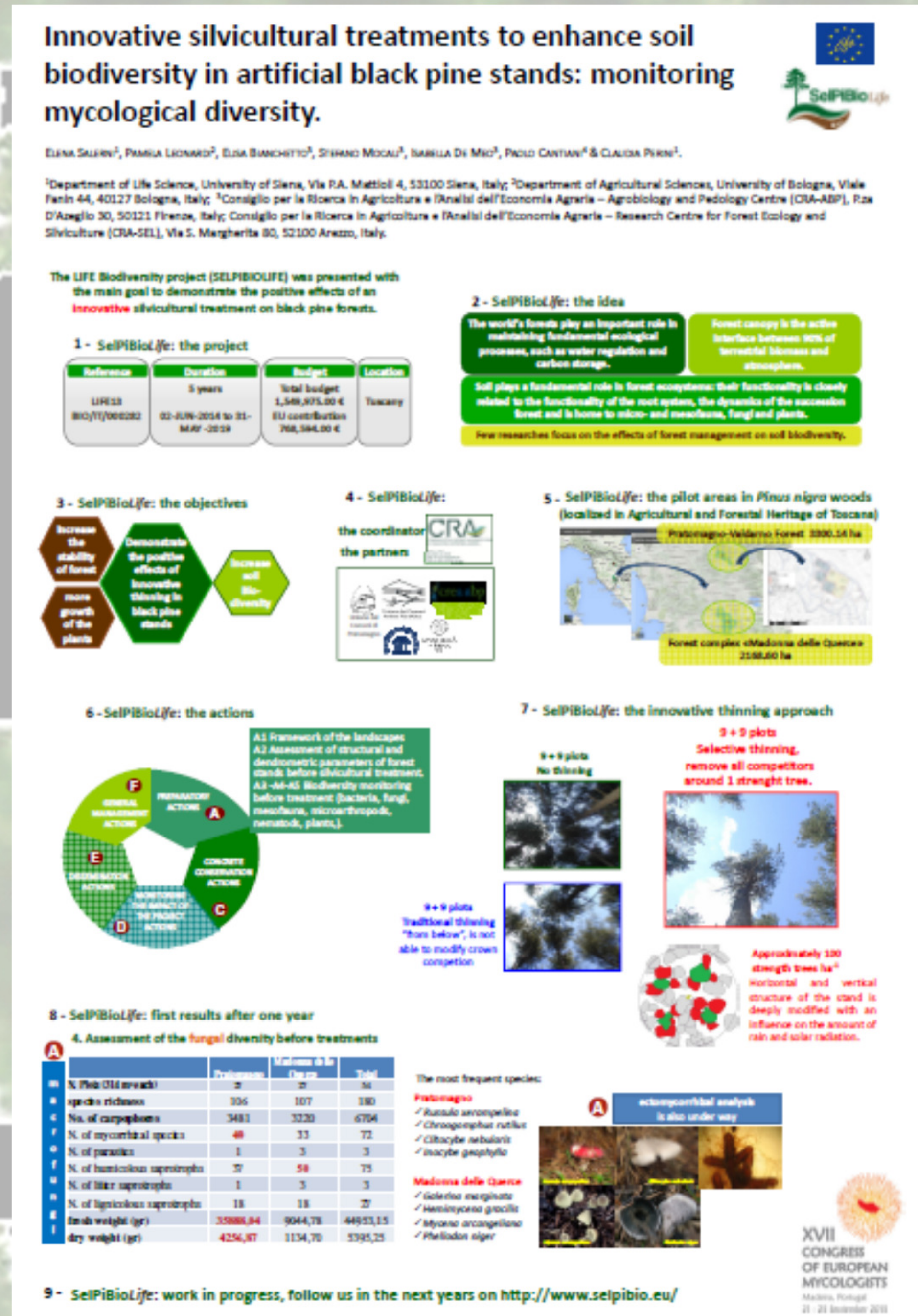
Few researches focuse on the effects of forest management on soil biodiversity

Soil biodiversity is increasingly under **threats** due to several pressures acting on soils.
Policies to protect and value soil biodiversity are still at an **early stage**…

L.R. 27.12.2012 n. 79 «Nuova disciplina in materia di Consorzi di Bonifica…»

Energy enters the soil system mainly through the degradation of dead organic matter…
The fertility and sustainability of a natural soil therefore depends significantly on the transformation speed of organic matter, mediated by soil biota.
This is why it is crucial to protect this resource with appropriate management practices.
Modern forestry management techniques must therefore be able to meet the compromise between the economic needs of public and private entities and the conservation and increasing of biodiversity.

In this context, a multidisciplinary **LIFE PROJECT** (SelpiBioLife, LIFE13 BIO/IT/000282) evaluate the application of an **INNOVATIVE FOREST MANAGEMENT** technique along with its effects on different soil taxa.



SelPiBio*Life*: The partner

The Council for Agricultural Research and Economics – CREA: Research Centre for Forest Ecology and Silviculture in Arezzo & for Agrobiology and Pedology in Firenze

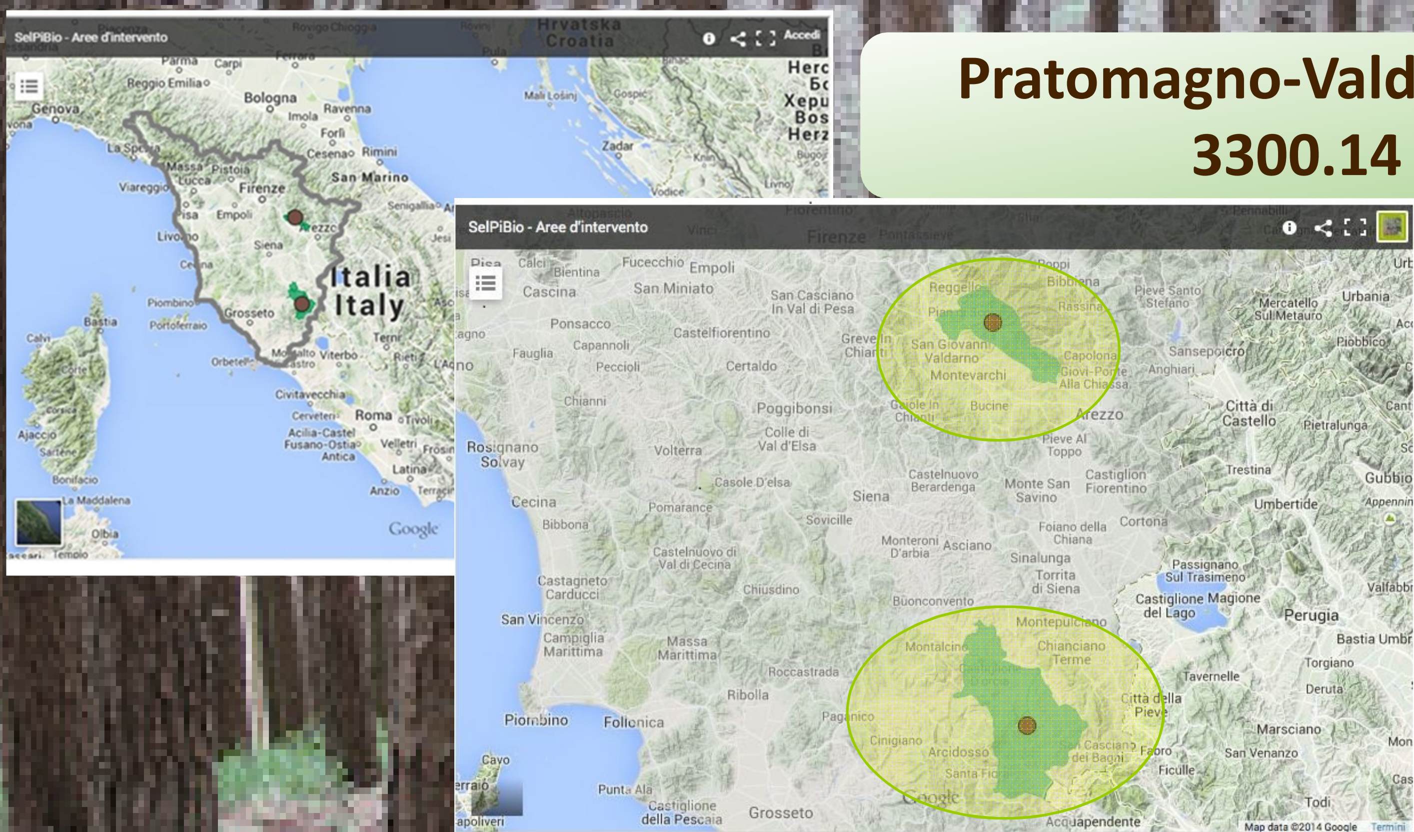
Unione dei Comuni Amiata Val D'Orcia & **U**nione dei Comuni Pratomagno

