Un'iniziativa

IL VERDE EDITORIALE

ORDINE DEI DOTTORI AGRONOMI E DEI DOTTORI FORESTALI DI MILANO
PROVINCE DI MILANO, LODI, MONZA E BRIANZA, PAVIA

Con il patrocinio di

CONSIGLIO DELL'ORDINE NAZIONALE DEI DOTTORI AGRONOMI E DEI DOTTORI FORESTALI
Ministero della Giustizia

Ministero della Giustizia
COLLEGIO NAZIONALE
PERITI AGRARI E PERITI AGRARI LAUREATI

ALBERI: IMPARARE A CONOSCERE LE RADICI

21 febbraio 2018
Rho (MI) - Myplant&Garden 2018
Sala Convegni, Corsia L, Padiglione 20, Fiera Milano Rho

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dottore in scienze naturali, Commissione Scientifica "L'architettura degli alberi"

Studio della forma e delle funzioni delle radici per conoscere gli alberi

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Myplant&Garden 2018

Alberi: imparare a conoscere le radici

Studio della forma e delle funzioni delle radici per conoscere gli alberi

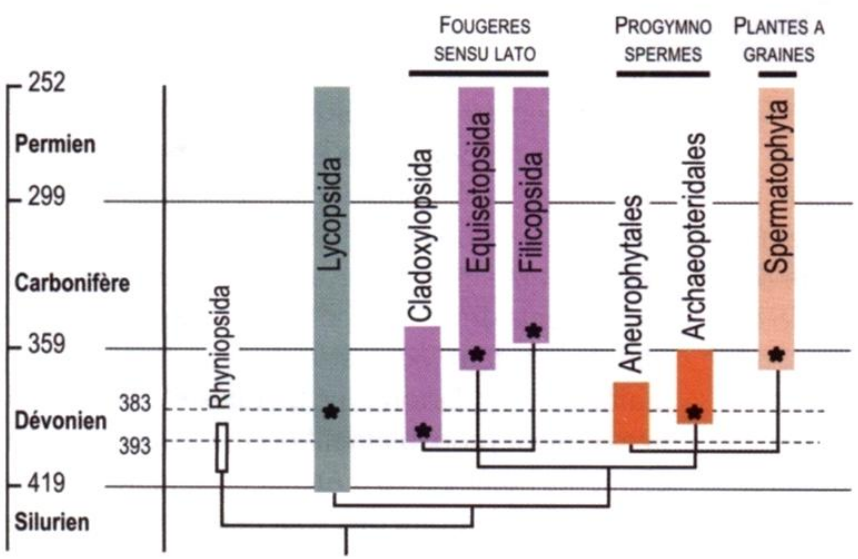

Damage (million m3)
250
200
150
100
50
0
Wind
Other abiotic causes
Bark beetles
Other biotic causes
Other causes
1850
1870
1890
1910
1930
1950
1970
1990
2010

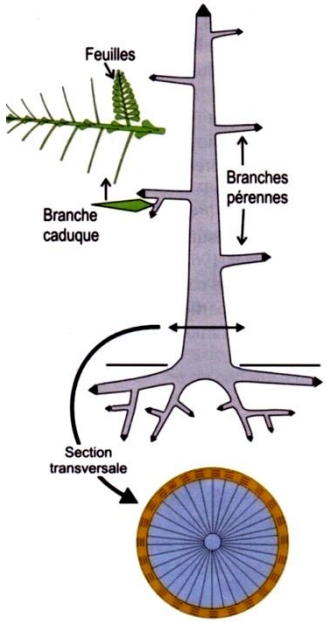
University of California: Root failure report -2011

5264 reports: 1790 are root failures (34%).	% of root failures
Quercus	26%
Pinus	20%
Eucalyptus	11%
Cupressus	10%
Fraxinus	3%
Acacia	4%
Ulmus	2%
Liquidambar	0.2%
Cedrus	1%
Sequoia	2%
Pyrus	1%

Età media 65 anni
Altezza media 16 m
Diametro medio 66 cm
7% Radici potate
47% Albero potato
48% Decadimento
57% Suolo saturo
76% Precipitazioni
58% Velocità vento oltre 40 Km/h

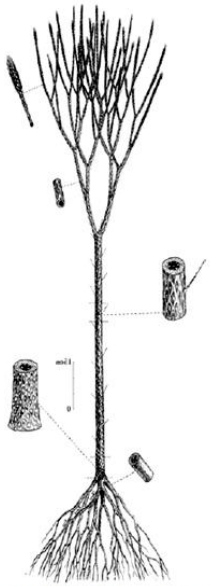
http://ucanr.edu/sites/treefail/Species_Profiles/Root_Failures/





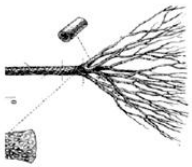
Noter l'épaisseur du xylème secondaire (bleu rayé)

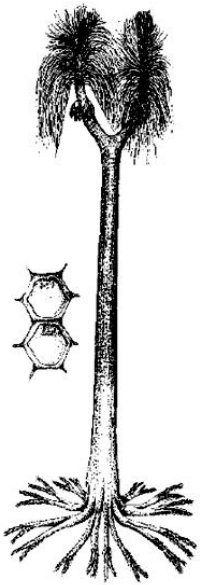
D. Archaeopteridales



Longostachys Dév. moyen

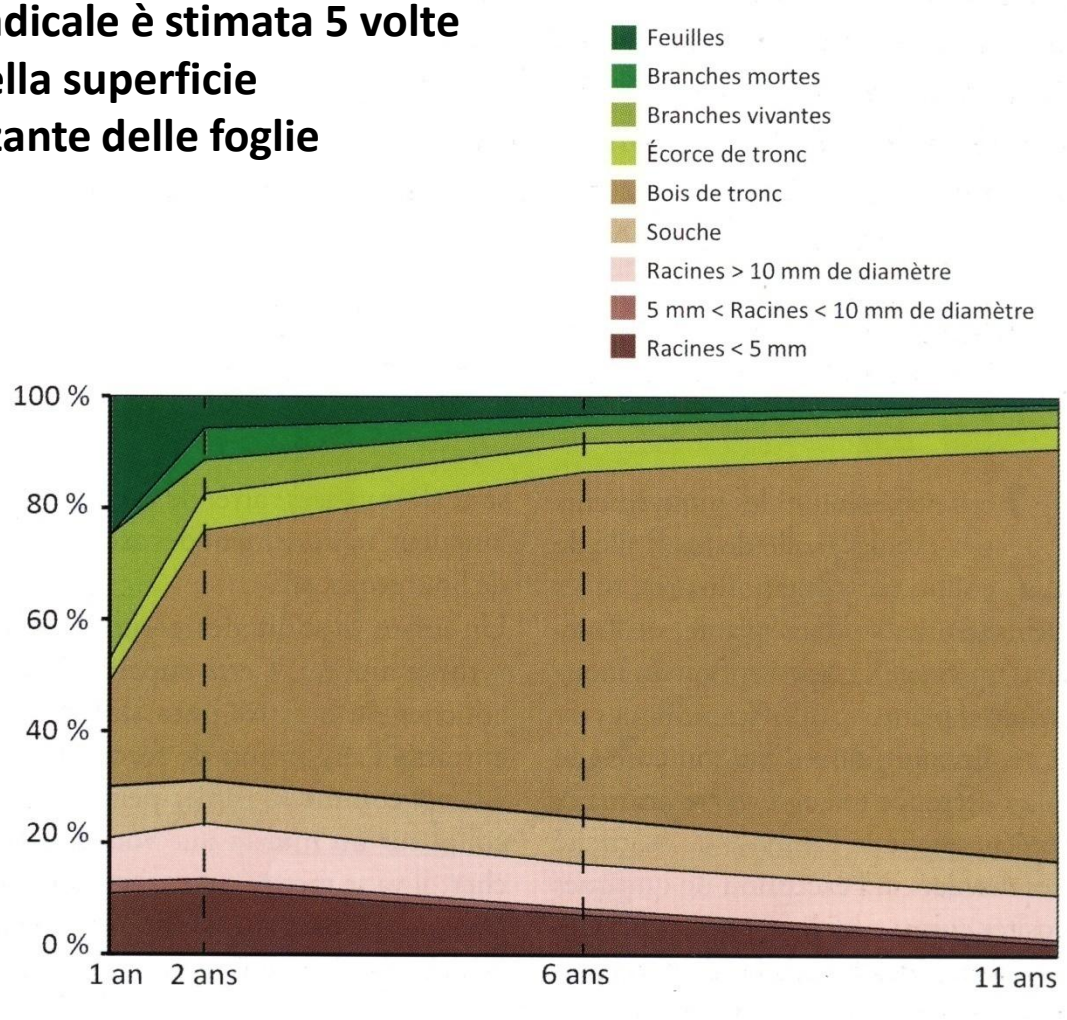
Image miroir dessus/dessous



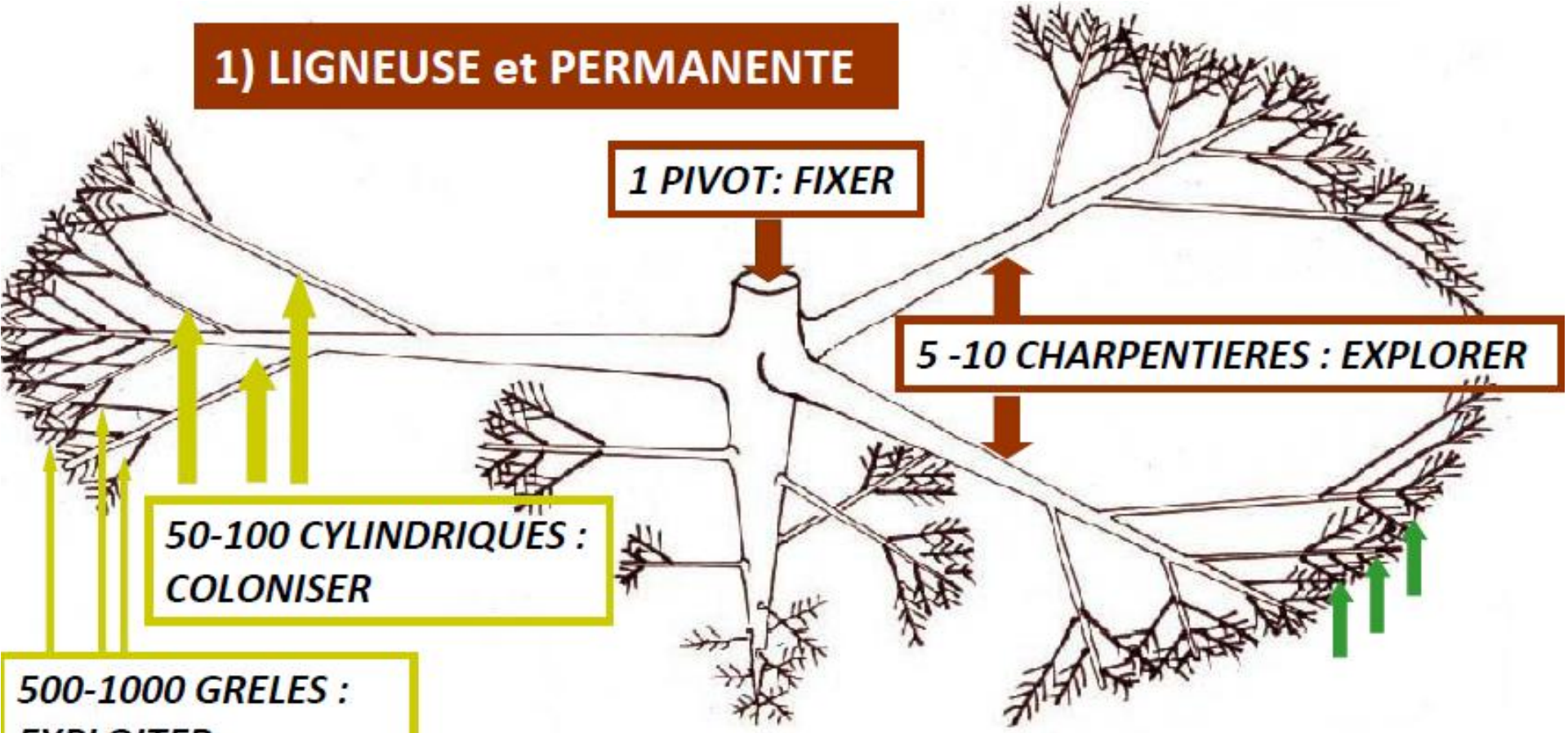


Sigillaria Carbonifère

In un albero di medie dimensioni la superficie radicale è stimata 5 volte maggiore della superficie fotosintetizzante delle foglie

