Barcham

The Tree Specialists

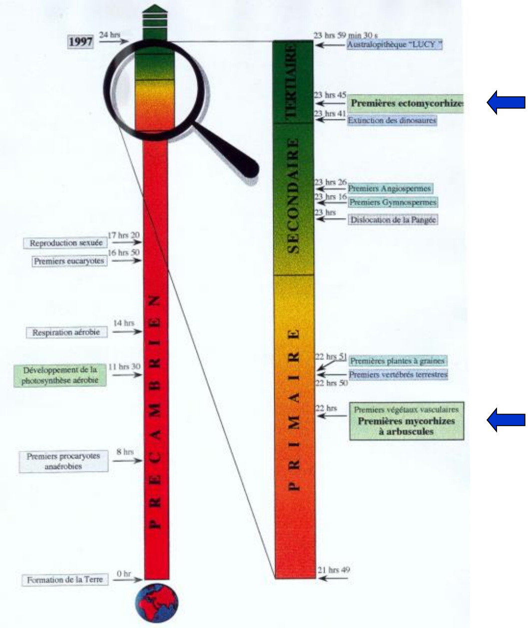
Ely, 10th July 2019

The Mycorrhizal World

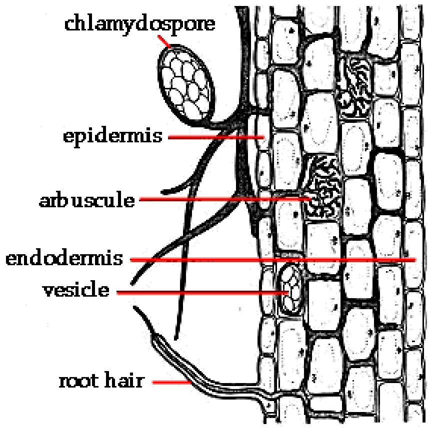
Lucio Montecchio

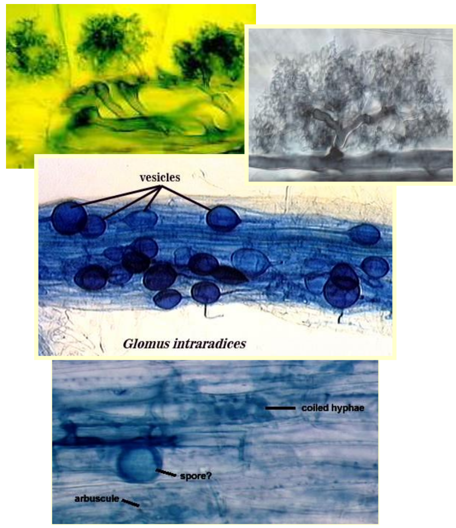
De Rebus Plantarum, Spin-off of the University of Padova

A very old cooperation

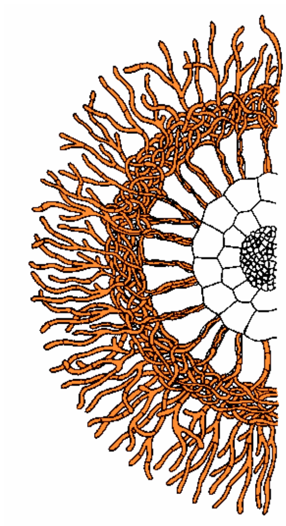


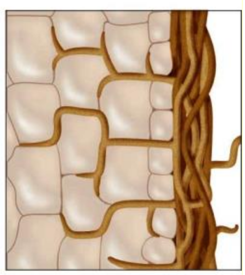
Endomycorrhizae
Endo = inside (the tip)





Ectomycorrhizae
Ecto = outside /the tip)

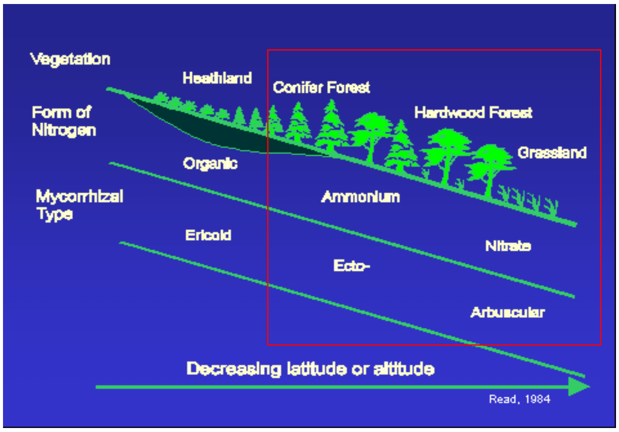




Many mycorrhizal types, and sub-types

	Plant	Fungus
Arbuscular mycorr.	**All taxa**	**Glomeromycetes**
Ectomycorrhizae	**Angiosperms, Gymnosperms**	**Basidiomycetes, Ascom.**
Ectendomycorrhizae	*Pinaceae*	Basidiom., Ascom.
Arbutoids	Ericales	Basidiom.
Monotropoids	Monotropoids	Basidiom.
Ericoids	Ericales, Briophytes	Ascom.
Orchidoids	*Orchidaceae*	Basidiom.

In trees, mainly ectomycorrhizae and arbuscular mycorrhizae



Truffles:
From ancient times to the first scientific studies

- **Pliny the Elder** (70 b.c.) thinks they are soil modifications.
- **Ray** (1700) observes spores inside truffles
- **De Borchii** (1780) demonstrates that spores produce mycelium
- **Vittorio Pico** (1787): truffles are different. First steps into mycorrhizal mycology.

Carlo Vittadini

1831: «roots uptake nutrients from the fungal mantle».

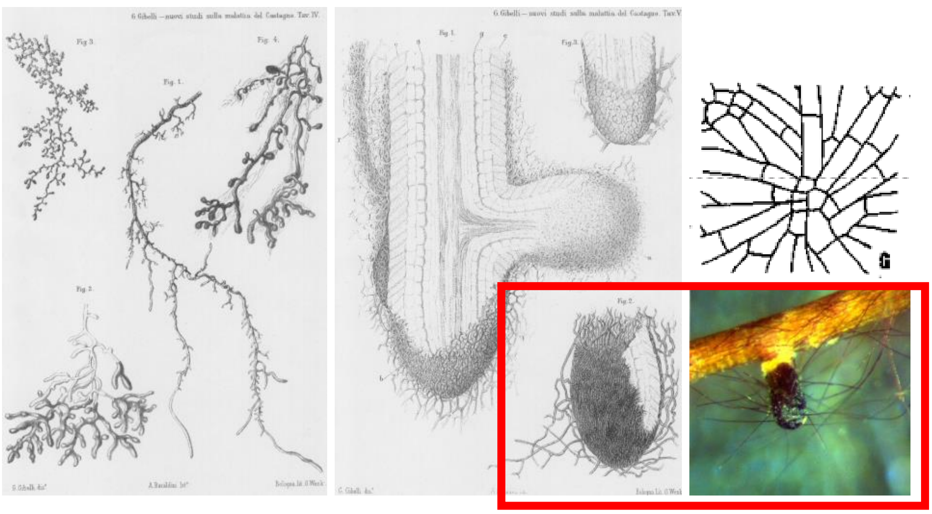
He publishes the first modern descriptions of truffle species:

Tuber aestivum, borchii, brumale, excavatum, ferrugineum, foetidum, macrosporum, maculatum, melanosporum, mesentericum, nitidum, (microsporum, oligosporum).

1882: 1st report of a mycorrhiza

By Giuseppe Gibelli

(studying sweet chestnuts infected by *Phytophthora*)



1885: from *symbiosis* to *mutualism*

Albert Bernhard Frank:

«Mycorrhiza» = fungus + root tip):

The fungus uptakes water and salts from the soil and transfer them to the plant.

The plant gives the fungus root exudates.

From mutualism to symbiosis

2008: a behavioural *continuum* …

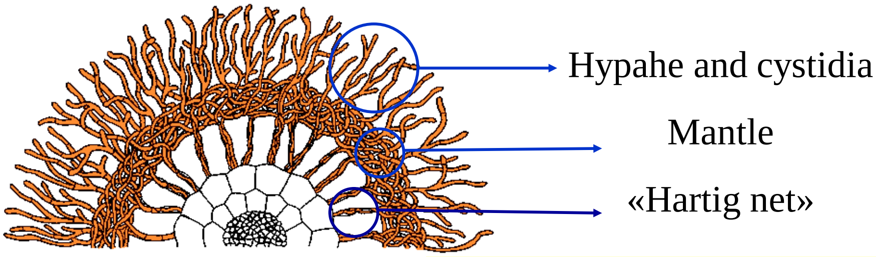
… sometimes to parasitism

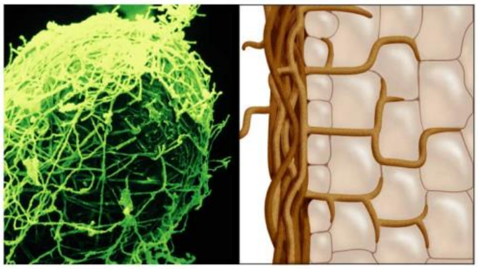
***Entoloma saepium/Rosa* e *Prunus* spp. (Götsche, 1972; Agerer e Waller, 1993)**

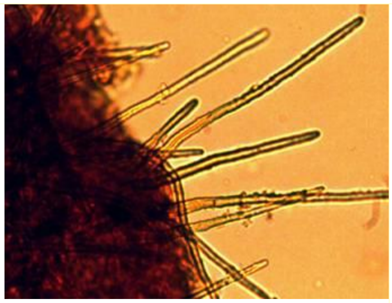
***Hygrophorus penarius*/faggio (Di Marino, Montecchio, Agerer, 2008)**

… likely related to species involved, age, genotypes, their physiological status, environmental conditions.

Anatomy of an ectomycorrhiza

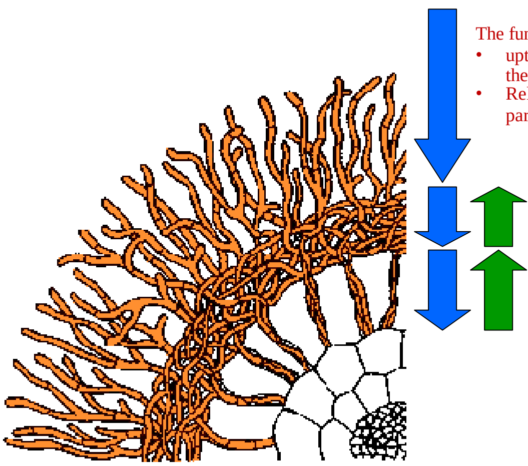






Ectomycorrhizae are

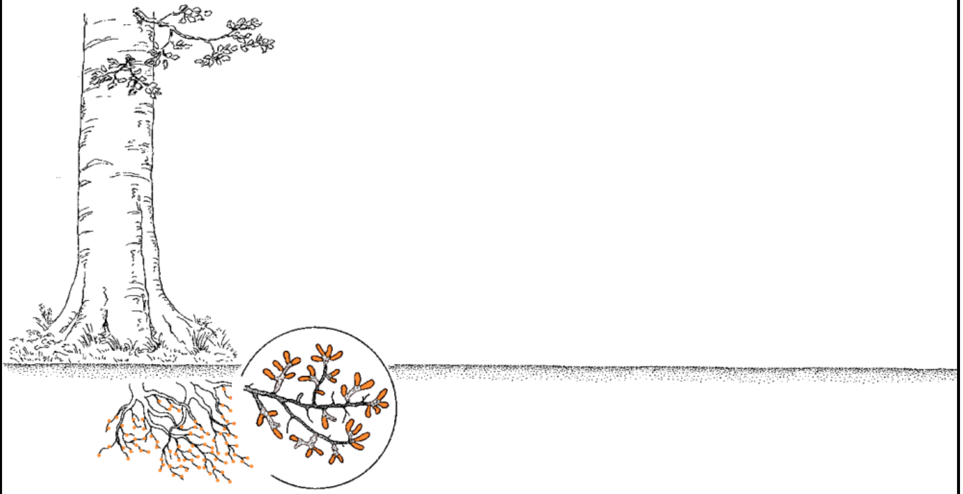
exactly **at the tree/soil interface**.