Compagnia delle Foreste Arezzo

Department of Life Science, University of Siena

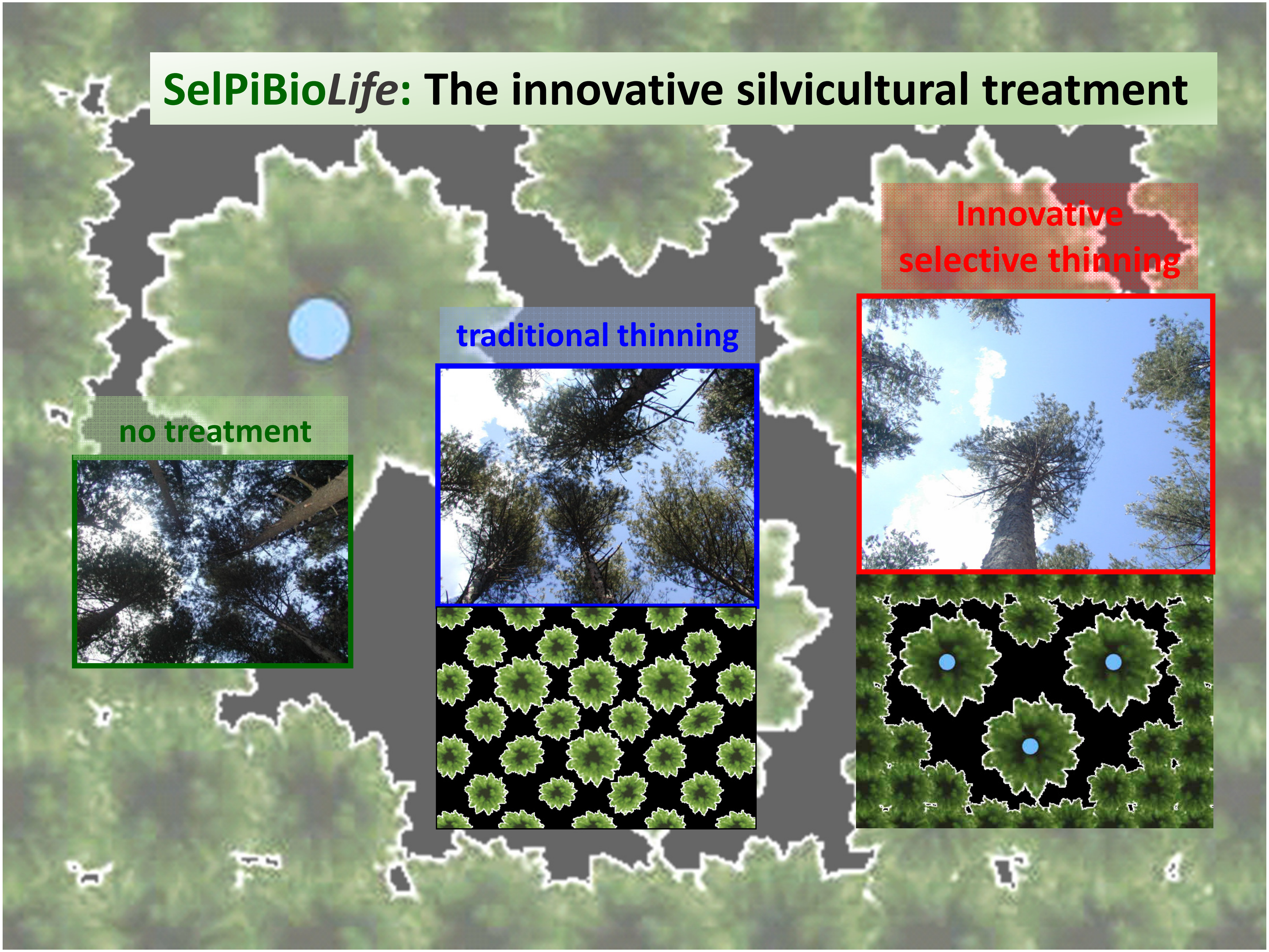
SelPiBio*Life*: The pilot areas

Silvicultural treatments and biodiversity monitoring are carried out in *Pinus nigra* reforestations belonging to the Tuscan Agricultural and Forest Heritage. In Tuscany Black pine stands covers 20.500 ha, its about 20% of our conifers forests.



Pratomagno-Valdarno Forest
3300.14 ha.

Forest complex «Madonna delle Querce» 2168.60 ha


SelPiBio*Life*: The innovative silvicultural treatment
Innovative
selective thinning
traditional thinning
no treatment

SelPiBio*Life*: Objective

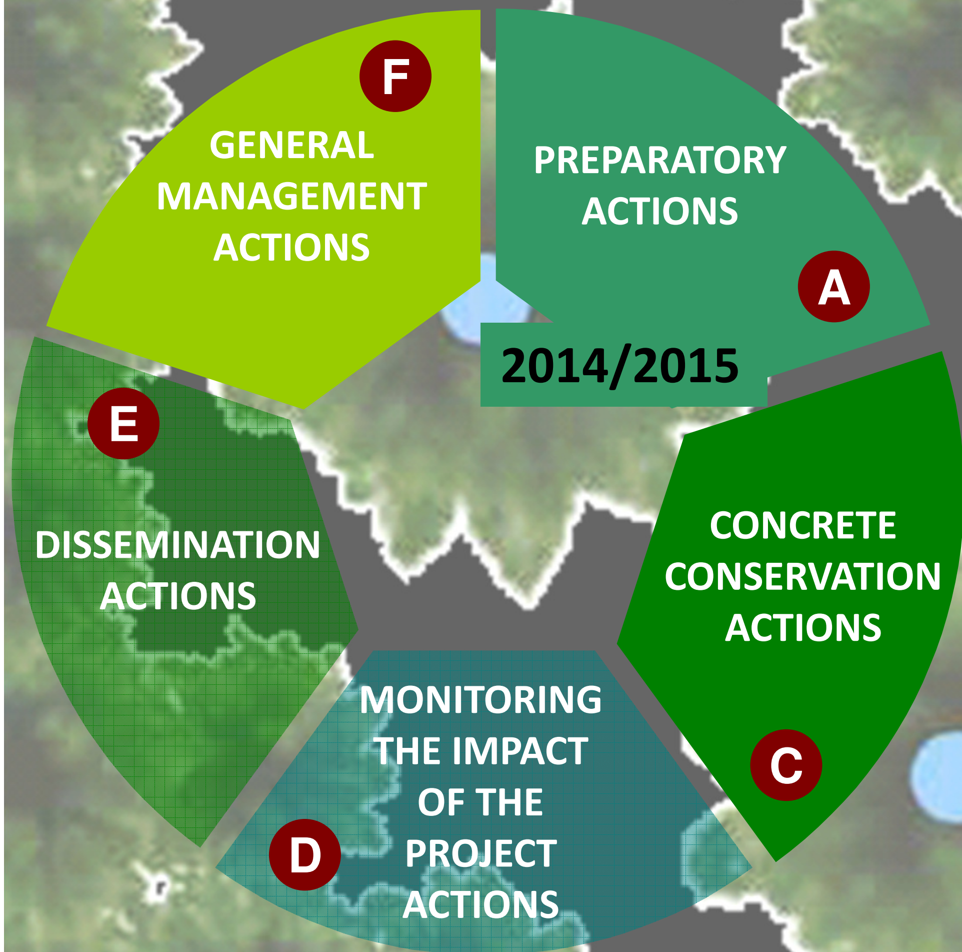
…demonstrate how an innovative silvicultural treatment, compared with traditional methods and with no treatment areas, could…

increase stability of forest

increase plant-growth

ENHANCE SOIL BIODIVERSITY

This new approach is in line with the EU 2020 Biodiversity Strategy (2011/2307(INI)), the Global and European Atlas of Soil Biodiversity (JRC, 2010), the Strategic Action Programs (SAP) of Italian National Biodiversity Strategy (SNB, 2013 national priorities).