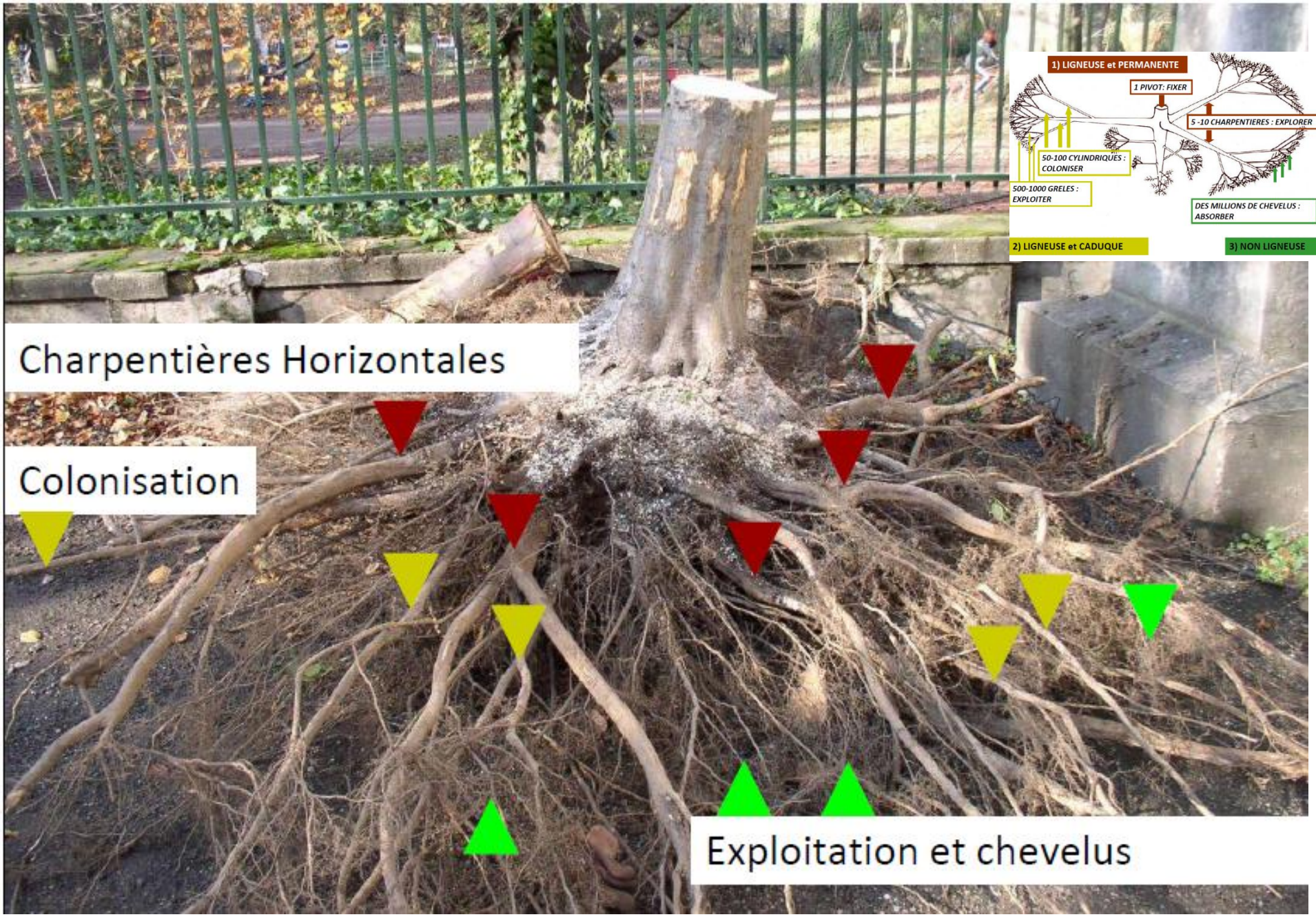


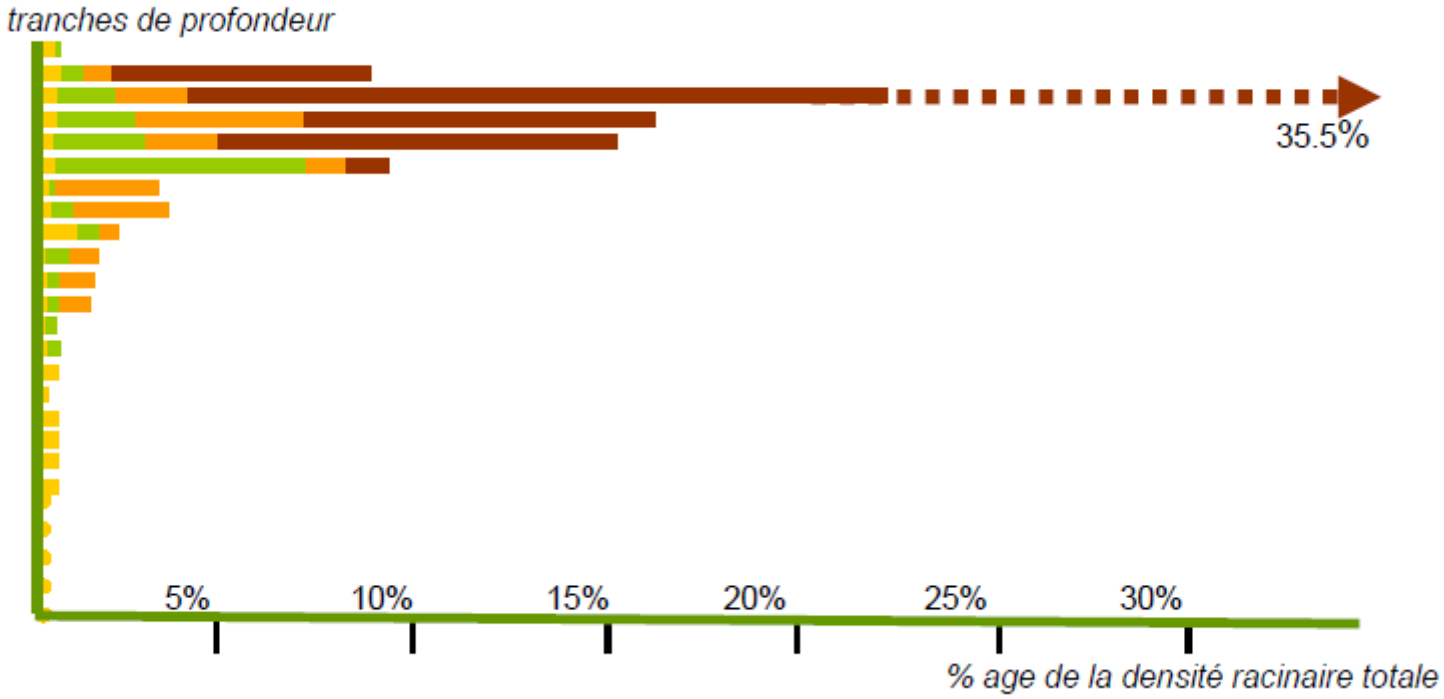
Organizzazione delle radici

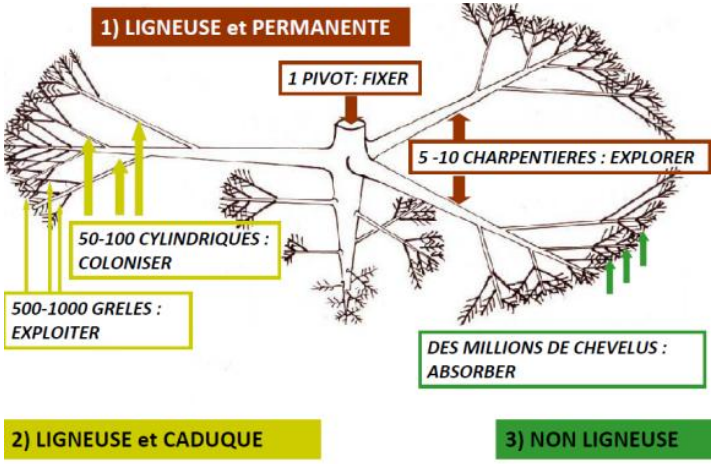


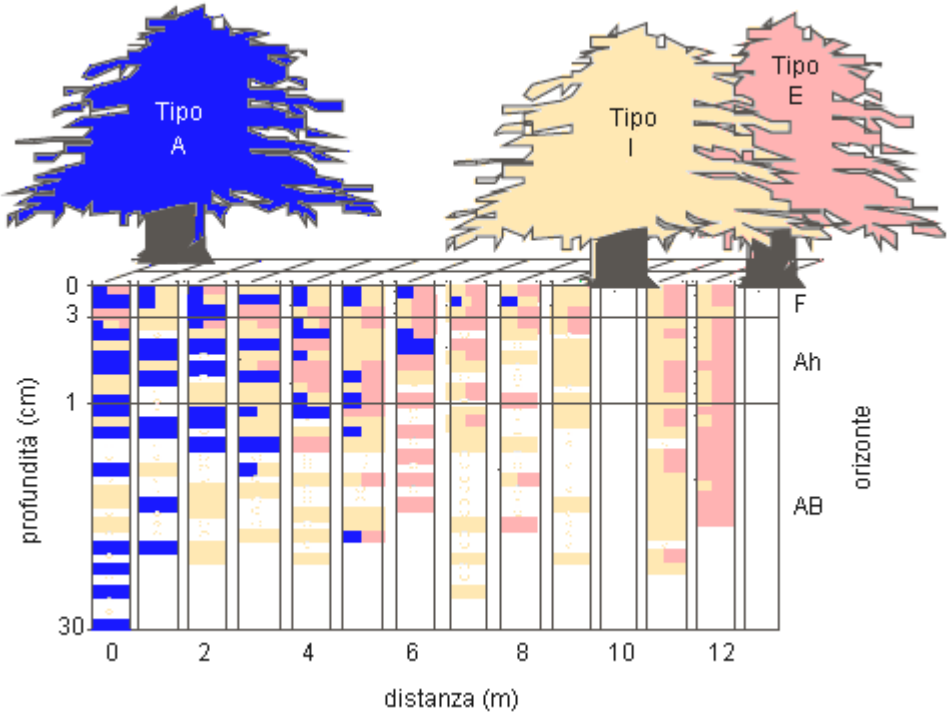
2) LIGNEUSE et CADUQUE

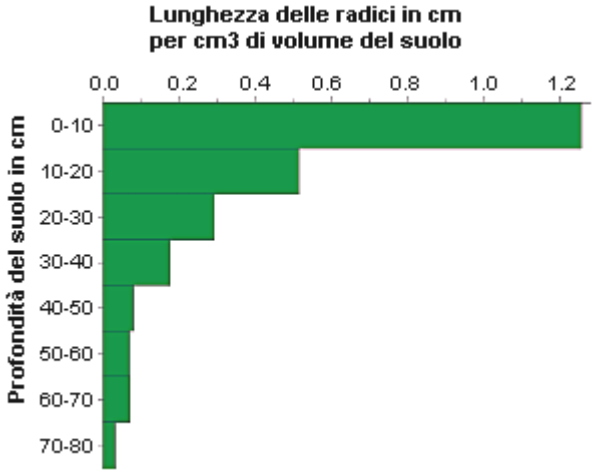
3) NON LIGNEUSE

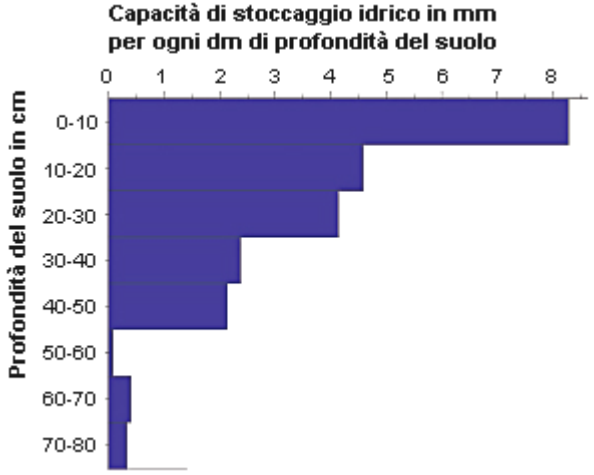

1) LIGNEUSE et PERMANENTE
1 PIVOT: FIXER
5 -10 CHARPENTIERES : EXPLORER
50-100 CYLINDRIQUES : COLONISER
500-1000 GRELES : EXPLOITER
DES MILLIONS DE CHEVELUS : ABSORBER
2) LIGNEUSE et CADUQUE
3) NON LIGNEUSE
Charpentières Horizontales
Colonisation
Exploitation et chevelus

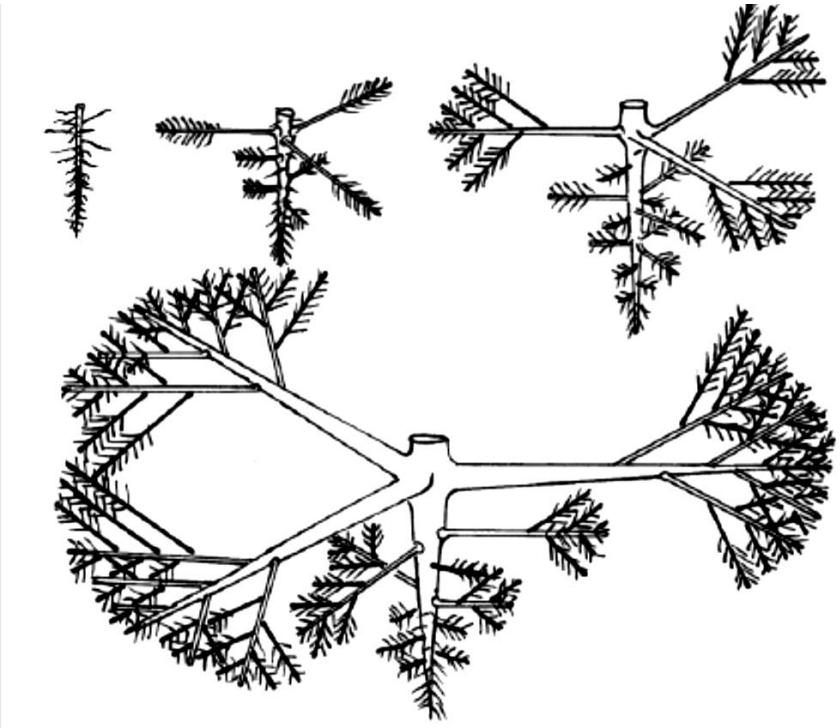

tranches de profondeur
35.5%
5%
10%
15%
20%
25%
30%
% age de la densité racinaire totale