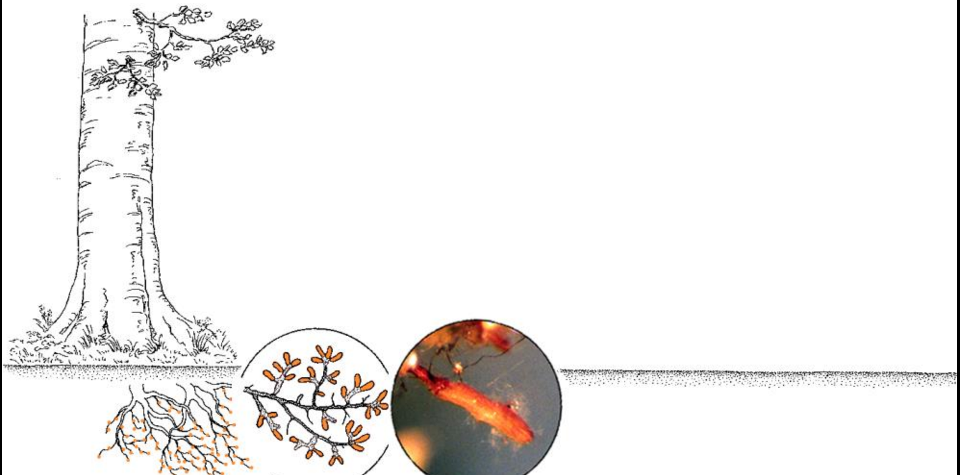


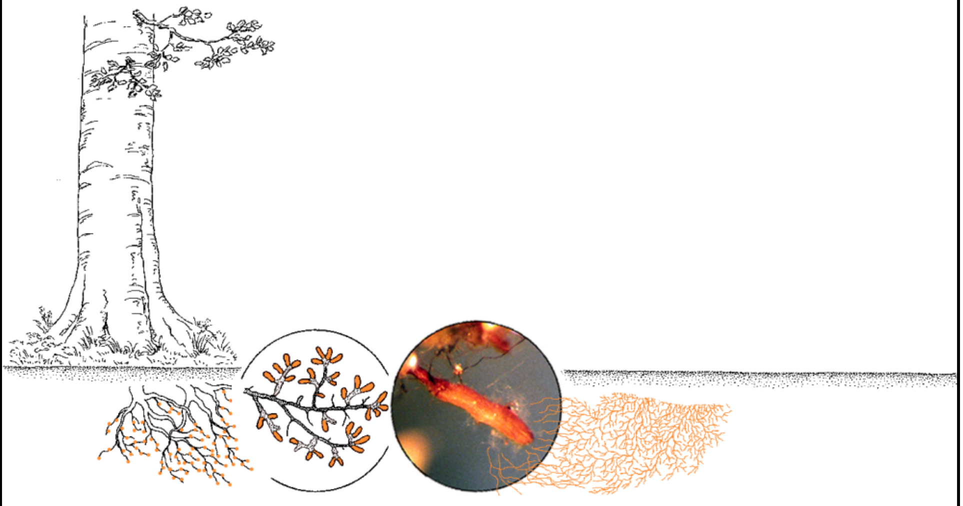
The fungus

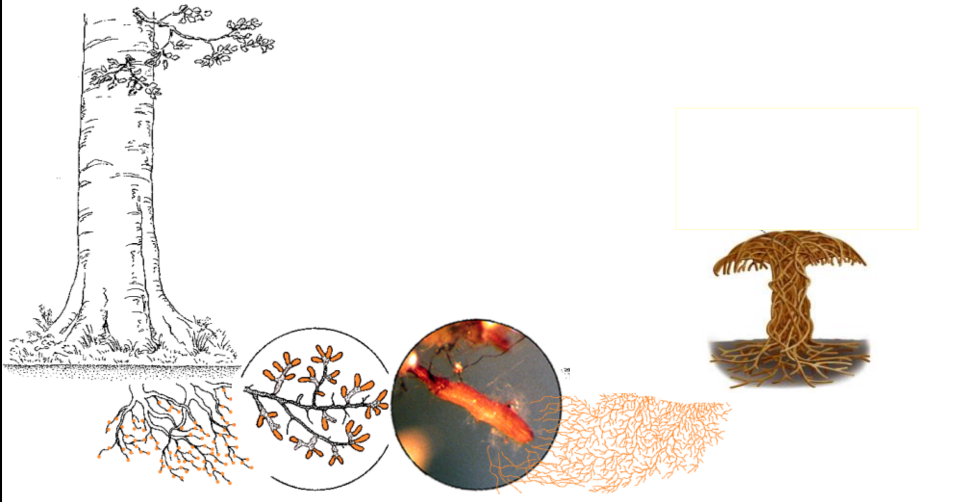
- uptakes water and nutrients transferring them to the root
- Releases micotoxins effective against root parasites

The tree gives root exudates in change

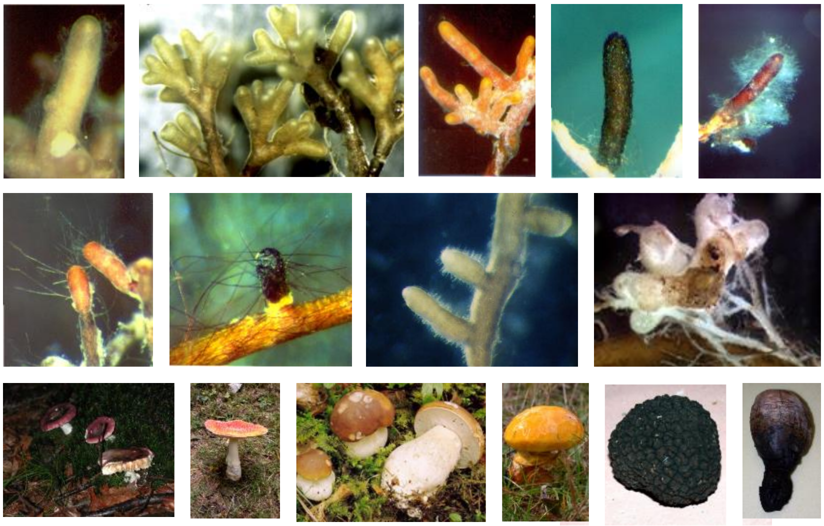






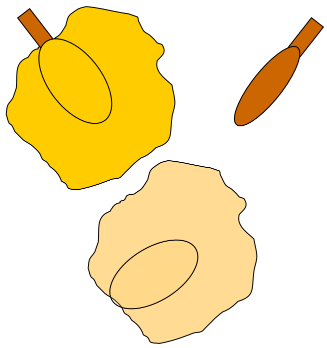


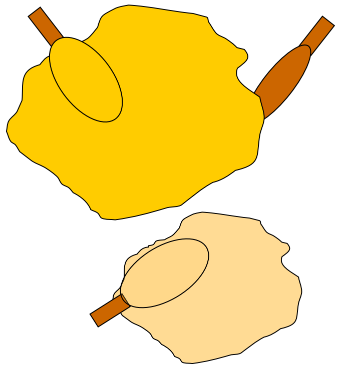
One tree, many fungi



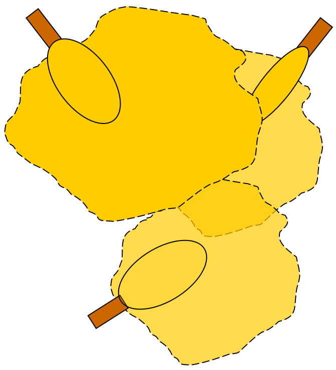
A dynamic composition driven by competition

Competition and infection

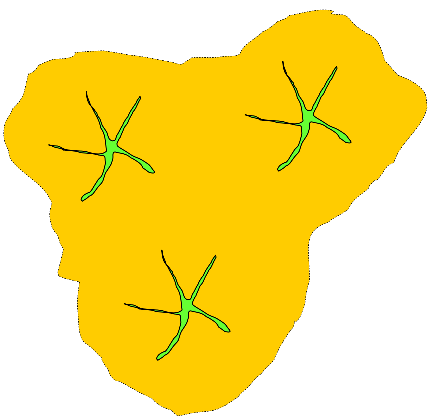




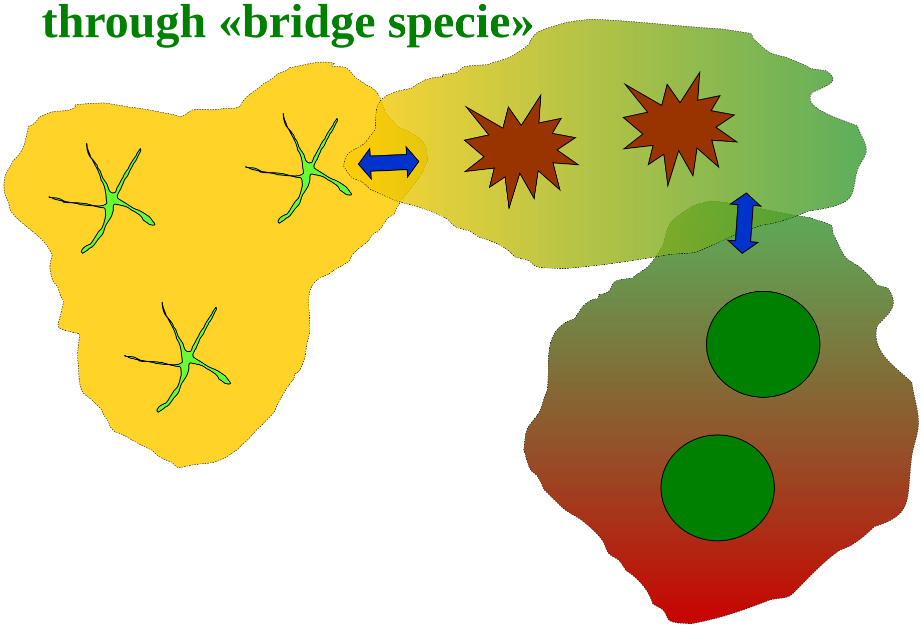
The best performing fungus spreads to the closest tips



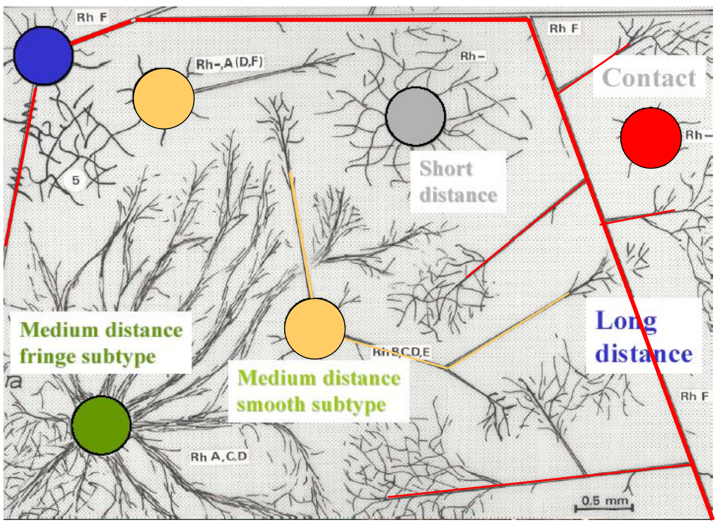
Infection inside the same species



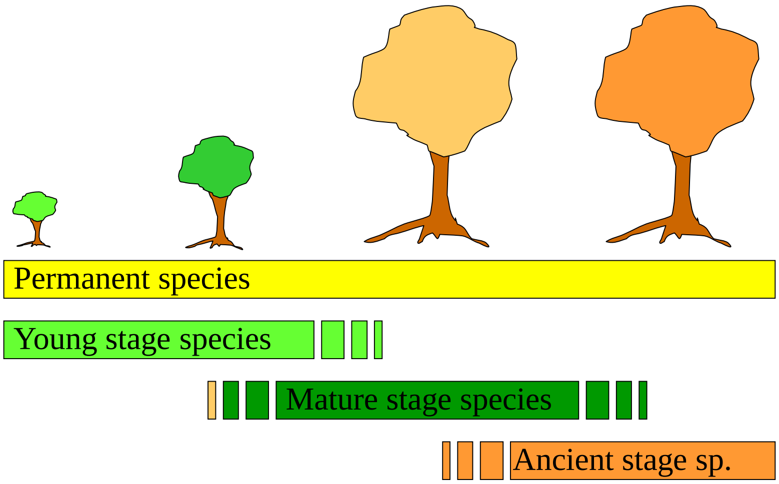
Infection between different species, also through «bridge specie»



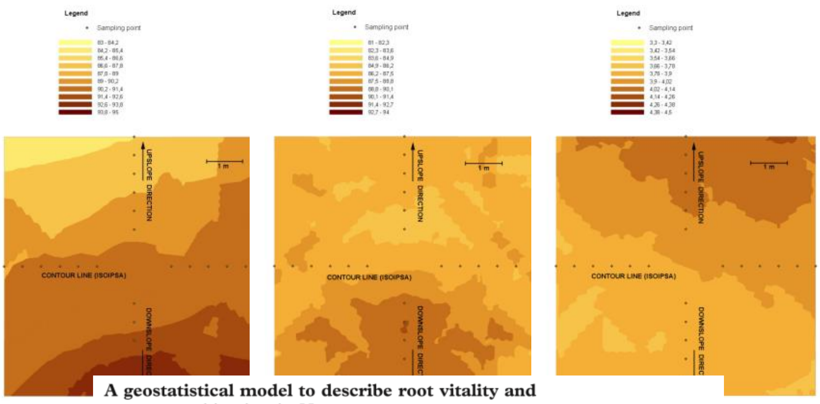
Exploration types: different species, similar benefits



The consortium changes with the plant's age



Change in space



A geostatistical model to describe root vitality and ectomycorrhization in Norway spruce

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[1]*Dipartimento Territorio e Sistemi Agro-Forestali, Università degli Studi di Padova, Padova, Italy, and* [2]*Centro di Ecologia Alpina, Viote del Monte Bondone, Trento, Italy*

Change with depth

(humus, pH, humidiy, etc.)