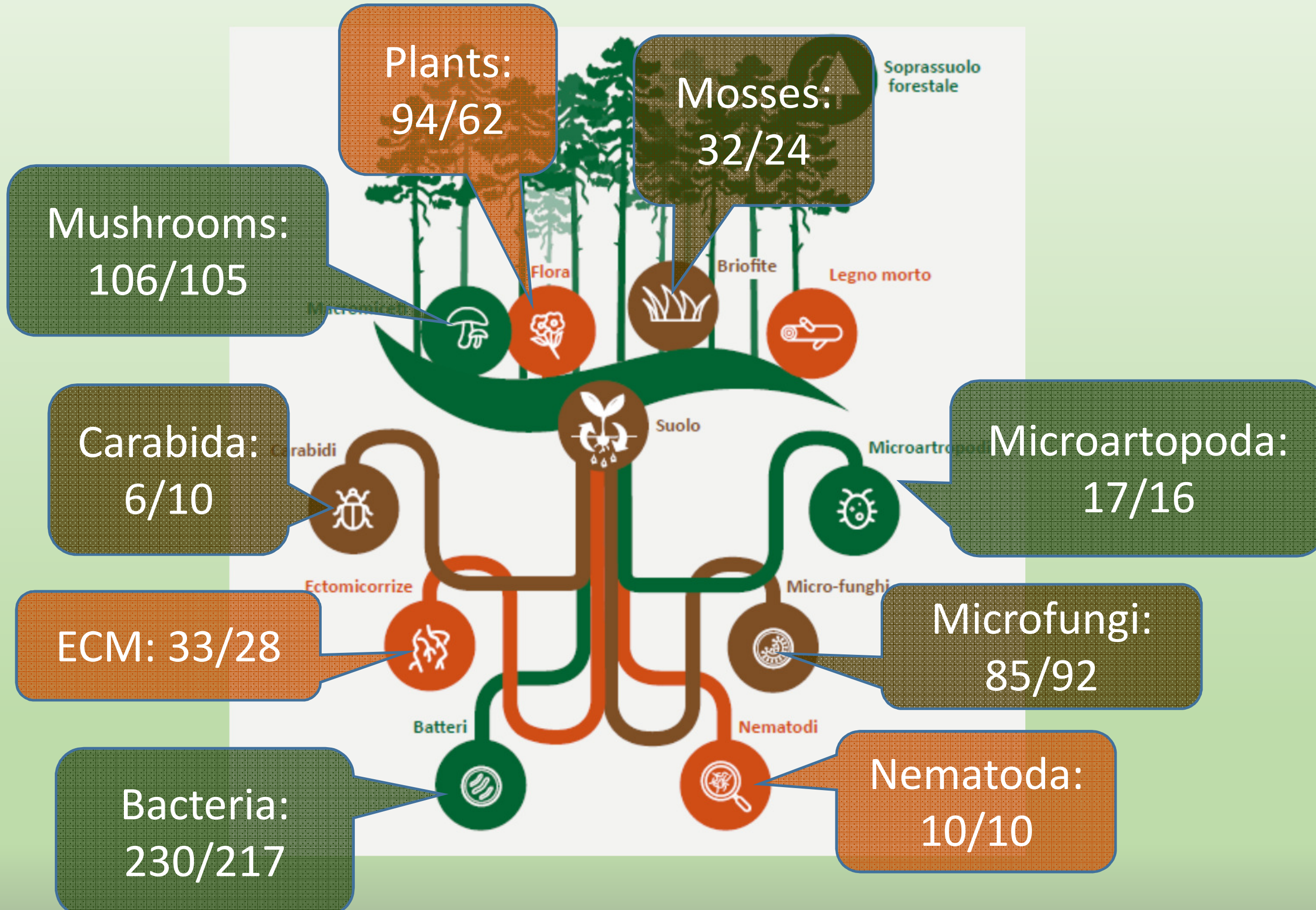


A1 Framework of the landscapes
A2 Assessment of structural and dendrometric parameters of forest stands before silvicultural treatment.
A3-A4-A5 **Biodiversity monitoring before treatment**

The "before treatment" research activity guaranteed a high quality dataset (data about 9 different taxa)**, comparable to those used in high profile journals, and a complete and objective inventory of various environmental variables.**

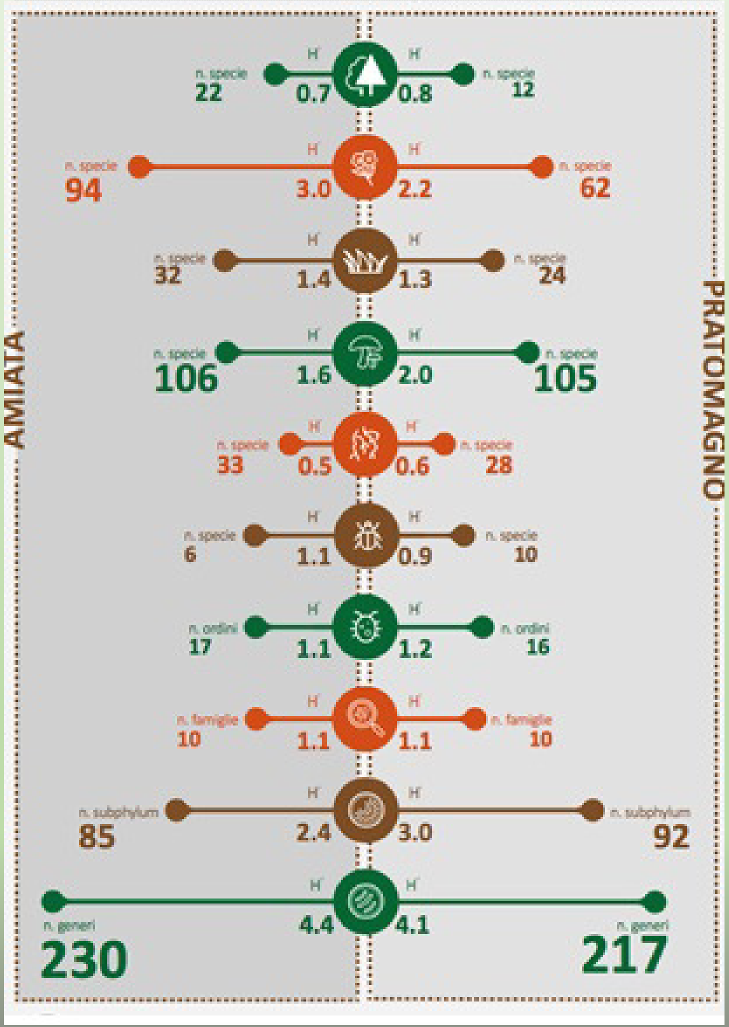
Biodiversity in numbers: before treatment

Amiata/Pratomagno



Biodiversity in numbers (Shannon index): before treatment

Amiata/Pratomagno



macrofungi

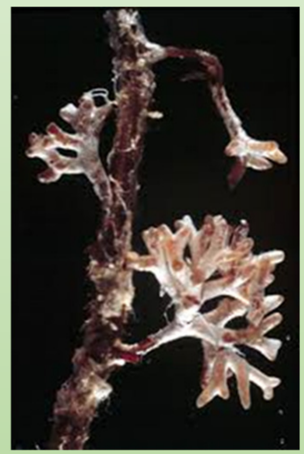
	Pratomagno	Amiata
species richness	105	106
No. of carpophores (cf)	3481	3220
fresh weight (gr)	35888,04	9044,78
dry weight (gr)	4256,87	1134,70

Pratomagno

- ✓ *Russula xerampelina*
- ✓ *Chroogomphus rutilus*
- ✓ *Clitocybe nebularis*
- ✓ *Inocybe geophylla*

Amiata

- ✓ *Galerina marginata*
- ✓ *Hemimycena gracilis*
- ✓ *Mycena arcangeliana*
- ✓ *Phellodon niger*