1) LIGNEUSE et PERMANENTE
1 PIVOT: FIXER
5 -10 CHARPENTIERES : EXPLORER
50-100 CYLINDRIQUES : COLONISER
500-1000 GRELES : EXPLOITER
DES MILLIONS DE CHEVELUS : ABSORBER
2) LIGNEUSE et CADUQUE
3) NON LIGNEUSE


Tipo A
Tipo I
Tipo E
0
3
1
30
profondità (cm)
F
Ah
AB
orizonte
0
2
4
6
8
10
12
distanza (m)

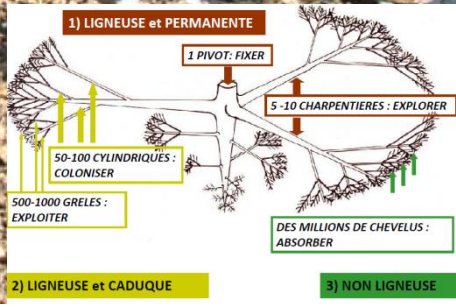

Lunghezza delle radici in cm
per cm3 di volume del suolo
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Profondità del suolo in cm
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80


Capacità di stoccaggio idrico in mm
per ogni dm di profondità del suolo
0
1
2
3
4
5
6
7
8
Profondità del suolo in cm
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80



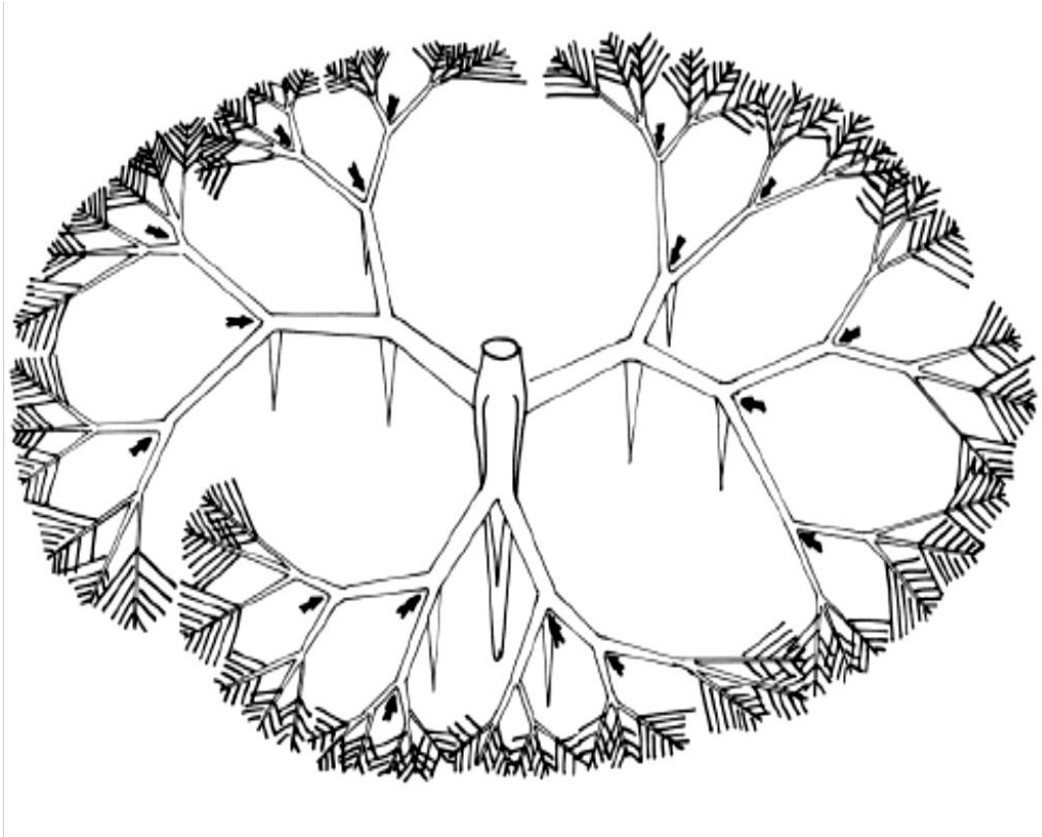
1) Plantula: Ancoraggio al suolo Autotrophia	**Fittone**	**Capillizio**			
2) Giovane pianta: Sfruttamento del suolo	**Fittone**	Sfruttamento	**Capillizio**		
3) Giovane individuo: Colonizzazione dell'ambiente	**Fittone**	Colonizzazione	Sfruttamento	**Capillizio**	
4) Giovane adulto: Esplorazione a distanza	**Fittone**	Intelaiatura	Colonizzazione	Sfruttamento	**Capillizio**
Ordine d'assi	**A1**	**A2**	**A3**	**A4**	**A5**

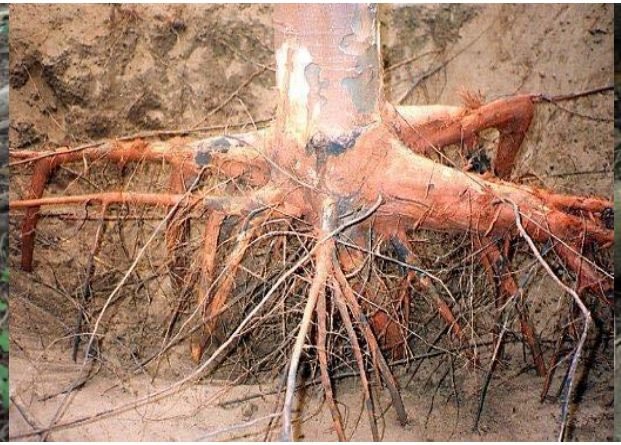
1) LIGNEUSE et PERMANENTE
1 PIVOT: FIXER
5 -10 CHARPENTIERES : EXPLORER
50-100 CYLINDRIQUES : COLONISER
500-1000 GRELES : EXPLOITER
DES MILLIONS DE CHEVELUS : ABSORBER
2) LIGNEUSE et CADUQUE
3) NON LIGNEUSE


1) LIGNEUSE et PERMANENTE
1 PIVOT: FIXER
5 -10 CHARPENTIERES : EXPLORER
50-100 CYLINDRIQUES : COLONISER
500-1000 GRELES : EXPLOITER
DES MILLIONS DE CHEVELUS : ABSORBER
2) LIGNEUSE et CADUQUE
3) NON LIGNEUSE


1) LIGNEUSE et PERMANENTE
1 PIVOT: FIXER
5 -10 CHARPENTIERES : EXPLORER
50-100 CYLINDRIQUES : COLONISER
500-1000 GRELES : EXPLOITER
DES MILLIONS DE CHEVELUS : ABSORBER
2) LIGNEUSE et CADUQUE
3) NON LIGNEUSE

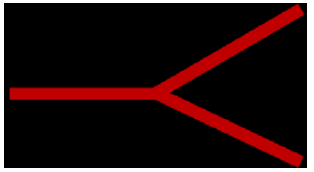
Reiterazioni: biforcazioni e fittoni soprannumerari