	O			E1			E2			EB		B1			B2			C		
	1	2	3	1	2	3	1	2	3	1	2	1	2	3	1	2	3	1	2	3
Tylospora sp.	I	I		I		*	I		*	I	I				I			III		
Cortinarius sp.	I		I					IV	I		I	II		II	II		I	I		I
P.reticulatum	III		IV	III		IV	II		II	I					I		III	I		
Piloderma sp. JS 15686														I			I			
Inocybe	I																			
P. byssinum			I																	
T. submollis	I		I		I															
P. fallax	I		I			I	I		I											
H. olivaceoalbus			I			I			I											
R. decolorans		IV			IV			I			*									
Dermocybe sp.	*		*	I		I	I			I										
Tomentolloid						*			I											
L. utilis							II		I	II		II								
Piloderma sp. 2							I		I	I	I	I	I		II					
Piloderma sp. 3										I		I			I					
Piloderma sp. 1											I		I			I				
S.luteus									I		III		III	II		IV	I			I
Non ID nr. 15																I				
Non ID nr. 12																	I			
Wilcoxina																			I	
R.adusta																			IV	
T.portentosum																				III

Presenza dei diversi taxa negli orizzonti di un suolo podzolico in una foresta di conifere nel nord della Svezia gli orizzonti sono indicati dalle lettere O, E, B e C. sono riportati per ciascun orizzonte i dati ricavati da 3 campioni. La abbondanza di ciascuna specie è indicata attraverso i seguenti simboli: *=<1%; I=1-25%; II=26-50%; III=51-75%; IV=76-100%. (da Rosling e coll. 2003)

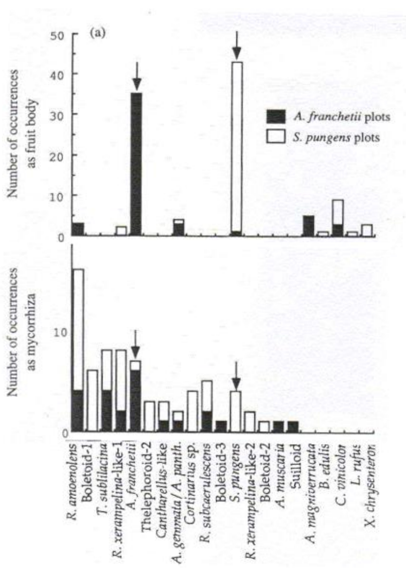
Consistenza del consorzio

Monitoraggio degli sporocarpi:

imprecisa corrispondenza

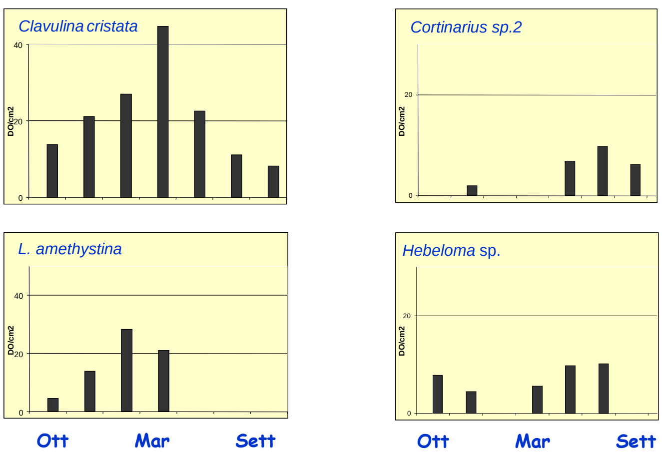
Riconoscimento da campioni radicali:

Maggior accuratezza

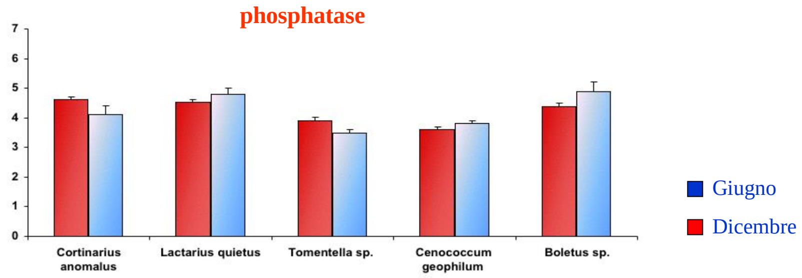


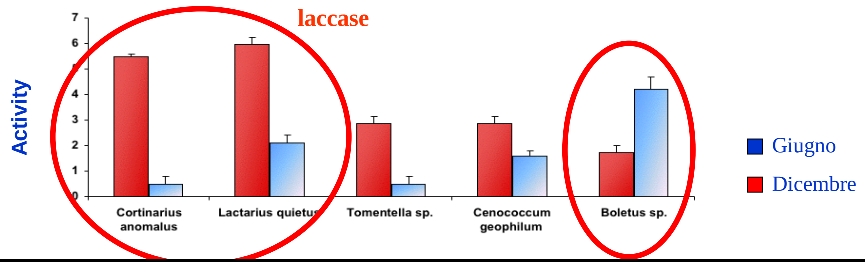
Change in time

Morfotipi	M	A	M	G	L	A	S	O	N	D
Cortinarius anomalus	√	√	√	√	√			√	√	√
Lactarius quietus	√	√	√	√	√				√	√
Byssocorticium atrovirens	√	√	√	√	√					
Cenococcum geophilum				√	√			√	√	√
Tomentella sp.				√	√			√	√	√
Piloderma sp.				√						
Hebeloma sp.										√
Laccaria amethystina										√
Russula nigricans										√
Clavulina cristata	√	√	√							√
Boletus sp.		√	√	√	√					√



Performances change with time, too.





How to assess a mycorrhizal community?

A sampling method to describe the Norway spruce ectomycorrhizal community at plant level

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Dipartimento Territorio e Sistemi Agro-Forestali, Università degli Studi di Padova, Italy

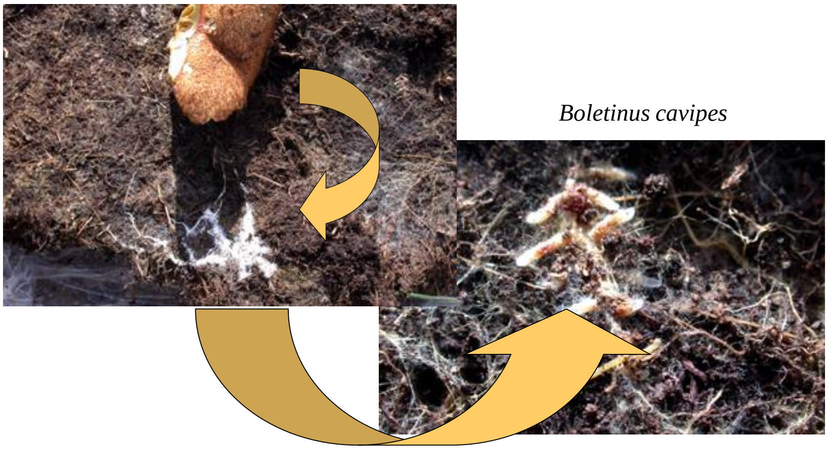
of EM to be observed in every root core can be reduced from 10 to 4, 7, 5 and 9 in Ma, Pa, Ga and

pleres in Fo, were shown to be more important, probably because of their distribution strategy.

Table VI. EM relative abundances (RA) in four trees in Pa site, considering 10 tips and 6 tips observed in each root core. In the right column: observed vs. expected RA, Chi-square = 29.64001, df = 1, $P < 0.001805$. In evidence: $(O - E)^2/E$ values > 1.63959 (=k).

	10 tips/root core (E)				6 tips/root core (O)				
	Tree								
	1	2	3	4	1	2	3	4	$(O - E)^2/E$
A. muscaria	10.706	16.972	2.777	8.164	11.944	14.930	5.000	7.777	0.018
A. byssoides	18.964	0.000	1.759	0.925	19.166	0.000	2.083	1.388	0.231
C. geophilum	54.108	41.382	35.300	34.943	56.041	33.750	42.777	52.847	**9.172**
E. granulatus	0.520	1.521	7.083	22.184	0.694	1.666	6.250	1.527	**19.233**
H. velutipes	0.000	6.967	21.180	3.042	0.000	2.777	5.555	3.472	0.060
H. rufescens	0.595	4.768	2.546	3.349	0.000	4.861	2.777	3.055	0.025
H. olivaceoalbus	0.000	0.000	2.546	4.117	0.000	0.000	2.777	5.000	0.189
I. appendiculata	3.645	1.388	3.842	0.000	3.125	2.083	3.472	0.000	0.000
L. badiosanguineus	1.041	2.979	3.888	5.456	0.694	4.375	2.777	4.444	0.187
L. deterrimus	0.520	0.925	2.546	0.000	0.694	1.388	1.388	0.000	0.000
P. nigra	4.166	6.539	6.388	2.232	2.500	12.152	10.833	2.083	0.009
R. ochroleuca	5.729	16.554	10.138	15.583	5.138	22.013	14.305	18.402	0.509

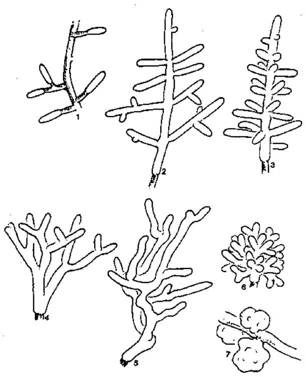
Only when a fruitbody is visible, it's easy to detect its mycorrhiza



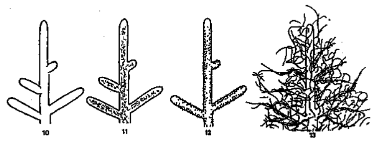
Usually, identification is not easy

- Only about 500 species described worldwide in detail.
- Taxonomy needs skill and time, and money.

Mycorrhizal types

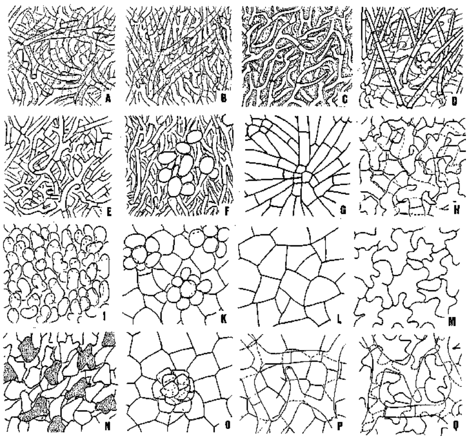


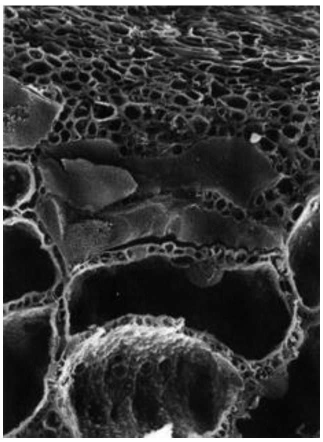
Figs. 1–7: Type of ramification – 1: Simple = unramified. – 2: Monopodial-pinnate. – 3. Monopodial-pyramidal. – 4. Dichotomous. – 5: Irregularly pinnate, dichotomous-like. 6: Coralloid. – 7: Tubercle-like.

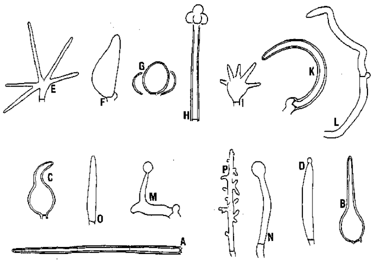


Figs. 10–13: Features of mantle surface. – 10: Smooth. – 11: Reticulate. – 12: Grainy (warty). – 13: Woolly.

Mantle and Hartig net

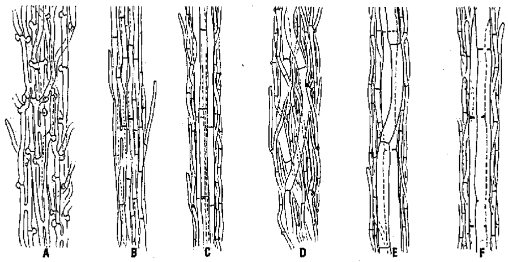




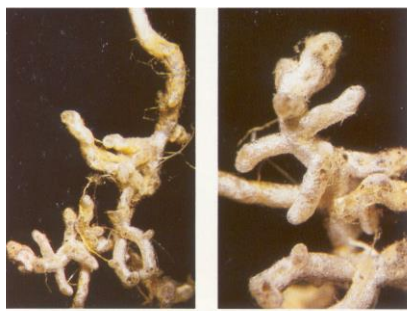


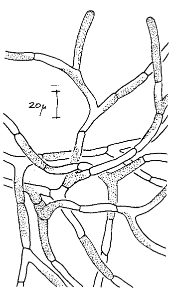
cystidia

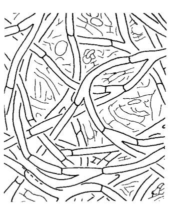
rhizomorphs

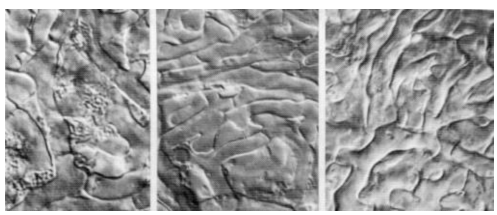


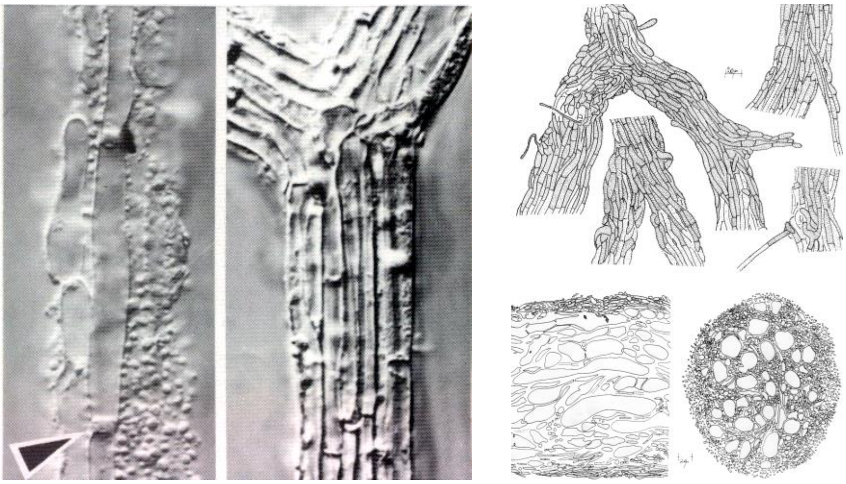
Main features in *Leccinum lepidum*

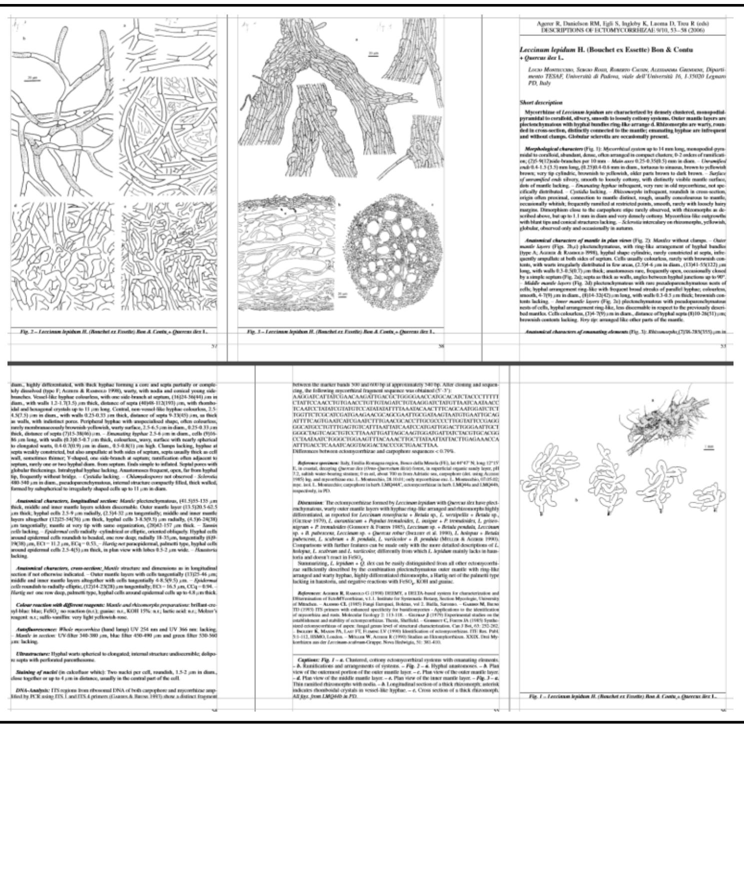












Agerer R, Danielson RM, Egli S, Ingleby K, Luoma D, Treu R (eds)
DESCRIPTIONS OF ECTOMYCORRHIZAE 9/10, 53–58 (2006)