ECM

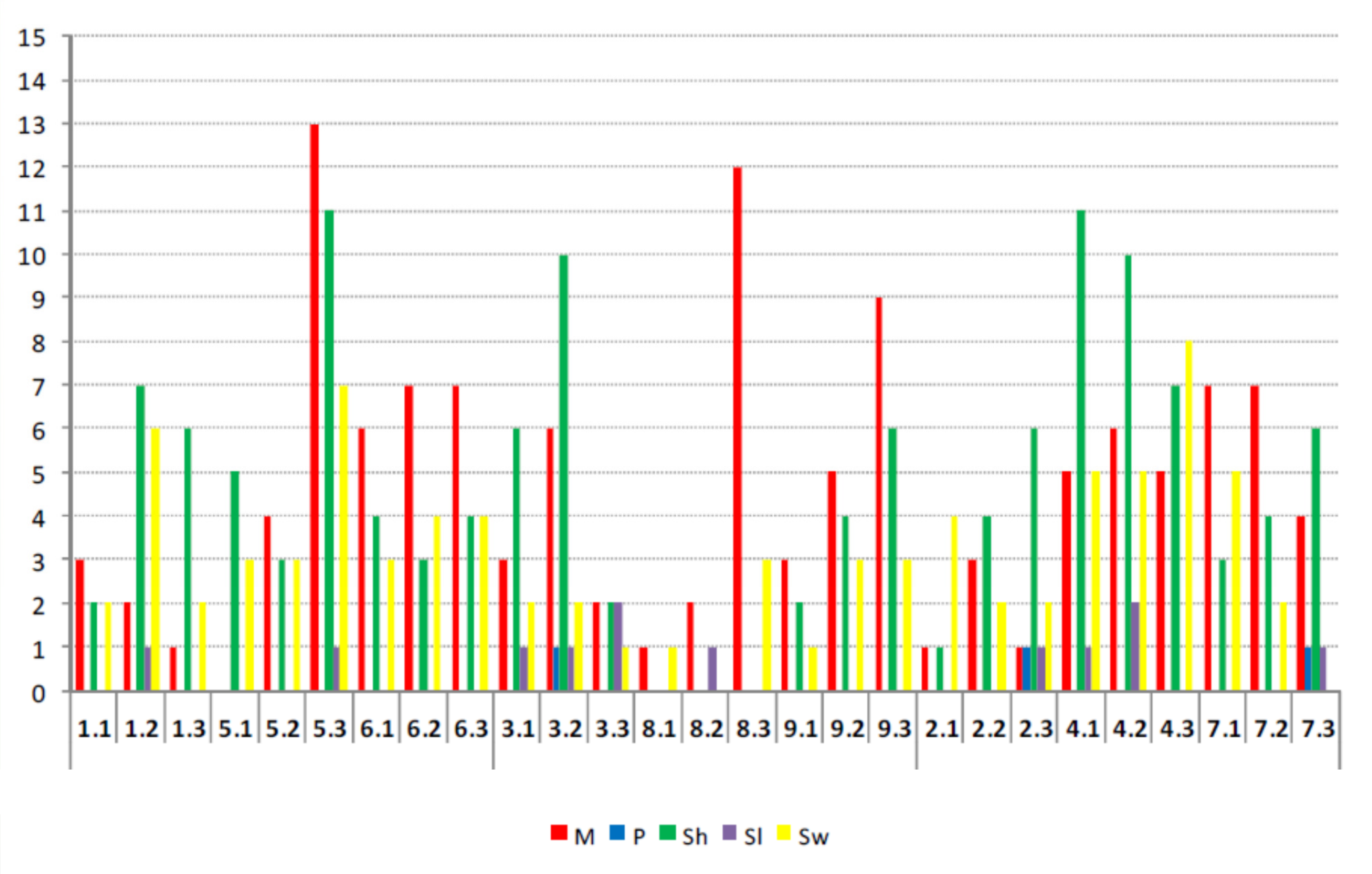
	Pratomagno	Amiata
Total root tips	2323	3602
Ectomycorrhizal tips (ECM)	1237	1717
Old roots	1886	1885

m a c r o f u n g i

Amiata: macrofungi – number of carpophores and weight: most frequent -> *Galerina marginata, Hemimycena gracilis, Hydenellum ferrugineum, Mycena aetites, M. arcangeliana, M. galopus, Phellodon niger*

	Plot	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2	4.3	5.1	5.2	5.3	6.1	6.2	6.3	7.1	7.2	7.3	8.1	8.2	8.3	9.1	9.2	9.3	PF (gr)	PS (gr)
	Trattamento SELPIBIO	I	I	I	T	T	T	C	C	C	T	T	T	I	I	I	I	I	I	T	T	T	C	C	C	C	C	C		
GT	SPECIE	n. corpi fruttiferi																												
Sh	*Entoloma hirtipes* (Schumach.) M.M. Moser								1																				0,15	0,01
Sh	*Entoloma xanthochroum* (P.D. Orton) Noordel.																					1							0,83	0,05
P	*Fomitopsis pinicola* (Sw.) P. Karst.																					1							277,24	138,62
Sh	*Galerina badipes* (Pers.) Kühner										3							1											0,38	0,03
Sw	*Galerina marginata* (Batsch) Kühner	1	4		1		1	12	5	4	3	7	23	5	10	53	6	4	11	11	12		1		3	1	4	37	84,51	6,05
P	*Ganoderma resinaceum* Boud.						1																						70,49	33,67
Sh	*Geastrum fimbriatum* Fr.								3																				2,42	0,88
Sh	*Geastrum quadrifidum* DC. ex Pers.												3																0,32	0,27
Sh	*Geastrum triplex* Jungh.					1																							0,93	0,76
M	*Genea verrucosa* Vittad.				1																								0,30	0,09
Sl	*Gymnopus brassicolens* (Romagn.) Antonín & Noordel.								125	256	3	55				35						4		22					302,04	28,78
Sh	*Gymnopus dryophilus* (Bull.) Murrill	2						42						5						14	12	8						2	137,98	13,49
Sh	*Gymnopus ocior* (Pers.) Antonín & Noordel.																					1							0,23	0,05
Sh	*Gymnopus peronatus* (Bolton) Gray		6					21							3	1													8,49	2,12
M	*Hebeloma crustuliniforme* (Bull.) Quél.															12		8	3						2			12	330,41	29,09
M	*Hebeloma laterinum* (Batsch) Vesterh.																			2									8,00	0,79
M	*Hebeloma sacchariolens* Quél.															4	3												15,60	1,47
Sh	*Hemimycena cryptomeriae* Noordel. & Antonín																										4		0,10	0,01
Sw(Sh)	*Hemimycena cucullata* (Pers.) Singer	1	8	20							3	33	79			68													27,18	2,63
Sl	*Hemimycena delectabilis* (Peck) Singer		1																										0,01	0,00
Sh	*Hemimycena gracilis* (Quél.) Singer		1	2		12	1	3	3		3			3	1												2		0,99	0,16
Sh	*Hemimycena lactea* (Pers.) Singer			2			4		1			30	5	3	3		1										2		1,57	0,23
Sh	*Hemimycena pithya* (Fr.) Dörfelt			4					4																				0,61	0,03
P	*Heterobasidion annosum* (Fr.) Bref.								1																				1,04	0,16
M	*Hydnellum ferrugineum* (Fr.) P. Karst.								2		16	4				7		6	1		5	5					6	257	1183,33	231,91
M	*Hydnum repandum* L.															8		23							6				144,22	17,64
Sh	*Hydropus floccipes* (Fr.) Singer																					1							0,10	0,01
M	*Hygrophorus agathosmus* (Fr.) Fr.										4									1	3								73,34	6,06
Sw(P)	*Hymenopellis radicata* (Relhan) R.H. Petersen					1																							6,73	0,78
Sw	*Hypholoma fasciculare* (Huds.) P. Kumm.		5		15													112	45									1	561,66	33,61
Sh	*Infundibulicybe alkaliviolascens* (Bellù) Bellù															1													10,54	1,57
M	*Inocybe geophylla* (Bull.) P. Kumm.							1	2			10			1	2										1			22,30	1,96
M	*Inocybe mixtilis* (Britzelm.) Sacc.												1															1	1,58	0,11

Amiata: macrofungi – trophic groups



m
a
c
r
o
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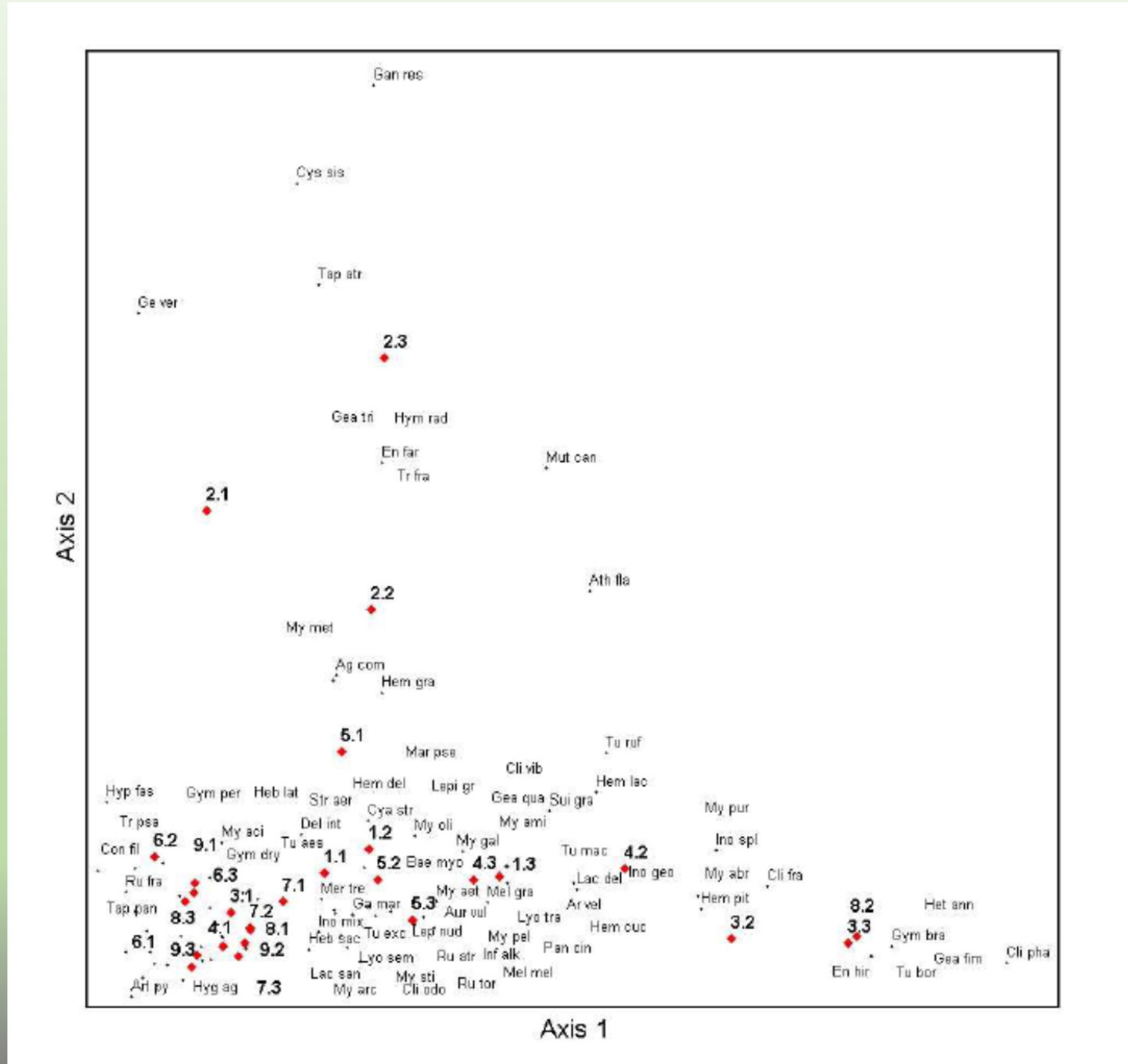
u
n
g
i