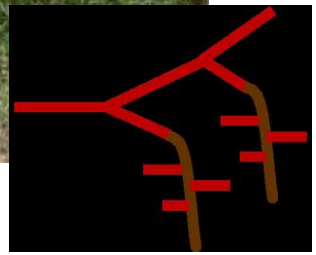


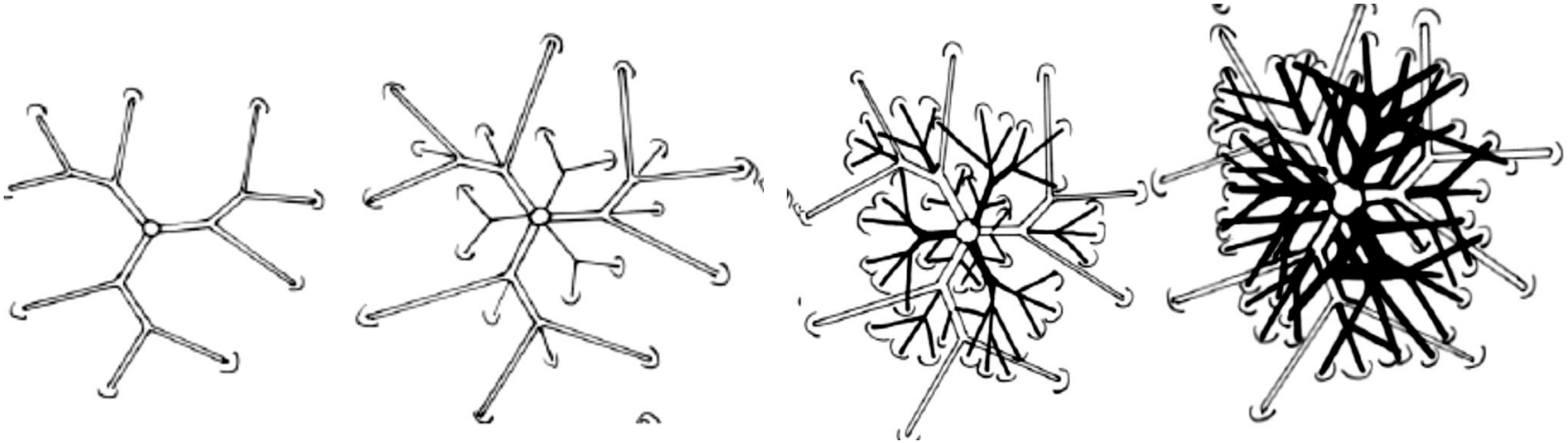

Ancoraggio

Stabilità

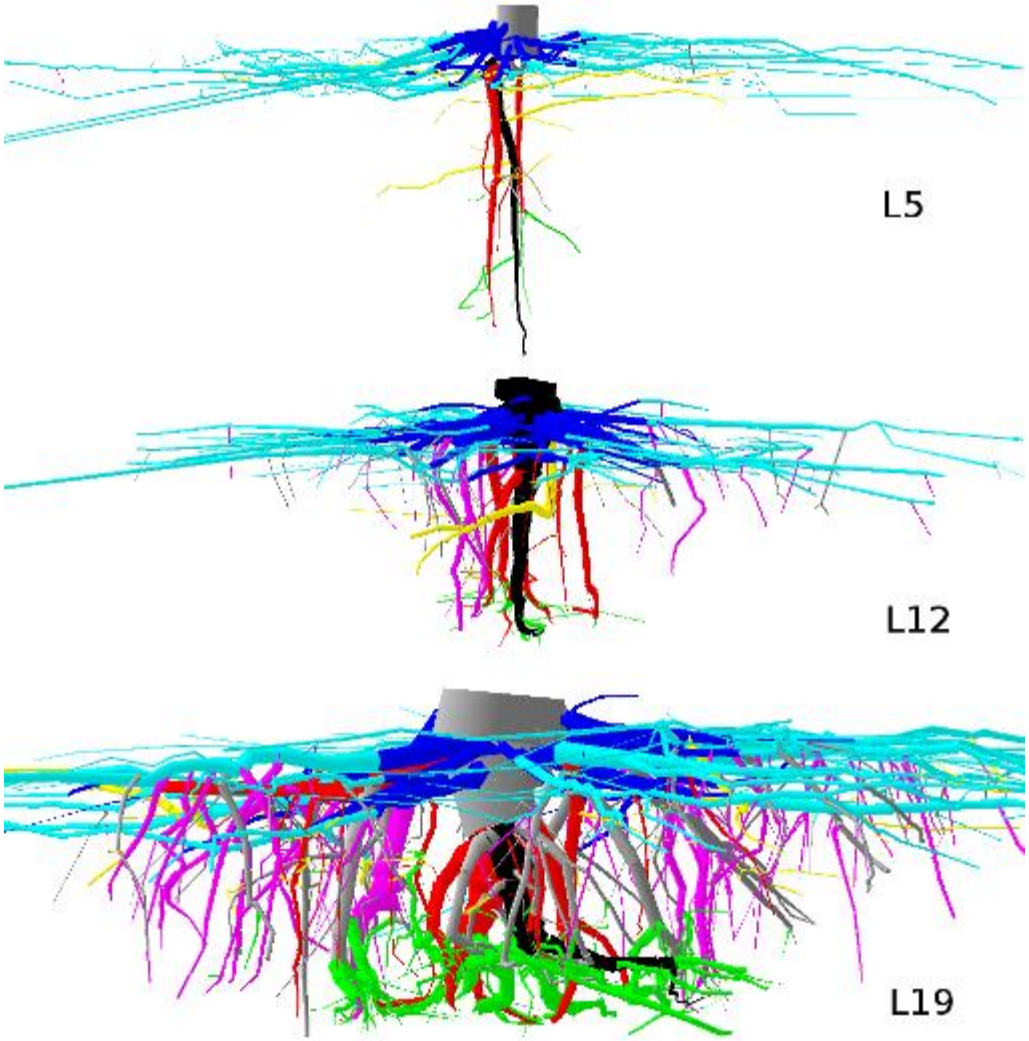


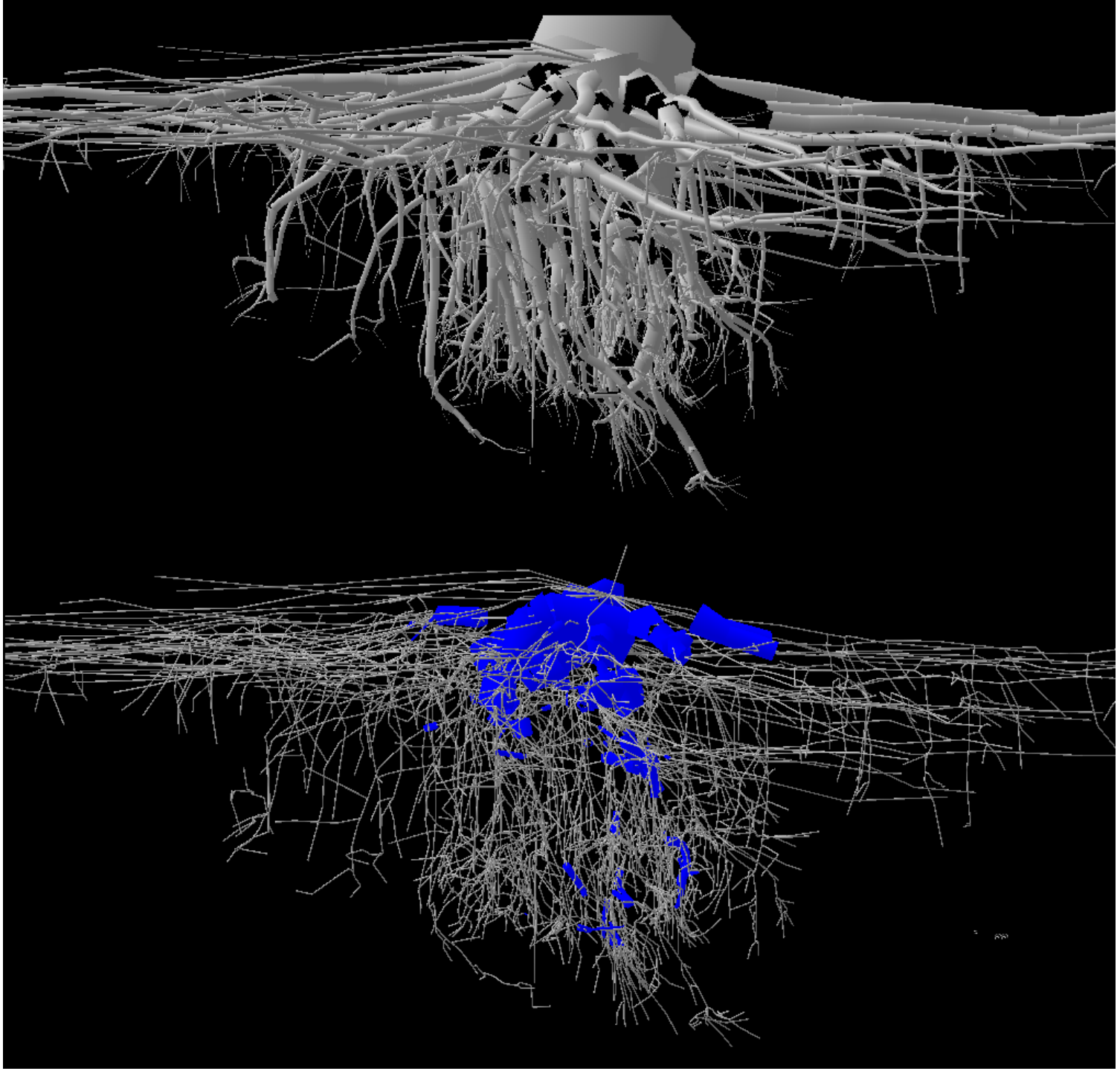


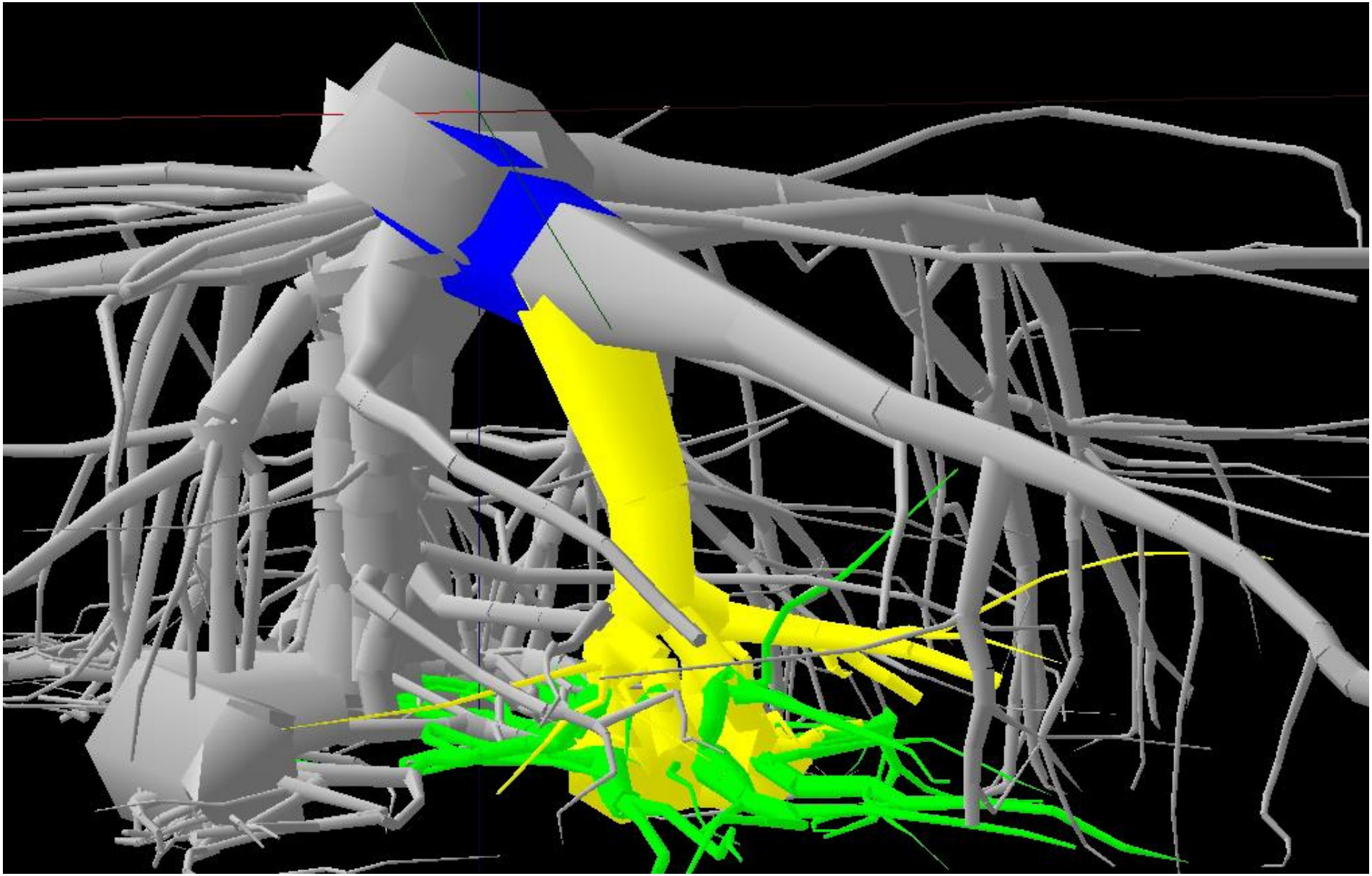
Sviluppo differito, anastomosi

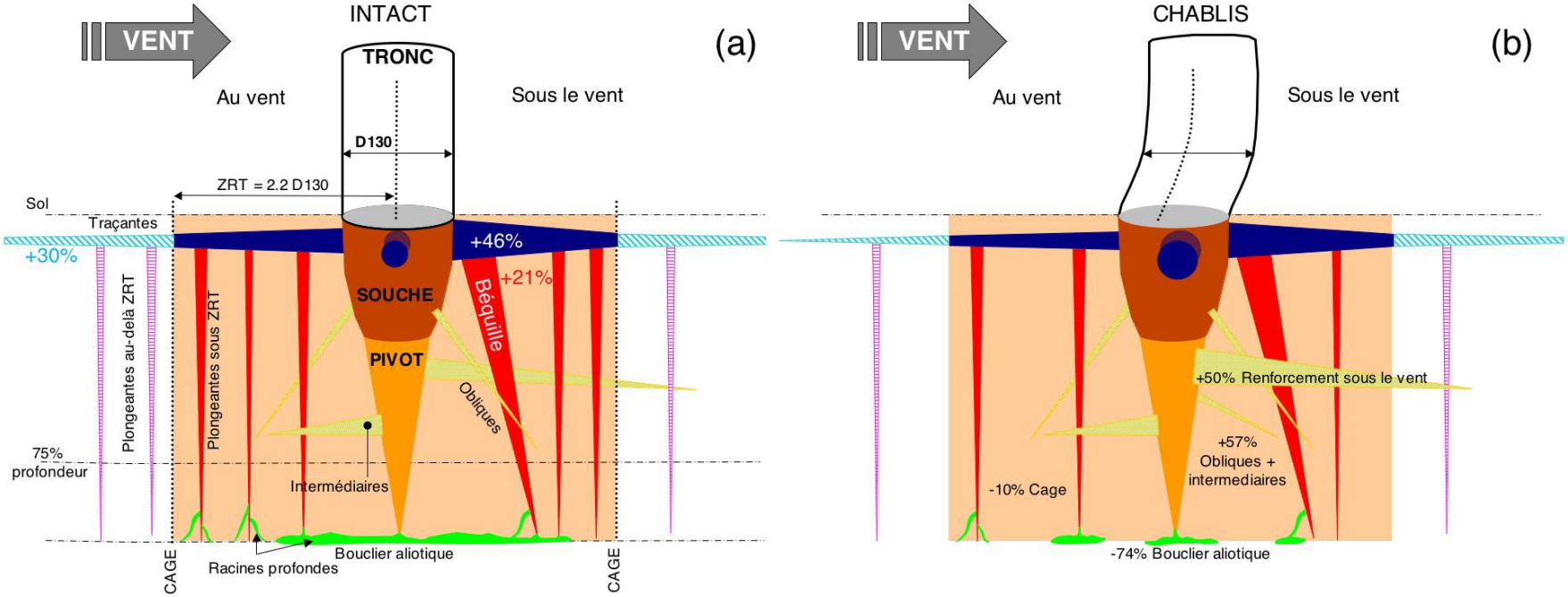


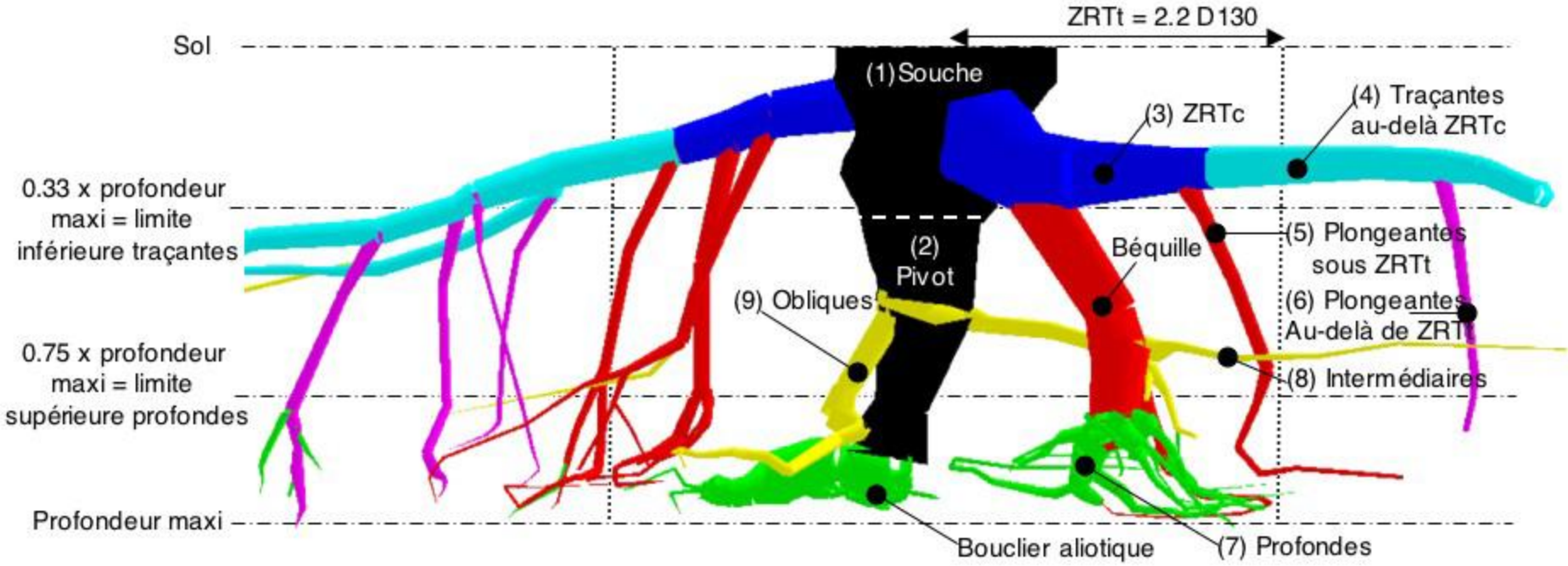
Radici: modellizazione e biomeccanica

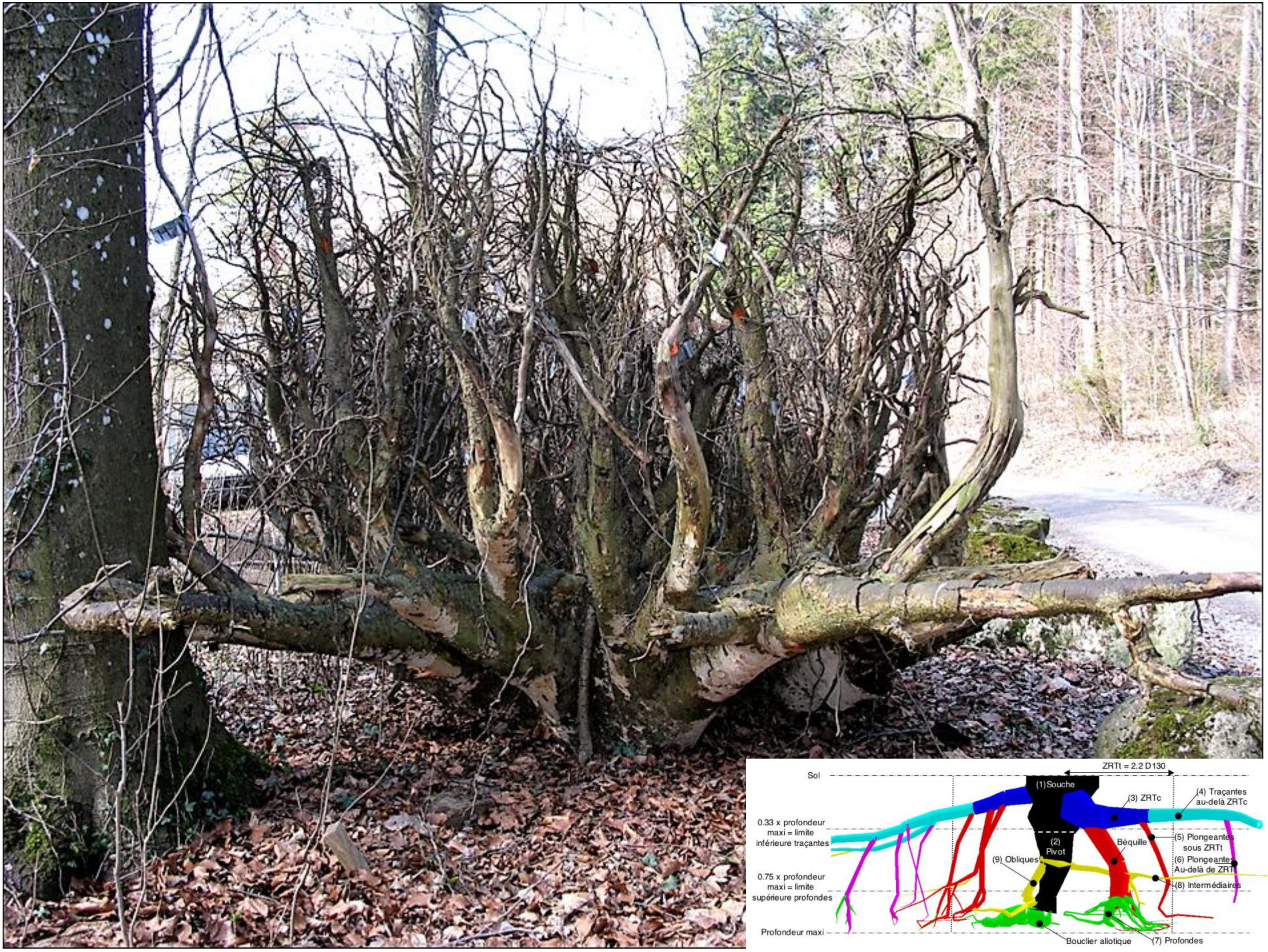

L5
L12
L19



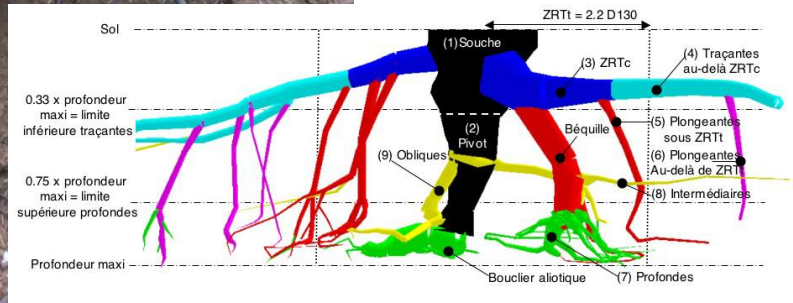


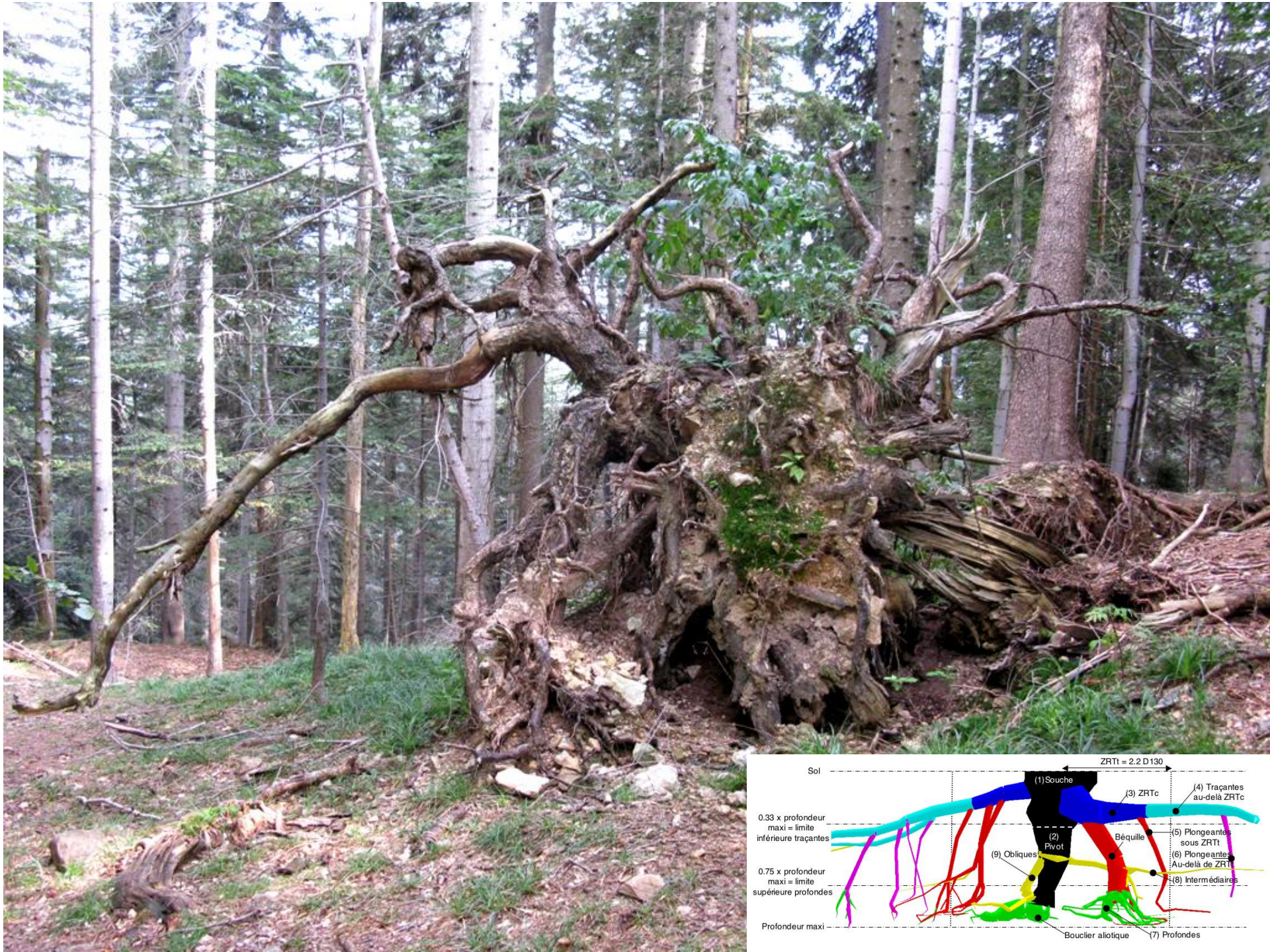

VENT
INTACT
(a)
TRONC
Au vent
Sous le vent
D130
ZRT = 2.2 D130
Sol
Traçantes
+30%
+46%
+21%
SOUCHE
Béquille
PIVOT
Obliques
Plongeantes au-delà ZRT
Plongeantes sous ZRT
75%
profondeur
Intermédiaires
CAGE
Racines profondes
Bouclier aliotique
CAGE
VENT
CHABLIS
(b)
Au vent
Sous le vent
+50% Renforcement sous le vent
+57%
Obliques +
intermediaires
-10% Cage
-74% Bouclier aliotique

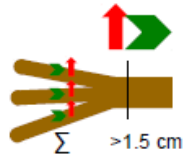

ZRTt = 2.2 D130
Sol
(1) Souche
(3) ZRTc
(4) Traçantes
au-delà ZRTc
0.33 x profondeur
maxi = limite
inférieure traçantes
(2)
Pivot
Béquille
(5) Plongeantes
sous ZRTt
(9) Obliques
(6) Plongeantes
Au-delà de ZRTt
0.75 x profondeur
maxi = limite
supérieure profondes
(8) Intermédiaires
Profondeur maxi
Bouclier aliotique
(7) Profondes


ZRTt = 2.2 D130
Sol
(1) Souche
(3) ZRTc
(4) Traçantes au-delà ZRTc
0.33 x profondeur maxi = limite inférieure traçantes
(2) Pivot
Béquille
(5) Plongeantes sous ZRTt
(6) Plongeantes Au-delà de ZRTt
(9) Obliques