***Leccinum lepidum* H. (Bouchet ex Essette) Bon & Contu**
***+ Quercus ilex* L.**

Lucio Montecchio, Sergio Rossi, Roberto Causin, Alessandra Gregnene, Dipartimento TESAF, Università di Padova, viale dell'Università 16, I-35020 Legnaro PD, Italy

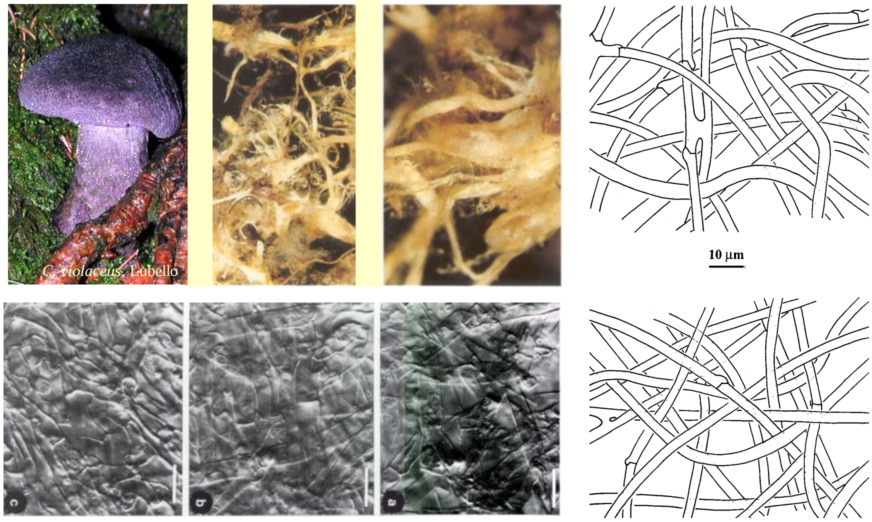
Short description

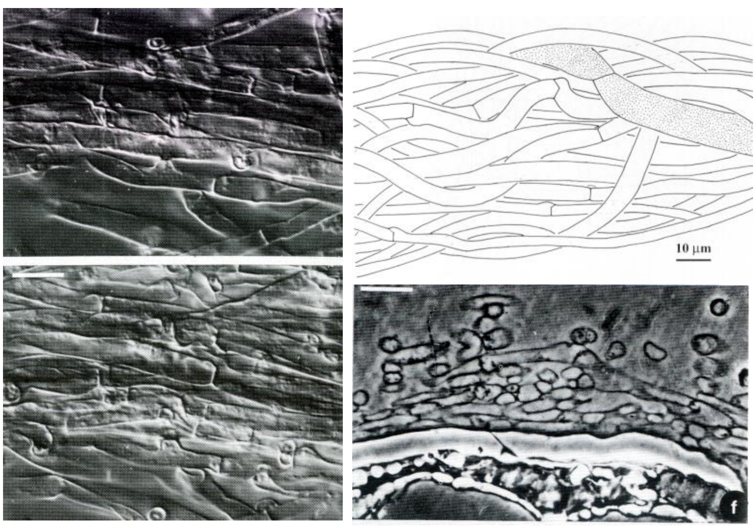
Mycorrhizae of *Leccinum lepidum* are characterized by densely clustered, monopodial-pyramidal to coralloid, silvery, smooth to loosely cottony systems. Outer mantle layers are plectenchymatous with hyphal bundles ring-like arrange d. Rhizomorphs are warty, rounded in cross-section, distinctly connected to the mantle; emanating hyphae are infrequent and without clamps. Globular sclerotia are occasionally present.

Fig. 2 – Leccinum lepidum H. (Bouchet ex Essette) Bon & Contu + Quercus ilex L.

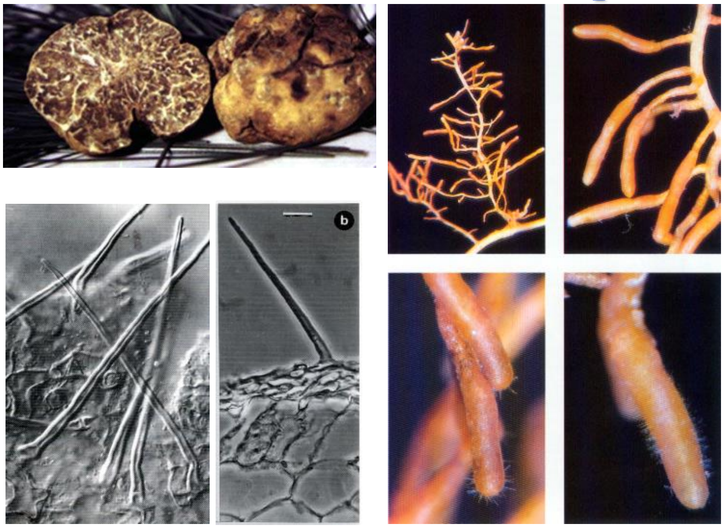
Fig. 3 – Leccinum lepidum H. (Bouchet ex Essette) Bon & Contu + Quercus ilex L.

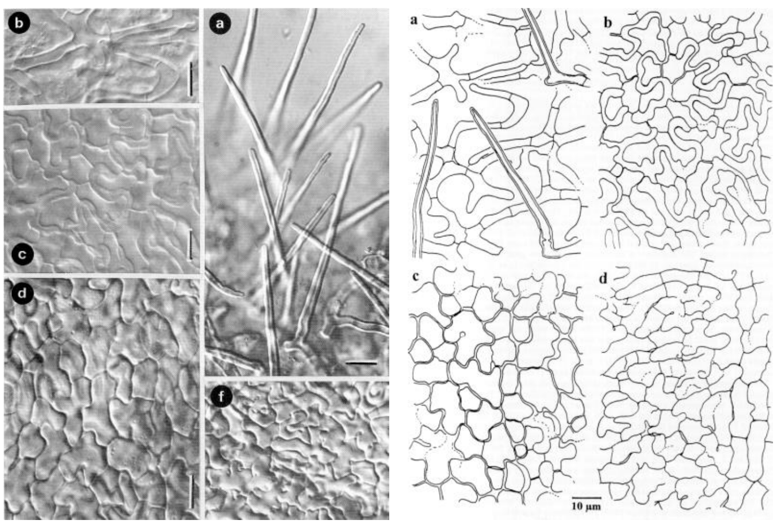
Main features in *Cortinarius* sp.





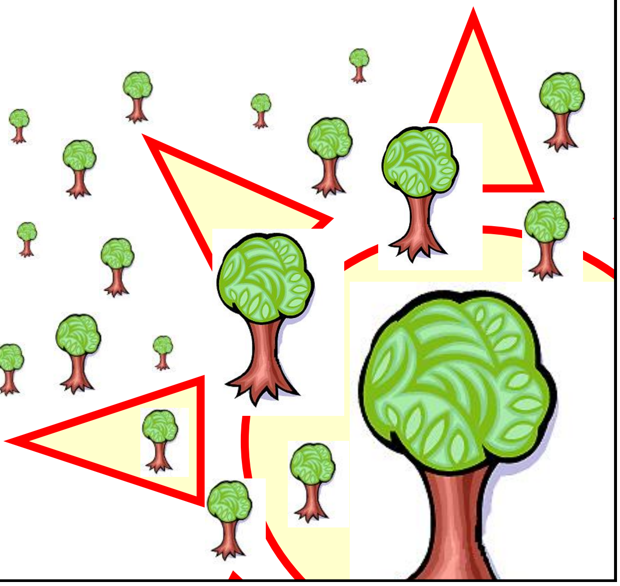
Main features in *Tuber* sp.



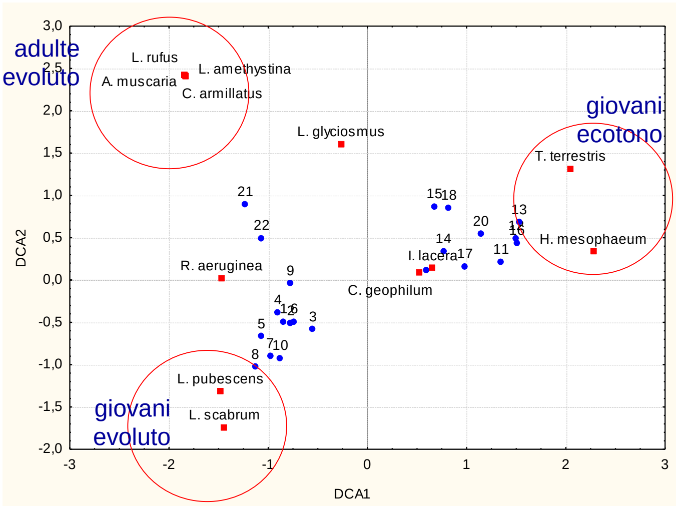


A bit of ecology

Pioneer trees need pioneer symbionts

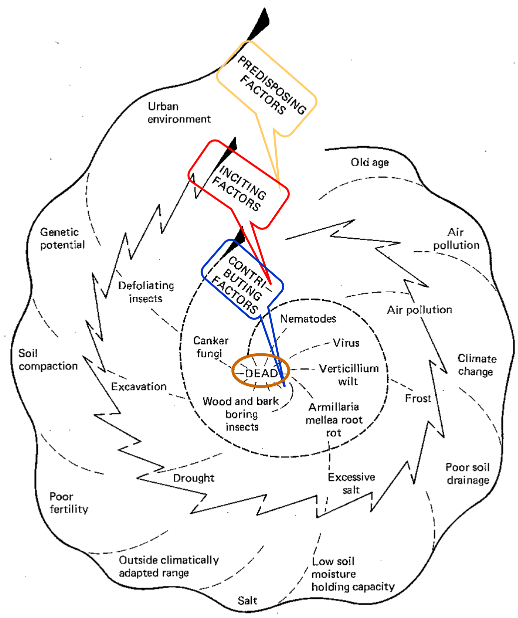


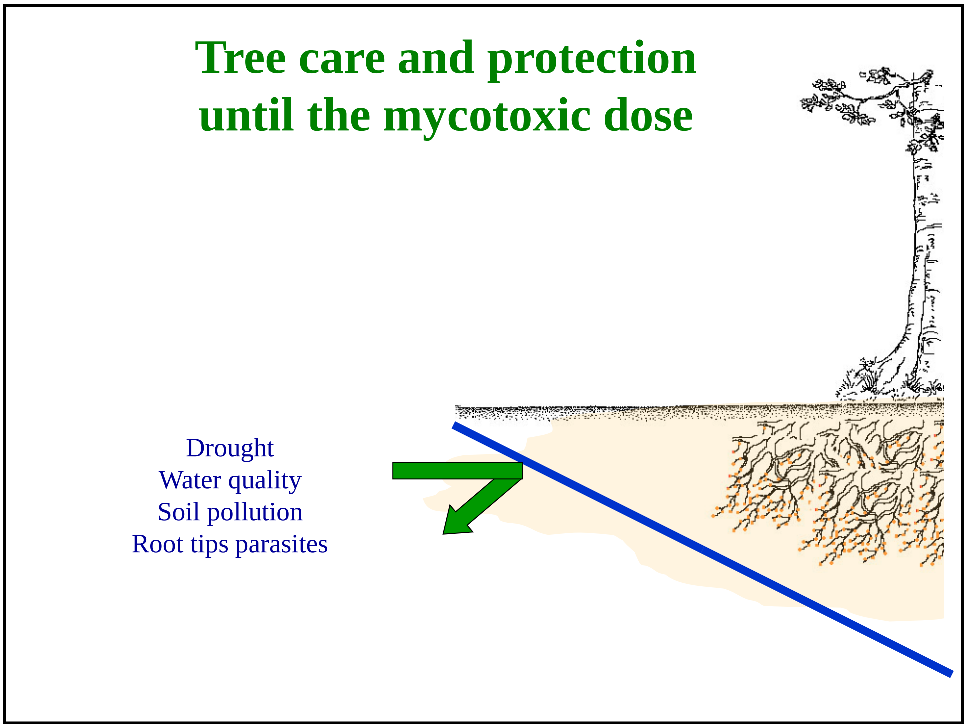
T. terrestris e H. mesophaeum: Very good in non-forest soils