Amiata: correspondence analysis (CA),

= > plots are similar -> good for future management…



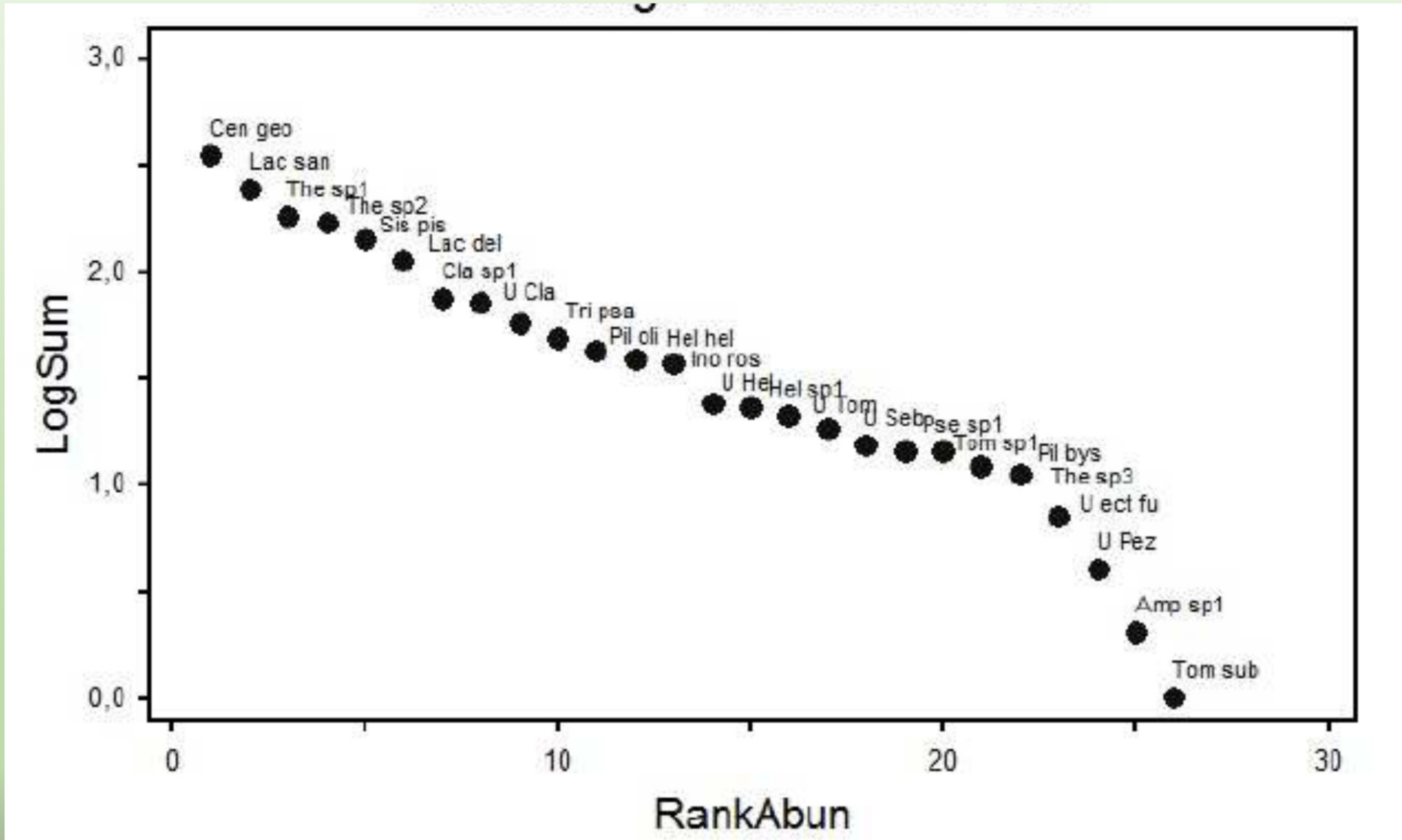
Amiata: number of ECM and root-tips

E
C
M

Specie	Abbreviazione	ECM	Apici
Amphinema sp. 1	Amp Sp.1	2	2
Cenococcum geophilum Fr.	Cen geo	347	464
Clavulina sp.1	cla sp.1	74	76
Helotiales sp. 1	Hel sp.1	23	83
Helvellosebacina helvelloides (Schwein.) Oberw.	Helv hel	38	38
Inocybe roseipes Malençon	Ino ros	37	54
Lactarius deliciosus (L.) Gray	Lac del	111	241
Lactarius sanguifluus (Paulet)	Lac san	241	502
Piloderma byssinum (P. Karst.) Jülich	Pil bys	12	12
Piloderma olivaceum (Parmasto) Hjortstam	Pil oli	42	76
Pseudotomentella sp.1	Pse sp.1	14	38
Rhizopogon roseolus (Corda) Th. Fr.	Rhi ros	15	50
Sistotrema pistilliferum Hauerslev	Sis pis	140	401
Suillus granulatus (L.) Roussel	Sui gra	48	138
Thelephoraceae sp. 1	The sp.1	180	350
Thelephoraceae sp. 2	The sp.2	167	384
Thelephoraceae sp. 3	The Sp.3	11	40
Tomentella sp. 1	Tom sp.1	14	14
Tomentella sublilacina (Ellis & Holw.) Wakef.	Tom sub	1	1
Tricholoma psammopus (Kalchbr.) Quél.	Tri psa	56	133
Uncultured *Clavulina*	Unc Cla	70	110
Uncultured ectomycorrhizal fungus	Unc ect	7	100
Uncultured *Helotiales*	Unc Hel	24	51
Uncultured *Pezizomycotina*	Unc Pez	4	10
Uncultured *Sebacina*	Unc seb	18	16
Uncultured *Tomentella*	Unc Tom	21	65