0.75 x profondeur maxi = limite supérieure profondes
(8) Intermédiaires
Profondeur maxi
Bouclier aliotique
(7) Profondes

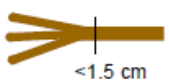

ZRTt = 2.2 D130
Sol
(1) Souche
(3) ZRTc
(4) Traçantes
au-delà ZRTc
0.33 x profondeur
maxi = limite
inférieure traçantes
(2)
Pivot
Béquille
(5) Plongeantes
sous ZRTt
(9) Obliques
(6) Plongeantes
Au-delà de ZRTt
0.75 x profondeur
maxi = limite
supérieure profondes
(8) Intermédiaires
Profondeur maxi
Bouclier aliotique
(7) Profondes


ZRTt = 2.2 D130
Sol
(1) Souche
(3) ZRTc
(4) Traçantes
au-delà ZRTc
0.33 x profondeur
maxi = limite
inférieure traçantes
(2)
Pivot
Béquille
(5) Plongeantes
sous ZRTt
(6) Plongeantes
Au-delà de ZRTt
(9) Obliques
0.75 x profondeur
maxi = limite
supérieure profondes
(8) Intermédiaires
Profondeur maxi
Bouclier aliotique
(7) Profondes


ZRTt = 2.2 D130
Sol
(1) Souche
(3) ZRTc
(4) Traçantes au-delà ZRTc
0.33 x profondeur maxi = limite inférieure traçantes
(2) Pivot
Béquille
(5) Plongeantes sous ZRTt
(9) Obliques
(6) Plongeantes Au-delà de ZRTt
0.75 x profondeur maxi = limite supérieure profondes
(8) Intermédiaires
Profondeur maxi
Bouclier aliotique
(7) Profondes

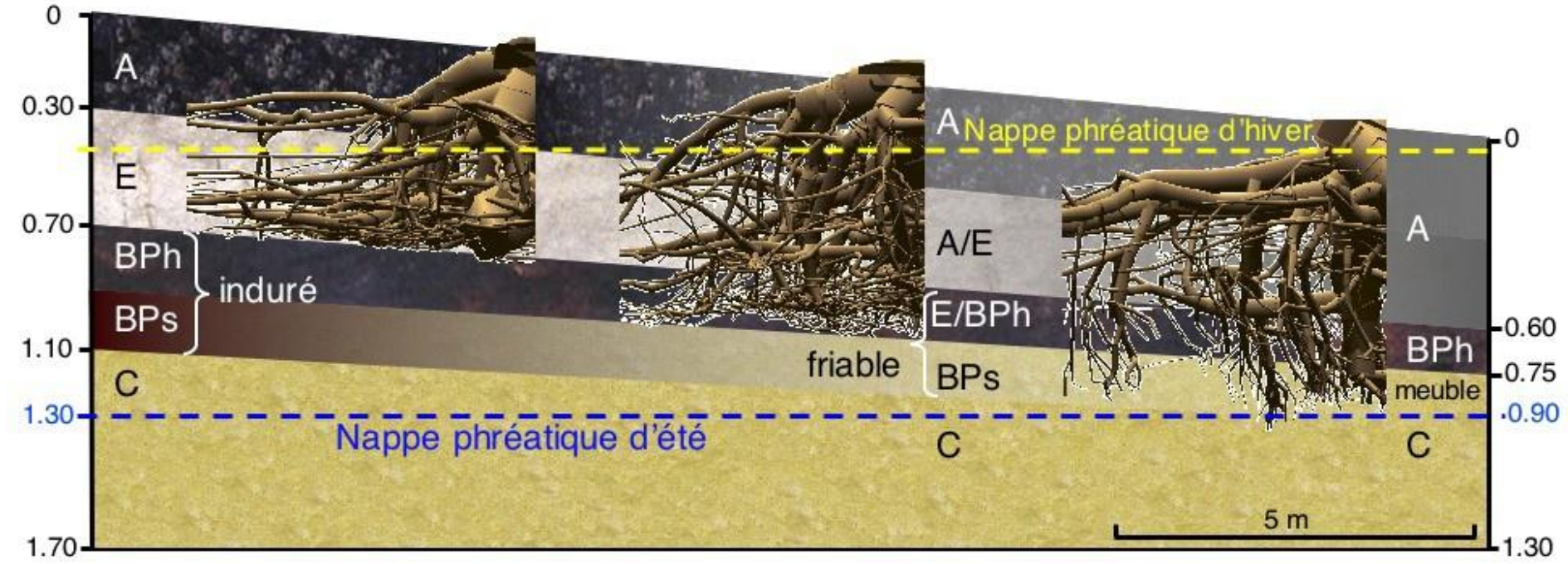


Perte de surface en section 14%
Perte de rigidité en flexion 68%



Perte de surface en section 6%
Perte de rigidité en flexion 81%

Radici e suoli




0
0.30
0.70
1.10
1.30
1.70
A
E
BPh
induré
BPs
C
Nappe phréatique d'hiver
A/E
E/BPh
friable
BPs
Nappe phréatique d'été
C
A
BPh
meuble
C
0
0.60
0.75
0.90
1.30
5 m