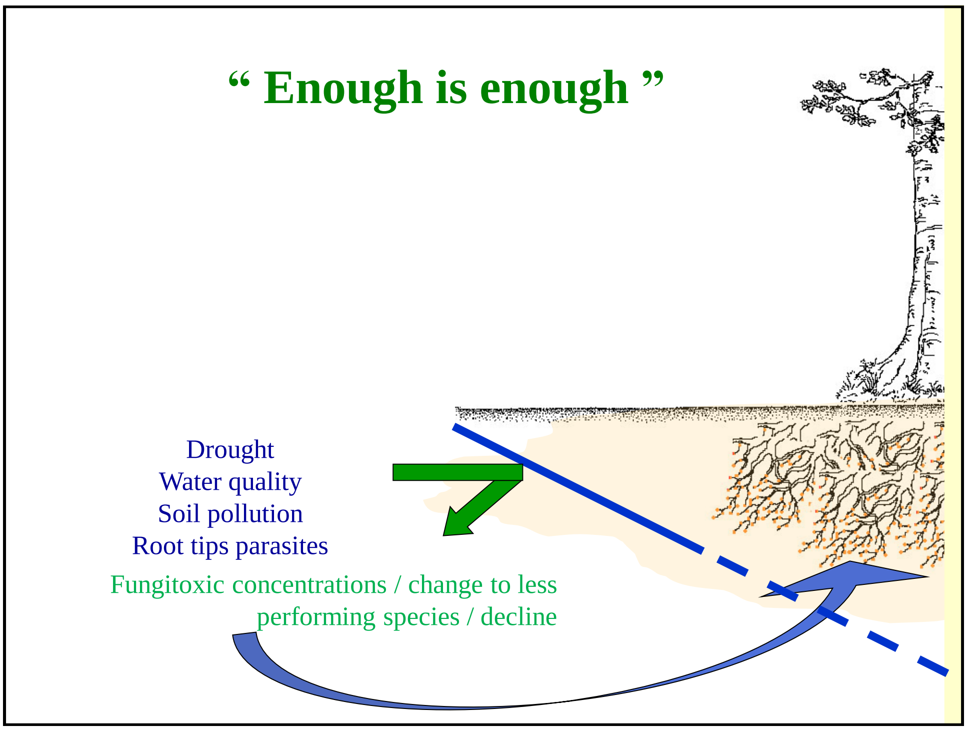


Mycorrhizal symbioses and trees' decline

Trees decline



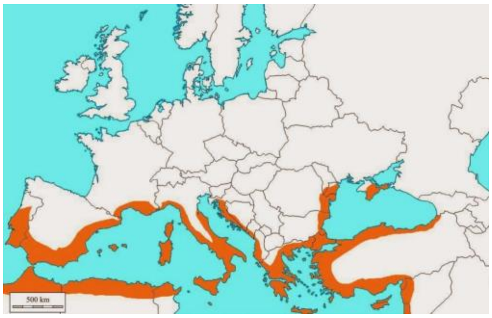

Tree care and protection
until the mycotoxic dose
Drought
Water quality
Soil pollution
Root tips parasites


“ Enough is enough ”
Drought
Water quality
Soil pollution
Root tips parasites
Fungitoxic concentrations / change to less
performing species / decline

An overview of oak decline in the Mediterranean region

Main declining oak species in the Mediterranean region

Common oak (*Quercus robur*)
Turkey oak (*Quercus cerris*)
Hungarian oak (*Quercus frainetto*)
Downy oak (*Quercus pubescens*)
Holm oak (Q. ilex)
Cork oak (Q. suber).



Oak decline show symptoms common to all forest trees decline

«Forest» decline is documented in Europe since the 1940s.

Since the eighties it has been reported also on Oak species (or was it a matter of knowlege and experience in survey?).

Symptoms are mainly associated to soil-related physiological stressors (drought, compaction, fertility, assolation, root up-take.

1)Root uptake deficiencies.
2)Canopy transparency increases due to yellowing, wilting, fall of leaves.
3) Annual internodes shorten.
4)Epicormic twigs appear along the trunk, downwards to the collar.

5)Human-assisted practices speed up the process: mainly intensive sylviculture, pasture, land-reclamation.

6)Endophytic fungi commonly present in all heatly trees turn to parasitism *(i.e. Biscogniauxia, Hypoxylon, Diplodia, Collybia).*

7)Known pests and pathogens infect declining trees causing root rots, bark cracks and wood decay
(i.e. Phytophthora, Armillaria, Ganoderma, Phellinus)

8)Fall and substitution by «stressors-tolerant» genotypes or species, not necessarily trees (i.e. Holm- and Cork oak with *Cistus*).

Visible symptoms are related to insufficient water uptake

Leaves far from the roots dies and epicormic twigs appear

Endophitic mutualits turn to a parasitic behaviour


Root and wood parasites compromise tree stability

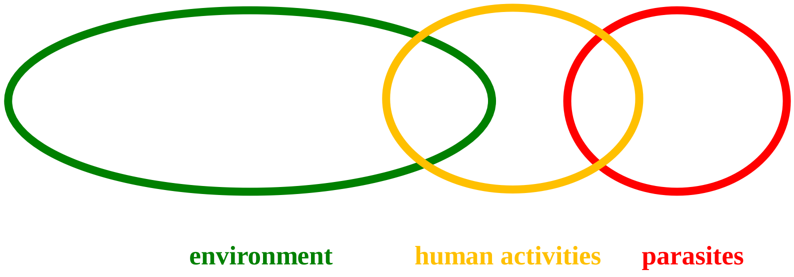




Declining trees fall down giving rom to different genotypes or species

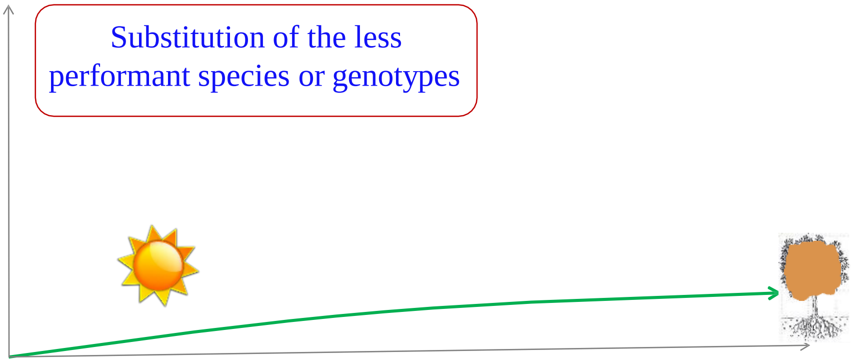
What «Decline» is?

The result of three consecutive, overlapping causes



«Environment»: well known ecological dynamics

Substitution of the less performant species or genotypes



Long-term Environmental factors

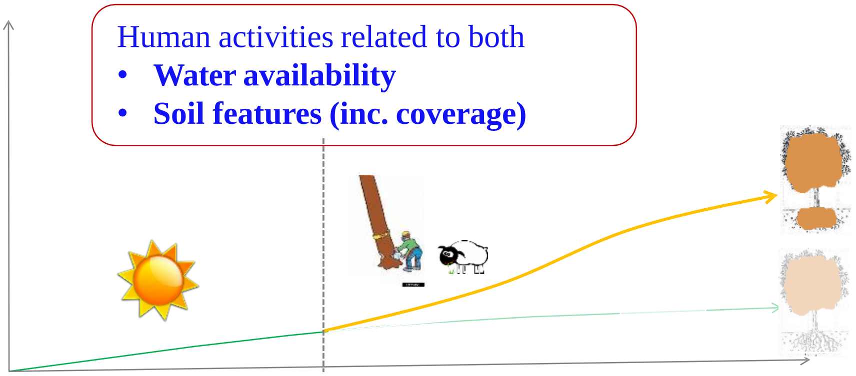
Low resilience to long-term **climate changes**

Senescence

Human activities compromising «soil health»

Human activities related to both

- **Water availability**
- **Soil features (inc. coverage)**



Medium-term Inciting factors

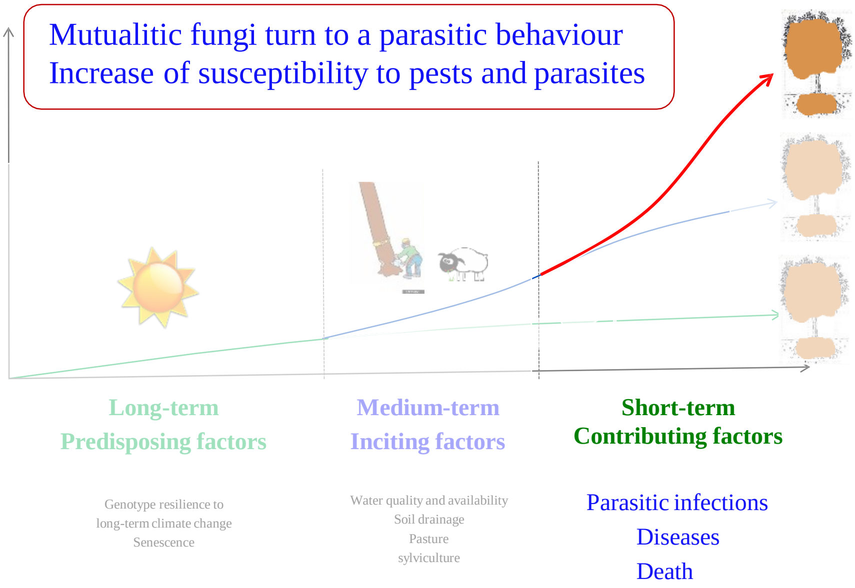
Water quality and availability

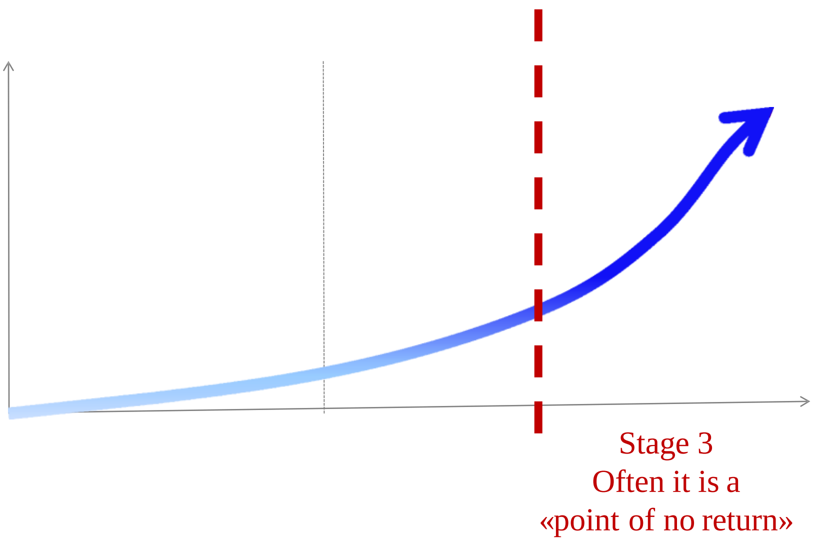
Soil drainage

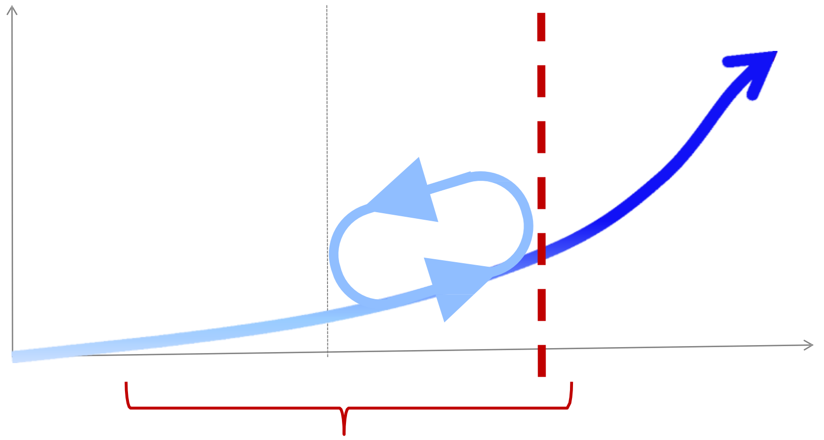
Pasture, grazing

Agriculture, Sylviculture

Pests and parasites as final effect on already stressed trees



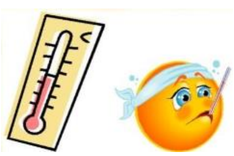


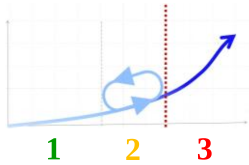


Here we can try to do something but …
What 1, 2, 3 means ?

Forest owners and managers need to quantify decline.
«1or Low» «2 or Medium» «3 or High» usually are nonobjective, mainly depending on previous experience and ability.

«How much declining is my declining oak»





Decline can be measured

through the composition of the ectomycorrhizal community.

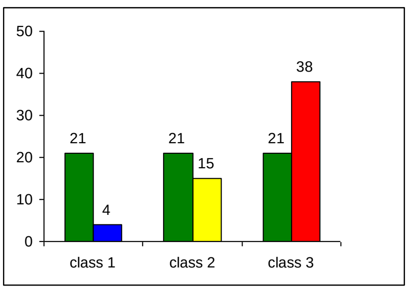
Changes in ectomycorrhizal diversity in a declining *Quercus ilex* coastal forest

Lucio Montecchio, Roberto Causin, Sergio Rossi and Sergio Mutto Accordi

Pedunculate oak decline: thinning effects on the ectomycorrhizal exploration groups

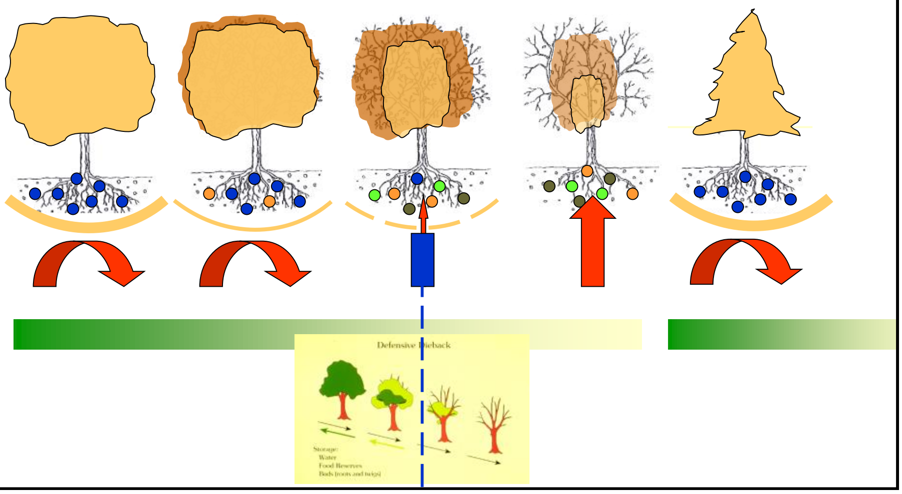
Elena Mosca[1], Linda Scattolin[1], Jean Garbaye[2], Sergio Mutto Accordi[1], Lucio Montecchio[1]
[1]Università degli Studi di Padova, Dipartimento Te.S.A.F., V.le dell'Università 16, I-35020 Legnaro, Italy; [2]INRA, UMR1136 Interactions Arbres/Microorganismes, F-54280 Champenoux, France

Few, peculiar species can say where we are



At least 1 among the «blue» ones?	Not a problem!
At least 1 among the yellows?	Do something
At least 1 among the reds?	Too late, sorry

Decline of both fungi and trees.
Species substitution



Tree species decline
Change in forest composition

Sweet Chestnut Ink Disease
cause, symptoms and control

What CID is?