E
C
M

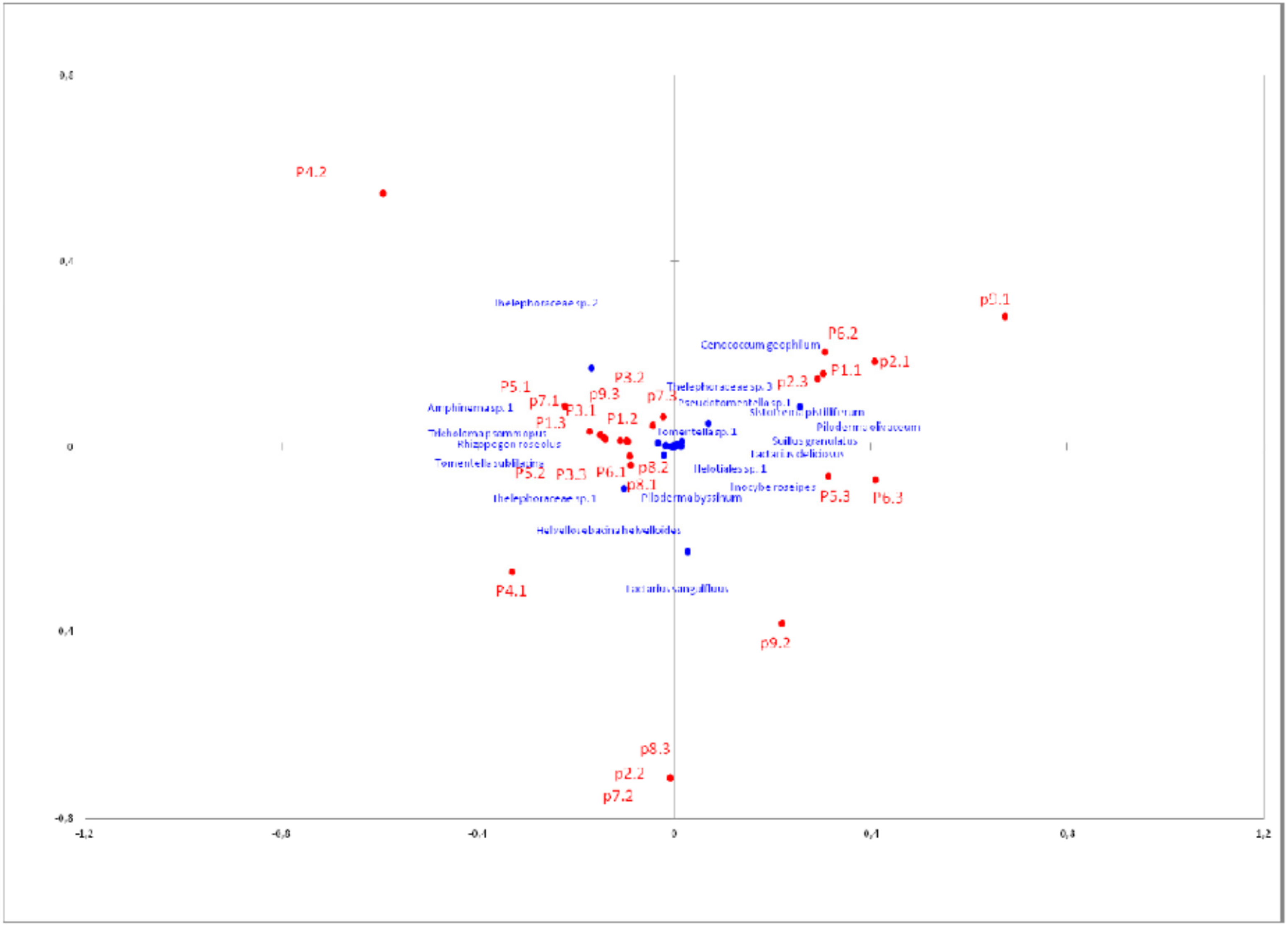
Amiata: Dominance–diversity curves of OTUs



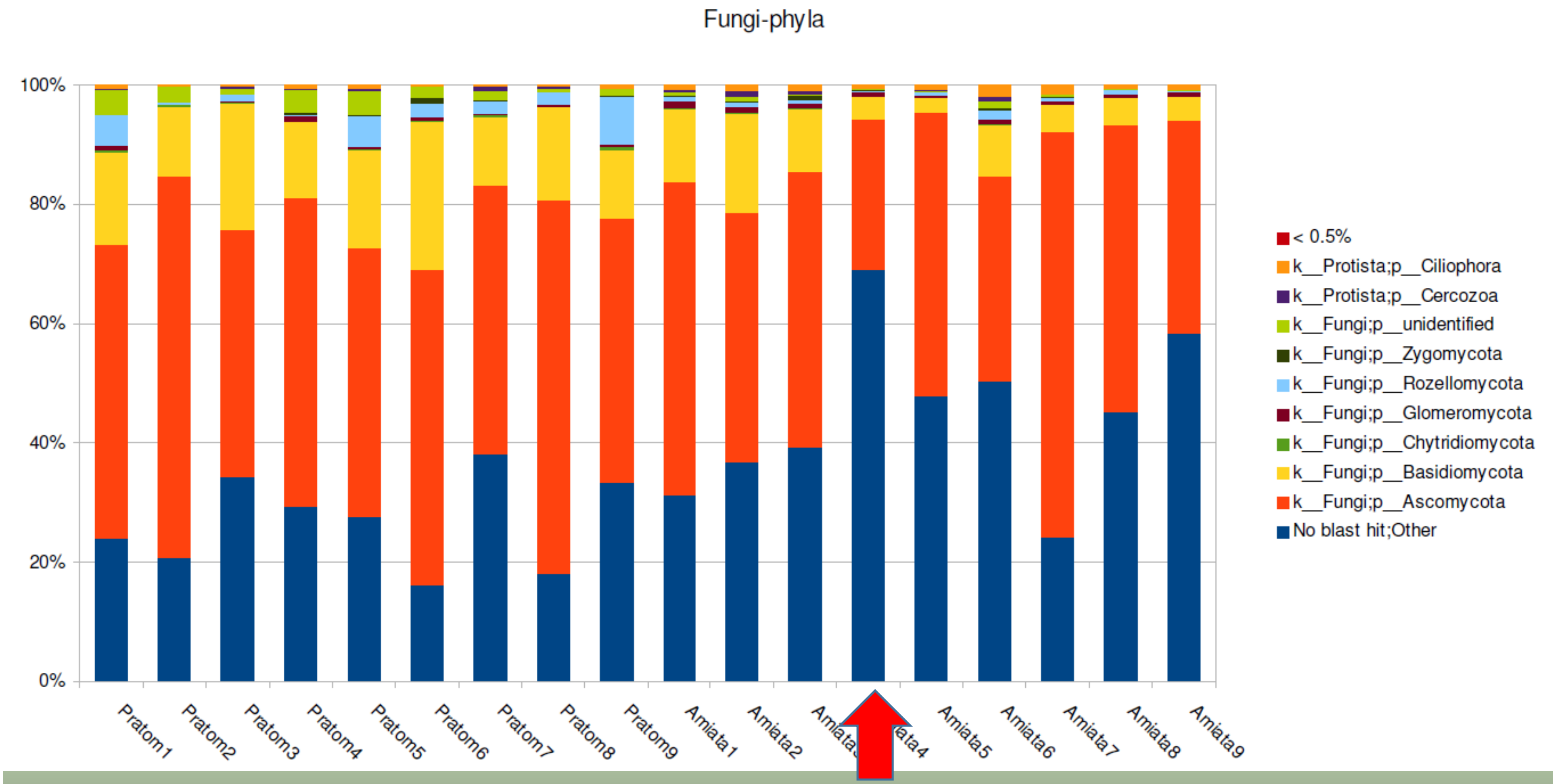
E
C
M

Amiata: correspondence analysis (CA),

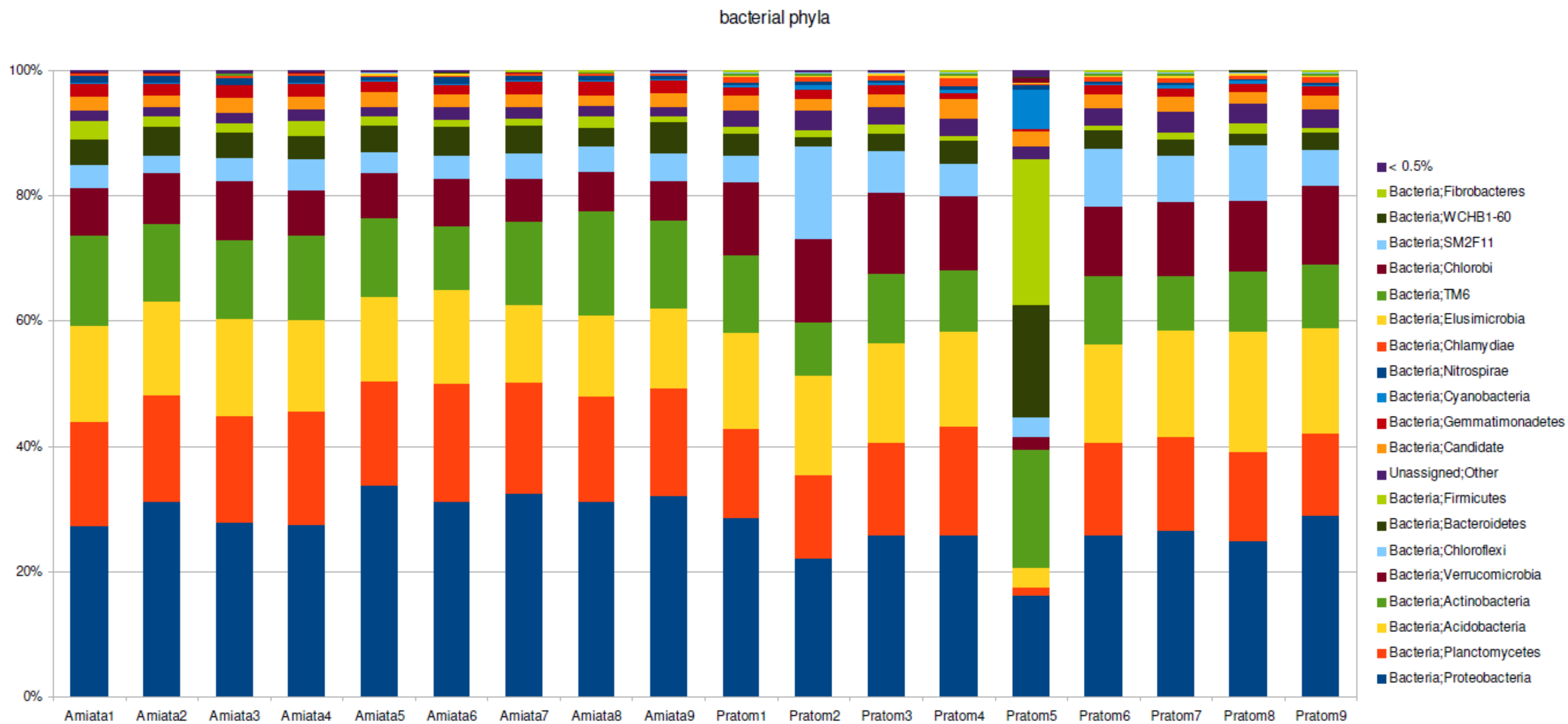
= > plots are similar -> good for future management…