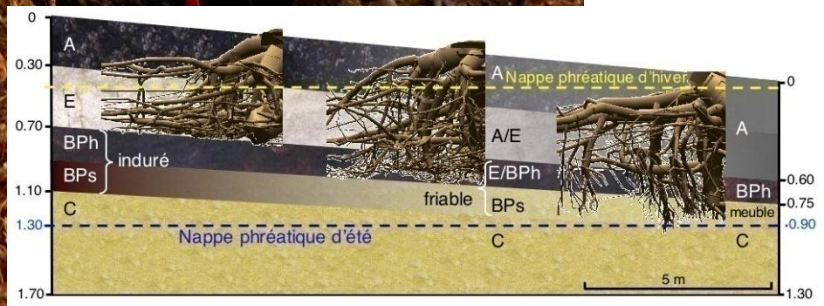

0
0.30
0.70
1.10
1.30
1.70
A
E
BPh
BPs
induré
C
friable
A
A/E
E/BPh
BPs
C
Nappe phréatique d'hiver
Nappe phréatique d'été
A
BPh
meuble
C
0
0.60
0.75
0.90
1.30
5 m


0
0.30
0.70
1.10
1.30
1.70
A
E
BPh
BPs
induré
C
friable
A/E
E/BPh
BPs
C
Nappe phréatique d'hiver
Nappe phréatique d'été
A
BPh
meuble
C
0
0.60
0.75
0.90
1.30
5 m


0
0.30
0.70
1.10
1.30
1.70
A
E
BPh
induré
BPs
C
Nappe phréatique d'été
A
Nappe phréatique d'hiver
A/E
E/BPh
friable
BPs
C
A
BPh
meuble
C
0
0.60
0.75
0.90
1.30
5 m


0
0.30
0.70
1.10
1.30
1.70
A
E
BPh
induré
BPs
C
friable
A
Nappe phréatique d'hiver
A/E
E/BPh
BPs
C
Nappe phréatique d'été
A
BPh
meuble
C
0
0.60
0.75
0.90
1.30
5 m


0
0.30
0.70
1.10
1.30
1.70
A
E
BPh
induré
BPs
C
friable
A/E
E/BPh
BPs
C
Nappe phréatique d'hiver
Nappe phréatique d'été
A
BPh
meuble
C
0
0.60
0.75
0.90
1.30
5 m


0
0.30
0.70
1.10
1.30
1.70
A
E
BPh
induré
BPs
C
Nappe phréatique d'été
A
Nappe phréatique d'hiver
A/E
E/BPh
friable
BPs
C
A
BPh
meuble
C
0
0.60
0.75
0.90
1.30
5 m


0
0.30
0.70
1.10
1.30
1.70
A
E
BPh
induré
BPs
C
Nappe phréatique d'été
A
Nappe phréatique d'hiver
A/E
E/BPh
friable
BPs
C
A
BPh
meuble
C
0
0.60
0.75
0.90
1.30
5 m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0.70
1.10
1.30
1.70
A
E
BPh
induré
BPs
C
friable
A
Nappe phréatique d'hiver
A/E
E/BPh
BPs
C
Nappe phréatique d'été
A
BPh
meuble
C
0
0.60
0.75
0.90
1.30
5 m


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0.70
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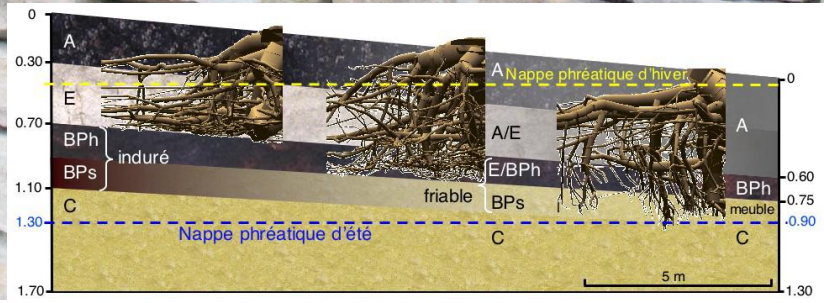
1.30
1.70
A
E
BPh
induré
BPs
C
Nappe phréatique d'hiver
Nappe phréatique d'été
A/E
E/BPh
friable
BPs
C
A
BPh
meuble
C
0
0.60
0.75
0.90
1.30
5 m


0
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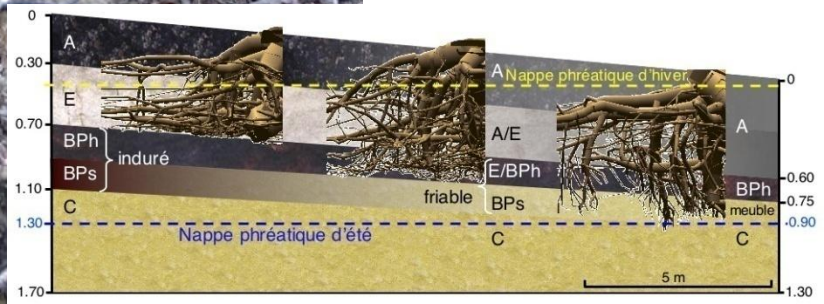
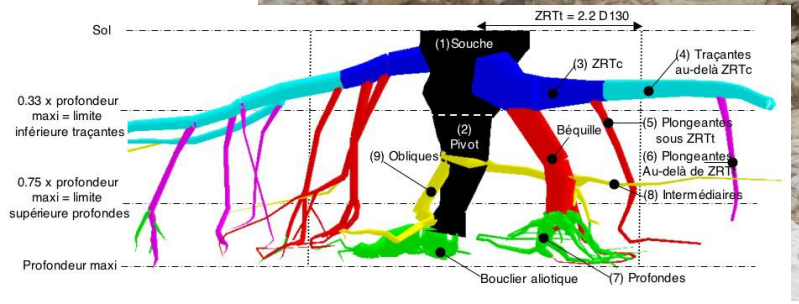
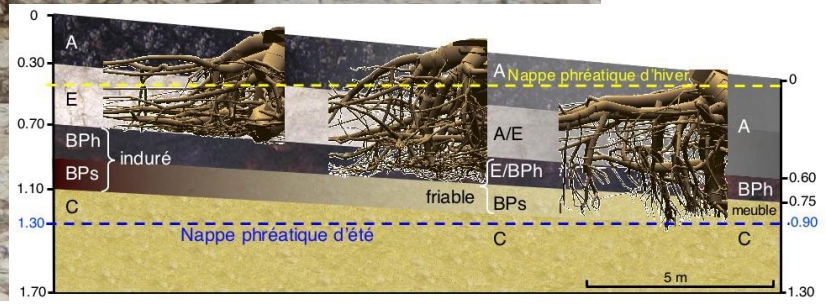
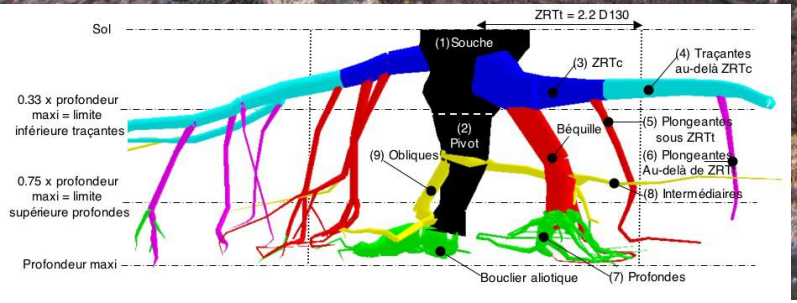
0.70
1.10
1.30
1.70
A
E
BPh
induré
BPs
C
friable
Nappe phréatique d'hiver
Nappe phréatique d'été
A/E
E/BPh
BPs
C
A
BPh
meuble
C
5 m
0
0.60
0.75
0.90
1.30

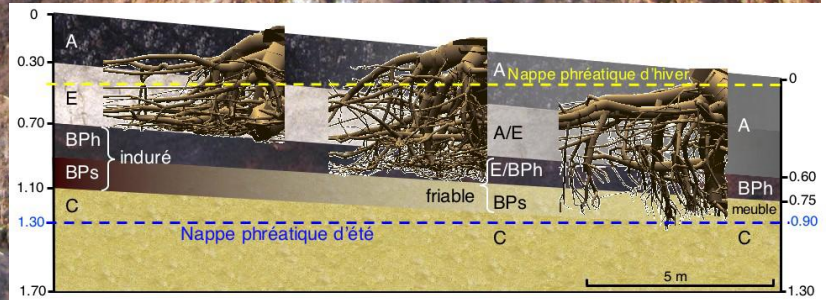

0
0.30
0.70
1.10
1.30
1.70
A
E
BPh
BPs
induré
C
Nappe phréatique d'été
A
Nappe phréatique d'hiver
A/E
E/BPh
friable
BPs
C
A
BPh
meuble
C
0
0.60
0.75
0.90
1.30
5 m

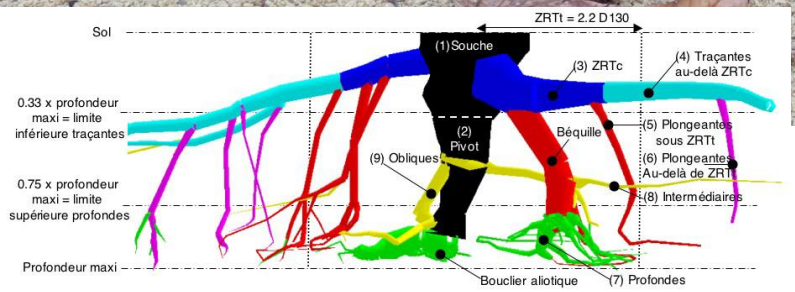
Stabilità e “supporti”

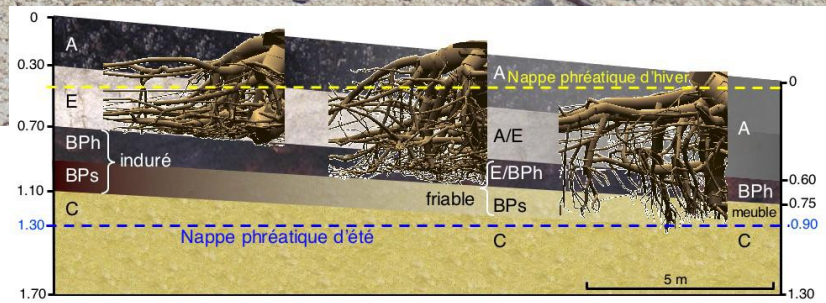


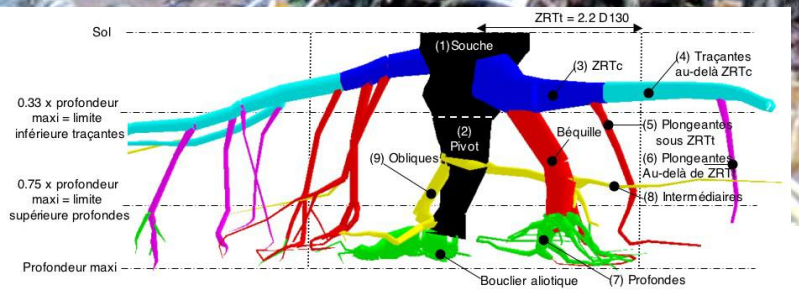


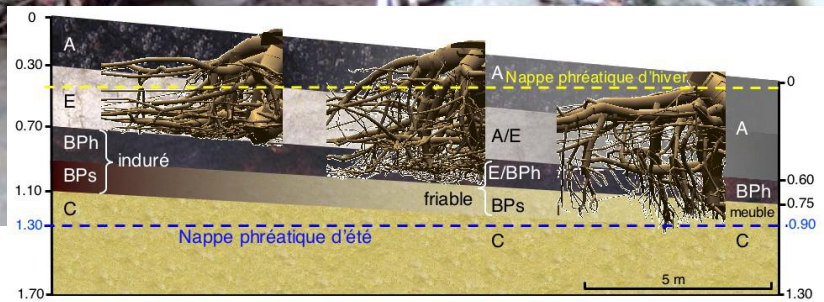

ZRTt = 2.2 D130
Sol
(1) Souche
(3) ZRTc
(4) Traçantes au-delà ZRTc
0.33 x profondeur maxi = limite inférieure traçantes
(2) Pivot
Béquille
(5) Plongeantes sous ZRTt
(9) Obliques
(6) Plongeantes Au-delà de ZRTt
(8) Intermédiaires
0.75 x profondeur maxi = limite supérieure profondes
Profondeur maxi
Bouclier aliotique
(7) Profondes