A lethal disease caused by *Phytophthora (cambivora* and *cinnamomi)*, a soil-borne parasite.

Compacted soils, poor drainage and temporary films of water allow the parasite to move to the root tips by means of its flagellated spores (rotating like a propeller).

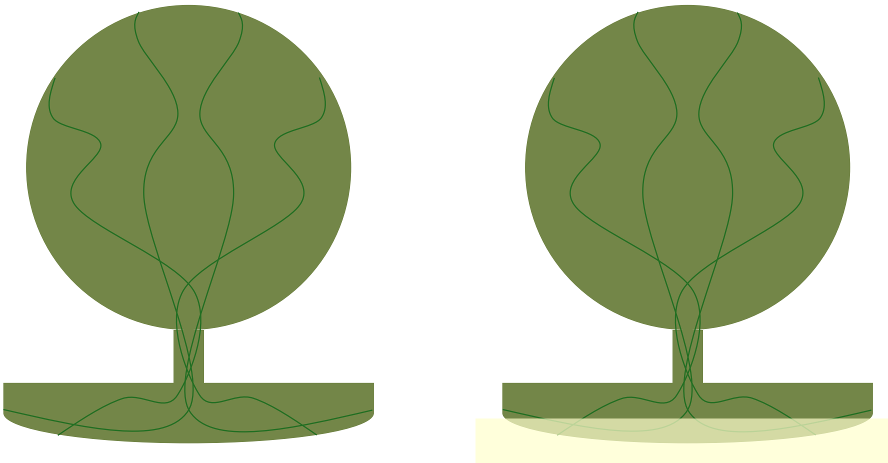
Flagellate spores need water to swim

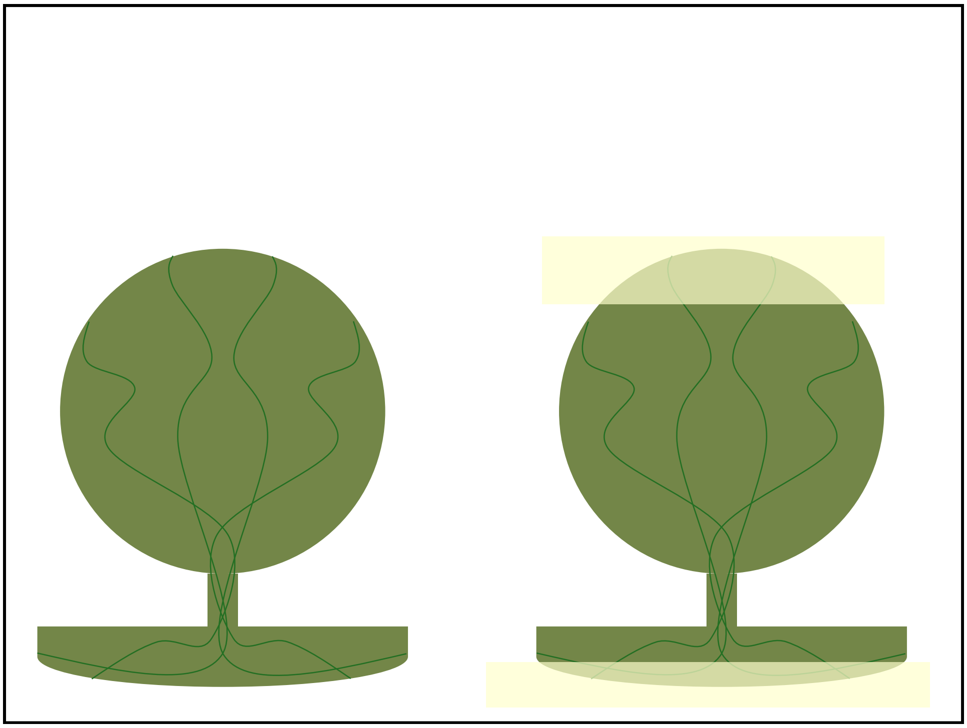
YouTube The Training Tree
Pubblicato il 28 ott 2016

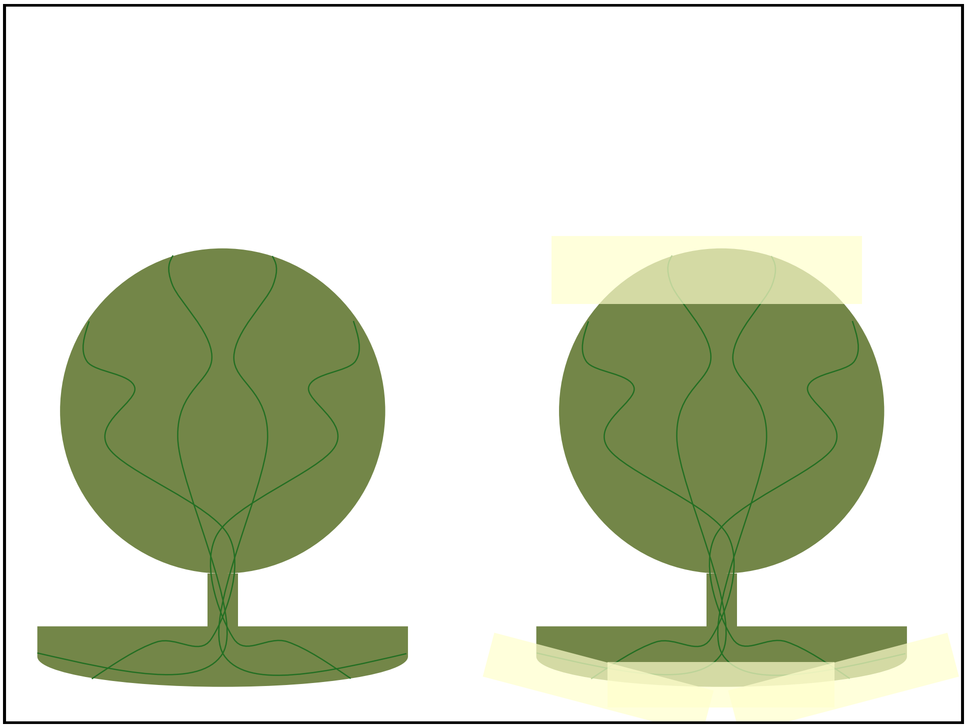
Phytophthora species are not true fungi. They are Oomycetes, Kingdom **Chromista**.

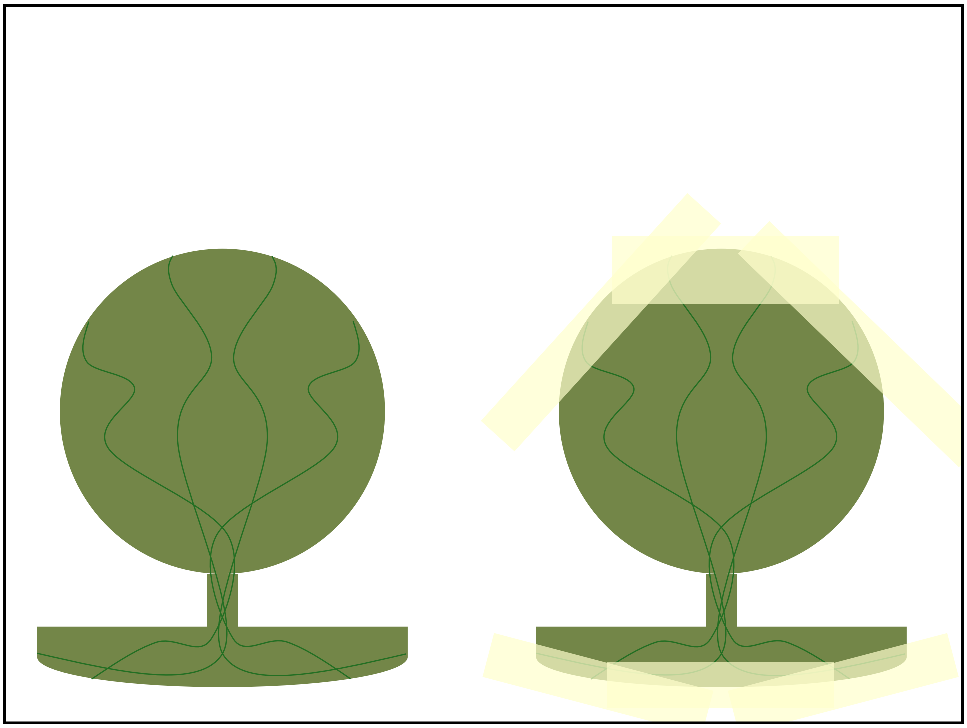
Lack of rootlets, lack of canopy

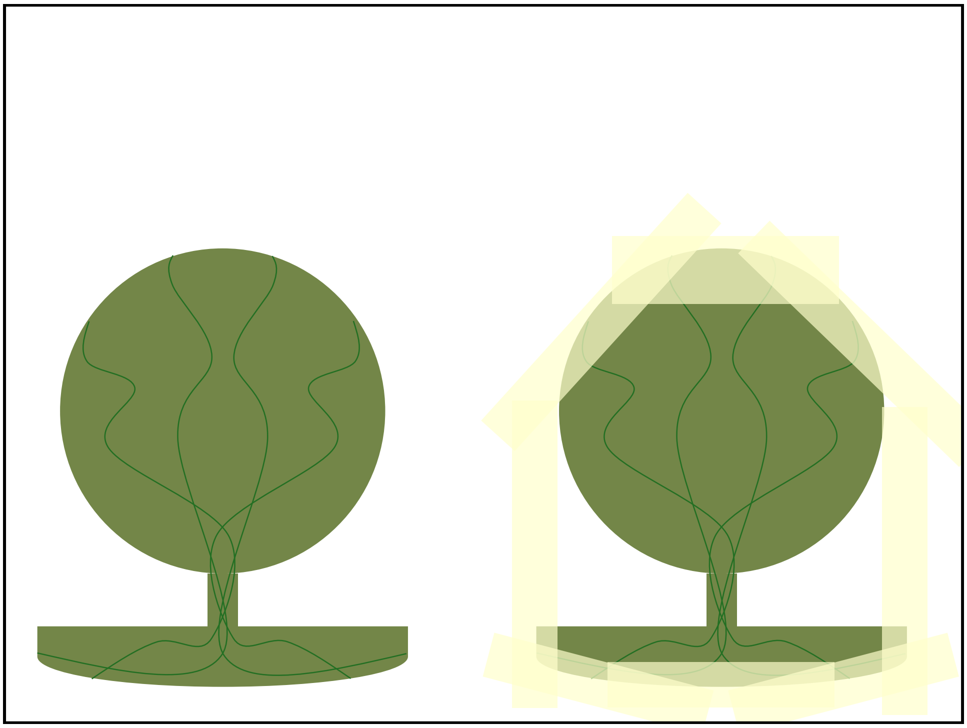
Macroscopic symtoms are related to a insufficient nutritional uptake.