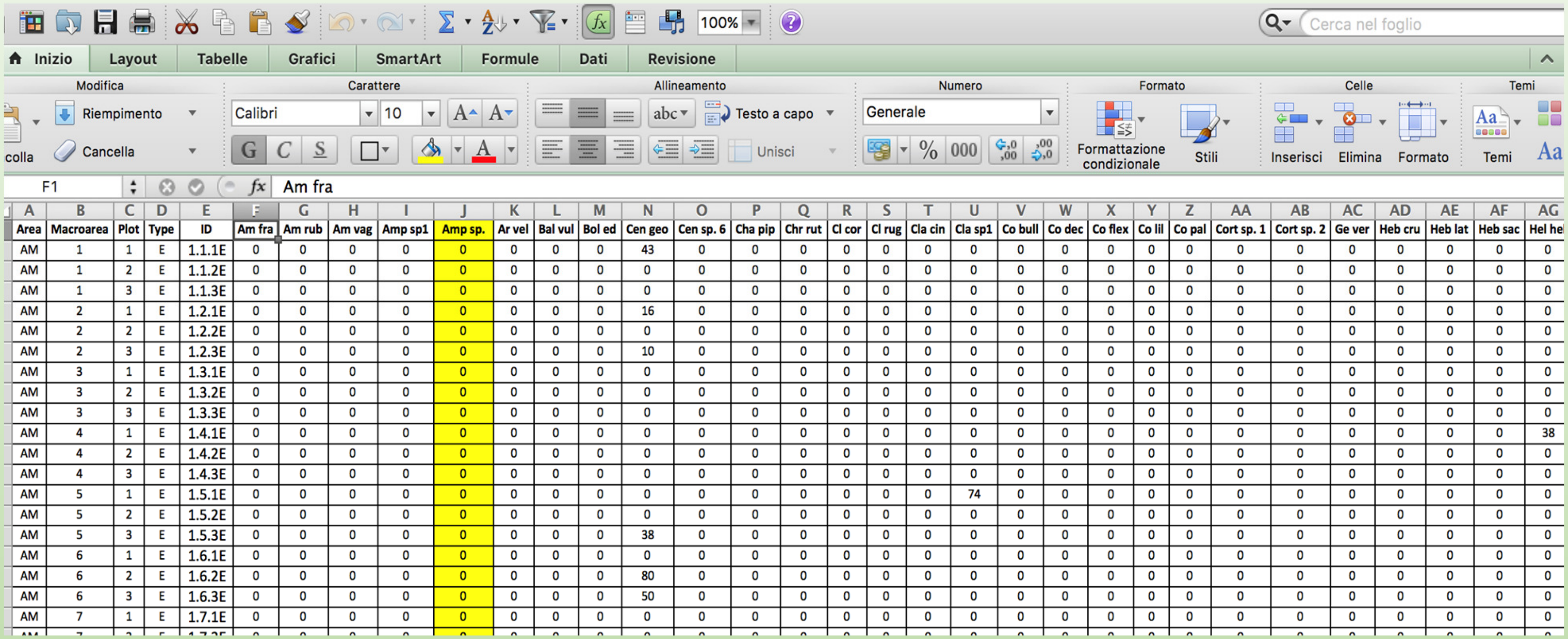
MicroFungi diversity (2015): more or less similar composition, only Amiata 4 show less Ascomycota



Bacterial diversity (2015): more or less similar, only Pratomagno 5 shows a complete different composition



The “before treatment” research activity guaranteed a high quality dataset (data about 9 different taxa) **and a complete and objective inventory of various environmental variables.**



Area	Macroarea	Plot	Type	ID	Am fra	Am rub	Am vag	Amp sp1	Amp sp.	Ar vel	Bal vul	Bol ed	Cen geo	Cen sp. 6	Cha pip	Chr rut	Cl cor	Cl rug	Cla cin	Cla sp1	Co bull	Co dec	Co flex	Co lil	Co pal	Cort sp. 1	Cort sp. 2	Ge ver	Heb cru	Heb lat	Heb sac	Hel he
AM	1	1	E	1.1.1E	0	0	0	0	0	0	0	0	43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM	1	2	E	1.1.2E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM	1	3	E	1.1.3E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM	2	1	E	1.2.1E	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM	2	2	E	1.2.2E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM	2	3	E	1.2.3E	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM	3	1	E	1.3.1E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM	3	2	E	1.3.2E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM	3	3	E	1.3.3E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM	4	1	E	1.4.1E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38
AM	4	2	E	1.4.2E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM	4	3	E	1.4.3E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM	5	1	E	1.5.1E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74	0	0	0	0	0	0	0	0	0	0	0	0
AM	5	2	E	1.5.2E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM	5	3	E	1.5.3E	0	0	0	0	0	0	0	0	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM	6	1	E	1.6.1E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM	6	2	E	1.6.2E	0	0	0	0	0	0	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM	6	3	E	1.6.3E	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM	7	1	E	1.7.1E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The latent potential of this research is incredibly high since few other works treated soil biodiversity in an informative and practical way so far; besides, no other research took into account the same soil taxa as those used in SelpiBioLife.

How to deal with the potential of this dataset?

Future perspectives concern **cross- taxon congruence** analysis, i.e to evaluate when diversity and/or composition patterns of different biological groups covary spatially, giving new insight into the relative contribution of environmental abiotic drivers and biotic interactions processes structuring the distribution of other taxa.

Cross-taxon congruence analysis = correlation in patterns of species richness and/or diversity (Pearson and Carroll, 1999)

↓

The use of one taxon (as a “surrogate” taxon) to predict community patterns for other taxonomic groups

Some background:
why cross-taxon analysis?

- Need for high quality biological data
- Limited resources for biodiversity surveys and conservation planning (much effort, expertise, and money)
- Difficulties of using complete and objective species inventories
- Lack of systematic knowledge of certain taxonomic groups

Cross- taxon congruence → when diversity and/or composition patterns of different biological groups covary spatially.

↓

- insight into the processes structuring the distribution of other taxa

Taxa usually used in literature:

- Vascular plants
- Birds
- Arthropods, especially insects (butterflies (Maccherini et al.,2009) , grasshoppers, ants, coleoptera…)
- Amphibian (Santi et al., 2010)
- Bryophytes (Maccherini et al., 2013) , lichens (Santi et al., 2016)
- Fungi (Chiarucci et al., 2005; Santi et al., 2010; Landi et al., 2014);
- Mites (Bonari et al., 2017);
- Earthworms (Santi et al.,2010)

Anyway, few research about soil biodiversity!!!