0
0.30
0.70
1.10
1.30
1.70
A
E
BPh
BPs
induré
C
friable
Nappe phréatique d'hiver
A/E
E/BPh
BPs
Nappe phréatique d'été
C
A
BPh
meuble
C
5 m
0
0.60
0.75
0.90
1.30


Sol
ZRTl = 2.2 D130
(1) Souche
(3) ZRTc
(4) Traçantes
au-delà ZRTc
0.33 x profondeur
maxi = limite
inférieure traçantes
(2)
Pivot
Béquille
(5) Plongeantes
sous ZRTt
(9) Obliques
(6) Plongeantes
Au-delà de ZRTt
0.75 x profondeur
maxi = limite
supérieure profondes
(8) Intermédiaires
Profondeur maxi
Bouclier aliotique
(7) Profondes


0
A
0.30
E
0.70
BPh
induré
BPs
1.10
C
1.30
Nappe phréatique d'été
1.70
A
Nappe phréatique d'hiver
A/E
E/BPh
friable
BPs
C
A
BPh
meuble
C
5 m
0
0.60
0.75
0.90
1.30


Sol
ZRTt = 2.2 D130
(1) Souche
(2) Pivot
(3) ZRTc
(4) Traçantes au-delà ZRTc
(5) Plongeantes sous ZRTt
(6) Plongeantes Au-delà de ZRTt
(7) Profondes
(8) Intermédiaires
(9) Obliques
Béquille
Bouclier aliotique
0.33 x profondeur maxi = limite inférieure traçantes
0.75 x profondeur maxi = limite supérieure profondes
Profondeur maxi


0
0.30
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1.10
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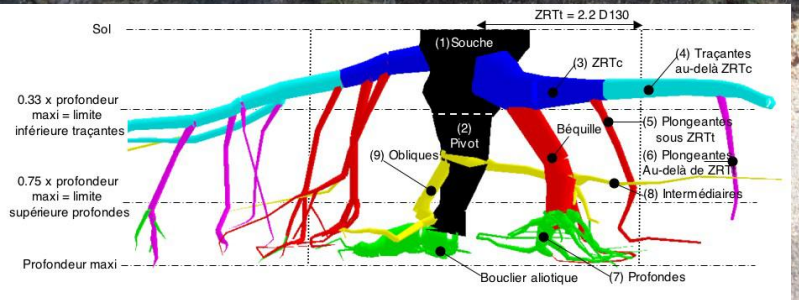
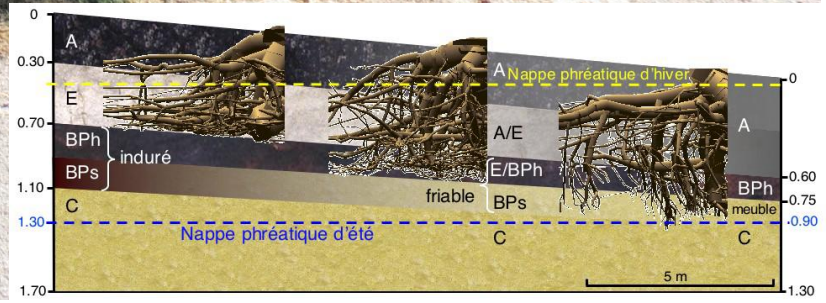
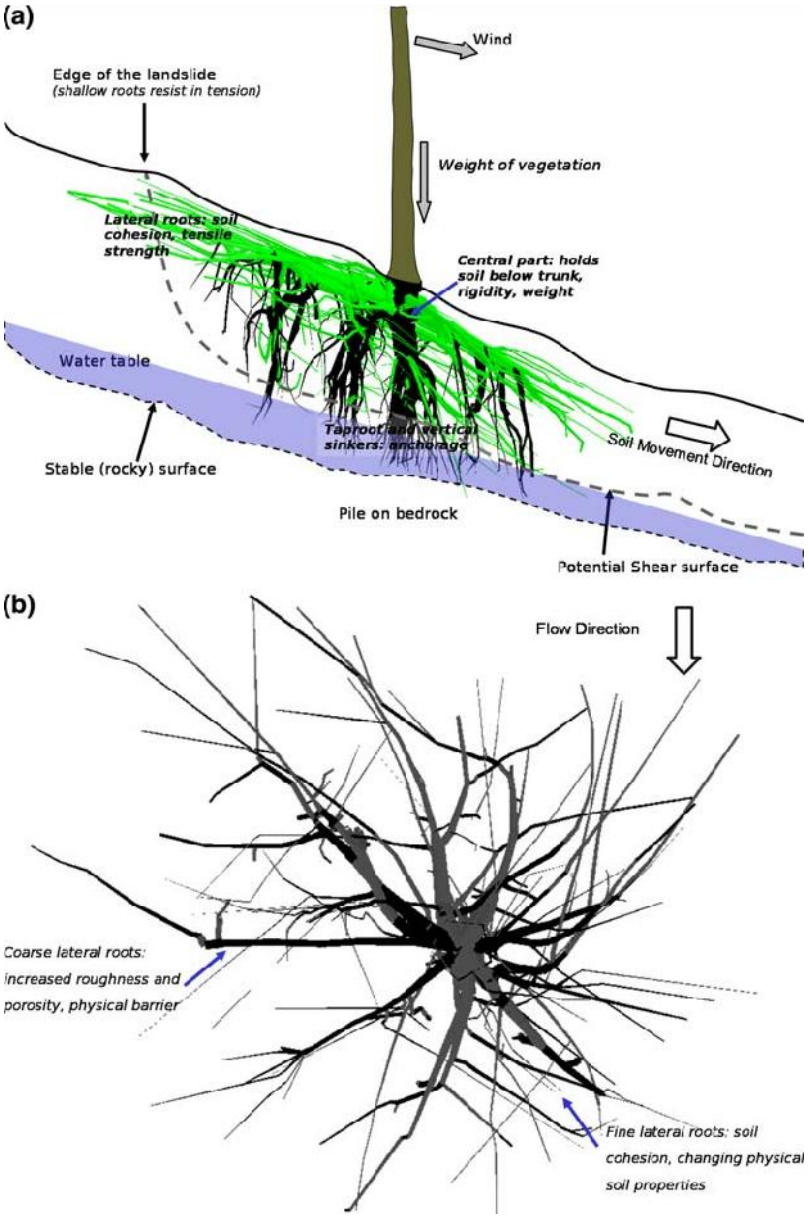
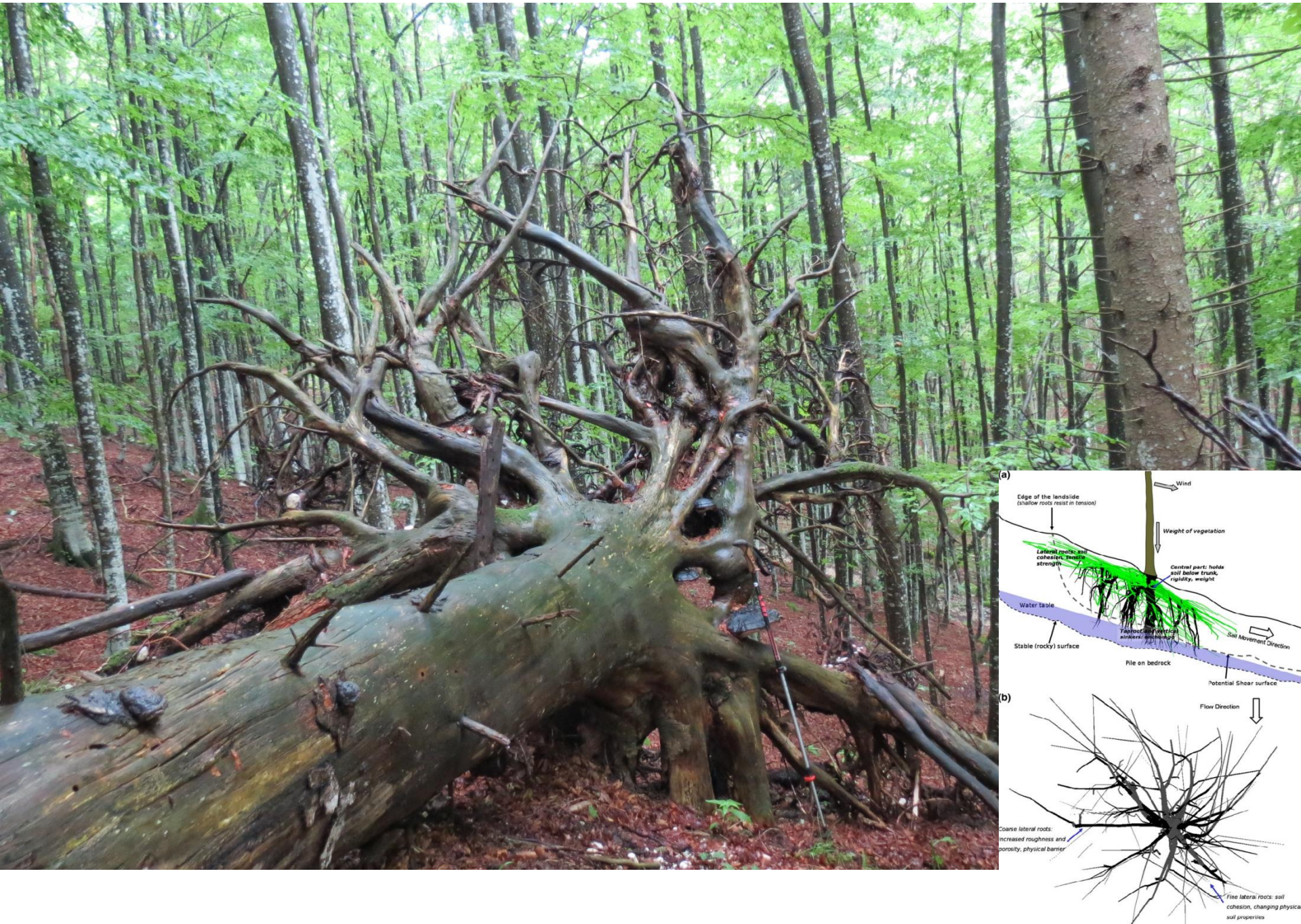
1.70
A
E
BPh
BPs
induré
C
friable
A/E
E/BPh
BPs
C
Nappe phréatique d'hiver
Nappe phréatique d'été
A
BPh
meuble
C
0
0.60
0.75
0.90
1.30
5 m


ZRTt = 2.2 D130
Sol
(1) Souche
(3) ZRTc
(4) Traçantes au-delà ZRTc
0.33 x profondeur maxi = limite inférieure traçantes
(2) Pivot
Béquille
(5) Plongeantes sous ZRTt
(9) Obliques
(6) Plongeantes Au-delà de ZRTt
(8) Intermédiaires
0.75 x profondeur maxi = limite supérieure profondes
Profondeur maxi
Bouclier aliotique
(7) Profondes


0
A
0.30
E
0.70
BPh
induré
BPs
1.10
C
1.30
Nappe phréatique d'été
1.70
Nappe phréatique d'hiver
A/E
E/BPh
friable
BPs
C
A
BPh
meuble
C
0
0.60
0.75
0.90
1.30
5 m

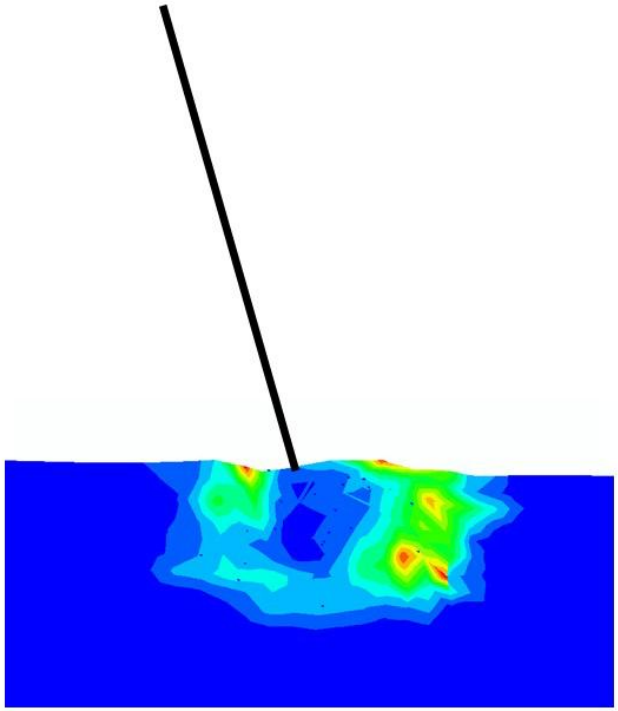
Stabilità e pendenze



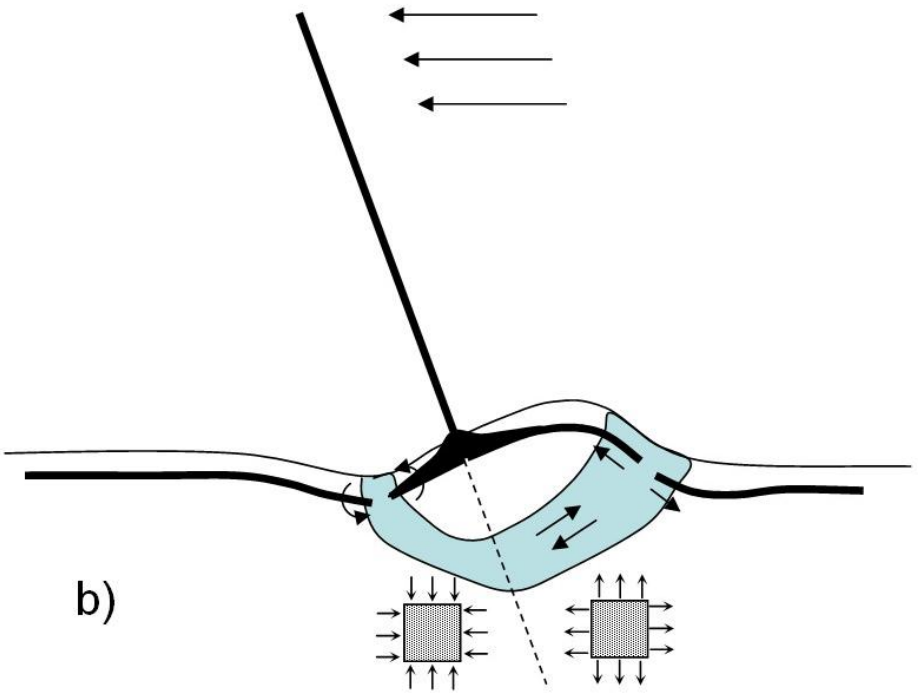

(a)
Wind
Edge of the landslide
(shallow roots resist in tension)
Weight of vegetation
Lateral roots: soil cohesion, tensile strength
Central part: holds soil below trunk, rigidity, weight
Water table
Stable (rocky) surface
Soil Movement Direction
Pile on bedrock
Potential Shear surface
(b)
Flow Direction
Coarse lateral roots: increased roughness and porosity, physical barrier
Fine lateral roots: soil cohesion, changing physical soil properties