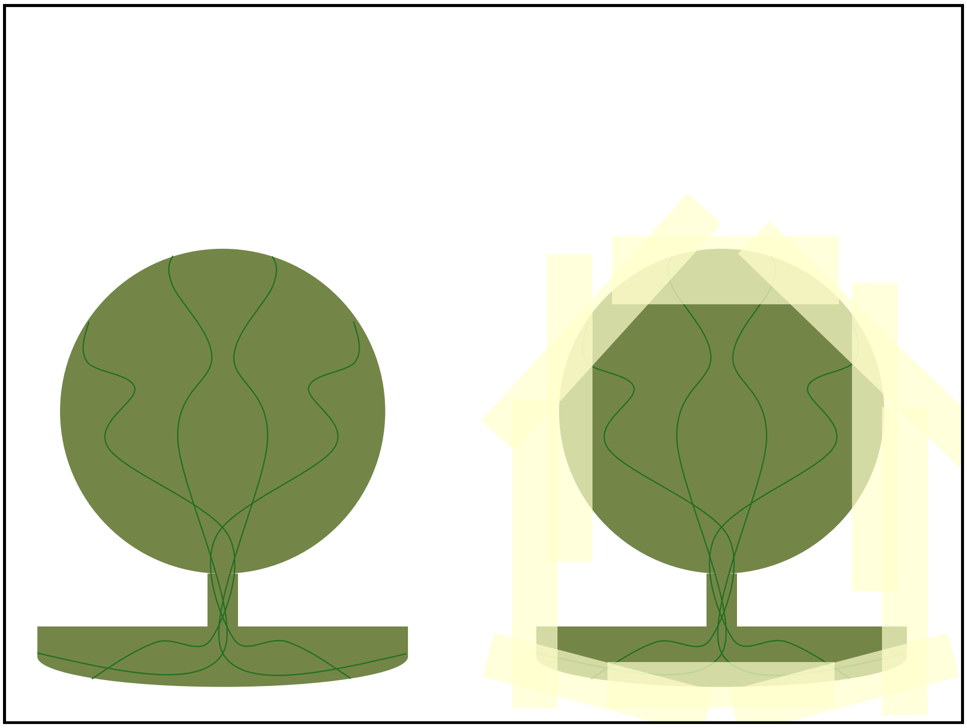


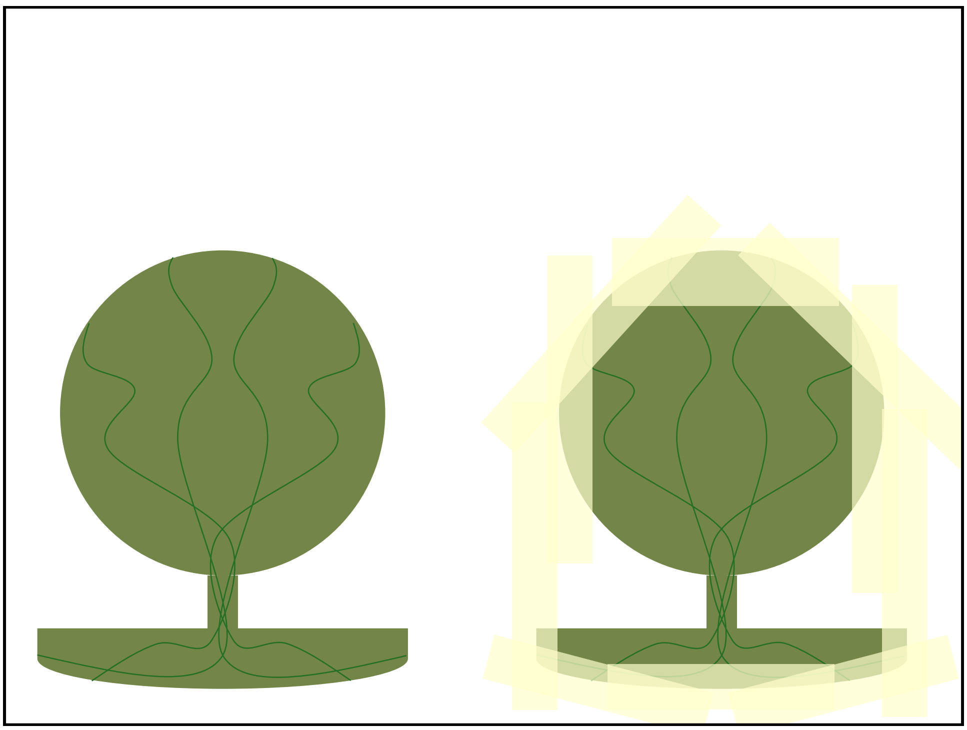












Three different stages od CID
Greenwich Park, October 2016

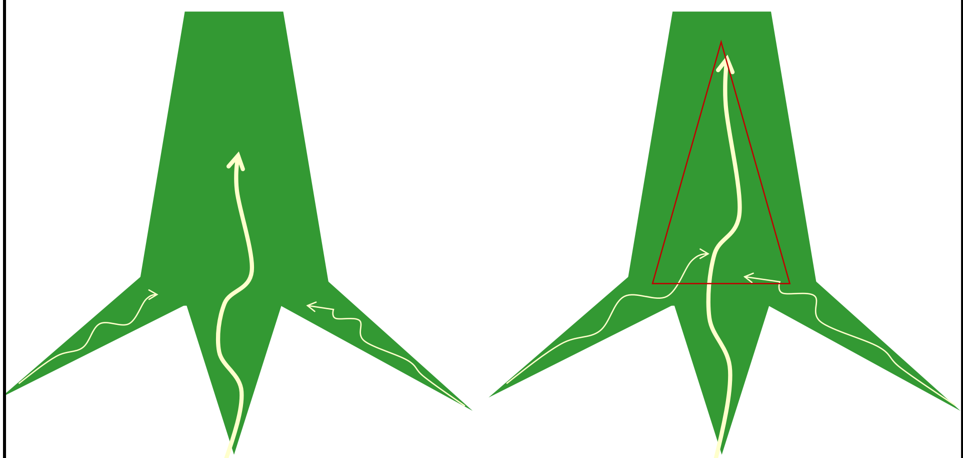
Three different stages od CID
Greenwich Park, October 2016

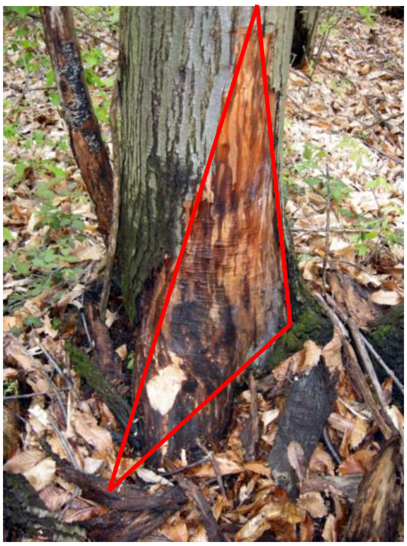
Three different stages od CID
Greenwich Park, October 2016

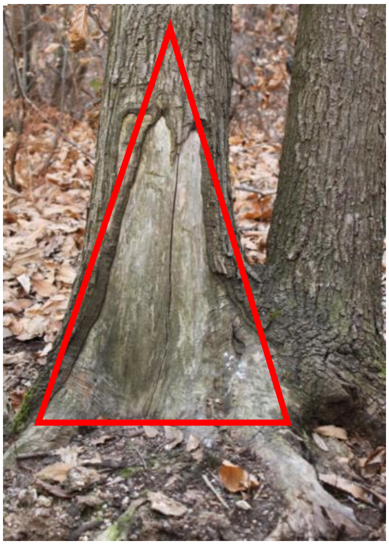
Early stages **above-ground** symtoms:
vertical cracks and necroses rising from main roots,
sometimes leaking tannins («ink», a tree reaction).

Tannins leak mainly in warm, mediterranean climates

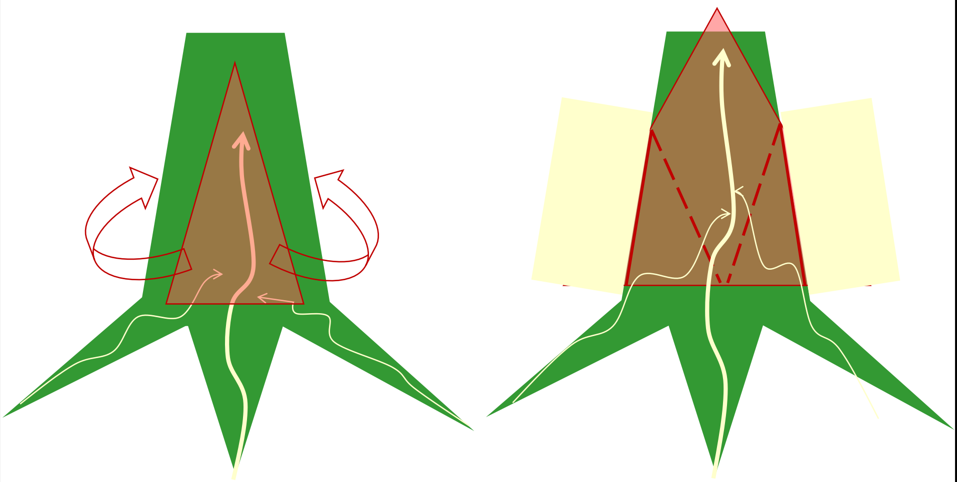
Then, individual necroses merge in
a bigger, (usually) triangular one.





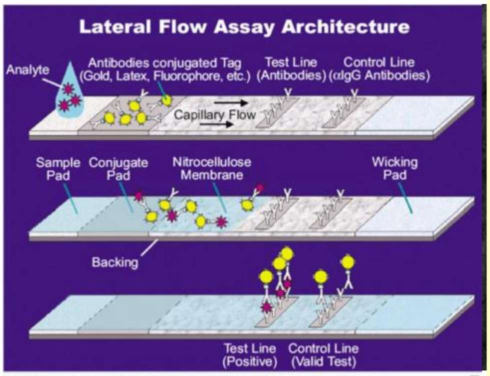


Once the necroses girdles the base,
uptake stops and the whole canopy dries out.



Diagnosis: is it easy?

to genus level, yes. Through lateral flow tests

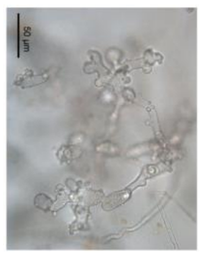


An illustration, by NASA, of a lateral flow assay.[1]

Diagnosis: is it easy?

to genus level, yes. Through lateral flow tests

to species level, no. We need a good lab and well trained staff



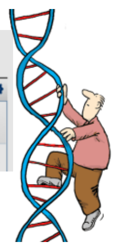
Sequences producing significant alignments:

Select: All None Selected:0

Alignments Download GenBank Graphics Distance tree of results

	Description	Max score	Total score	Query cover	E value	Ident	Accession
☐	Phytophthora cinnamomi strain CBS 144.22 cytochrome oxidase subunit I (cox1) gene, part	717	1130	84%	0.0	100%	KC609419.1

NCBI BLAST



Early stages **below-ground** symtoms:
infected, still non symptomatic chestnuts show a peculiar mycorrhizal community

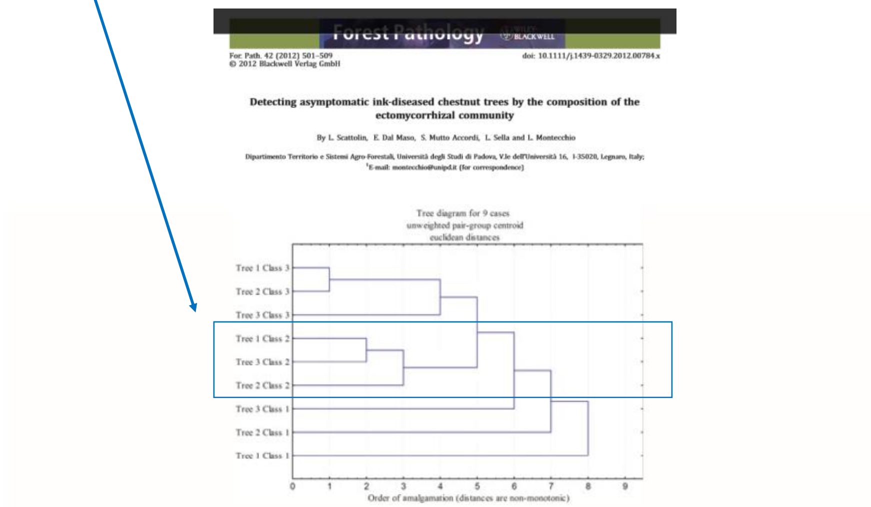


Fig. 4. Cluster analysis dendrogram, based on the Euclidean distances from the tree centroids using the data acquired in October 2008 (trees 1, 2 and 3).

For. Path. 42 (2012) 501–509
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doi: 10.1111/j.1439-0329.2012.00784.x

Detecting asymptomatic ink-diseased chestnut trees by the composition of the ectomycorrhizal community

By L. Scattolin, E. Dal Maso, S. Mutto Accordi, L. Sella and L. Montecchio

Dipartimento Territorio e Sistemi Agro-Forestali, Università degli Studi di Padova, V.le dell'Università 16, I-35020, Legnaro, Italy;
[1]E-mail: montecchio@unipd.it (for correspondence)

Piante infette ma ancora asintomatiche sono facilmente identificabili

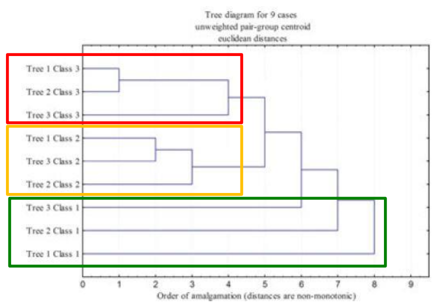

Fig. 4. Cluster analysis dendrogram, based on the Euclidean distances from the tree centroids using the data acquired in October 2008 (trees 1, 2 and 3).

Prevention:
forecasting and survey

Forest Pathology

For. Path.
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doi: 10.1111/efp.12172

Large-scale fuzzy rule-based prediction for suitable chestnut ink disease sites: a case study in north-east Italy

By E. Dal Maso[1] and L. Montecchio[1,2]

Large-scale fuzzy prediction of chestnut ink disease 7

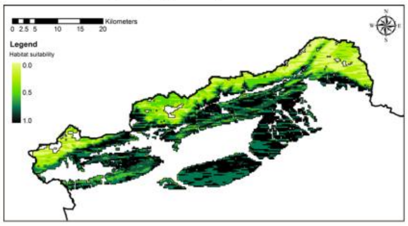


Fig. 4. Predicted spatial habitat suitability for chestnut ink disease in the study area. Different colours represent different levels of predicted probability.

Containment

In urban forestry pesticides effective against *Phytophthora* are not allowed.
Integrated pest management (IPM) strategies to:

- Improve soil health, drainage and composition (addition of organic substance)
- Biostimulate trees to increase their natural defences (trunk injection)

Control of CID through trunk injection

ARBORICULTURAL JOURNAL, 2017
https://doi.org/10.1080/03071375.2017.1345538
Arboricultural Association trees.org.uk
Taylor & Francis
Taylor & Francis Group
Check for updates

An enhanced trunk injection formulation of potassium phosphite against chestnut ink disease

Elisa Dal Maso[a,b], Jonathan Cocking[b,c] and Lucio Montecchio[a,b]

[a]Dipartimento Territorio e Sistemi Agro-Forestali, Università degli Studi di Padova, Legnaro, Italy; [b]PAN/De Rebus Plantarum, Spinoff of the University of Padova, Padova, Italy; [c]JCA Ltd, Halifax, UK

ABSTRACT
Chestnut ink disease, caused by *Phytophthora cinnamomi* and *P. cambivora*, is one of the most destructive diseases affecting *Castanea sativa*. Currently, disease control requires careful integrated chemical and agronomic measures. Trunk injection with potassium phosphite was proven to be effective in reducing symptoms but little is known about the ideal formulation. In this research, potassium phosphite at different concentrations and with some other bio stimulants was injected into sweet chestnuts which had been inoculated with a local strain of *P. cinnamomi*. The most effective formulation, potassium phosphite mixed with a micronutrient solution, was then tested with a preventive approach; as a result, the trunk injection treatments completely ceased the development of the disease *in planta* in most cases. In order to consider the importance of each component of the solution, potassium phosphite and the bio stimulant elements were tested *in vitro* singly and in an isobolographic analysis of interactions. The results broaden the knowledge base on endotherapic treatments as an effective measure for the management of chestnut ink disease with potential for many other diseases.