Main reviews

Heino, 2010: acquatic ecosystems; *Gaston, 1996*; *Reid, 1998*: terrestrial organisms; Westgate et al., 2017

About Soil cross-taxon…

European Journal of Soil Biology 49 (2012) 55–62

Contents lists available at SciVerse ScienceDirect

European Journal of Soil Biology

journal homepage: http://www.elsevier.com/locate/ejsobi

ELSEVIER

Original article

Cross-taxa congruence, indicators and environmental gradients in soils under agricultural and extensive land management

Aidan. M. Keith[a,b,c,*,1], Bas Boots[a,1], Christina Hazard[a], Robin Niechoj[d], Julio Arroyo[a], Gary D. Bending[e], Tom Bolger[a], John Breen[d], Nicholas Clipson[a], Fiona M. Doohan[a], Christine T. Griffin[b], Olaf Schmidt[f]

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micro-organisms (bacteria, fungi, mycorrhiza), and micro-, meso- and macro-fauna (nematodes; mites; earthworms, ants)

ELSEVIER

Applied Soil Ecology

Volume 97, January 2016, Pages 86-97

Mite community composition across a European transect and its relationships to variation in other components of soil biodiversity

T. Dirilgen[a], J. Arroyo[a], W.J. Dimmers[b], J. Faber[b], D. Stone[c], P. Martins da Silva[d], F. Carvalho[d], R. Schmelz[e], B.S. Griffiths[f], R. Francisco[d], R.E. Creamer[c], J.-P. Sousa[d], T. Bolger[a]

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https://doi.org/10.1016/j.apsoil.2015.06.008

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Referred to by ERRATUM: Dirilgen T. et al (2016) Mite composition across a European Tr…
Applied Soil Ecology, Volume 114, June 2017, Pages 170
PDF (93KB)

Mite, Collembola, Enchytraeidae, Nematoda and microbes

Hydrobiologia

March 2014, Volume 726, Issue 1, pp 95–107

Small ones and big ones: cross-taxon congruence reflects organism body size in ombrotrophic bogs

Authors | Authors and affiliations

Michal Hájek, Aloisie Poulíčková, Martina Vašutová, Vít Syrovátka, Martin Jiroušek, Jana Štěpánková, Věra Opravilová, Petra Hájková

Primary Research Paper

First Online: 03 December 2013

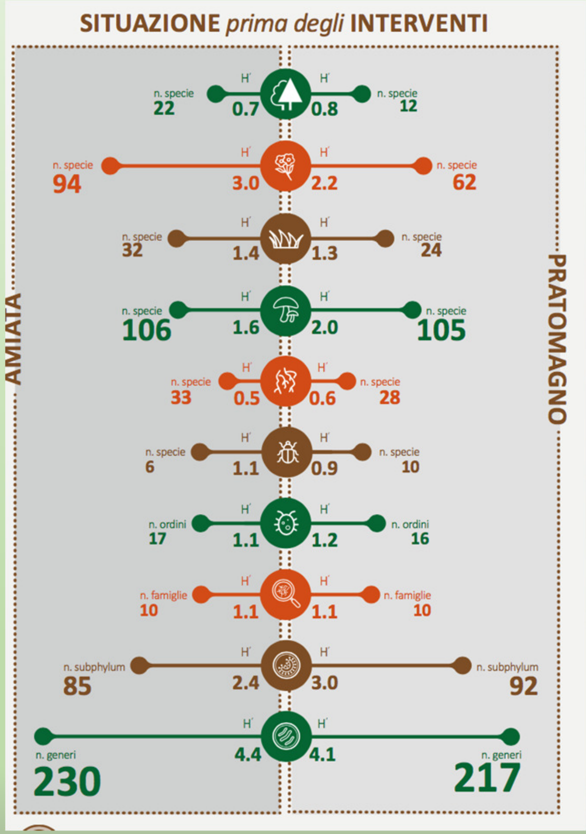
DOI: 10.1007/s10750-013-1754-8

Cite this article as:
Hájek, M., Poulíčková, A., Vašutová, M. et al. Hydrobiologia (2014) 726: 95. doi:10.1007/s10750-013-1754-8

vascular plants, bryophytes, fungi, diatoms, desmids and testate amoebae

Something to pay attention to…
in SelPiBioLife Project

Different taxonomic resolution (species, family, order…)

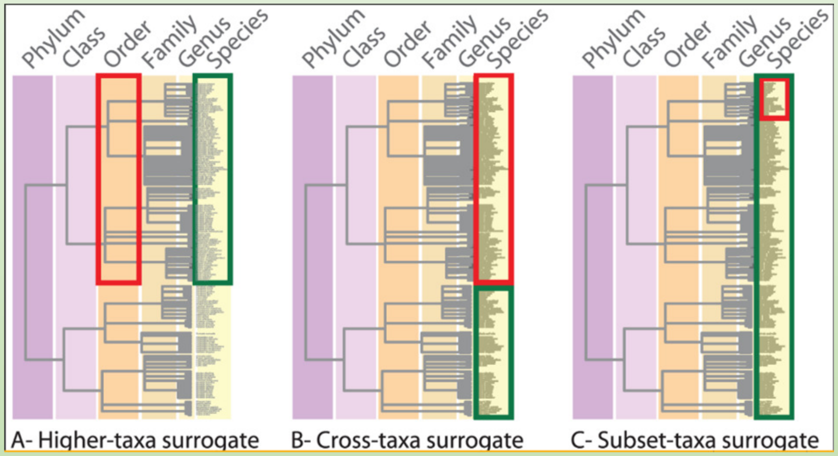


◆Guareschi et al., 2015, macroinvertebrate family richness, water beetle species richness and water bug species richness.

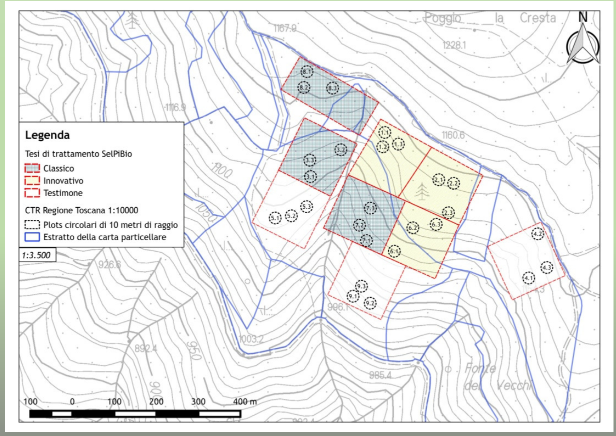
Something to pay attention to…
in SelPiBioLife Project

-*higher-taxa*, where a taxon acts as a surrogate for taxa at lower taxonomic levels; *cross-taxa*, where a taxon acts as a surrogate for another taxon at the same taxonomic level, or; *subset-taxa* surrogate, where a taxon acts as a surrogate for the entire target community;

- surrogate effectiveness was typically lower than generally assumed (Mellin et al., 2011)



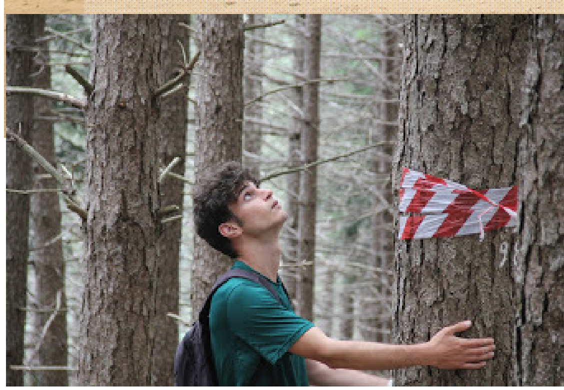
Samples obtained at which scale? (Site-Area-Plot?)

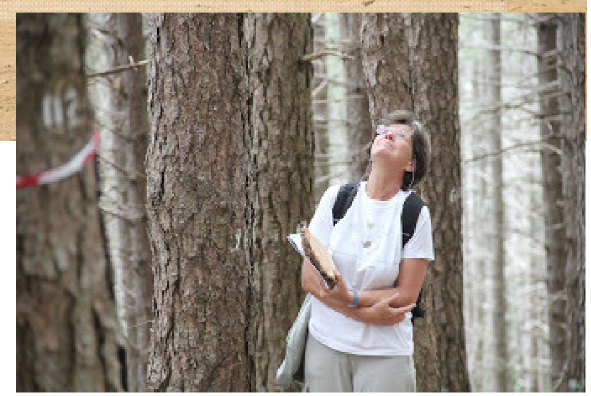



Guideline
F
GENERAL MANAGEMENT ACTIONS
E
DISSEMINATION ACTIONS
D
OF THE PROJECT ACTIONS
SelPiBioLife
SELECTIVE THINNING
Increasing mechanical stability and biodiversity in black pine plantations
SelPiBioLife technical handbook
LA CLARA SELECTIVA
IL DIRADA
Selective thinning in artificial black pine plantations
I diradamenti selettivi nel Progetto SelPiBioLIFE
Un progetto per la biodiversità nelle pi
artificiali
Tradizionale
Non gestito
2 videos
Brochure
...accrescere la biodiversità del suolo
www.selpibio.eu
Bollettino SelPiBio Life 1
BIODIVERSITÀ
prima dei diradamenti

IMPORTANT the interest and happyness!

We just realized various meetings, realized open area Laboratory and had a well participation.





MORE AT NEXT CONFERENCE!

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Thanks!