Stabilità e suoli

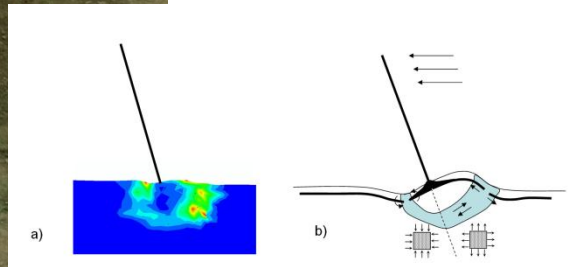
a)



b)

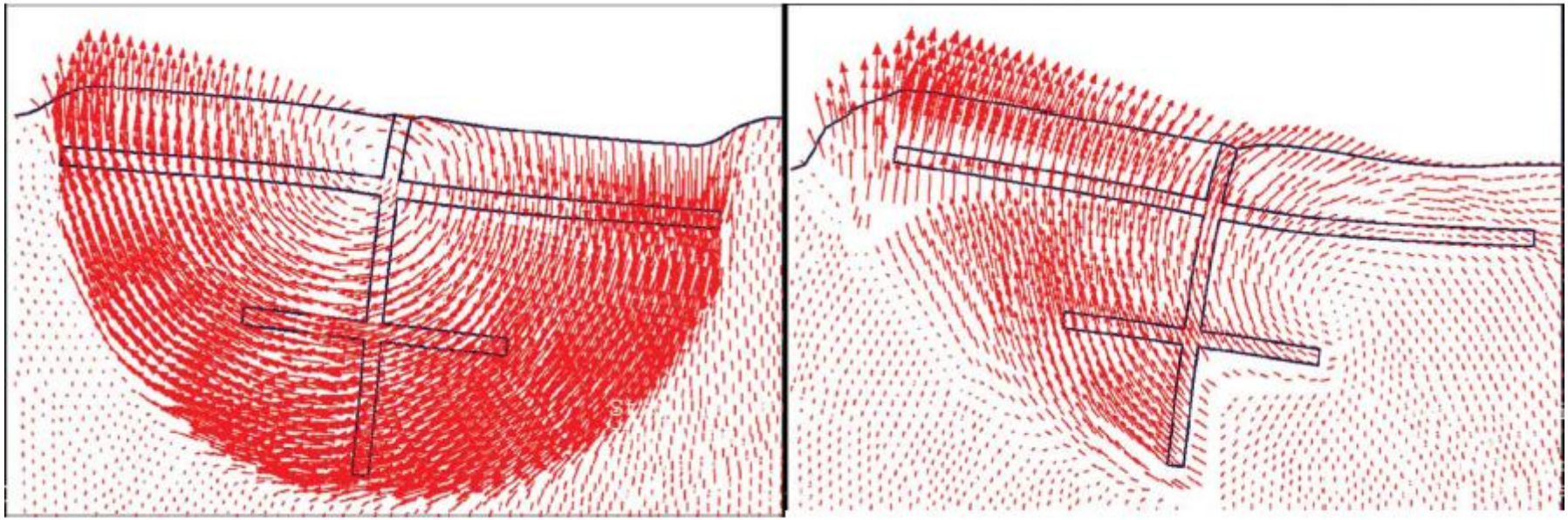



a)
b)


a)
b)

a)
b)


a)
b)

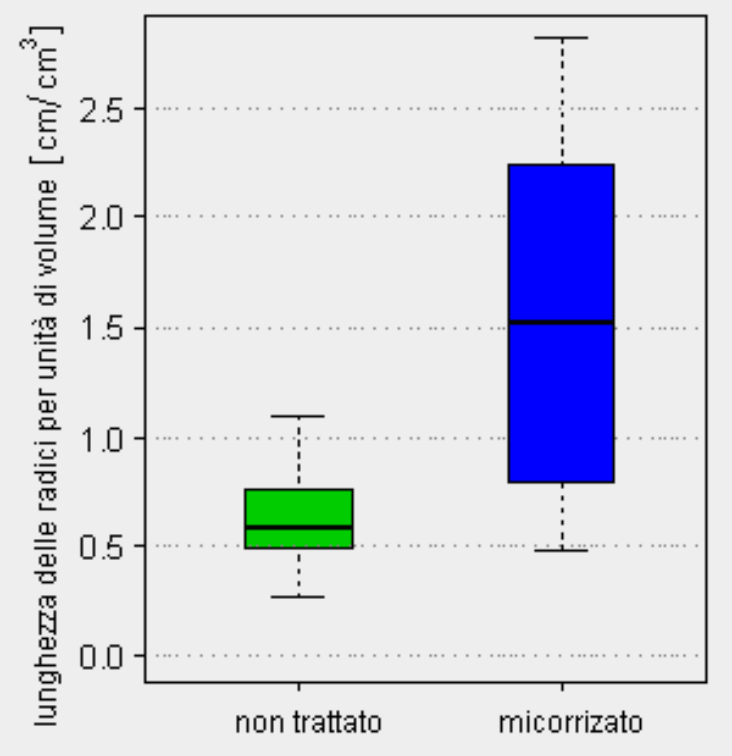


Argilla: molto plastica grande coesione

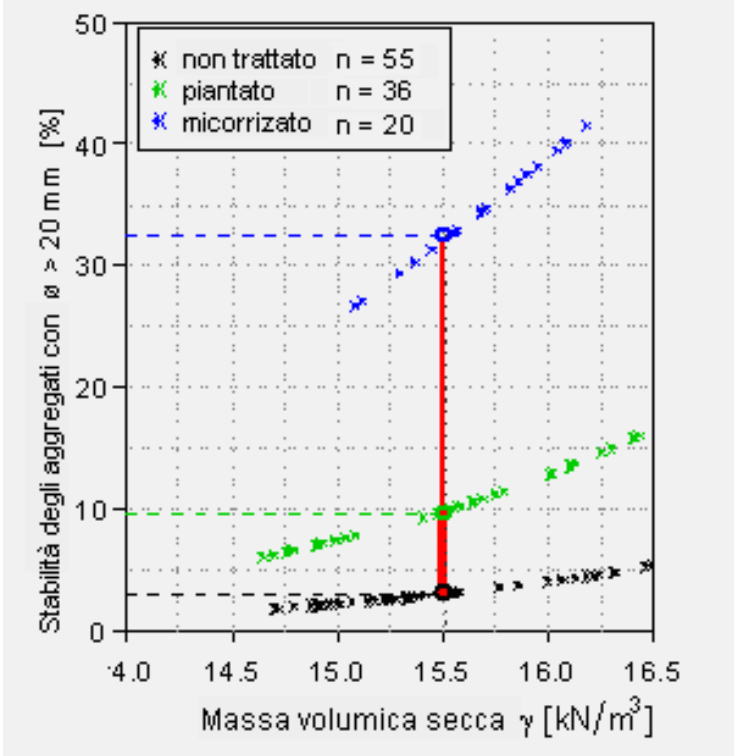
Sabbia: non plastica nessuna coesione

Benefici		*Glomus mosseae*	*Glomus aggregatum*	*Glomus intraradices*	*Glomus etunicatum*
Aumento resa	Incremento produzione	buono	buono	**eccellente**	buono
Assorbimento nutrienti	Incremento assorbimento Azoto (N) e Fosforo (P)	**eccellente**	buono	**eccellente**	medio
	Aumento attività enzimatica e assorbimento micronutrienti	**eccellente**	buono	buono	**eccellente**
	Tolleranza ad alti livelli di fertilità	buono	**eccellente**	buono	buono
Sviluppo apparato radicale	Aumento apparato radicale e attività enzimatica nel suolo	buono	buono	buono	**eccellente**
	Sanità apparato radicale	**eccellente**	buono	buono	**eccellente**
	Maggiore tolleranza alla siccità	buono	buono	**eccellente**	**eccellente**
Fisiologia della pianta	Resistenza stress da post trapianto	buono	buono	buono	**eccellente**
	Aumento fioritura e allegagione	**eccellente**	buono	buono	**eccellente**
Tolleranza della pianta	Incremento delle prestazioni in terreni sabbiosi	buono	**eccellente**	buono	buono
	Aumento tolleranza salinità	buono	buono	**eccellente**	medio
	Maggiore tolleranza all'esposizione di sostanze tossiche nel suolo	buono	buono	**eccellente**	medio

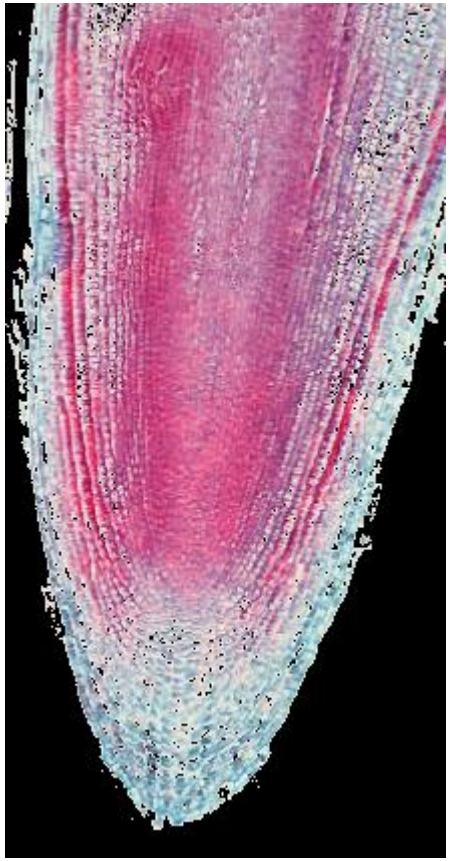
10000 specie funghi micorrize. Dal 10 al 40% dei fotosintati sono ceduti alle micorrize. La superficie assorbente di una sola specie micorriza può raggiungere i 100mq

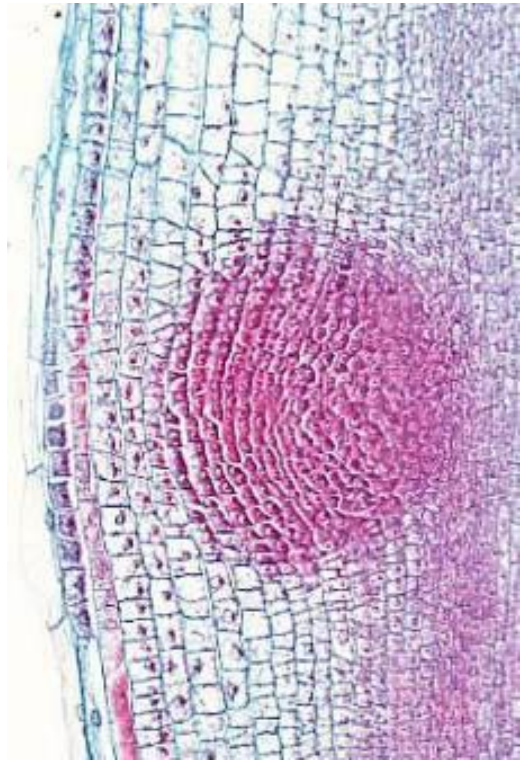


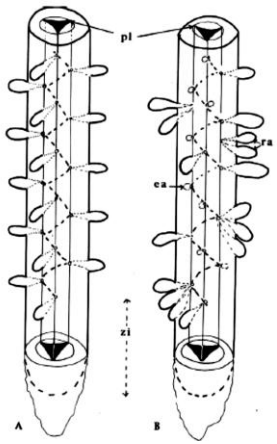
Intensità della radicazione delle piante di ontano bianco (Alnus incana) non trattate e micorrizate. Dopo un periodo di sei mesi, lo sviluppo in lunghezza delle radici delle piante micorrizate è di circa tre volte maggiore.



Stabilità di aggregazione del suolo in funzione della massa volumica secca (densità del suolo) di campioni di terreno non trattati, piantati e micorrizati. Dopo una fase di crescita di sei mesi per una densità media del suolo di 15,5 kN/m³ [=1.5 kg/dm³; n.d.T.], la proporzione della componente del terreno stabilmente aggregato (diametro maggiore a 20 mm) nei suoli micorrizati assume un valore tre volte superiore rispetto a quello dei suoli piantati ma non micorriza







Grazie