KEYWORDS
Phytophthora cinnamomi; *Castanea sativa*; xylematic injection; micronutrients; isobolographic analysis

Potassium salts of phosphorous acid vs. Chestnut Ink Disease

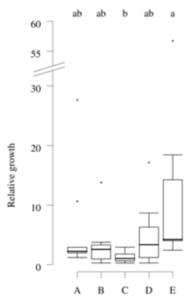
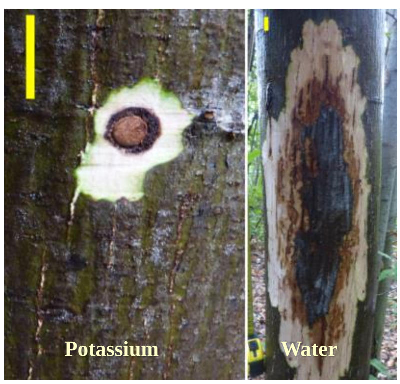


Figure 22. Differences in the relative increase of the necrotic areas after 50 days from the treatments. A = Potassium phosphite 35 %; B = Potassium phosphite 70 %; C = Potassium phosphite 35 % plus micronutrient solution 0.1 %; D = Potassium phosphite 35 % plus allicin solution 20%; E = Control.



Curative
Injection 21 days after infection.
End of trial 50 days after injection (= 71).

Preventative (bar=2cm)
Injection 27 days before infection.
End of trial 50 days after infection (=77).

Artificial mycorrhization

Benefits

Nitrogen and potassium uptaken easily
Increase of useful bacterial communities
Biocontrol of root parasites

⬇

Quicker growth
Higher resistence to transplant stresses
Higher resitance to root parasites

When it’s useful
(not in a natural forest soil, of course)

- Non-pioneer species on poor soils.
- Edible fruit bodies production.

It’s possible
(1887: Frank)

Artificial inoculation

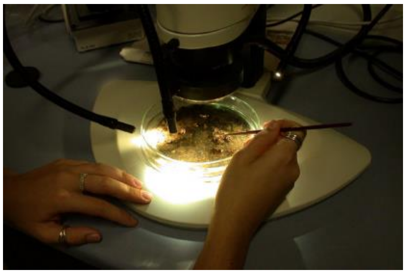
- Transplanting close to a mycorrhized tree («proximity»)
- Sowing into naturally infected soil
- Mixing carpophores into soil
- **Mixing mycelium into soil**

The fungus must be …

- A pioneer species (easy to isolate and grow far from living tips).
- Able to maintain his abilities for a long time, also when growing in artificial substrates for weeks.
- Compatible with the nursery conditions and environment.
- Compatible with the destination tree and environment

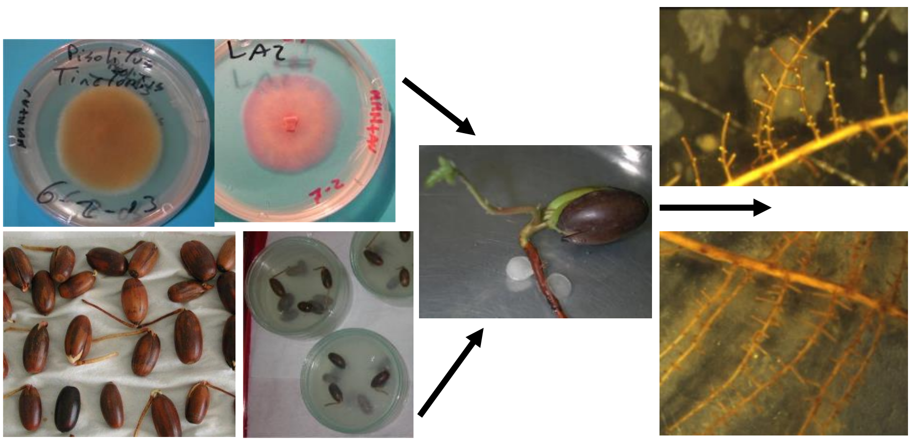
Laccaria laccata

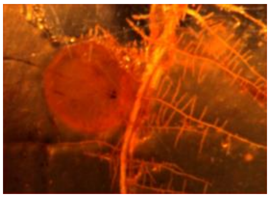
Production

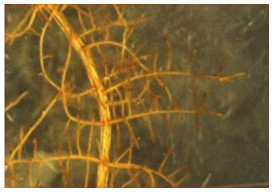


Ad hoc labs and skillful technicians

Preliminary investigations *in vitro*



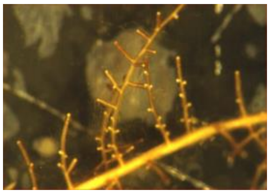


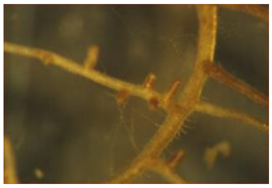


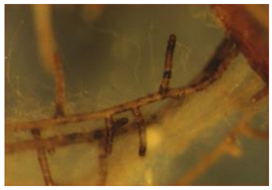
Laccaria amethystina LA3

Laccaria bicolor LB1

Laccaria laccata LL2







Laccaria laccata LL3

Laccaria laccata LL4

Paxillus involutus PI-I

Production of pure strains of the selected species

Different methods

Artificial mycorrhization

Adjustment of the growing methods:

- Disinfection of substrates, pots, seed.
- Composition e pH of the soils
- Decrease fertilizzation
- Avoid fungides
- Avoid herbicides
- Decrease watering

- Survey, survey, survey

Hygiene !!!

Laccaria laccata: on pinus mugo 12 months after

Laccaria bicolor fruiting from the bottom of a tray!

Perspectives

- Long term plans (i.e. mix of non-antagonistic species)
- Local strains
- Quality control and certification

Certification: not easy

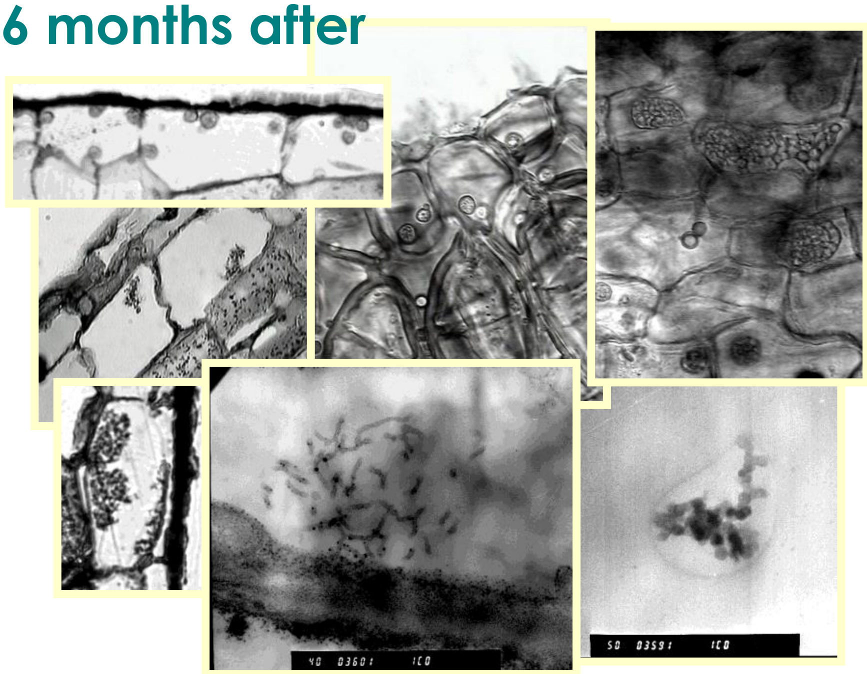
R. fibula: not mycorhizal *H. crustuliniforme: yes*

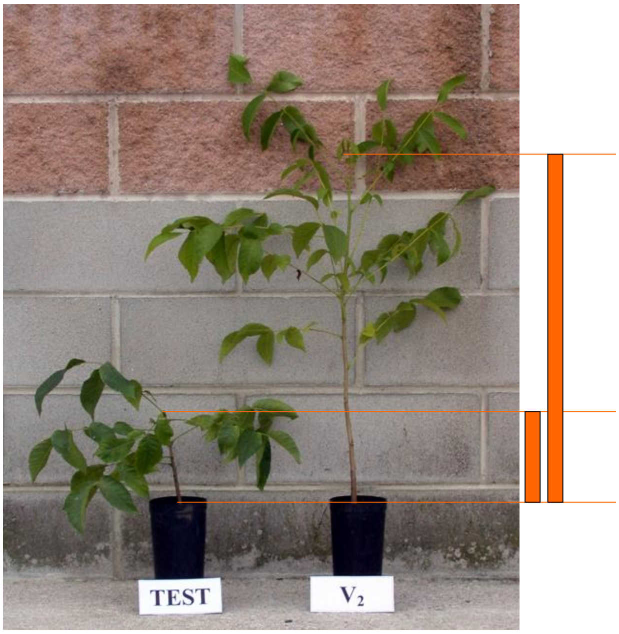
Artificail mycorrhization on *Juglans regia*

5 treatments x 100 replicates.

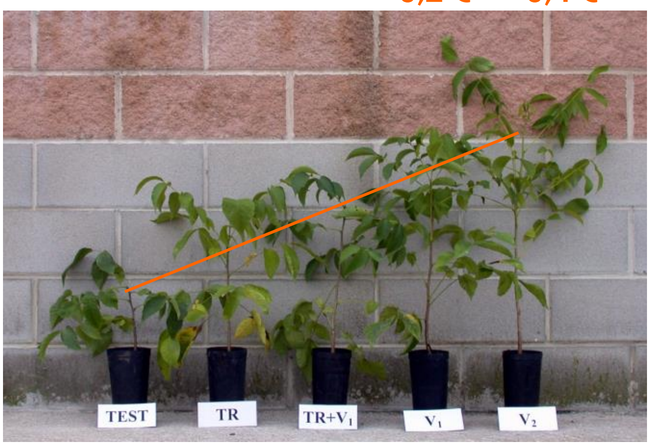
- Control
- *T. harzianum*
- *T. harzianum* + AM dose a
- AM dose a
- AM dose 2a

6 months after





+ 0,2 € + 0,4 €



Height	c	cb	cba	ba	a
Diameter (base)	c	c	bc	ba	a
Root biomass	b	ba	ba	ba	a

Tukey-Kramer; P = 0.05

TRUFFLES!

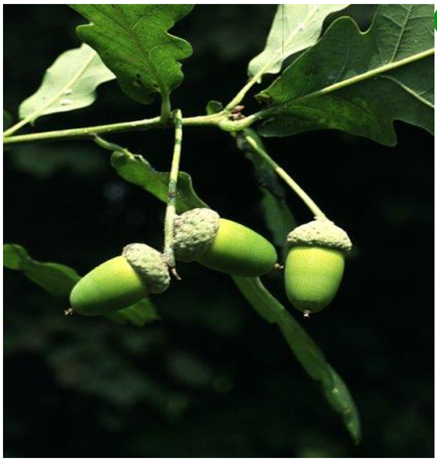
White truffles

Black truffles

9 species allowed to collect in Italy

1) Tartufo bianco pregiato	(*Tuber magnatum* Pico)
2) Tartufo bianchetto	(*Tuber borchii* Pico)
3) Tartufo nero pregiato	(*Tuber melanosporum* Vitt.)
4) Tartufo scorzone	(*Tuber aestivum* Vitt.)
5) Tartufo uncinato	(*Tuber uncinatum* Chat.)
6) Tartufo brumale	(*Tuber brumale* Vitt.)
7) Tartufo moscato	(*T. brumale* var. *moschatum* De Ferry
8) Tartufo mesentericum	(*Tuber mesentericum* Vitt.)
9) Tartufo macrosporum	(*Tuber macrosporum* Vitt.)

TUBER MAGNATUM PICO



Q. robur

P. alba

Tuber magnatum

TUBER BORCHII

3. PIANTE SIMBIONTI AUTOCTONE IN VENETO

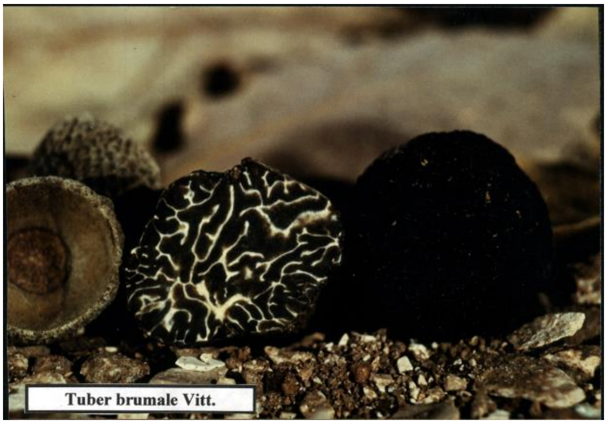
Q. pubescens

Q. ilex

Tuber borchii

TUBER MELANOSPORUM

TUBER BRUMALE



TUBER MOSCHATUM

TUBER UNCINATUM Chatin

C. avellana

O. carpinifolia

Tuber aestivum

TOXIC !!!

Tuber rufum

Balsamia vulgaris

Choiromyces meandriformis

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